PAKISTAN

WATER AND POWER DEVELOPMENT AUTHORITY (WAPDA)

Dasu Hydropower Project

ENVIRONMENTAL AND SOCIAL ASSESSMENT

EXECUTIVE SUMMARY

Report by Independent Environment and Social Consultants

April 2014

Contents

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List of Acronyms

BCM	Billion cubic meters
CH_4	Methane
CIIA	Cumulative and Induced Impact Assessment
CITES	Convention on International Trade in Endangered Species
CO_2,	Carbon dioxide
CO_{2e},	Equivalent carbon dioxide
CSC	Construction Supervision Consultants
DB	Diamer-Basha Hydropower Project
DCO	District Coordinating Officer
DHC	Dasu Hydropower Consultants
DHP	Dasu Hydropower Project
EARF	Environmental Assessment and Review Framework
ECP	Environmental Code of Practices
EHS	Environment, Health, and Safety
EIA	Environmental Impact Assessment

EMP	Environmental Management Plan
EPA	Environmental Protection Agency
ESA	Environmental and Social Assessment
ESMP	Environmental and Social Management Plan
EU	Environment Unit
Fsl	Full supply level
GDP	Gross domestic product
GHG	Greenhouse gas
GIS	Geographic Information System
GLOF	Glacial lake outburst flood
GoP	Government of Pakistan
GWh	Gigawatt hour
Ha	Hectare
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
IBWS	Indus Basin Water System
ICOLD	International Commission on Large Dams
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
KKH	Karakoram Highway
Km	Kilometer
KP	Khyber Pakhtunkhwa
kV	Kilovolt
kWh	Kilowatt hour
LLO	Low-Level Outlet
LPG	Liquid petroleum gas
MAF	Million acre feet
Masl	Meters above sea level
M&E	Monitoring and Evaluation
MW	Megawatt
NEQS	National Environmental Quality Standards
NGO	Non Governmental Organization
NO	Nitrogen oxide
N_2O	Nitrous oxide
NTDC	National Transmission and Dispatch Company
OP	Operational Policy
Pak-EPA	Pakistan Environmental Protection Agency
PCR	Physical Cultural Resources
PEPA	Pakistan Environmental Protection Act
PKR	Pakistani Rupees
PM	Particulate matter
PMU	Project Management Unit
PRA	Participatory rural appraisal
RAP	Resettlement Action Plan
RCC	Roller compacted concrete
SRMP	Social and Resettlement Management Plan
SRU	Social and Resettlement Unit
SSESA	Strategic Sectoral Environmental and Social Assessment
ToR	Terms of Reference
UIB	Upper Indus Basin
WAPDA	Water and Power Development Authority
WBG	World Bank Group
WCAP	Water Sector Capacity Building and Advisory Services Project
WEC	WAPDA Environmental Cell
WWF	World Wildlife Fund

1. Introduction

The Dasu Hydropower Project (DHP) is a major investment project proposed by the Government of Pakistan (GoP) to modernize and expand the energy sector of the country, while shifting from thermal generated electricity to clean, low cost and high reward generation of hydropower. The project is situated in remote mountainous terrain in the Upper Indus valley in the district of Kohistan, Khyber Pakhtunkhwa (KP) province in the north of Pakistan. The DHP has three major components: (a) the main dam, powerhouse and its ancillaries, residential complex, and allied facilities; (b) realignment of a stretch of about 65 km of the Karakoram Highway (KKH); and (c) transmission lines for power evacuation from the powerhouse. Since the detailed designs for (a) and (b) above have been completed, a comprehensive Environmental and Social Assessment (ESA) has been carried out and presented in a main ESA report. The planning and design of the alignment and towers for (c) above have not been finalized yet. Therefore an Environmental Assessment and Review Framework (EARF) has been prepared as a standalone document, which provides guidance on the subsequent detailed environmental and social impact assessment that will be undertaken when the detailed design of the transmission line is prepared. This Executive Summary presents the potential environmental and social impacts of the DHP project as described in the ESA and EARF. Mitigation measures are described and included in relevant environmental and social management plans 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 energy crisis which is primarily caused by an increasing gap between insufficient supply and a growing demand. The demand for power in the country is still relatively low compared with more industrialized countries. Nevertheless, electricity use over the decade between 2001 and 2011 grew an estimated 7.6 percent per year. Supply increased in the same period only 3.5 percent per year, resulting in a shortfall of over 7,700 MW in 2011. If production is not accelerated, the gap between demand and supply is expected to increase to over 17,000 MW by 2029.

The Vision 2025 Program of WAPDA: In order to increase hydropower generation capacity while maintaining water supply to the Indus irrigation system, the Water and Power Development Authority (WAPDA) prepared its "Vision 2025" program. The proposed DHP is an integral part of this program and the Power Policy 2013 of the GoP. The objectives of the Power Policy 2013 are to improve electric power generation capacity, revive the country's economy by injecting cheap hydropower energy, and meet the future needs of the Indus Basin irrigation system.

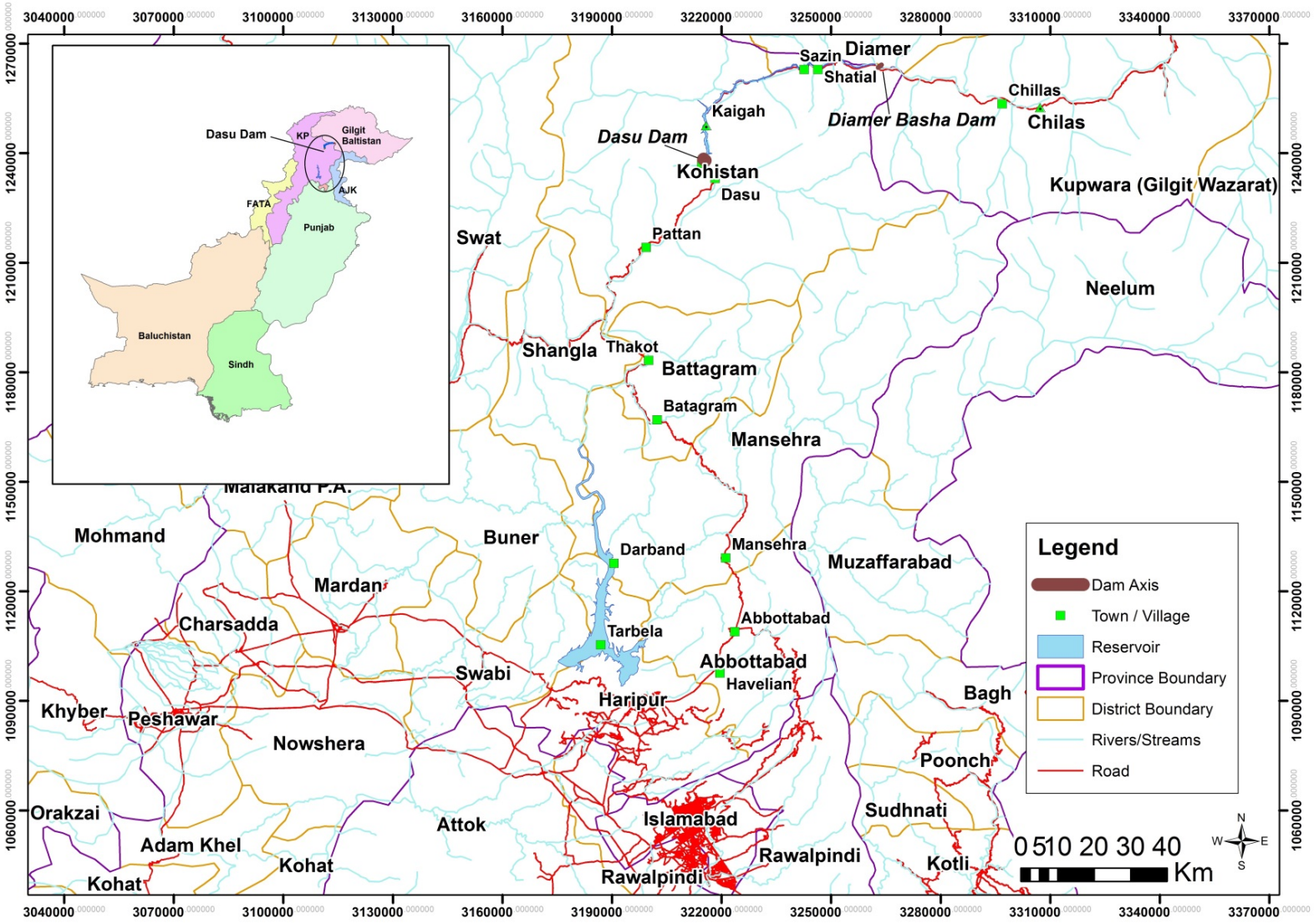
1.2. The Proposed Project

A feasibility study for the DHP was carried out in 2009 to identify the project location and to prepare preliminary engineering designs, cost estimates and a preliminary EIA. The detailed design has been prepared by an international consortium of consultants, the Dasu Hydropower Consultants (DHC). Financial assistance for the study and design was provided by the World Bank under the Water Sector Capacity Building and Advisory Services Project (WCAP).

Location: The DHP is located on the Indus River at a site about 7 km upstream of Dasu Bridge near the small town of Dasu, the capital of Kohistan District in KP province (see **Figure 1**). At this site the Indus River flows in a deep and narrow valley (about 750-800 meters above sea level, masl) of the lower Himalayas, which have an average altitude of 2,000 to 4,000 m. The project area is accessible through the KKH, which is the only road between Islamabad (350 km away) and the north of Pakistan and China (Kashgar). About 74 km further upstream along the Indus another structure under the "Vision 2025" program is planned: the Diamer-Basha (DB) Dam.

Main structure and powerhouse: The DHP includes the construction of a 242 m high concrete dam in the gorge like valley. Behind the main structure there will be a reservoir about 73 km long (at full supply the level will be 950 masl) with an average width of 365 m and a total surface of about 24 km². The DHP also includes an underground powerhouse, housing 12 turbines, each producing 360 MW of power. The total maximum generation capacity will be 4,320 MW. At completion, the DHP is estimated to generate about 21,500 GWh of energy per year, significantly alleviating the shortage of electricity in the country.

Figure 1: Location of DHP in Pakistan



KKH, access roads, and power supply: Apart from the hydraulic and electrical infrastructure needed, the project includes realignment of about 62 km of the KKH at a higher level (above the reservoir), since the current alignment will be submerged, including the construction of eight new bridges. About 12 km of access road from Dasu-Komila town to the dam site is planned, together with about 23 km of new access roads along the right bank, about 18 km of minor roads and tracks, and one suspension bridge crossing the Indus at Kandia. Also included in the project is the construction of a 132 kV transmission line between Dasu and Dubair grid station, located some 45 km downstream of the project site. The line will provide the project and the residential colony with electricity during the years of construction and is included in the present ESA.

Transmission lines: Two 500 kV transmission lines, each 250 km, will be built to connect the Dasu plant with the main power distribution network at Pathar Garh near Hassanabdal (District Attock). The construction of the long distance transmission lines will be implemented by the National Transmission and Dispatch Company (NTDC). The EARF for this component has been prepared. It includes a socio-economic survey and an impact screening in the area, and a description of consultations held with the communities. A detailed Environmental and Social Assessment (ESA) for the lines will be carried out in 2014-2015, in accordance with the Bank's safeguard policies.

Phasing of the project: The project will be implemented in two stages. Stage 1 (2015-2022) will include the construction of the main hydraulic structures and the installation of six of the planned twelve turbines. Stage 2, which includes the installation of the six remaining turbines, will start after construction of the DB project and is estimated to take four years to complete.

1.3. The Environmental and Social Assessment

Studies and basic data: The ESA is based on field studies and data collected between 2011 and 2013 by the DHC team charged with the design of the project. A team of independent consultants was hired in parallel by WAPDA, to provide input into the baseline and impact assessment work of the design team, supplement their analysis as needed, and assemble the present ESA report in line with World Bank standards. During their review of the environmental and social reports (May 2012–November 2013) the independent consultants developed a common approach with DHC in estimating and interpreting the potential impacts of the project and possible mitigation measures. The continuous feedback proved to be very useful. The role and scope of work of the independent consultants is described further in section 1.4 below.

Contents of the present document: After a description of the Pakistani legal and administrative framework and the applicable World Bank policies in chapter 2, a project description is presented in chapter 3, followed by a discussion of project alternatives in chapter 4. A description of the physical, biological and socio-economic environment is given in chapter 5. In chapter 6 several relevant issues such as risks of earthquakes, landslides and flooding are discussed, including the effects of climate change. Potential adverse effects of the DHP are described in chapter 7 of the ESA report. Potential cumulative impacts and concerns associated with other hydropower developments in the Upper Indus Basin (UIB) are presented in chapter 8. Possible mitigating measures to offset, reduce or compensate potential negative impacts of the project are included in the Environmental and Social Management Plan (ESMP) that is summarized in chapter 9; these measures are presented in more detail in the accompanying ESA and Social and Resettlement Management Plan (SRMP) volumes. Chapter 9 includes a description of the institutional aspects and responsibilities in the project. Finally, chapter 10 provides an overview of all stakeholder consultations and activities for disclosure and access to information.

1.4. Composition of Study Team

Independent consultants: WAPDA engaged a team of independent consultants - Reitse Koopmans, Mohammad Omar Khalid and Hans van Zon – to assess the environmental and social impacts of the project, and to prepare the main ESA report and this Executive Summary. The independent consultants commenced working shortly after the start of project design (August 2011) and they were authorized to recruit/access professional expertise as required to carry out the independent ESA. During the ESA process, the independent consultants regularly interacted with the DHC's design team, provided technical advice and recommendations, carried out their own field visits, participated in consultations, and conducted their independent analysis and impact assessment.

Social study team (DHC): The national members of the social and resettlement team included Maqsood Ahmed, Ramzan Chaudhary, Awais Hassan Khan (Resettlement Specialists); Anwar Fazal Ahmed, Arslan Tariq (Sociologists); Saima Raoof and Ujala Saleem (Gender Specialists); Rana Muhammad Saleem (Consultation Specialist); Ahmed Saleem (Communications Specialist); Noorul Hadi (Livelihood Specialist);

and Ilyas Qureshi (Public Health Specialist). The international experts included Mohammad Zaman, Sunil Gonnetilleke and Haimin Wang (Resettlement Specialists); Iffat Idris (Social/Conflict Analyst); and Bernhard Eder (Public Health Specialist).

Environmental study team (DHC): The national environmental team members included Zafar Iqbal Chaudry and Mudassar Hassan (Environmental Specialists), William George and Tahir Omer (Fish Experts), Sajid Nadeem (Wildlife Expert), Rehmatulla Qureshi (Vegetation Expert), Ihsan H. Nadiem and Irshad Ahmad Soomro (PCR Specialists), Allah Bakhsh Sufi (CIIA Specialist) and Noman Saeed (GIS Specialist). The international team members included Venkata Nukala (Lead Environmental Specialist), Malcolm Winsby (Aquatic Ecologist), Kashif Sheikh (Terrestrial Ecologist) and Masud Karim (Environmental Specialist-Climate Change).

International Panel of Experts: WAPDA has also engaged an international panel of experts (IPOE) consisting of renowned specialists including Erik Helland-Hansen from Norway (Environmental Expert) and Shi Guoqing from China (Social Expert). These experts together with experts from various other disciplines have reviewed the design of the project including the environmental and social aspects. They participated in three missions to Pakistan, had discussions with design consultants and WAPDA, made site visits, reviewed the ESA reports and provided their respective comments, which have been addressed while preparing the present reports.

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.

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);
- 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;
- KP Wildlife Protection, Preservation, Conservation and Management Act (1975) protects the province's wildlife resources directly and other natural resources indirectly. The act is particularly relevant for the Kaigah private game reserve (5000 ha, community managed);
- 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 DHP will generate 4,320 MW, therefore an EIA for this project is mandatory.

EIA Approval: The owner of the project, i.e., WAPDA, submitted a preliminary EIA to the provincial environmental authority, KP-EPA, during the feasibility studies of the main components of the project (e.g., the dam, hydropower plant, and ancillaries) as well as the KKH realignment. A formal approval of this report was

received by WAPDA from the KP EPA on 23 November 2011. This approval is valid for three years and is extendable for periods of three years. On the basis of the detailed design WAPDA submitted in December 2013 the present detailed ESA report to KP-EPA. With respect to the 500 kV transmission lines, a separate EIA approval of the Provincial EPAs (of KP and Punjab) will be required. NTDC will be responsible for obtaining this approval once the full environmental assessment of the transmission lines is carried out.

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 environmental screening "Category A" projects proposed for Bank financing, in order to ensure that these projects are environmentally and socially sound and sustainable. All three main project components: (a) the DHP project; (b) the reconstruction of KKH; and (c) the construction of long-distance transmission lines have been placed in "Category A". This is because of the scope and size of the project, which involves large-scale construction activities on an untamed part of one of the largest rivers of the world, the Indus, with the potential to affect the safety and livelihood of the population living downstream and to block the main road connection to the north and to China, the KKH. The environmental issues that need to be addressed are relevant during both construction and operation. In accordance with the requirements of Operational Policy (OP) 4.01, environmental and social assessment has been carried out and ESMP prepared for two of the project components to mitigate or minimize all potential adverse environmental and social impacts; the assessment of the third component will be undertaken when design commences.

Natural Habitat (OP 4.04): With the exception of one community-managed wildlife conservation area situated at Kaigah, there are no protected areas, wildlife sanctuaries or critical habitats in or near to the project area (excluding the area of influence of the 500 kV transmission lines, which are discussed separately in the EARF). Some infringements on this reserve are expected due to road construction, reservoir inundation and quarrying activities. DHP moreover will change the fast flowing uncontrolled and sediment laden river Indus and the lower part of the valley slopes into a slow flowing narrow (300-400 m wide) and deep reservoir (150-200 m), which extends for about 73 km upstream. The construction of the dam will create a lacustrine and wetland environment in the reservoir area and impair the connectivity of the river by creating a barrier for the free movement of aquatic biota. Additional terrestrial natural habitat outside the Kaigah conservation area will also be affected, both directly (e.g., by inundation from the reservoir) and indirectly (e.g., as a result of increased pressure on natural resources in highland forests and other habitats as a result of resettlement and in-migration). Offset measures are proposed in the ESA to compensate the loss of natural habitat through development of ecological conservation areas and implementation of afforestation and forest rejuvenation programs.

Involuntary Resettlement (OP 4.12): For the development of project infrastructure, reservoir area and realignment of KKH, an estimated 4,643 ha of land has to be acquired by WAPDA. This will result in the relocation of some 34 hamlets/small villages affecting some 767 households or 6,953 persons. An SRMP has been prepared to guide the planning and implementation of compensatory measures, resettlement and restoration of livelihood in line with relevant Pakistani laws and OP 4.12.

Forestry (OP 4.36): The policy recognizes the need to reduce deforestation and promote sustainable forest conservation and management in reducing poverty. Pakistan has forests covering only 2.0 percent of its territory, although northern Pakistan has 29 percent forest cover. These forests will not be directly be affected by the project. However after resettlement of the population further up the valley, the pressure on high altitude forests will increase due to increased agriculture and grazing activities, firewood collection and illegal logging. Degradation of forest resources and wildlife will increase. Afforestation and forest rejuvenation programs are proposed as part of ESA, as mentioned earlier, to address the potentially increased pressure on the local forests.

Safety of Dams (OP 4.37): The dam safety policy is applicable since the works include the construction of a high dam, with associated infrastructure, located in a mountainous area upstream of a populated valley further downstream. Most of the water of the Indus River originates from glacier and snow melt in the UIB. The structure is designed to withstand maximum floods that may be caused by glacial lake outbursts. The establishment of a Glacier Monitoring and Research Center that will support WAPDA's Planning Unit for monitoring and research in the UIB will be part of the project. Regular inspections together with instrumentation and monitoring will be included in a separate component of the project, as well as the monitoring of the movement of sediment, and the establishment of a flood early warning system. The IPOE has reviewed the design and operational and maintenance aspects of the project, particularly the safety and early warning systems, and has found all aspects to be compliant with the policy.

International Waterways (OP 7.50): The project is located on the Indus River, which is an international waterway shared by India and Pakistan. Therefore OP 7.50 is applicable and hence the project will require a riparian notification consistent with the policy.

Physical Cultural Resources (OP/BP 4.11): The ESA study has shown that there are several important physical and cultural resources in the area including two valuable and beautifully decorated 400 year old mosques and an extensive field of ancient rock carvings dating from Stone Age to Buddhist periods. These sites should be protected. Since the narrow Indus valley has been the only connection between the Indian subcontinent and China since pre-historic times the possibility of unexpected "chance finds" in the project area is high. Therefore procedures dealing with "chance finds" are to be included in the bidding documents for the construction contracts.

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

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

Environmental Health and Safety Guidelines: The World Bank Group Environment, Health, and Safety (WBG EHS) Guidelines (1997) contain performance levels and measures for development of industrial projects that are considered to be achievable in new facilities at reasonable costs by existing technology.

Gender Policy (OP/BP 4.20): The World Bank's Gender Policy aims to reduce gender disparities and enhance women's participation in the economic development of member countries. During the ESA, gender aspects have been considered and women's participation has been ensured as far as possible while carrying out the stakeholder consultations. These aspects have been included in the Gender Action Plan and the Income and Livelihood Restoration Program (ILRP) prepared as part of the SRMP.

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

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

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

2.4. Compliance Status with Pakistani Legislation and World Bank Policies

The present compliance status of the project (excluding the 500 kV transmission line component) with Pakistani legislation and World Bank safeguard policies is indicated in **Table 1** below.

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

	Legislation/Policy	Actions Taken to Comply
GoP	Pakistan Environmental Protection Act, 1997	WAPDA received a No Objection Certificate for the project from KP-EPA on 23 November 2011 based on the EIA prepared during the feasibility studies. No further approval is required from KP-EPA. Nonetheless, WAPDA submitted the ESA reports to KP-EPA in December 2013.
	EIA Guidelines for Power Projects	The updated ESA is prepared and will be submitted to KP-EPA for review.
	International treaties	Verification of protected sites, Red List and protection of vulnerable habitats.
	Public information and disclosure	Public information centers will be established at Dasu on both river banks. The Executive Summary of the ESA and the Resettlement Action Plan (RAP) have been translated to Urdu and are available at the WAPDA office in Dasu, along with other project information. The draft ESA report has been disclosed on WAPDA's website. Final round of consultations has been held by DHP with the affected community and other stakeholders in Dasu, Islamabad and Peshawar.

	Legislation/Policy	Actions Taken to Comply
World Bank	Early screening and Scoping	Scoping sessions were held through consultative workshops at Peshawar, Lahore, Karachi and Islamabad; and consultations at the affected villages.
	Participatory approach	Workshops, consultation meetings and focus group discussions were held.
	Integrate EA and SA	Natural environment, human health, social aspects, PCR are integrated in planning documents.
	Natural Habitats	Verification of protected sites and ecosystems, Red List and endangered flora and fauna has been done. Discussions with conservation agencies (WWF, IUCN) were held on possible compensation measures. Ecological flow requirements along the Indus basin were studied and used to determine improved ecological flow commitments.
	Risk assessment	Health and safety risks for population and workers are identified in the ESA and will be included in an Occupational Health and Safety Plan; Environmental Code of Practices (ECP) – occupational health, labor – will be included in tender documents; an Emergency Response Plan will be prepared by the Contractor before commencing the construction activities; a Dam Safety Panel of international experts has been nominated for review of dam design and construction.
	Climate Change and floods	Impact of increased snow-melt and climate change and effect on Indus floods were studied. The dam is designed to withstand glacial lake outburst floods (GLOFs) as well as increased flow rates from climate change. The project will also support glacial monitoring efforts in the upper watershed
	Cumulative Impacts	Cumulative impact assessment has been conducted as part of the ESA to cover the (i) impacts of all existing and proposed development in Upper Indus Basin (Diamer-Basha, Tarbela and Dasu) and (ii) contribution of Dasu towards increments effects.
	Alternatives	Alternatives considered included: the "without project" case; alternative power supply sources; location of the project facilities, dam and water ways; dam type; power generation equipment and construction phasing.
	Pollution	Baseline survey of environmental quality has been carried out. Stricter environmental standards were applied and ECPs will be included in contract documents.
	Physical and Cultural Resources	Verification with Department of Archaeology implemented. Mitigation measures include salvage of the historic mosque located in the flooded zone, as well as protection and tourism promotion of rock art at Shatial. Chance find procedures will be included in contract documents and a project archeologist will be on stand-by.
	Gender	Gender consultations were carried out during ESA. A Gender Action Plan has been prepared.
	Public Health	A comprehensive study on public health aspects has been conducted and a Public Health Action Plan has been prepared
	Consultation and access to information	Consultations have been held in all the affected villages and with the *jirgas*, or committee of elders. Stakeholder workshops were conducted in Peshawar, Lahore, Karachi and Islamabad in 2012. The draft ESA and SRMP reports have been disclosed to the affected communities in public meetings in Dasu, Peshawar and Islamabad in February 2014. The Executive Summary report is translated in Urdu and is available through two Public Information Centers established at the project site. The reports (in English and Urdu) have also been made available in public libraries and were posted to WAPDA's website on 24 January 2014. The ESA, its Summary, and SRMP were also sent to the World Bank InfoShop and disclosed on 24 January 2014.

3. Project Description

3.1. Background

Demand for electricity: Demand for power has been rising rapidly in Pakistan and is predicted to rise at an increasing rate in the coming years. At present, there is significantly greater demand for electricity than the installed generation capacity (20,600 MW). The estimated shortfall is over 7,300 MW in winter and 3,350 MW in summer. Rationing of electrical power by frequent load shedding has been as high as 5,000 MW. This situation causes serious economic losses to the country and could increase the risk of social unrest. The high

cost of electricity generation is another major problem in the sector. Costs have risen steeply over the last ten years. Because hydropower investments are capital intensive, the share in thermal power plants has grown, even though they are both expensive and polluting. Consequently, despite huge hydropower potential in Pakistan, especially in the Indus Basin, its share in energy production has declined from 64 percent in 1970 to 32 percent at present (6,600 MW).

Power shortages: The long hours of load shedding affect households and industrial and commercial activities and influence the quality of life. Schools, colleges, clinics and hospitals, businesses and industry are all affected, reducing revenues and productivity. Load shedding also deters investment. Its financial impact has been estimated at 3 to 4 percent of GDP, or about USD10 billion a year. These serious economic losses also have an impact on unemployment and poverty. On a number of occasions, frequent and prolonged power cuts have caused social unrest.

Government interventions: In an attempt to address the problems in the energy sector the 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 GoP has undertaken projects such as the World Bank funded Electricity Distribution and Transmission Improvement Project, and the Asian Development Bank funded Energy Efficient Investment Program. However, these programs are often complementary to, rather than substitutes for large scale hydropower projects such as DHP.

Program for hydropower development: In the 1980s, WAPDA began studies to identify potential water storage and hydropower projects. The total identified capacity of hydropower projects was estimated at 46,000 MW. Nine of these projects are located in the UIB. On the basis of these studies, WAPDA prepared its "Vision 2025" program to address the increasing water and power demands of the country. The program was approved by the GoP in 2001. It includes an ambitious development program to construct hydropower plants that could generate an additional 16,000 MW. DHP was the second project on the list.

Feasibility study: A feasibility study for DHP was carried out in 2009, which looked at various alternative project sites near Dasu and determined the hydraulic and other infrastructure required for a project with generating capacity of 4,320 MW and an annual energy generation of 21,300 GWh. The current location and detailed designs are largely based on the results of the feasibility study.

3.2. Project Objective

The overall project objective is to facilitate a sustainable expansion of Pakistan's electricity generation capacity in order to bridge the increasing gap between supply and demand. The project will also contribute to the country's strategy to move away from high cost fossil fuel powered thermal plants towards low cost, cleaner hydropower generation, that will also reduce greenhouse gas (GHG) emissions. The cost of electricity generation will be considerably reduced and foreign exchange will be saved by reducing fuel imports. The project will also support strengthening of WAPDA's capacity to prepare future hydropower projects and manage Pakistan's vast hydropower potential.

3.3. Location of the project

The DHP is to be constructed some 7 km upstream of Dasu Bridge near Dasu town in Kohistan District (KP province). The site is about 74 km downstream of the projected DB dam. The DHP is located in a remote and thinly populated mountainous area and is only accessible from Islamabad by GT Road and the KKH via Abbottabad-Mansehra-Besham-Pattan-Dasu. There is no river transport or rail link to the area. The nearest small airport is in Pattan located about 40 km from Dasu. The project area lies in a high risk zone for earthquakes. The lay-out of the project is shown in **Figure 2**.

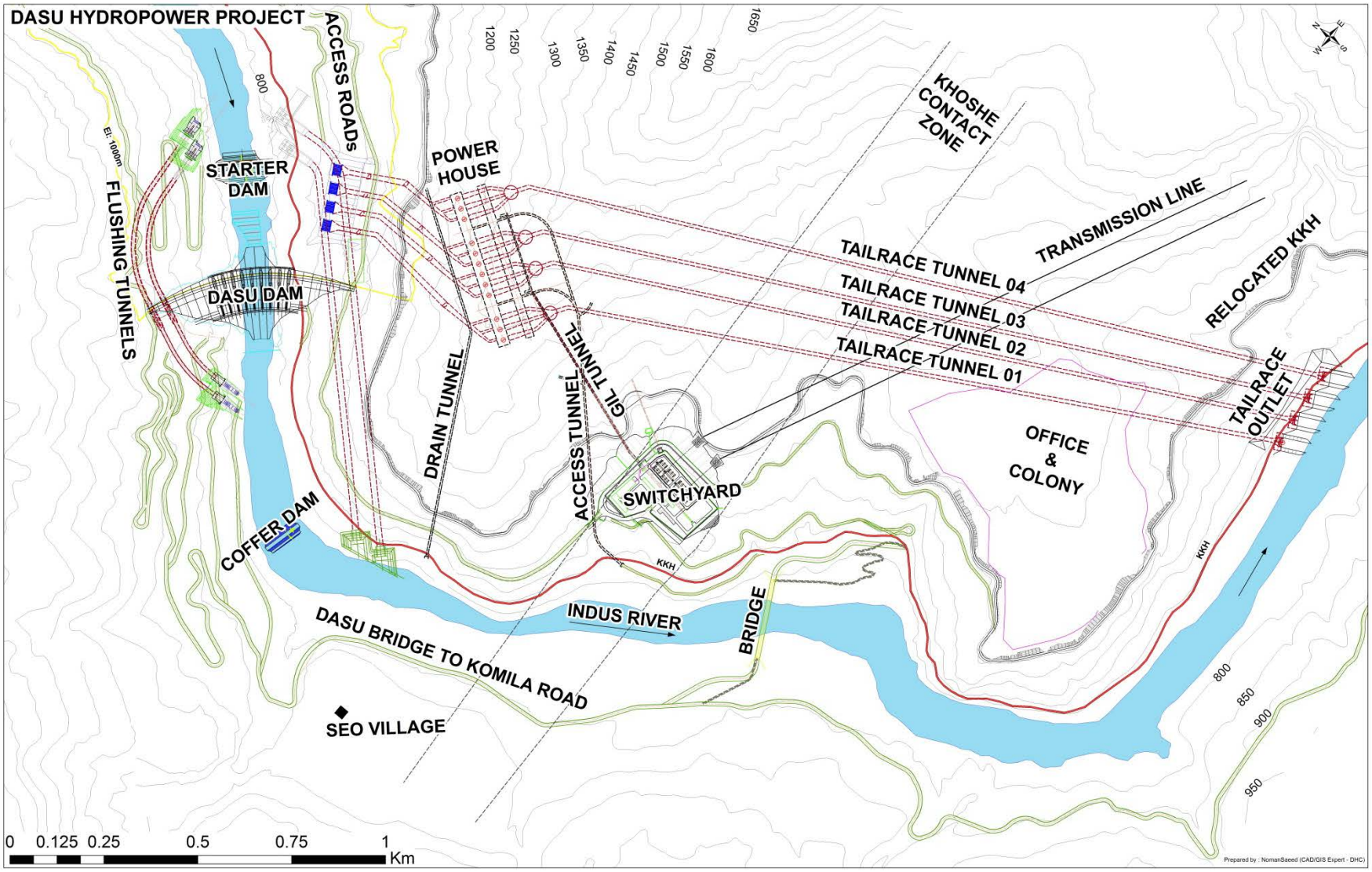


Figure 2: Layout of Dasu Hydropower Project

3.4. Project Components

(a) Main hydraulic structure. This component will primarily consist of the civil works required for the main structure in the Indus River and associated civil works to raise the water level and create energy to run the power generating turbines and generators. The structure will be designed to pass the probable maximum flood of 50,360 m^3/s safely and will have openings/tunnels to flush sediment coming from upstream. The arch-gravity structure will be constructed with roller compacted concrete (RCC). The height will be about 242 m above the foundation at full supply level (fsl) or 950 masl, with a crest length of about 570 m. This structure will allow an operational storage capacity of 0.82 billion cubic meters (BCM), between 900 and 950 masl and a dead storage of 0.57 BCM. At fsl, the reservoir will be 74 km long with an average width of 365 m, covering some 24 km^2 of valley bottom.

(b) Installation of power generating facilities and sediment control. When fully developed, the project will have two underground powerhouses housing 12 turbines, each producing 360 MW of power. The excavated caverns for the powerhouse and transformers will be located on the left bank of the river. Four 2.2 km long tailrace tunnels will convey and discharge the water into the Indus River at a site some four km downstream of the main structure. There will be nine low-level outlets (LLOs) in the main structure for discharging sediment and flood water together with two sediment expulsion tunnels on the right bank to be operated during the high flood period. In order to cope with the high floods during summer (June-September), there will be a spillway, consisting of a radial, frontal overflow with eight bays, with a maximum discharge capacity of 36,800 m^3/s. The power generation facilities consist of intake structures with four power tunnels, each connected to three power generating units of 360 MW. At full development the four power tunnels will serve the 12 vertical shaft Francis turbines, for a total installed capacity of 4,320 MW. The power will be transported to a power yard through underground tunnels and further connected to the transmission network of NTDC.

(c) Preparatory and permanent works. It is envisaged to construct two large diversion tunnels (1.2 and 1.1 km long) on the left bank in order to divert the river while the main structure is under construction. The site of the main hydraulic structure will be protected by two coffer dams during construction. Other works include the construction of new access roads on the Indus right bank, jeepable roads to some remote villages and two new suspension bridges over the reservoir. Residences, office buildings and a WAPDA colony, including access roads, housing for staff and supporting facilities, will be built at a site not far from the tailrace outlet near Dasu and some 5 km north of Dasu town. Temporary facilities such as construction yards, workshops, and labor camps will have to be constructed and sites reserved for excavation, spoil disposal and stockpiling. The required power (30 MW) during construction of the dam and colony will be supplied from Dubair Khwar hydropower project near Pattan, through a new 45 km long 132 kV transmission line. The transmission line follows the KKH alignment between Pattan and Dasu through a scarcely populated and barren area, with few villages.

(d) Transmission line. For transmission and distribution of power, two parallel transmission lines will connect DHP with the 500 kV Grid Station at Pathar Garh in Punjab. The transmission line will extend over a distance of about 250 km and will traverse five districts of KP, including Kohistan, Battagram, Mansehra, Abbottabad and Haripur before connecting to the grid station. NTDC carried out an initial study and has started preparation of the detailed design. The construction of the transmission lines falls into screening "Category A" and therefore a separate environmental and social assessment will be prepared (consultants are being recruited). The ESA is expected to be completed in 2014-15. In the interim, the EARF has been prepared for this component, on the basis of a provisional corridor designed by NTDC for the transmission line.

NTDC had earlier developed a Master Plan for evacuation of power from 26 planned hydropower plants (HPPs) in the mountainous northern areas. This formed the basis for the National Power System Expansion Plan of Pakistan up to 2030. The plan assumed that the DB dam would be developed before Dasu. The power supply from DB was supposed to meet the power demands of large centers such as Islamabad and Peshawar, with power from Dasu transmitted to centers such as Faisalabad. The situation has changed now, as Dasu is likely to come on line before DB and power from Dasu will be used to meet the demand of the larger centers like Islamabad.

(e) Karakoram Highway (KKH). Another major element is the realignment of the KKH, since about 52 km of this road will be inundated by the reservoir. This realignment is critical, since the traffic on the KKH should not be interrupted or affected by the project; the KKH is the only road connection and thus a lifeline between Islamabad and the north of the country (Gilgit-Baltistan); it is also important for trade with China. About 3,000 vehicles travel the highway daily, including about 600 heavily loaded trucks. The road section which will be submerged by the reservoir will be rebuilt at a higher level along the slopes of the valley. It will include construction of approximately 62 km of new highway and 3 km of link roads. This will be a major operation in

difficult terrain. The work includes the construction of new bridges, retention walls, culverts and access roads. The realignment will be undertaken under two contracts on the basis of priority implementation: (i) first, the construction of 15.6 km of new highway and 3 km of link roads; and (ii) the construction of the remaining 46.1 km of the new highway. Completion of the first segment will ensure that construction works at the main structure are carried out without obstructing traffic along the KKH, while construction of the second segment will be needed to avoid submergence of the highway in the Dasu reservoir. The entire operation is expected to be completed between 2014 and 2016.

(f) Implementation of Social and Resettlement Management Plans. The main elements of the SRMP are compensation of affected people for lost assets, resettlement site development, assistance in relocation, and livelihood restoration and development. In addition, the SRMP includes provisions to support communities in the project areas for both sustainable livelihood development and broader local area development. The SRMP includes a Public Health Action Plan to address possible health impacts under the project and a Gender Action Plan. It includes both short-term income and livelihood measures during the construction phase as well as long-term measures that extend 10 years into implementation.

(g) Implementation of Environmental Management Plan. The Environmental Management Plan (EMP) includes afforestation and watershed management in the upland areas along the reservoir and the reconstructed KKH; measures to enhance aquatic life and fisheries downstream and in the reservoir; baseline studies of terrestrial and aquatic ecology in the UIB, including monitoring of biodiversity, forests and wildlife; preservation and protection of cultural property (historic mosque and petroglyphs); and actions to address unforeseen issues that may arise during the project. Construction related environmental issues will be addressed in the construction contracts, thus the cost of such measures is included in construction costs. The EMP includes those issues that are not or cannot be covered under the construction contracts.

(h) Flood warning system, watershed, sediment and river monitoring program. Most of the water resources of the Indus River are derived from glacier melt, and the DHP is designed to withstand probable maximum floods that may be caused by GLOFs. Nevertheless, continued monitoring of glaciers is crucial for the water security of the country, and useful for developing the knowledge base for operation of the dam and for planning future hydropower investments in the Indus Basin. The component will support improved monitoring of flows and watershed improvements. It will also support sediment, river and project infrastructure monitoring programs that will help to optimize project operations and to develop further projects on the Indus cascade.

(i) Construction supervision, monitoring & evaluation of project impacts. This component covers the cost of consulting and other services for project implementation, construction supervision and project management support. It also covers financial management, preparation of any additional designs, and bidding documents. The monitoring and evaluation (M&E) activities will provide continuous feedback to the GoP, Ministry of Water and Power and WAPDA on the project's performance and impact of its various components. The monitoring will be carried out by independent M&E consultants. They will also supervise implementation of the SRMP and EMP and monitor and evaluate positive and negative impacts of the project.

(j) Project management support, capacity building, technical assistance and training. This component will support WAPDA in implementing project related activities, the establishment of a Project Management Unit (PMU), capacity building, operational cost and auditing, technical assistance and training activities. It will also help to strengthen WAPDA's capacity to develop strategies to become a financially autonomous entity and its ability to develop and finance hydropower infrastructure with strong technical expertise and adequate internal control. Strategic studies will be supported to address technical, financial or management issues, mitigation measures, pilot projects and preparation of future projects that may be identified during project implementation and agreed upon with the World Bank.

3.5. Phasing

The DHP will be developed in two stages, each consisting of two phases. During each phase power generating capacity of 1,080 MW (three turbines of 360 MW) will be installed. During Phase-1 (5 years, 2015-2020) the major hydraulic structures, related infrastructure and one power tunnel, including generating facilities for 1,080 MW of installed capacity, will be constructed. The realignment of the KKH will be completed. Another tunnel will be constructed during Phase-2, together with power generating facilities for another 1,080 MW. Both Phases of Stage-1 will be implemented simultaneously (2015-2022). The Second Stage will include the construction of a third and a fourth power tunnel and generating facilities (six turbines) for an additional 2,160 MW. Phase-3 and Phase-4 would preferably be carried out after the development of the DB dam. See also **Table 2.**

Table 2: Staged Development of DHP in Relation to Diamer-Basha

	Stage 1		Stage 2	
	➢ **Phase-1**	➢ **Phase-2**	➢ **Phase-3**	**Phase-4**
Works	➢ Dam, all ancillary infrastructure (including KKH realignment and first 500 kV transmission line), & three turbines	➢ Additional tunnel and three turbines	➢ Additional tunnel and three turbines and second 500 kV transmission line	➢ Additional tunnel and three turbines
➢ Total installed capacity in MW	➢ 1,080	➢ 2,160	➢ 3,240	➢ 4,320
➢ Generation electricity in GWh	➢ 8,058	➢ 12,225	➢ 18,730	➢ 21,485
➢ Start	➢ 2015		➢ To be initiated after the completion of Diamer-Basha	
➢ Completion	➢ 2022 (first power after 5 years)		➢ 4 years after commencement	

Notes:
Diamer-Basha (DB) detailed design is ready and project is likely to be completed in 15 years; DHP Stage 2 will be started after the completion of DB, and would take four years to complete; DHP Stage 1 will be completed in seven years; the first unit will start generating after five years.

3.6. Project Cost

The estimated project cost is shown in **Table 3**.

Table 3: Overall Estimate of Project Cost (Million Dollars)

	Description	Phase 1	Phase 2	Phase 3	Phase 4
A	Main structure and related hydraulic infrastructure	1,246	0	0	0
B	Underground powerhouse complex including gates	424	203	199	181
	Generating equipment	287	244	275	244
C	Prepatory Works	295	0	0	0
D	500 KV transmission line (including cost of ESA study and ESMP implementation)	301	0	301	0
E	Social and environmental management costs	389	0	0	0
F, G	Administration and other costs	128	35	47	47
	Contingencies	580	116	491	377
	Total Base Cost	**3,650**	**598**	**1,313**	**849**

4. Project Alternatives

4.1. Alternatives to the Project

Energy Scenario in Pakistan: Pakistan's acute power and energy crisis is primarily caused by the increasing gap between the supply (+3.5 percent/year) and the demand for electricity (+7.6 percent/year). Moreover existing thermal power plants do not produce at their full capacity due to the lack of foreign currency needed for purchasing imported fuel (85 percent of oil is imported).

Without Project Alternative: The "without project" alternative is not realistic, because Pakistan will inevitably build additional generating plants to eliminate power shortages. Indeed, given the increasingly prohibitive costs of fuel oil-based electricity generation, development of Pakistan's hydropower resources at a variety of scales represents the only reasonable prospect of eliminating these shortages

Energy Efficiency and Demand Side Management: There exist a series of options such as demand side management and improved utilization efficiency, and reduced transmission and distribution losses that have high economic returns and are already being undertaken by various Pakistani organizations. However, these are complementary to, rather than mutually exclusive substitutes for Dasu and they will be implemented regardless of whether Dasu is built or not.

Alternative Hydropower Projects: Pakistan has a large potential of renewable and clean energy resources in the form of hydropower. Out of an estimated potential of 46,000 MW so far only about 6,500 MW or 14 percent is utilized. The majority of the hydropower potential can be found in the UIB. Compared to various ongoing and planned hydropower schemes in the country, DHP has the lowest cost per kWh generated and the least environmental and social impacts because of its nature (run-of-river).

Other Sources of Renewable Energy: Alternate renewable sources such as wind and solar power cannot be developed to a scale comparable to DHP since they will be three times as expensive as DHP. Both of these options need to be developed to the extent technically and financially feasible. They are complementary, but not substitutes for DHP. 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. It is not anticipated that DHP would crowd out the ability of the GoP, provincial governments and/or the private sector to finance small and medium scale investments in renewable energy.

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.

4.2. Site selection of main structure and hydraulic and electrical infrastructure

DHP was initially identified as a potential hydropower project in 1981 and the location of the project was projected about 7 km upstream of Dasu bridge. The 2009 feasibility study was carried out with the assumption that the project would be implemented after completion of the DB dam. In the study several locations between 3 and 9 km upstream from Dasu bridge were investigated. The initial six locations for the main structure were reduced (on geo-technical grounds) to three technically feasible alternatives. The final selection of the site was done after extensive consultations with the affected population. The selected site appeared to be technically and economically more feasible and had considerably lower environmental and social impacts, with less need for resettlement. The alternative made it possible also to preserve the attractive and historic 400 year old mosque in the village of Seo, an important cultural and religious site. The alternative was widely supported by the residents from the area.

4.3. Alternatives for the type of structure

Three types of main structure were considered during the feasibility study: (a) RCC; (b) a Concrete Faced Rock fill structure; and (c) an Earth fill structure. The feasibility study recommended a RCC structure on the basis of availability of construction material locally, lower cost and technical advantages. No significant differences in environmental impacts were expected among the three alternatives.

4.4. Alternatives for the lay-out of intake and tail race tunnels

Three alternative lay-outs of waterways (intake and tail race tunnels) were considered during the feasibility study. However the study did not evaluate the stability of the various types of rock and the possible impacts of the Khoshe fault, a geological contact near the proposed underground power house. Presence of this fault could lead to water leakage and influence the design and construction cost of the tunnels. The layout for alternative 1, in which the power house is located upstream of the Khoshe fault, with tail race tunnels crossing the fault, was recommended during the feasibility study. In alternative 2 the powerhouse is located downstream of the fault, with power tunnels crossing the fault. In alternative 3 any crossing of the fault is avoided, but the tail race

tunnels are curved, which is a disadvantage. During detailed design, further investigations on Khoshe fault were carried out and alternative 4 was also studied. Khoshe fault was found to be not active and without having a weak or fractured rock structure and hence would not influence the design of tunnels. Alternative 4 is a slight modification of alternative 1, in which the tail race tunnels are straight without any bend. This alternative was selected because of higher efficiency, since a straight tunnel has much lower head losses due to friction.

4.5. Alternative sources of construction material

Coarse aggregates: About 9.2 million tons of coarse aggregate will be required for the construction of the dam. Four quarries were identified on the left bank with suitable material and with easy access (along the KKH alignment that will be submerged after filling of the reservoir). The potential borrow sites are concentrated on the left bank since the right bank of the Indus is very steep and susceptible to landslides; this makes it unsuitable for quarrying. Further, it would not be accessible at an early stage of the project. After study, the quarry at Kaigah (about 8 km upstream of the dam) was selected since: (a) the quarry is located in the future reservoir area, thus avoiding additional land acquisition and resettlement; (b) enough level space is available for an aggregate processing plant and for storage of aggregates and transportation facilities (conveyor belt); and (c) after filling of the reservoir the quarry will be covered with alluvial sediments, avoiding visible exposure in the landscape. The other three sites were unsuitable due to insufficient space for installation of crushers and transport facilities. The site at the Kaigah nullah thus remained as the only technically feasible alternative.

Adverse environmental impacts: The selection of this site may have consequences for the Kaigah Community-managed Game Reserve, which borders the old KKH alignment and the quarry site. In the Game Reserve (5,000 ha) some limited trophy hunting is allowed. The site is managed by the community of Kaigah village, who have been trained in wildlife conservation management and who receive an annual share of the sales of hunting licenses. During construction the operation of a quarry at Kaigah could negatively affect presence of wildlife in the area. The community also may suffer from loss of income, if hunters stay away. These negative impacts are considered to be unavoidable, since there are no realistic alternatives at hand. Appropriate mitigation and compensatory measures, discussed later in the document, have been proposed to address these impacts.

Sand: About five million tons of good quality sand will be required for construction. River sand is available in small quantities and is often unsuitable. Suitable sand deposits are located some 80 km downstream (Maira) or 120 km upstream (Chilas) from Dasu. Use of these deposits is expensive because of high transportation costs; it would also negatively affect the aquatic ecology of the Indus. For these reasons it was decided to use manufactured sand from the Kaigah quarry, since the coarse aggregate facilities can be used for manufacturing fine aggregates as well.

Pozzolan: Natural pozzolan (a fine material to use in concrete) is available in the area at three different sites. However, all three sites have insufficient quantities of pozzolan and often of variable quality. Currently, the replacement of pozzolan by manufacturing fine material from the aggregates is the subject of further studies.

4.6. Alternatives for the selection of generating equipment

The feasibility study proposed to install eight turbines of 540 MW each for the generation of a total of 4,320 MW. These turbines are huge and difficult to transport. The current condition of the KKH may also present an important limitation on selection of equipment. A comprehensive study was made to determine the maximum weight and width of generating equipment that could safely travel on the KKH. This was tested during trial transports towards the DB dam. Another factor that was considered was the possible influence of future changes in the flow regime of the Indus due to climate change. Three combinations of generating equipment were evaluated: (a) 8 units of 540 MW; (b) 10 units of 432 MW; and (c) 12 units of 360 MW. Option (c) was selected as the most feasible option on the basis of energy production and transportation requirements.

4.7. Alternative construction schedules

The DHP requires very large, committed investments. A staged development is the most practical way to achieve early power generation with relatively low investment cost (committed financing from the World Bank). This approach could also help to address uncertainties regarding future investment for Stage 2; the current WB financing is limited to Stage 1 only. Both WAPDA and the World Bank agreed on a two stage development of DHP, with each stage divided into two phases. The development of stage two is assumed to be implemented after completion of the DB project construction, which will considerably reduce the sediment load into the Dasu reservoir and thereby prolong the life of DHP.

4.8. Alternatives for resettlement

The project will cause displacement of 767 households with 9,653 inhabitants in 34 villages. Various alternatives for resettlement were discussed with the affected communities. After detailed discussions, a combination of various options will be selected; the following two are the main options:

- **Option 1:** Community-based relocation close to the current settlements, but at a higher location, with site and services to be developed by the project. This option includes the possibility of a self-managed relocation in Dasu Tehsil or elsewhere in Kohistan District, with additional compensation and benefits prior to relocation. About 90 percent of the community preferred this option.
- **Option 2:** Relocation to "down country" (outside Kohistan), with extra compensation and benefits prior to relocation. A minority of about 10 percent of the affected community preferred this option.

5. Description of Environment

5.1. Physical Environment

Definition of the impact area: The impact area of DHP includes all permanent and temporary areas (the footprint) to be acquired for the reservoir and for construction works, housing areas, offices, camps and for realignment of KKH. Upstream of the dam the impact area also includes the left and right bank of the Indus, from the riverbed up to the fsl of the reservoir at 950 masl and higher to cover the resettlement areas up to 1,500 masl. On the right bank the impact area also extends to this elevation to cover the corridor (width 500 m) associated with the realignment of 62 km of the KKH. The direct impact area of the project along the Indus river extends towards a point about 10 km downstream of Dasu bridge. Here the direct influence of the tailrace tunnels of the project is estimated to end and the flow pattern in the river will be "normalized" under the planned base-load operations of the power plant. Upstream from the dam the impact area extends towards the upper end of the reservoir, where the impacts of changes in hydrology and sedimentation begin. Also included in the direct impact area are the borrow areas needed for the project and the 45 km long corridor (width 100 m) in the Indus valley from Dubair Khwar to Dasu needed for the construction of a 132-kV transmission line to provide energy during the construction stage. The 250 km long corridor for the main 500 kV transmission lines between Dasu and Pathar Garh Grid Station in Punjab also is included. For the transmission line corridor a separate EARF has been prepared by consultants, indicating provisional environmental and social concerns. The results are briefly described in chapter 7 of this summary, including an approach to completing the ESA for this component.

The area of influence: The area of influence of the project is much larger than the area of direct impact and is estimated to cover the Indus valley between Dasu and the Tarbela Reservoir (downstream of the dam there are no impacts expected from DHP). The project also could seriously influence the traffic and transportation of people and goods on the KKH between Hassanabdal and Khunjerab pass (China border) in both directions.

Physiography: The area of Indus-Kohistan belongs to the lower Himalayas and in the project area consists of mountains between 2,000 and 4,000 m altitude. At some distance higher mountains can be found (> 5,000 m). The Indus has cut a deep valley in the mountain piedmont. The river enters the impact area in a western direction near Diamer, flowing through a relatively wide valley for some distance towards Shatial. Near Lootar, the valley bends southward and forms a narrow gorge-like valley. From the mountainous hinterland small lateral tributaries and nullahs (small streams) discharge water originating from rainfall and snow-melt into the main river. The Indus here is fast flowing and full of sediment. The area has a low population density. In total there are 34 small villages or hamlets in the direct impact area, 17 on the left bank (along the KKH) and 17 on the right bank of the Indus. Dasu–Komila is the only somewhat larger town with about 7,150 inhabitants. Most of the area is heavily sloping and very rocky. There is little land that is level or gently sloping. Along some of the nullahs cultivation is found, usually on terraced soils or on alluvial fans and old river terraces.

Climate: The area is characterized by a large variation in climatic conditions, strongly varying with altitude. In general the area has a low annual rainfall, between 200 mm and 300 mm. However, there is a strong increase in rainfall with altitude. It is not unusual that rainfall (often in the form of snow) amounts to values of 1,000 mm at altitudes of 3,000–5,000 m. The summers are usually hot in the valleys (average day temperature of 36°C in August) and winters are cold (average day temperature of -6°C in January). The area is not influenced by the monsoon and lies in the rainfall shadow of the higher mountains. During winter the precipitation falls as snow. Generally the areas between 1,500 m and 5,000 m in the UIB are snow covered during most of the winter months. The areas above 5,000 m are permanently snow covered. Although annual precipitation is low at the

valley floor there can be occasional but intense rainfall events, often with significant hydrological and geomorphological significance (erosion). Winds can be very variable in the project area and the dominant wind directions depend largely on the topography.

Geology: The project is situated in the so-called "Kohistan Arc Complex zone." This is an area of igneous and sedimentary rocks that was formed during the mid-Cretaceous period. The area lies near the divide where the Asian and Indian continental plates meet, resulting in considerable thrusting, uplifting, tilting and plutonic activity. In the project area mainly granulites and amphibolites can be found on both sides of the Indus. Near the main structure and powerhouses, there is a major geological fault, the Khoshe, which is no longer active. This fault forms the contact zone between the granulites and the amphibolites and plays an important role in the final layout of the underground rock chambers housing the powerhouses and the final design and type of construction of the tailrace tunnels. The riverbed itself consists of a mixture of glacio-fluvial deposits, terrace material and landslide materials. Higher on the slopes some terrace remnants are found with unconsolidated moraine (glacial) deposits.

Seismology: No earthquake monitoring was done prior to the last century. However, based on historical documentation, it is evident that the region experienced severe earthquakes. The epicenters of three well-studied earthquakes of magnitude 5.9 or above have been recorded near the project site. Another smaller concentration of epicenters of recent earthquakes (2002-2003) is located in the Raikot area, north of the project. The epicenter of the heavy Kashmir earthquake of October 2005 (magnitude 7.6) was located at a distance of 90-100 km from the project.

Rock stability and landslides: The project area is characterized by steep and moderately steep slopes. Both granulite and amphibolite rock slopes are susceptible to rock fall and block toppling. Their stability depends largely on rock properties, structural discontinuities, groundwater and earthquakes. Frequent landslides are not very common in the area. However at a number of sites huge loose moraine deposits can be found on steep and almost vertical slopes on either side of the Indus. Especially the areas near Seo, Tial Medan and in Kandia valley are susceptible for landslides. During heavy rainfall there is often considerable rockfall and landslides that may block the KKH.

Sedimentation: The Indus River carries a heavy sediment load due to the ruggedness of the catchment area and the strong erosional forces in the upper catchment caused by deforestation and lack of protective vegetation cover. Another factor is the great variation between day and night temperatures. This may cause cracking and disintegration of rocks and subsequent erosion and landslides on unstable slopes. Erosion materials in side valleys are transported by melted snow towards the tributaries and finally discharge as mud flows into the Indus. The river also derives sediments from vast alluvial fields and moraine deposits formed along its banks well upstream. The annual runoff is estimated at 67 BCM and 79 percent of the flow occurs between June and September. The annual sediment load of the Indus at Dasu is estimated at 200 million tons, 98 percent of which occurs between June and September.

Hydrology: The Indus flows from the Tibetan Plateau in a westerly direction through India and is joined in Pakistan by four major tributaries: the Shigar and Shyok rivers in Baltistan and the Gilgit-Hunza river in Gilgit district and the Astor river in Diamer district, before reaching Dasu. During the last stretch before Dasu the Indus flows in a deep narrow channel with a steep gradient of 3.0 m/km and bends near Kandia in a southern direction. The slopes of the river are often without any vegetation and very rocky. There are several lateral river valleys and some 14 nullahs flow into the main river in the project area. The flow rate of the Indus is characterized by a high flow (or summer) season from June to September and a low flow (or winter) season from October to May. By far the largest share (about 80 percent) of the Indus water originates from melting of snow and ice from the glaciers and ice fields of the Himalaya, Karakoram and Hindu Kush mountains. Approximately 80 percent of the water flows in the summer months (June to September); these flows carry the greatest load of sediments towards the Tarbela reservoir (Tarbela dam is the first downstream barrier in the Indus).

Groundwater: The groundwater table in the river valley is deep. The depth of the aquifers near the main structure varies between 48 and 68 m.

Flooding: A number of historic floods have been recorded in the upper Indus catchment area. Floods occur because of sudden blockage by one or more landslides of the Indus or one of its major tributaries and resulting overtopping that triggers a sudden outburst by the river. Heavy floods also can occur when an ice barrier breaks or a glacial lake suddenly empties, creating havoc in downstream areas. Nearly 60 GLOFs have been reported since 1830. Other causes of floods are heavy and prolonged storms and intensive/extreme glacier and snow melting.

Quality of surface water: The water quality of the Indus and its small tributaries has been investigated during the high and low flow season. 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. The concentration of nickel also exceeds the Pak-EPA standard at some sampling sites, but this has no impact on human health.

Air quality: The parameters for fine dust such as PM_{10} (24 hours) were found to be within the Pak-EPA limit; however fine particulate matter ($PM_{2.5}$) at 50 percent of the investigated sites (mainly in residential areas along KKH) was found to slightly exceed the Pak-EPA's prescribed limits. Possible sources could be fuel burning (coal, wood, and fuel oil), incineration (house and municipal garbage) or traffic. The concentration of ambient gasses was found to be within the standard limits of Pak-EPA at all sites.

Noise pollution: Noise levels in the urban centers are relatively high and in most cases exceed the Pak-EPA standard limits. The noise levels at different locations (near bus stations and markets) were found in the range of 45-67 dB.

5.2. Biological Environment

General biodiversity: The mountain areas of Pakistan are home to unique wildlife and wilderness areas. The biodiversity of the mountain reaches above DHP is significant; however, the Indus valley bottom (including the project area proper and the future reservoir area) is largely covered by scrub vegetation with typically low biodiversity. In Kohistan, 232 species of plants, 199 species of avifauna, 31 species of mammals and 18 species of reptiles and amphibians are recorded. Some 180 species of fish are known from the Indus and its tributaries; the number of fish species in the project area is expected to be low and only five species were identified during the field investigations. None of the plants are endemic or threatened; among the animal species, only the Markhor, a wild goat that sometimes visits the project area, is classified by IUCN as endangered.

Protected and sensitive areas: There are no designated national protected areas, forests or nature reserves in the project area. In the valley of the Kaigah nullah, the community-managed Game Reserve of 5,000 ha is officially demarcated by the KP Wildlife Department as a Community Conservation Area and managed by the Kaigah community. The reserve, supported by WWF, has the largest population of Markhor in Kohistan. The reserve also provides protection to other mammals and a variety of bird species. Other sensitive areas within the project boundaries for Markhor, Musk deer, Black bear, Tragopan, Monal pheasant as well as other rare species are located in Laachi nullah and Sazin Kot (Indus left bank) and Kandia Valley and an area opposite Shori nullah (right bank). In all these areas, a high biodiversity is only found at higher elevations (above 1,500 m). The biodiversity of these mountainous ecosystems is under heavy stress from deforestation, firewood collection, overgrazing, over-hunting, over-harvesting of medicinal plants, soil erosion, use of pesticides, and weak law enforcement. In the downstream vicinity of the project area (some 50 km downstream of the proposed Dasu dam) is the Palas Valley (1400 km^2), an isolated, undisturbed and pristine valley with a rich diversity in flora and fauna. The proposed transmission line corridor crosses the valley, which houses the largest population in the world of Western Tragopan (classified by IUCN as vulnerable) and at least seven other species of rare birds. The Asian black bear is quite common. Natural forests and flora in the valley are unique and several new taxa of plants, unknown in Pakistan, were recently discovered. The Palas Valley is listed as an Important Bird Area by Birdlife International.

Terrestrial ecosystems: The project area is located along the Indus River, which is flanked by mostly desolate valleys and high mountain ranges. The terrain is rocky and barren, with scattered vegetation. Occasionally sand deposits are found in the valley and adjacent river terraces. The river beds are characterized by rocky outcrops with stony cliffs, large boulders and washed gravels. There is no littoral zone outside the tributaries (nullahs). The steep slopes suffer from extensive soil erosion. The perennial flow of water from springs/streams and nullahs maintains the lifeline of the Indus River. In the valleys near human settlements, there are deep soil depositions that are frequently cultivated using irrigation. Most of the project area between 800 and 1,500 m is characterized as a "mountainous dry sub-tropical scrub zone," covered by shrubs. There is little wildlife other than small mammals (rodents), reptiles and amphibians and insects. Big mammals such as deer, Markhor, or jackal have a wider ranging habitat and rarely approach the riverine area that is going to be inundated. At lower altitudes, up to 950 m, the vegetation is dominated by *Artemisia maritima* and grasses. On foothills and intermediate slopes plots of mixed forest mostly comprising Olea europaea, Quercus baloot, Pistacia chinensis, Cotoneaster microphyllus, Rumex hastatus, Dodonea viscosa and Maytenus royleanus are encountered. Above 1,500 m, outside the project's key impact area, a variety of vegetation characterized as sub-tropical pine forest, which consists of thorny and small-leaved evergreen species is found. These higher mountain zones play an important role in the summer livelihood (grazing, forestry, hunting, firewood) of the local community.

Field surveys and terrestrial species recorded: Biological surveys were carried out at selected stations within the project area. None of the recorded 232 floral species are endangered, rare or vulnerable (IUCN Red-List). A large number of the plant species are of economic or medicinal value for the inhabitants of the area. Most of the 199 recorded avifauna reported is classified as "abundant and common." The Western-horned Tragopan is listed as "vulnerable". The Monal Pheasant and the Rufous-tailed Rock Thrush are classified as "rare", and the Grey-necked Bunting and White-bellied Redstart as "scarce." From the wider project area, 31 mammal species are reported. Most of these are confined to the mountain tops at higher altitudes (>3,000 m), outside the project area, and they rarely visit the Indus riverine habitats. Two of these species are reported "critically endangered:" the Common Leopard and the Markhor goat are "endangered". The Eurasian otter is reported in the Diamer-Basha area. Eighteen species of amphibians and reptiles are reported in the project area. The current state of knowledge about northern Pakistan insect biodiversity is very inadequate. During the surveys, 39 species of water birds were observed.

Aquatic ecosystems: Physical, geological, meteorological and hydro-biological conditions vary substantially along the river. The uppermost section of the river flows east-west in the mountain peak zone for about 950 km before it reaches the project area. The aquatic ecosystem of Indus in the project area is characterized by water mainly originating from snow and glacier melt with highly turbulent flow with a lot of sediments during summer months and less turbulent and almost sediment free water during winter months.

Aquatic ecological surveys and species recorded: In addition to field surveys, data from earlier studies and from literature were collected. Ranges of parameter values were: water temperature 15-24°C; conductivity 63-149 µS/cm; calcium carbonate hardness 30-110 mg/l; dissolved oxygen 4.8-7.4; and NO_3 0.20-1.20 mg/l. During summer, the river contains its maximum sediment load (sand, clay and silt). This sediment load plays an important role in the existence and distribution of fish and other aquatic life. Vegetation is scarce; only the banks of some nullahs show patches of vegetation (herbs, shrubs and trees). Fifty-nine species of phytoplankton were identified in plankton samples from stations upstream of the proposed dam site, and thirty-five in samples from downstream stations. Composition of phytoplankton is indicative for oligotrophic to low-mesotrophic water.

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. Five species of fish are recorded in the project area, based on samples taken from both the Indus and tributaries. The first of two sampling trips (6 persons, 10 days) yielded only 25 fish, and the second one 50, belonging to four species. The fish sampling carried out in winter 2013/2014 also yielded about 60 fish (24 hour fishing using gill/cast nets at 16 locations). The main reasons for poor fish catch and diversity are the long torrential upper courses in the Himalayas, glacier-fed water and high sediment load or low mean discharge rate of water during winter. Fish sampling for the Diamer-Basha Hydropower Project (2006) yielded 14 species, but this also can be considered low, probably due to high-altitude tributaries, low water temperature, high water velocity, low benthic productivity and long stretches of gorges.

Fish species: Most species in the project area are members of the carp (Cyprinidae) and loach (Noemacheilidae) families. The piscifauna is dominated by endemic genera of the sub-family Schizothoricinae (snow carp or snow trout: *Plagiostomus, Esocinus and Labitus*), one genus of the sub-family Noemacheilidae (*Triplophysa*) and one species of the Sisoridae family (the catfish Glyptosternum reticulatum). These genera inhabit torrential and swift streams and rivers of the mountain region and have evolved morphologic features adapted to these habitat conditions. Plagiostomus (local name Swati) is the dominant fish species in the Dasu area representing more than 75 percent of total fish catch; the two other species of snow carp represent another 15 percent. None of these species are listed in IUCN Red List. Mahaseer is another important cold water fish species known from the Indus (long distance migrant and endangered), but its habitat starts about 70 to 80 km downstream of the dam site.

Habitat of snow carp: In the project area fish are found mainly in the tributaries; in the main stem of the river they are mostly found near the confluences during low flow season in winter. Tributaries with snow carp fish habitat on the upstream side of the dam site are Kandia, Tangir, Darel, Kaigah, Summar, and Goshali; on the downstream side these are Sieglo and Jalkot. Snow carps thrive in the snow-fed river habitat of clear, shallow water of stony substratum with an average depth from 0.5 to 3 meters, and river flows with low to high velocities (0.5 to 1.5 m/s). Average temperature requirements are 4 to 20^{o}C and dissolved oxygen requirements are 8 to 12 mg/l. Snow carps are bottom feeders and mainly feed on periphytic algae and diatoms.

Migration of snow carp: Snow carps are short distance migrants. In the project area, they migrate within the tributaries, not along the main stem of the Indus. From April to September (spring and summer, high flows),

they prefer upstream headwaters habitat at higher elevations. From September to April (low flows and winter), they prefer lower elevations and the confluence zone with the Indus. The triggers for migrations are high flows, high sediment load and low temperatures. During spring, when flows start increasing in the rivers due to snow-melt, the fish migrate upstream, due to high flows and turbidity at lower elevations (within tributaries). In the autumn, when the temperatures start to drop at higher elevations, the fish migrate downstream. Mahaseer is reported to ascend the Indus River to Besham and above and to spawn in Allai Khwar (river) (65 km downstream of Dasu dam), which has been described as the last upstream safe haven for the species.

Spawning of snow carp: Females spawn in two seasons, one in September-October and other in March-April. Sexually matured snow carp (when they reach 18-24 cm length, at the age of 2-3 years) spawn in tributaries in clear water (along stream banks, backwater pools and near confluences of other tributaries and the main stem) on gravelly/stony ground or on fine pebbles at 10-30 cm depth. Low water currents of 0.5-1.5 m/sec, pH 7.5, dissolved oxygen concentration of 8-12 mg/l and gravel sizes of 50-60 mm are the optimum conditions for spawning.

Fisheries: There is no regular fisheries management in the Dasu area and no fish farming. Local people fish as a part time activity, not as commercial fishermen. Very few sell their catch, instead using the fish for home consumption. There are no fish processing or storing centers in the project area, nor any fish shops or fish markets. Fish catches from the Indus help to meet protein requirements of local people, since meat is expensive. Limited financial resources compel local people to undertake fishing. Fishing in the project area is not supported or assisted by government or non-government agencies.

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. The 100 km long Tarbela reservoir is known as a staging ground for migrating birds. The Dasu reservoir will further enhance the habitat availability for resting of migratory birds. However, in the absence of feeding grounds in the vicinity of the DHP, winter migrants are not anticipated to rest longer than one day in the project area.

5.3. Social and Economic Environment

Kohistan District: Kohistan means "land of mountains." The district is one of the most isolated and the least developed districts, not only in Hazara Division but in the entire country. In the past, during the rule of the Wali of Swat, Kohistan was united with the area west of the watershed, between the Indus and Swat rivers. Swat is situated to its west, Chilas, Darial and Tangir on the northern side and Naran, Kaghan and Alai valley form the southern and eastern border. Dasu is the headquarters of the district. The district consists of three tehsils: Pattan, Palas and Dasu. The Indus flows through Kohistan and divides it socially and culturally on its left and right banks. The KKH forms the lifeline between this isolated and remote district and the populated areas downstream. Dasu is 350 km from Islamabad and about halfway between Islamabad and the Khunjerab Pass at the Chinese border.

Demography: Kohistan has been predominantly inhabited by Dardic and Pashtun tribes since ancient times. The region has been invaded and contested by Persians, Greeks, Scythians, Kushans, Turks, Mughals, and the British. The population in 2008 was 477,000, of which 55 percent were male and 45 percent female, a ratio of 1.22. The entire district is considered to be rural, since there are no major cities. Almost all inhabitants are Muslim and belong to the Hanafi Sunni branch. Population density is low, with 63 persons per km^2. The average household in 1998 consisted of 6.4 persons. Population growth is very low: between 1981 and 1998 the average annual growth was below 0.1 percent. The national growth rate over the same period amounted to 2.7 percent.

Education and literacy: The literacy rate in Kohistan (measured by people above 10 years of age) is low at only 30 percent, compared to the national level of 57 percent. Low enrollment rates and even lower completion rates of primary schools are assumed to be the prime cause for low literacy. Gender disparity in education, health and employment is a prominent and widespread feature in Kohistan society. Almost all social indicators show considerable gender gaps. Most obvious is in education, with a sizable gender gap in literacy and enrollment rates as compared to national statistics.

Health situation: The health situation in the district is very poor, especially in the remote valleys at some distance from the KKH. There are only a few Basic Health Units in the area. Maternal and child mortality rates are very high; around ten percent of children die before their fifth birthday. The people in the area are particularly vulnerable to disease due to high mountain conditions and remoteness as well as their poverty and chronic malnourishment. The problem becomes especially pressing during winter. In the cold months the prevalence of respiratory infections and other dangerous communicable diseases tends to increase sharply. This is why interventions are needed especially in winter.

Economy and employment: According to the 1998 Census, Kohistan had the country's lowest scores in terms of socio-economic development indicators. The proportion of the population that was working and employed was 26.4 percent, equivalent to 70.5 percent of the total labor force. Of those employed, 72 percent were self-employed, 11 percent worked as employees and 17 percent were unpaid family helpers. Livestock – goat, sheep, cattle, bullocks and some poultry – is the main source of income, and more important than farming (which is mainly subsistence). There is hardly any flat or gently sloping cultivable land. Small terraces have to be built on steep slopes to grow one crop per year (mostly wheat) at altitudes above 1,200 m; double cropping (predominantly wheat, maize and some rice) is possible on the lower valley terraces. Some income is obtained from forest products. Families are mostly transhumant agro-pastoralists, migrating during summer to higher altitudes in search of pastures and a cooler climate. This seasonal migration between the winter residences at the valley bottom and the higher summer residences at elevations between 1,500 m and 3,000 m is typical for the area. Most of the affected households in the project area have three homes and land for agriculture at three different places – one near the Indus River, one in the middle elevations and one in the very high elevations near the glaciers for extreme summers. The seasonal migration means that their economic activities are spread between the low and high elevation areas.

Land tenure and land use: Almost all land in the area is uncultivable and consists of rock outcrop, gravelly scrubland, rock land, steep rocky slopes with boulders, rock fragments and shallow soils and other so-called waste lands. Forests are found at higher altitudes on both sides of the Indus. Some agriculture is found on river terraces, high moraine terraces and on alluvial fans along the small streams (nullahs). On most of these lands small terraces have been built, which form an intricate pattern on the slopes. Because of the scarcity of cultivable land, there are many disputes over land, forests, and even water (streams), some of them long lasting. Traditionally the land was not permanently allotted to any individual or tribe and all the tribes owned all communal land in Kohistan. The tribes used to rotate their lands every five to ten years. However, after 1960 all the tribes decided to allot the lands on a permanent basis. At present the land is divided among the tribes and most is allocated to individuals. Nonetheless, there is no formal or regular system of land tenure in the entire district. Likewise, there are no land titles or records due to lack of cadastral maps.

Agriculture and local irrigation: Despite the scarcity of cultivable land in the district, people practice some agriculture where it is possible, to grow wheat, vegetables and other crops for home consumption and as fodder. Very few crops are grown for the market. The district is not self-supporting. Wheat and rice have to be imported from "down country." The kharif (summer) crops are grown in high altitude lateral valleys. Both kharif and rabi (winter) crops are grown on the lower valley slopes and along the banks of the Indus, wherever land is available. Dominant crops grown in the district are maize, wheat and rice. Pulses such as peas, red beans, vegetables and potatoes are grown on a smaller scale. Irrigation is not systematic, but some "wild" irrigation through small channels is found at places where mountain streams easily can be tapped and utilized. Almost all the valleys have such streams (nullahs). In some areas land is also irrigated from springs.

Seasonal migration: Migration is widespread in the project area. Livestock holding offers the opportunity to utilize the extensive grazing areas at high altitudes and therefore is common. During summer there is sufficient fodder and grassland for the extensive herds of cattle, goats and sheep. Usually people begin to migrate to higher elevations in May and remain there through the summer. Around mid-October they start moving back towards the river valley, where they remain during winter. Winters can be severe. Often there is a shortage of sufficient fodder for livestock, particularly during late winter when crop residues from previous season are exhausted. Cattle are often undernourished. Most people have two or more summer residences at higher altitudes, usually one at the middle level (1,200-1,500 m), see **Figure 3**, often with some farmland and other houses at higher elevations around 2,000 m or higher, where the grazing areas are found. Out-migration from the area is limited to those who leave the area in search of (temporary) labor opportunities in towns like Abbottabad, Mansehra, Rawalpindi and Swat. Entrepreneurs often migrate temporarily to downstream areas, where there are more opportunities for business. People who seek higher education often leave the area during their studies, sometimes for good.

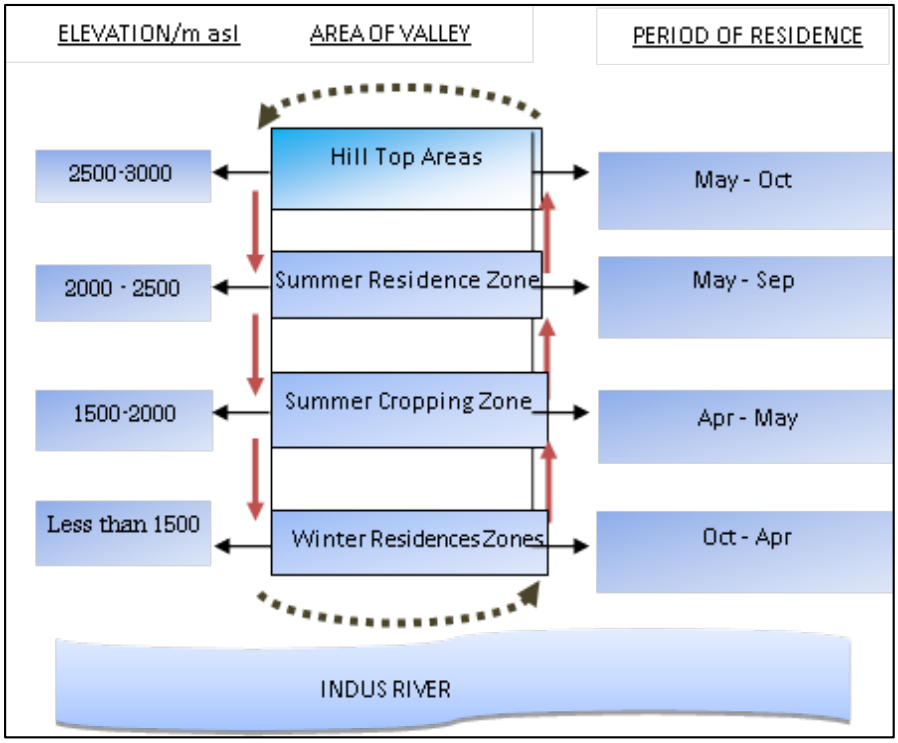


Figure 3: Seasonal Migration of Population between Various Elevations

5.4. Social and Cultural Aspects

Customs and traditions: The tribal people of Kohistan have a social structure that is rooted in strong traditions and local customs. People consider themselves different from the majority of the Pakistani population, especially with regard to ancestry. Religious leaders have a large influence. Due to their influence and the remoteness of the area, daily information (television, radio, newspapers) is very limited and only available to a few people. Information disseminated by imams is considered to be more reliable. Printed material is little used, because of the low literacy. Outsiders are not always welcome in the area. There is often a certain sense of suspicion that people from elsewhere bring modernity and a hidden agenda of social change, which could be detrimental to the prevailing religious and cultural practices. NGOs in particular are not welcome.

Social structure and role of women: The social structure is based on the extended family pattern. The family includes the household of the parents (including grandparents, uncles, etc.) together with the families of the married sons. The authoritative head of the household (usually the father or the eldest brother) has the responsibility and authority to make decisions on behalf of the entire extended family. Kohistan has a highly patriarchal society in which women are absent from public life. Girls and women usually have hardly any opportunity for education or work outside their homes. They do not participate in politics and have no say in decision-making, even within the household. Purdah is strictly observed and women are rarely seen outside. They work at home caring for children, men and livestock. Collecting firewood and doing farm work are among their tasks, but this is done within the confines of purdah: only in restricted areas of the farm and the forest, where no men will be allowed. Polygamy is common and permission of previous wives before marrying another wife is seldom sought. Men still make every effort to prevent women from being influenced by the outside world. Televisions and dish antennas have become slightly more common, but are restricted to rooms with access for men only.

Tribal systems and leadership: Kohistan is divided by the Indus into Indus Kohistan on the right bank and Hazara Kohistan on the left bank. Both have their own history, culture and language. Different tribes live in the valleys of the tributaries on each side of the Indus. The main tribes are the Manzar and Money on the right bank of the Indus, while the Koka Kheil, Manik Kheil and Darram Kheil live on the left bank. Generally a sub-tribe includes the population of two or three villages. A sub-tribe is traditionally headed by a tribal head or *malik*. In every village or sub-tribe there is at least one malik, but often people informally give this title to other respected elderly people as well. The malik takes decisions on behalf of the village community with involvement and

consultation of the notables of the village and the tribe. Issues beyond the level of the malik are resolved through the jirga process described below.

District administration and traditional governance system: Since 1976, Kohistan has been a district administered under the Provincially Administrated Tribal Areas in KP province. The district practices the local traditional governance system, which is accepted by the provincial government and in accordance with federal laws. The district administration involves the maliks and conducts jirgas for local decision-making and resolution of disputes, as well as project administration. A jirga is a committee of elders representing all parties to a problem or issue which deliberate and decide on village or inter-village or inter-tribal problems and issues. Jirgas are constituted at different levels and are convened to resolve a particular issue. In the case of a family dispute the jirga will be formed at family level; if the dispute is at village level a village jirga will be formed and for tribal questions a tribal jirga will be formed. Inter-tribal affairs will include involvement of maliks from the different tribes. In resolving issues which require legal interpretation, jirgas at tehsil or district level will be convened, which will include the District Coordinating Officer (DCO) or his representative.

5.5. Physical Cultural Resources

Pre-history and history: The Indus valley in pre-historic and historic periods has been the only connection between China and the subcontinent on the other side of the Himalayan and Karakoram mountains. Traders, armies and caravans have used this single road through the dangerous and rugged terrain following the Indus River. The over 50,000 rock drawings and inscriptions found over a stretch of more than 100 km give evidence of this. There is proof that part of Alexander the Great's Greek army passed northwards on the road. The area also witnessed the rise and fall of the Buddhist culture (1st–9th century CE) for which evidence is found at many places in Kohistan. In the 8th–12th century CE, the road was known as the Silk Road, the main artery of trade and exchange of culture and goods between China, the Indian subcontinent, the Middle East and Europe.

Various Physical Cultural Resources: A number of PCRs are present in the study area. They include the following: (a) rock carvings near Shatial; (b) a total of 33 mosques in the affected villages; (c) older and more recent graveyards; and (d) moveable artifacts. The rock carvings around Shatial will not be submerged, but they are unique representations of the Buddhist period and should be saved. They are unprotected now and endangered by developments related to construction works and other activities of the project. Since another 30,000 of these engravings of often older periods (up to 5000 BCE) will be lost due to submergence in the Diamer-Basha reservoir, it is important to realize that after completion of both the DB and DHP projects, the rock carving cluster near Shatial will be the only sites where the petroglyphs are found in their original condition and location. Therefore these sites should be preserved in situ (further discussed later in the document).

6. Other Relevant Issues

6.1. Risk of earthquakes

The DHP site is located in a zone with high seismic activity, classified as "Serious Seismic Danger Zone." Historical documentation provides evidence of earthquakes in Kohistan. For the design of DHP the records of all earthquakes in a 150-km radius of the dam from 1828 to 2011 were collected from different international and national sources. This resulted in a list of 2,115 recorded earthquakes with a magnitude of more than 3.0. The epicenters of three well-studied earthquakes of magnitude 5.9 or above, all situated within 100 km from the dam site, were analyzed in detail. All these data were used to prepare a seismic hazard assessment for the project, resulting in a set of safe dam design parameters. The dam design is in accordance with the international standards (International Commission on Large Dams - ICOLD) for dam construction in an earthquake zone of class VIII. According to these standards the dam is considered to be safe under strong earthquake action. In the seismic hazard assessment, the risk of reservoir-triggered earthquakes also was considered. A committee of international experts recruited by WAPDA reviewed and approved the dam 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 seismic monitoring.

6.2. Risk of landslides

Landslides are a common natural phenomenon on the mountain slopes along the KKH. Natural landslides can occur due to lubrication of rock support structure from rainfall or water seepage. The use of explosives to break rocks may cause vibrations which can trigger landslides, as can earthquakes and tremors. Landslide-prone areas

near the project site and reservoir have been identified and mapped. Any blasting activities required in these areas should be controlled and contained within a limited area. As much as possible explosives with a low intensity should be used. Extreme care should be exercised to protect workers and the public from the dangers of sudden landslides, which may occur during excavation and blasting works. Particularly after heavy rainfall there may be increased risk of such incidents.

6.3. Risk of flooding

Although the risk of flooding in the Indus Basin may increase in coming years due to rising air temperature, shift in rainfall patterns and increased glacier melt in the upstream regions, the risk of flooding and related damage in the area is low. Large floods such as the unprecedented catastrophic flood events in July 2010 are not very likely to occur, since the UIB is outside the influence of the monsoon rains. Most of the water in the Indus comes from snow and ice melt. Moreover the Indus valley is narrow with steep slopes. The riverbed is deeply cut into the embankments and therefore it would be difficult for flooding to occur. However, erosional forces may undermine embankments occasionally, resulting in loss of land and deposition of sediment elsewhere downstream in or along the riverbed. Floods in the northern areas of Pakistan, including the UIB, are not exclusively associated with extreme rainfall events; they can also occur after rivers burst through blockages caused by landslides. However, such flooding events related to landslides are rare and usually restricted to tributaries. Recently (2010) there was a huge landslide in the Hunza Valley, which blocked the Hunza River and eroded a considerable length of the KKH near Ata-Abad, creating a lake that is still there. This event caused many problems for the local population and affected the road connection and trade with China. On 27 February 2012 the obstruction was removed by blasting, resulting in a sudden flood wave, which was even recorded in Dasu (rise in water level of 2.4 m after two days). More often, though, rivers are blocked by an ice dam from glaciers. A lake is formed behind the glacier and through overtopping or collapse of the natural dam, a sudden outburst flood can occur, sometimes with devastating results.

6.4. 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.

Recent studies have been concentrated on the effects of glacier melt. Major issues to be investigated are, among others: (a) the importance of the contribution of snow and glacier melt on the hydrology of the Indus; (b) the observed changes in the extent of the glaciers; and (c) the effects of climate change on the amount of melt-water.

From the studies it has been concluded that glaciers in the Himalaya and Karakoram are receding faster than glaciers in any other part of the world. Digital terrain models and satellite observations show that the reduction of the thickness of ice in the Western Himalayan glaciers ranges between 0.50 and 0.90 m per year, although in some areas in the Karakoram, an extension and increase of glaciers has been reported. After a period with increased flows due to accelerated glacier melt, it is expected that summer and late spring discharges of the Indus will be consistently lower by 2050. In a likely scenario of global warming based on IPCC predictions (Fourth Assessment Report, 2007, A1B Special Report on Emissions Scenarios, period 2046-2065 combined with five Global Circulation Models), the reduction of the share of melt-water in the Indus discharge has been estimated at 8.4 percent. However, this could be partly compensated by an expected increase of precipitation in the upstream areas, especially in those areas that are under influence of the monsoon (northwest Pakistan).

The relation between climate change and hydrology is extremely complex. This is especially so because obtaining adequate data on climate and hydrology requires proper monitoring over a long period of time. Moreover, regional circumstances may vary considerably, especially in high mountain areas, which often lead to conflicting data. More studies should be undertaken and more reliable data collected in the coming years.

In view of the importance of these data for developing reliable and accurate knowledge about basin hydrology and future water availability of the Indus River, it is recommended that the DHP contribute to the following efforts: (a) establishing a telemetric network in the UIB; and (b) supporting WAPDA's Glacial Monitoring Program including glacial studies, satellite monitoring and studies into the effects of GLOFs.

6.5. Greenhouse gas emissions

Major GHG emissions of concern during the construction phase of the project include CO_2, CH_4, and nitrous oxide (N_2O). Other GHGs are of less concern because construction and operational activities associated with the project are not likely to generate substantial quantities of them. The GHG emissions have been estimated on the basis of IPCC guidelines. During construction (2015–2020), the following GHG quantities have been estimated: (a) annual average emission of 21,527 tons CO_{2e}; and (b) during the total construction period 129,161 tons CO_{2e}. During operation the annual emission has been estimated at 5,484 tons CO_{2e}. Comparison between GHG emissions from DHP with those of thermal alternatives is shown below in **Table 4**.

Table 4: Comparison of GHG Emissions from DHP and Thermal Alternatives

Phases/ Turbines	Capacity (MW)	Annual Energy (GWh/a)	Total CO_2e emission per year (million ton)				
			DHP	HSFO*	Thar Coal	Natural Gas	CCGT**
Phase 1/3	1,080	8,058	0.0055	5.76	7.53	4.40	2.96
Phase 2/6	2,160	12,225	0.0055	8.74	11.42	6.67	4.49
Phase 3/9	3,240	15,544	0.0055	13.00	14.52	8.06	5.71
Phase 4/12	4,320	18,440	0.0055	15.42	17.23	9.56	6.78

*High sulfur fuel oil; ** Combined Cycle Gas Turbine

From the table it can be seen that GHG emissions are negligible compared to thermal alternatives. Other emissions of DHP are also negligible, whereas thermal generation emits large amounts of fine dust (PM), carbon monoxides (CO), and nitrogen oxides (NO), resulting in severe health impacts and environmental damage.

7. Potential Impacts and Mitigation Measures

7.1. General

Most direct and significant negative impacts of the project are caused by the loss of existing physical infrastructure and land that will be flooded by the reservoir and by the need to resettle an estimated 6,953 people living in 34 small villages/hamlets in the lower parts of the Indus valley to higher altitudes on the mountain. Much land is needed for the location of project facilities, staff quarters and housing. Other adverse impacts will be mainly of temporary nature during the construction. However, the permanent presence of the Dasu hydropower plant, including all its facilities, and the permanent presence of WAPDA employees and their families will drastically change the life and the social and economic structure of the local communities in the area. The overall positive impact of the project, which is the installation of 4,320 MW of additional hydropower generating capacity, will be experienced countrywide. It will provide a major boost in energy production in Pakistan in an environmental friendly and clean manner with minimal carbon emission.

7.2. Impact Assessment Methodology

Potential environmental and social impacts were identified on basis of the earlier feasibility study (2009) and the focus group discussions and stakeholder consultation workshops which were held in Peshawar, Lahore, Karachi and Islamabad. The significance of potential impacts was assessed using the following criteria:

Impact Magnitude: The potential impacts of the project have been categorized as major, moderate, minor or negligible based on consideration of the parameters such as: (a) duration of the impact; (b) spatial extent of the impact; (c) reversibility; (d) likelihood; and (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 5**.

Table 5: Significance of Impact Criteria

	Sensitivity of Receptors			
Magnitude of Impact	**Very Severe**	**Severe**	**Mild**	**Low / Minimal**
Major	Critical	High	Moderate	Minimal
Medium	High	High	Moderate	Minimal
Minor	Moderate	Moderate	Low	Minimal
Minimal	Minimal	Minimal	Minimal	Minimal

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 these impacts and their significance is presented in **Table 6**.

Table 6: 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:						
Changes in physiography and landform	All phases	Mild	Major	Moderate adverse	• Development and implementation of a Landscape and Replanting Plan in the project footprint areas	Low adverse
Change in land use (3,900 ha) t	Pre-construction, Construction	Severe	Major	High adverse	• Compensation and assistance to affected households and communities according to eligibility matrix of RAP • Implementation of landscaping and plantation plan	Low to moderate adverse
Loss of natural vegetation and trees	Pre-construction, Construction	Mild	Medium	Moderate adverse	• Planting of native trees near resettlement villages and along roads • Promoting the use of alternatives to fuel wood • Afforestation and Forest Rejuvenation Plan	Low to Moderate Adverse
Inundation of 33 mosques in affected villages	Pre-construction, Construction	Severe	Medium	High adverse	• Disassembling and rebuilding of five wooden mosques in new resettlement villages at higher elevations, as discussed and agreed with the communities. • Replacement of remaining 28 mosques with the new ones in resettlement villages.	Minimal
Impact of increased traffic and transportation on KKH	All phases	Severe	Medium	High adverse	• Traffic Management Plan, including awareness raising and safety measures	Low to moderate adverse
Inundation of 52 km of KKH -	All phases	Very Severe	Major	Critical	• Realignment and construction of 62 km of new KKH at higher level	Minimal
Loss of bridges and access roads connecting villages on right bank	All phases	Severe	Major	High adverse	• Building of a new suspension bridges over the reservoir and construction of new access roads along the right bank	Minimal
Adverse impacts on natural habitat	All phases	Severe	Major	High adverse	• Study, selection and implementation of minimum two community-led conservation activities in the DHP sub-catchment areas • Supporting and promoting conservation activities in Kaigah game reserve • Compensation of community for any losses from sales of hunting permits during construction stage	Moderate to high adverse
Social impacts due to Project Siting:						
Change in land use (3,900 ha)	Pre-construction and construction	Severe	Major	High adverse	• Prepare and implement RAP; temporary lease of land needed for construction facilities	Low to moderate adverse
Resettlement of 767 households, totaling 6,953 people	Pre-construction and construction	Severe	Major	High adverse	• Compensation and assistance to affected households and communities according to eligibility matrix of Resettlement Action Plan	Moderate to high adverse
Relocation of shops/commercial establishments	Pre-construction,	Mild	Medium	Moderate adverse	• Compensation for lost assets and commercial enterprises • Assistance and livelihood restoration of affected persons	Low to moderate

Impact	Phase	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
	Construction				according to RAP	adverse
Loss of civic amenities	Pre-construction, Construction	Mild	Medium	Moderate adverse	• Rebuilding of civic amenities by project	Minimal
Loss of 143 ha agricultural land and 280 ha grazing land	Pre-construction, Construction	Severe	Medium	Moderate adverse	• Compensation for lost land, crops and fruit trees and livelihood assistance according to RAP • Implementation of Income and Livelihood Restoration Plan and Area Development and Community Support Program	Moderate to high adverse
Increased pressure on high altitude forests and grazing areas	All phases	Mild	Medium	Moderate adverse	• Forest management plan, including forest rejuvenation	Moderate adverse
Impacts of construction of 132 kV power supply line for project and colony	Pre-construction Construction	Mild	Medium	Moderate adverse	• Compensation of owners of land • Avoiding residential and agricultural areas and dense forest • Reduction of health hazards for community and workers	Minimal
Generation of sustainable employment	Construction and Operation	Mild	Medium	Moderate beneficial	• Fixed quota for local workers and technicians • Vocational training; monitoring of labor rights, workforce composition, working and living conditions	High beneficial
Increased economic activity	All phases	Mild	Medium	Moderate beneficial	• Establishment of new businesses and commercial enterprises; local employment	Moderate beneficial
Environmental Impacts during Construction:						
Increased traffic on KKH and local access roads	Construction	Severe	Medium	High adverse	• Traffic Management Plan, including awareness raising and safety measures	Low adverse
Impacts on Kaigah Community-managed Game Reserve	Construction	Severe	Medium	High adverse	• Monitoring of noise levels during the quarry operation • Reduction of duration, timing and strength of blasting operations and vibrations according to internationally recognized standards • Use of Kaigah quarry only for borrowing material for dam construction and construction of the new KKH section (limited period) • Control of access to the reserve area for workers and public in cooperation with the community • Awareness raising of workers, employees and general public regarding the importance of this area	Moderate adverse
Impact on river habitat due to construction activities and drying of river section between two coffer dams	Construction	Mild	Medium	Moderate adverse	• Control of waste water and sediment releases to river • Water quality management protocols in ECPs • Studies to improve aquatic baseline data; monitoring	Low adverse
Fish entrainment and mortality	Construction and Operation	Mild	Minor	Low adverse	• Protection measures at inlets of tunnels to deter movement of fish	Low adverse
Potential risk air, noise, soil and water pollution by construction works	Construction	Medium	Medium	Moderate adverse	• Pollution Prevention Plans to be prepared by Contractor • ECP plan by Contractor	Minimal
Risk of pollution from solid waste and waste effluents	Construction	Mild	Medium	Moderate adverse	• Waste Disposal and Effluent Management Plan • ECP by Contractor	Minimal

Impact	Phase	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Loss of land in disposal areas	Construction	Low	Minor	Minimal	• Re-use plan for rock material • Disposal Area Management and Restoration Plan	Minimal
Impacts of noise and dust from construction, traffic and use of explosives	Construction	Severe	Medium	High adverse	• No blasting during night time • Awareness raising and grievance mechanism	Minimal
Increased risk of landslides	Construction and Operation	Severe	Medium	High adverse	• Permanent monitoring in construction areas • Preventive measures in high alert areas • Emergency Preparedness Plan	Low to moderate adverse
Impacts from increased human activities on flora and fauna	All phases	Mild	Minor	Moderate adverse	• Use of non-wood fuel for cooking and heating • Improvements to community forestry management • Code of conduct for workers and employees • Awareness raising for workers and protection of flora and fauna	Moderate adverse
Risk of water pollution of storage tanks in reservoir area	Construction	Mild	Minor	Low adverse	• Removal of oil tanks and other potential sources of pollution from reservoir area	Minimal
Shortages in local water supply and sanitation in residential areas	Construction	Mild	Medium	Moderate adverse	• Drinking Water Supply and Sanitation Plan to be prepared by Contractor independent from local domestic services	Minimal
Disturbance of visual landscape and natural habitats	Construction and Operation	Mild	Medium	Moderate adverse	• Landscaping plan; establishing nurseries • Plantation of trees	Minimal
Social Impacts during Construction:						
Safety hazards due to increased traffic especially for children and elderly people; increased risk of accidents, unsafe working conditions and health risks for workforce	Construction and Operation	Severe	Medium	High adverse	• Traffic Management Plan addressing general access • Safety and security actions and procedures to protect local community • Occupational Health and Safety Plan to be implemented • Emergency Preparedness Plan; Contractor follows IFC Performance; Standards on Labor and Working Conditions; • Safety training for workers	Low adverse
Possible conflict and tension between communities and migrants	Construction and Operation	Severe	Major	High adverse	• Awareness campaign • Development of Migration Management Plan • Grievance mechanisms to address complaints	Minimal
Conflict due to inpparopriate behavior by workers	Construction and Operation	Mild	Medium	Moderate adverse	• Awareness campaign; Code of conduct for workers • Grievance mechanism	Minimal
Reduced safety and health risks by interaction of workforce with local residents	Construction and Operation	Mild	Medium	Moderate adverse	• Public Health Action Plan • Safeguards and awareness raising against communicable diseases	Minimal
Increased load on local services and supplies	Construction	Mild	Medium	Moderate adverse	• Contractor to procure camp supplies in a manner not affecting availability of essential commodities	Minimal
Environmental impacts during Operation and Maintenance:						
Impact on 571 ha of aquatic habitat along Indus and its tributaries in reservoir area	Operation	Mild	Medium	Moderate adverse	• Developing of fish hatchery with native snow carps for stocking fish in the affected tributaries and reservoir • Monitoring of spawning areas	Low to moderate adverse

Impact	Phase	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
					• Monitoring programs	
Impacts of first filling of reservoir on safety of people and livestock and stability of slopes	Operation	Severe	Major	High adverse	• Awareness campaign and warning signs • Slow rate (1 m/day) • Permanent monitoring of slopes	Minimal
Barrier effect to fish migration	Operation	Mild	Medium	Moderate adverse	• Compensatory fish hatchery • Study of fish migration; establishment of baseline data	Low to moderate adverse
Reduced water flows between dam and tailrace (4.4 km) during low flow season	Operation	Very Severe	Major	Critical	• Release of 20 m3/s of environmental flow from dam and 222 m3/s from tail race • Downstream monitoring and adjustment of flows if required	Moderate to high adverse
Impact on downstream and aquatic habitats and fish due to changes in water flows and quality (temperature, DO, sedimentation)	Operation	Mild	Medium	Moderate adverse	• Monitoring of downstream water quality and aquatic habitats	Low to moderate adverse
Impact of sedimentation on reservoir area	Operation	Severe	Medium	High adverse	• Yearly flushing after 10-15 years of operation • Reduction after completion of DB dam	Low adverse
Impact of daily reservoir operations during base-load operation	Operation	Mild	Moderate	Moderate adverse	• Fish Conservation and Management Plan • Monitoring and study	Low adverse
Impact on downstream fish and fisheries during flushing operation	Operation	Severe	Major	High adverse	• Flushing during high flow season (not in low flow/winter) • Development of ramp down criteria (5-10 cm/hr) • Monitoring dissolved oxygen and temperature in reservoir and de-stratification or simultaneous release of water from LLOs and spillways if required • Downstream monitoring of fish, habitats and sediments	Moderate to high adverse
Impact on downstream fish and fisheries due to changes in hydrological flows due to peaking operations	Operation (Post DB)	Mild	Medium	Moderate adverse	• Continuous operation of one turbine • Using remaining flow for peak operation	Low adverse
Risk of bird collision and electrocution with transmission cables	Construction and Operation	Mild	Medium	Moderate adverse	• Carrying out of avian risk assessment • Maintaining 1.5 meter spacing between energized components and grounded hardware; covering energized parts and hardware • Installing visibility enhancement objects such as marker balls, bird deterrents, or diverters	Low adverse
Social impacts during Operation and Maintenance:						
Creation of large number of employment opportunities through reservoir fisheries	Operation	Severe	Major	High beneficial	• Fish Conservation and Management Plan • Employment of local people	Beneficial

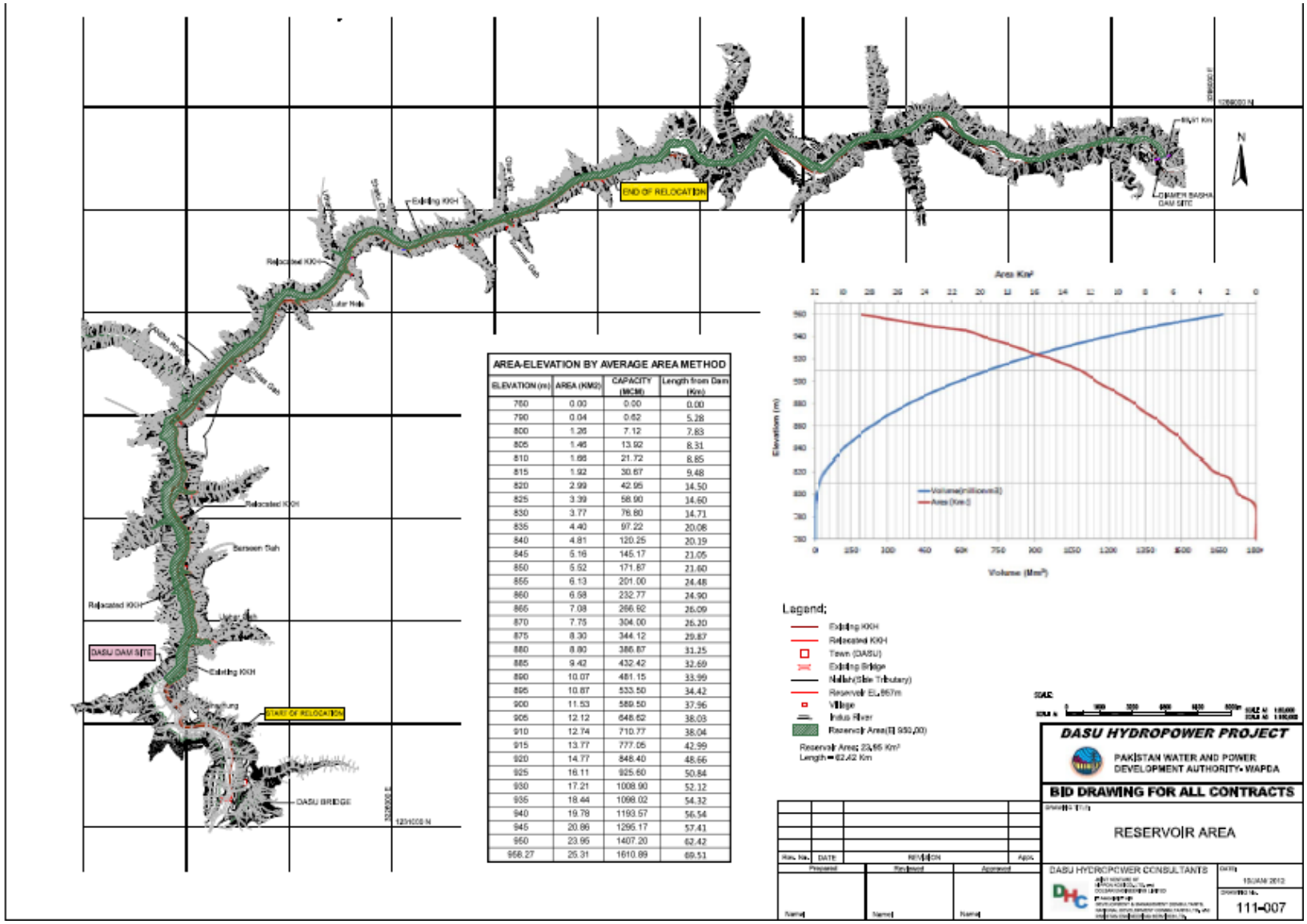
7.4. Environmental impacts due to project siting

Change in physiography: The character of the Indus River and its valley bottom will change from a fast flowing uncontrolled sediment-laden river with steep rocky slopes into a narrow controlled water reservoir (average width 365 m), extending about 73 km upstream at fsl (see **Figure 4**). The reservoir will penetrate several km inland in lateral valleys of tributaries and nullahs (small streams) and is expected to develop similar aquatic and terrestrial natural habitats as now can be found at the confluence of snow-fed small streams with the Indus. Farm lands on terraces along these minor streams, including small hamlets up to a level of 957 m, will be flooded by the reservoir. The reservoir will have a depth between 100 and 175 m near the dam. Reservoir storage volume is expected to decrease by 80 percent due to rapid sedimentation about 15 years after commissioning of the Dasu dam. Hence flushing will be carried out every year after the 15th year for releasing sediments from the reservoir. If however DB dam is commissioned by that time, sedimentation inflow into the Dasu reservoir will be reduced and flushing of Dasu will not be required for another 35 years. Downstream of the main structure the topography of the lower slopes of the valley will drastically change through excavation and blasting in order to create level terraces (154 ha) to establish construction yards, offices, camps, housing and disposal areas for the project.

Change in land use: Land use on about 3,900 ha will change as a consequence of the project (to be replaced by project infrastructure, resettlement villages, reservoir and KKH). Natural and semi-natural habitats in this area mainly consist of steep rocky slopes covered with Artemissia and low scrub vegetation (2,380 ha), river and nullahs (1067 ha), forest patches and tree clumps (50 ha) and exposed riverine sand areas (139 ha). Around 425 ha of farmland on terraces, grazing areas and some orchards will be flooded and disappear into the reservoir. The total area covered by the reservoir is about 2,400 ha. The loss of natural and semi-natural habitats, both with limited biodiversity, is relatively minor and will be partly compensated by the natural development of a lacustrine and partly wetland environment with potential for fisheries and some tourism development. There are no critical habitats directly influenced by the project. The loss of farmland will be compensated under the resettlement framework and where available alternative new agricultural lands will be reclaimed at higher altitudes. Compensation for lost assets of affected households and persons has been indicated in a detailed eligibility matrix that is part of the RAP. Livelihood restoration (short-term and long-term) for those affected by loss of land is a major issue.

Loss of natural vegetation and trees: For the project some 21,000 trees will have to be cut, including 2,982 fruit and medicinal trees, most of them growing in the villages and along roads. Trees should be cut prior to the flooding of the reservoir area. Small bushes and other vegetation can be left to be inundated. Loss of trees and natural vegetation will have an effect on the collection of firewood. Selling of fire wood is an important source of income for the population of the project area and a common practice along the KKH both in winter season (heating and cooking) and summer (cooking). People will move to higher places in order to collect firewood. It is expected that the project will attract about 7,000 in-migrants. This influx will create a huge demand for firewood due to increased energy requirements for cooking and heating during winter. This is expected to increase the pressure on forest resources at higher altitudes. These areas, often covered by Himalayan temperate forests and Alpine forests, are already under severe stress. Mitigation of the loss of trees is included in the eligibility framework laid out in the RAP, and will also be compensated by planting trees (at a rate of 5:1) near the new resettlement sites, in the WAPDA colony, and along roads. The project will also support the local government to establish a market for the supply of non-timber fuels such as liquid petroleum gas (LPG) for cooking and heating in order to reduce the pressure on firewood. At higher altitudes a project plan for afforestation and rejuvenation of forest will be prepared and implemented for the conservation and sustainable development of forest ecosystems in compliance with World Bank OP 4.36 on Forests. According to WWF-Pakistan this can only be done after an updated GIS forest inventory of Kohistan has been carried out. Such an inventory should be included in a forest and wildlife management study, which should be implemented during the construction phase of the project (see also section 7.5 under increased pressure on high altitude forests).

Impacts on natural habitat: The DHP reservoir will cover about 2,400 ha, which includes permanent flooding of about 1,800 ha of natural terrestrial habitat. Most of the affected terrestrial habitat is covered with barren rocks and slopes with little vegetation. Based on analysis of satellite imagery and field surveys, the affected land is mostly covered by barren slopes/rocks (61 percent), followed by river/nullahs (27 percent), grazing land/pasture (6 percent), exposed sand (3.5 percent), vegetation cover (1.3 percent), cultivated land (0.92 percent), and houses (0.13 percent). The key impact would include loss of about 82 ha of natural habitat from the Kaigah Community Game Reserve (including the area affected by KKH relocation).



AREA-ELEVATION BY AVERAGE AREA METHOD

ELEVATION (m)	AREA (KM2)	CAPACITY (MCM)	Length from Dam (Km)
780	0.00	0.00	0.00
790	0.04	0.62	5.28
800	1.26	7.12	7.83
805	1.46	13.92	8.31
810	1.68	21.72	8.85
815	1.92	30.67	9.48
820	2.99	42.95	14.50
825	3.39	58.90	14.60
830	3.77	78.80	14.71
835	4.40	97.22	20.08
840	4.81	120.25	20.19
845	5.16	145.17	21.05
850	5.52	171.87	21.60
855	6.13	201.00	24.48
860	6.58	232.77	24.90
865	7.08	266.92	26.09
870	7.75	304.00	26.20
875	8.30	344.12	29.87
880	8.80	386.87	31.25
885	9.42	432.42	32.69
890	10.07	481.15	33.99
895	10.87	533.50	34.42
900	11.53	589.50	37.96
905	12.12	648.62	38.03
910	12.74	710.77	38.04
915	13.77	777.05	42.99
920	14.77	848.40	48.66
925	16.11	925.60	50.84
930	17.21	1008.90	52.12
935	18.44	1098.02	54.32
940	19.78	1193.57	56.54
945	20.86	1295.17	57.41
950	23.95	1407.20	62.42
958.27	25.31	1610.89	69.51

Figure 4: Reservoir Area

The game reserve is bordered by the KKH and located at a short distance from the proposed quarry site. In the area limited hunting of Markhor (one license only) is allowed by the KP wildlife department. With the proceeds of the yearly auction of hunting rights a number of community development activities are financed, including construction of a few hunting lodges. About 1.6 percent of the 5,000 ha area of the game reserve will be permanently affected by the project due to reservoir submergence and KKH realignment. The permanently affected area is located on the lower elevations of the reserve, which is mainly inhabited by the community of Kaigah village and consists of residential areas, some agricultural fields, grazing areas, and also an existing quarry site. The rest of the area will be temporarily affected by noise from construction activities. (construction related impacts are discussed later in this chapter). In addition, there will be loss of about 160 ha natural habitat along the tributaries and about 1,550 ha of other natural terrestrial habitat with low biodiversity, consisting mainly of gravelly and rocky mountain slopes, often sparsely vegetated. Other natural habitats that may be indirectly affected by the project (through resettlement of people) are the forests and grazing areas mostly located at higher altitudes (>2,000 masl) as discussed above. To mitigate the potential impacts on these areas, the project will support the identification and development of two compensation areas (offsets) for conservation of natural habitat and wildlife, in compliance with World Bank OP 4.04.

Impacts on PCRs in project area: A total of 33 mosques (five of them are of wooden structure) together with houses and other structures in the affected villages will be flooded by the reservoir. In consultation with the local community it was agreed that the affected wooden mosques will be disassembled, transported and reassembled in the resettlement villages at higher elevations. The remaining 28 mosques will be replaced with new ones in the resettlement villages. Also 16 graveyards spread over the valley will be submerged by the reservoir. Alternative proposals for mitigation were discussed with the various communities. Most preferred to leave the graves at the place of burial. Other cultural resources that will not be submerged but should be protected against adverse impacts from the project are the burial ground in Seo, which is near the disposal areas and the cluster of petroglyphs (rock carvings) near Shatial, which is part of a much larger field of 50,000 rock carvings extending from Shatial over more than 100 km towards the bridge of Raikot. This is one of the largest fields of rock art in the world, with carvings dating from the Stone Age (9th millennium BCE) to the Buddhist period. The project will support the KP Archaeological Department in procuring the land where the rock carvings of Shatial are located, providing proper fencing and protection of the carvings and developing tourist facilities at the site. Also support for documentation will be provided, In case of any chance finds discovered during construction activities, the works will be stopped in the area and the Archaeological Department will be informed. Provisions for this will be included in the contracts and a qualified archeologist will be on standby during the construction period. Furthermore, an archaeological survey will be carried out by an archaeologist engaged by WAPDA before the commencement of construction activities in the project area to identify any PCR sites/artifacts.

Impacts due to increased traffic and transportation: During the design stage and during mobilization of the Contractor, traffic along KKH and in Dasu-Komila town will increase and this will only grow when construction starts. This will lead to congestion at certain places like the main street, central markets and bus stops. Apart from congestion there will be increased air pollution and noise at these places. This may result in friction with shopkeepers, hotel/restaurant owners and the general public. Road safety will decrease and risk of accidents will increase. In order to be prepared for this situation a Traffic Management Plan will be prepared by the PMU in cooperation with the Contractors and the local authorities. This plan should include a proposal for a by-pass road along the main markets of Dasu-Komila. In total about 13 km of by-pass roads are foreseen.

Inundation of 52 km of KKH: Around 52 km of the KKH will be submerged by the reservoir. This part of the road lies between Dasu and Shatial. A new alignment will be constructed at a higher level on the left bank of the Indus. A total of 65 km of highway will be constructed, including 10 km of road downstream of the dam and a link road 3 km long. Eight new bridges on the KKH will have to be built to cross nullahs and small streams. About 45 ha of land will be acquired for road construction purposes.

Loss of access to villages: Two suspension bridges over the Indus connecting both river banks and some secondary access roads on the right bank will be lost. As compensation for these losses a new suspension bridge near Kandia and a total of 35 km of new access roads, from Komila to Kandia bridge, will have to be built, all at a higher level on the right bank of the Indus. A new jeepable track of 18 km along the right bank north of Kandia bridge will provide access to the villages on the right bank. All new settlement sites should be provided with good access roads. Other existing facilities for pedestrians to cross the river, such as foot bridges and cable cars should be replaced by appropriate alternatives.

7.5. Social Impacts during Pre-construction Stage

Land acquisition for the project: A total of 4,643 ha of land will be acquired for the project (not including the future 500 kV transmission line). This includes 2,778 ha for the reservoir (which is land below the 1,000 m asl), 174 ha for physical project infrastructure and 205 ha for construction of roads (KKH and access roads). Temporary leasing of land might be needed for the period of construction for installing of construction facilities such as batching plant, construction workshops, labor camps and borrow areas. In the area to be acquired, apart from natural wasteland, some 425 ha of agricultural land are included, consisting of farm land, grazing areas and orchards. Family income from land in terms of crops, fodder and forest products will be lost. This will require proper compensation measures, resettlement at higher altitudes and assistance including livelihood restoration. Agricultural compensation is problematic since new cultivable lands at higher altitudes are extremely scarce and generally low in fertility. New sources of employment and living will need to be found. According to inventory surveys and a census, a total of 767 households consisting of some 6,953 persons, more or less equally divided between the river banks, will be affected by the project and will have to be resettled above 1,000 m or elsewhere. A RAP has been prepared to address and mitigate the impacts on the affected households. The objective of the plan is to restore the income and livelihood conditions of the people to at least pre-project level. The affectees will not only receive cash compensation for land based on rate basis negotiated by the District Collector with the affected communities/jirgas for land, structures and other assets, but also will be given additional assistance for relocation, re-employment and livelihood restoration.

Relocation of inhabitants of 34 hamlets: The footprint of the project will affect 34 hamlets and villages, each of them often consisting of not more than 25 to 30 houses. A total of 923 structures will be lost of which 83 percent are residential structures. Given the past experience of resettlement in Pakistan and the DHP context in particular, the project has adopted a community based relocation strategy to sites in upper elevations. In this approach the community will be relocated to sites of their own choice and is characterized by: (a) community decision making with regard to site layout and civic amenities to be established; (b) site and services development at project cost; (c) subsidized plots for each affected family of the concerned community settling on higher elevations; and (d) shifting and reconstruction grants as per the entitlement matrix. The approach for community preferred sites was well received (90 percent) and considered practical by the jirgas, as well as at stakeholder workshops. Only a limited number of affected households (10 percent) want to move on their own to other places in Kohistan and as far as Mansehra and Abbottabad mentioning their kinship links in those places and/or availability of cheaper land for resettlement, including more job prospects in the cities. This may be a feasible option on a household basis; choices and responses will be further confirmed at the implementation stage. The resettlement process will be a dynamic one, and the project management team will adopt a flexible and open attitude towards people's requests and continue to explore potentials options while maintaining the main focus of relocation to upper elevations. All resettlement options and requests will be subject to careful technical assessment, review, consultation and agreement with the concerned communities.

Relocation of 50 shops and commercial establishments: Most of the commercial enterprises affected by the project are located on the left bank of the Indus, near the KKH. The commercial enterprises on the right bank usually consist of residential houses with a small shop as annex. Compensation and/or resettlement assistance is worked out in detail in the RAP and the Resettlement Framework.

Loss of civic amenities: A survey of 27 out of 34 villages revealed that there are 31 existing mosques, seven schools, two basic health units, three community centers and 17 graveyards, as well as facilities for drinking water supply and irrigation, and latrines. Surveys of community assets for the remaining villages are ongoing. Most of the affected villages have direct access roads from KKH (left bank) or internal access roads (right bank). The RAP has provisions for reconstruction of these civic amenities at new sites in the upper elevation as desired by the communities, including the provision of electricity.

Loss of 425 ha of farm land, grazing area and crops: About 600 families that are presently involved in terrace agriculture will lose their crops in the lower valleys and along the banks of the Indus River. However, many have lands in high-altitude lateral valleys where crop production is possible during the warmer summer season. The combination of summer and valley crops is sufficient for family consumption requirements (there is no local market). Many farm families focusing on limited terrace cultivation will continue with crop cultivation at higher elevation. Livestock herding at higher altitudes during summer will continue, but the winter farming activity along the river embankments will cease after the construction of the dam. In order to mitigate these adverse developments an adequate livelihood restoration program has been developed to sustain and improve agriculture and livestock herding. Simultaneously, new opportunities such as reservoir fisheries development, an Afforestation and Forest Rejuvenation Plan and provision of temporary employment and additional income

in clearing of vegetation and trees in the reservoir area, and other social development activities have been designed in the RAP and EMP.

Increased pressure on high altitude grazing area and forests: Resettlement of 767 families above 1,000 m altitude will mean that pressure on the mountain zone between 1,000 and 1,500 m and higher will increase. The grazing areas and forests around 2,000 m are already under pressure, resulting in deforestation, erosion and decrease of flora and fauna. This pressure will certainly increase as a consequence of the project. An Afforestation and Forest Rejuvenation Plan will be prepared, with the objective of forest rejuvenation and sustainable management of forests and grazing areas at higher altitudes. This will be implemented as part of the EMP with support of the livelihood restoration program.

Impacts of the construction of the 132 kV power supply line to project and colony: The construction of 45 km of transmission line for power supply of the project during construction will require land acquisition for the footprint of the 233 towers of the line. Total land acquisition is low (about 1 ha) and no resettlement is expected. There may be other impacts on crops, trees and structures as well as restriction on use of land in the corridor. Detailed impact surveys will be carried out and compensation plans will be prepared following the project resettlement policy framework already developed as part of the SRMP.

Generation of employment in the region: Currently only 26 percent of the population is employed, most of whom are self-employed in agriculture or livestock holding or as small shopkeepers. About 17 percent of those employed work as unpaid family helpers. Only 12 percent are employees. The project offers good opportunities for local residents to apply for employment as unskilled and skilled construction workers. The construction contracts will require the Contractor(s) to employ local workers and technicians on the basis of an agreed quota. Construction works will offer opportunities for unskilled workers and technicians for about 10 years. There will also be employment opportunities for office staff, administrative and logistic functions and in transportation. Important for sustainable livelihood restoration is that sufficient vocational training and skill development is provided. A pro-active program to this end has already been started by WAPDA**:** local youths are receiving six months of vocational training in various lines of work to prepare them for guaranteed jobs in the project construction work. Establishment of vocational training centers for men and women will be part of the project resettlement plans. After the construction phase there will be other opportunities for more permanent functions within project operation and maintenance. These opportunities for work for local residents could boost employment and improve the social and economic position of the population. This will be a major and significant positive impact of the project.

Increased economic activity: The considerable influx of people during all phases of the project (up to 12,000 during construction) will considerably stimulate the local economy, by involving local businesses and village level enterprises. New opportunities for local businesses, suppliers, hotel owners, shopkeepers and the transportation sector will be created.

7.6. Environmental Impacts during Construction Stage

Increased traffic on KKH and local access roads: The KKH is the lifeline of the northern areas and the only highway connecting China and the north of Pakistan with the rest of the country. About 2,590 vehicles per day, including 200 heavily loaded trucks, currently use the KKH for transportation of goods. During construction of the project it is estimated that daily 200-300 extra trucks, needed for the supply of construction materials, will make use of the KKH. Additional project vehicles using the KKH and exceptional heavy transports of turbine sections may cause traffic congestion and safety hazards. The access road to the project running along the busy Komila bazaar and those from borrow areas and to deposition sites are also expected to create traffic problems and safety hazards. To mitigate these problems the Contractor(s) will be required to prepare a Traffic Management Plan coordinated and supervised by the PMU and in cooperation with the local authorities. This plan should include safety measures, traffic control measures, provision of by-passes at busy places and provisions for repair of damage caused by project vehicles.

Impacts on Kaigah Game Reserve: Noise and vibrations from blasting and excavation operations from the quarry (expected to last about 2.75 years) together with 5.5 km of KKH construction within the borders of the game reserve (expected to last about 7-8 months) will have negative impacts on wildlife. Most wildlife habitat in the reserve is located about 3-5 km from the construction activities, higher up in the mountains. Impacts are expected to be limited to lower altitudes - areas that are likely to be avoided by wildlife most of the year. The project may also result in a reduction of community income for conservation management during the years of construction, which comes from the sale of hunting permits (limited trophy hunting). Controlled and optimum blasting and regular monitoring should be done in order to comply with international standards to avoid impacts on wildlife as much as possible. The impacts on people, wildlife and hunting activities should be strictly

monitored and compensation should be paid for the loss of income due to project activities in and near the reserve. The community will be consulted and involved in promoting and strengthening ecological conservation measures in the game reserve.

Impact on river habitat due to construction activities in the river: To facilitate construction of the dam, coffer dams will be placed upstream and downstream of the work areas to keep the river bed dry for about 980 m. Aquatic biological production will be eliminated from this stream length, part of which (the dam footprint) will be removed for the life of the dam. Pre-construction and construction activities have the potential to adversely affect aquatic biota due to use of explosives, and release of high concentrations of sediment, fuels/oils and other toxic compounds, and solid waste. High sediment loads will be produced during placement of the coffer dams and again when water first passes through the work area after completion of dam and plunge pool construction. Sediment concentrations above natural levels can cause mortality of biota directly; for fish, damaged gills and sediment clogging of gill chambers eventually leads to death. Measures proposed in ECPs to protect the water quality will mitigate the potential effects on fish.

Entrainment and mortality of fish: The construction of diversion tunnels where high water velocities may develop will have an impact on fish. Fish trying to move downstream in water conduits such as diversion tunnels, powerhouse intake tunnels, LLOs and spillways will potentially be subjected to high levels of mortality and injury. Inlets will have to be protected either with electric or acoustic methods to prevent fish from being caught by the flow.

Potential risk of air, soil and water pollution: During construction there is a high risk of accidental spills and leakages from fuel and oil tanks, vehicles, machinery and stored chemicals that are used in construction areas, yards, batching plants, quarry areas, worker camps, residential areas and storage sites. These spills can pollute soils and contaminate surface and groundwater in the area. Air pollution may be caused by emissions from construction related traffic and machinery. A Pollution Prevention Plan will be prepared prior to the start of work. Proper baseline data of soil, air and quality of surface and groundwater should be collected in advance. Moreover the Contractor(s) should implement the measures prescribed in the ECPs, which will be included in the contracts. Contractors should take appropriate measures to avoid and contain any spillage and pollution of the soil and water resources both upstream and downstream of the dam. Construction equipment and vehicles should be well maintained, so that emissions are minimal. Dust generation from construction sites should be restricted as much as possible and water sprinkling should be carried out as appropriate, especially at those places where earthmoving, excavation and blasting will be carried out. Air quality should be properly monitored, especially near the population centers and WAPDA colonies. Detailed ECPs are included in the main ESA.

Potential loss of land in disposal areas: With the construction of tunnels and underground chambers to house the powerhouse and switch yard facilities, huge quantities of rock will have to be excavated and brought to the surface. It is estimated that the quantity of rock to be excavated will be 10.25 million m^3, excluding the excavations from KKH. Around 7.2 million m^3 will be generated in the first phase. Excavated rock can be used for various types of infrastructure works, including road construction. Part of the excavated rock can be used as concrete aggregate provided it meets the quality standards needed for the work. Mixing with freshly quarried rock is possible. The remaining spoil will be disposed of in designated and safe disposal areas. Several potential disposal areas have been identified. Potential risks of pollution of groundwater resources by excavated rock material containing heavy metals will have to be verified by the Contractor(s). A re-use plan for excavated material and a spoil disposal plan should be prepared in advance.

N**oise and dust generated by construction works, increased traffic and use of explosives**: It has been estimated that at least 20,000 tons of explosives will be used for excavation of tunnels and rock chambers and for construction of the main structure and the road. Apart from noise produced by blasting and drilling operations, a lot of noise and dust will be produced by excavation equipment, other machinery, concrete mixing, and traffic from trucks and vehicles. The city of Dasu-Komila and the village of Seo are very vulnerable to the increased noise from traffic. Noise levels may exceed the national standards. Noise from explosions and ground vibrations will be common during excavations. At low to medium levels, ground vibrations and air blasts can result in community annoyance. At higher levels this can lead to structural damage to buildings. As mentioned earlier, the use of explosives may also scare away wildlife at the Kaigah Community-managed game reserve and elsewhere in the project area. Continuous monitoring of noise levels is essential, as well as continued consultations with the affected communities.

Increased risk of landslides: During construction there will be an increased risk of landslides and slope collapse. Landslides are natural and common phenomena in the project area and along the KKH. Landslides on

freshly-cut slopes can occur due to lubrication or saturation of the rock support structure by rainfall or water seepage. The use of explosives to break the rock can generate vibrations that can trigger a landslide. Landslide-prone areas in the project area have been identified and classified on the basis of potential risks. Any blasting activities in these areas should be controlled and contained within defined limits. Pro-active measures should be developed to stabilize and protect slopes and to protect worker safety. Access will 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. Permanent monitoring by the Contractor is required.

Impacts of increased human activities on flora and fauna: Human activities during construction will strongly increase in the area with the influx of 7,000 in-migrants, including construction workers and technicians, suppliers and business men and followers. The population increase will create a huge demand for firewood due to increased energy requirements for cooking and space heating during winter, and will put more pressure on community forest resources. Contractors should include provisions in the contracts for the supply of non-wood fuels such as LPG to the construction staff for cooking and heating purposes and the project should support development of an LPG market in Dasu. The project will also support the improvements required for community forestry management. A forestry management study is proposed during the pre-construction stage to identify and develop forestry management opportunities. The population increase will also have an impact on the local environment through increased pollution, noise, disturbance, hunting, poaching and fishing. The Contractor should introduce and enforce a Code of Conduct and raise awareness about the protection of flora and fauna among the work force to reduce impacts such as disturbance and poaching. In addition, WAPDA will maintain a liaison with the concerned departments and local community for the protection of the forest and wildlife of the area.

Risk of water pollution from storage tanks: By converting the valley into a reservoir, oil tanks and underground storage containers (chemicals, lubricants, and pest control agents) present in the area will be submerged, with the risk of serious pollution of the water of the reservoir. These should be identified and removed during the construction period and prior to the first filling of the reservoir.

Risk of pollution from solid waste and waste effluents: Large construction works generate large quantities of excess materials from construction sites (concrete, steel cuttings, discarded material) and wastes from field camps and construction yards, including garbage, recyclable waste, food waste, and other debris. In addition small quantities of hazardous waste will be generated from maintenance activities, including contaminated soil, oil filters and other waste products. The Contractor will identify suitable sites for disposal of hazardous and non-hazardous waste. The selection will be done in consultation with the PMU and the local municipal authorities. Protocols and measures will be prescribed in the ECPs to be included in the contracts with the Contractors. Siting of any fuel and hazardous material storage sites, including refueling facilities, asphalt plants and construction yards are to be located at minimum 100 m from the banks of any streams and at least 500 m away from any residential areas, cultural or archaeological sites.

Shortages and/or negative effects on local water supply and sanitation: The influx of large numbers of workers, technicians and staff and their families will require well-organized drinking water supply and sanitation facilities. A Drinking Water Management Plan, based on separate water supply and sanitation for the work force, will have to be prepared by the Contractor. In designing such a plan it is important to maintain and safeguard the water supply and sanitation facilities for the local population.

Disturbance of visual landscape: The project will drastically change the visual landscape at the project site and especially at places where slopes have been excavated for construction of roads and project infrastructure, at disposal sites and in borrow areas. Proper landscaping will have to be done and an overall Landscape Plan will have to be prepared, that will be worked out in more detail for the area where the project infrastructure is located. Also landscape plans for the residential areas and the offices should be developed to create a good living and working environment. Tree planting should be well organized and where possible vegetation and natural habitats will have to be restored.

7.7. Social Impacts during Construction Stage

Safety hazards for children and elderly people due to increased traffic: The construction activities can potentially impact the residents of Dasu-Komila and along KKH, particularly the movement and safety of school children. In addition, due to increased use of trucks and other vehicles on the narrow roads in the project area and on the access roads, pedestrians, particularly elderly people and children, will be more exposed to dangerous situations, which may lead to traffic accidents. The Traffic Management Plan that will be implemented will aim at ensuring access to residential areas, and preventing unsafe situations, especially near

schools, housing areas, construction areas, camps and offices. There will be appropriate medical services and a facility with the capacity to treat emergency cases and trauma patients.

Possible conflict and tension between communities and inmigrants: The project construction will bring significant changes in the lives and livelihoods of the local people, including new opportunities for employment and income. The development will also attract several thousand new in-migrants to the project area. This influx of workers, business people and followers will increase the population of Dasu-Komila more than three times within a few years. Unless properly managed, this sudden influx of people could have negative impacts, such as an increased crime rate, tensions and social conflicts between the various groups. In order to prevent such problems, the project will develop a pro-active Migration Management Plan (included in the Management Plan for Construction-related Impacts – Volume 8 of SRMP), before the arrival of the first in-migrants. This plan will address key issues, including housing and accommodation, food security, local infrastructure, community health, labor contracts, employment and business opportunities, security, integration and cultural understanding and community and area development. Plan procedures and rules will be worked out by the PMU in close cooperation with the Contractors and local authorities.

Conflict due to culturally inappropriate behavior by workers: Workers coming from different parts of Pakistan may have norms and values in social behavior and religion that differ from those of the resident population. This situation will be addressed by an awareness campaign implemented in the beginning of the construction phase. The Contractors should be aware of the possibility and risks of miscommunications between local residents and workers, which easily could lead to social unrest. This should be prevented by raising awareness and implementing a Code of Conduct for the workers.

Reduced safety and adverse effects on health situation: The influx and accommodation of a large work force will result in increased concerns for the safety of the local population, particularly women and children. These concerns will be addressed by raising awareness of the associated risks for the local population. The awareness campaign will also be aimed at the risk of interaction between the resident population and the construction work force, including the spread of sexually transmitted diseases. Apart from awareness raising and prevention, the medical health facilities in the project area will be supported to deal with such incidences. Measures to this end are included in a Public Health and Safety Plan that will be implemented.

Increased load on local services and supplies: The project area is situated in a remote area far from the main population centers of the country. Especially at the beginning of the project, there will be a limited number of shops, markets, service providers and suppliers of commodities. With the presence of a considerable work force in the area there could be shortages for the resident population, especially since the area is dependent on supplies transported along the KKH, which is often blocked for one or more days This potential impact will be mitigated by requesting Contractors to procure their supplies in a manner that will not significantly affect the availability of essential commodities in the area for the residents.

Increased risk of accidents for workforce: The rough terrain and difficult work conditions in some parts of the area will require the Contractors and project management to pay close attention to the increased risk of accidents, unsafe working conditions and health risks. This is especially true for underground work in tunnels and caverns, but also during excavation and construction work. The Contractors should follow closely the International Finance Corporation (IFC) Performance Standard on Labor and Working Conditions, as well as EHS Guidelines. Special attention should be focused on safety training for workers to prevent and minimize accidents and also on how to deal with emergencies.

7.8. Environmental Impacts during Operation and Maintenance

Impact on 570 ha of aquatic habitat of the Indus and Indus tributaries through the creation of the reservoir. About 570 ha of river and tributaries will be the subject of biotic and abiotic changes caused by the reservoir. Reservoir ecology will not be typical of a natural lake environment and will undergo rapid reduction in size caused by rapid sedimentation. Water velocities along the length of the reservoir will generally be lower than in pre-reservoir river conditions. Although the reservoir will resemble a lake, surface water velocities will be high compared to most lakes and storage reservoirs. The relatively high water velocities suggest that conditions may be mainly compatible for riverine fish species, particularly along the reservoir shoreline. Spawning areas in the tributaries will be submerged and it is expected that new natural spawning areas could develop at the confluence of tributaries with the main water body at its higher end. Maintenance of these spawning areas could stimulate a proper shallow aquatic habitat with sufficient places for hiding and feeding for fish, including snow carp and other species. Developing a fish hatchery for production of native snow carp (such as are already established in India and Nepal) and stocking of snow carp in the tributaries and reservoir is recommended to compensate for the loss of habitat and fish catches through DHP. Further studies are

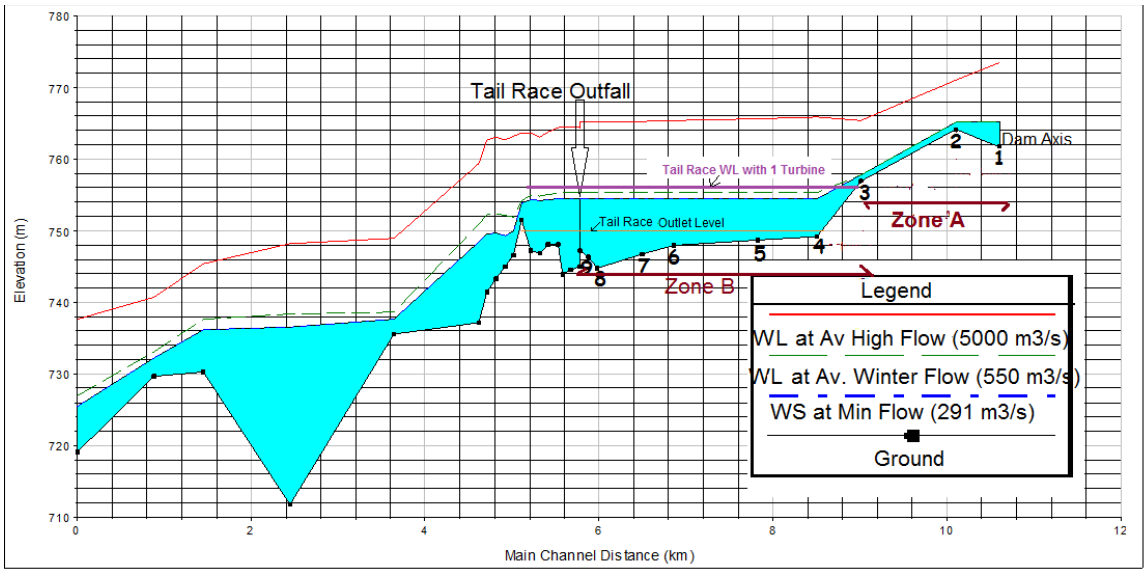
recommended during construction and operation to establish detailed baseline data on aquatic ecology and to carefully monitor the actual impacts, in order to develop additional offset measures and research on hatchery development as required.

Impacts of first filling of reservoir on safety of people and livestock and stability of slopes: Upon completion of the main structure, the reservoir will be filled at a slow rate. First filling is possible during either high or low flow season, but the optimal and easiest is to start around mid-June in the beginning of the high flow season. The water level is expected to rise around 1-2 m per day. This slow rate is maintained in order not to destabilize the slopes of the valley and to prevent landslides; it will also provide an opportunity for most of the terrestrial fauna to escape to safe heights. Within hours the water level will reach the LLOs. From this moment the water level rise will be controlled by opening the LLOs in the main structure and releasing the extra inflow into the river. The entire first-filling operation will take about two months. During this period, the flow from the reservoir to the Indus downstream will be slightly reduced. In total about 2 percent of the total annual water flow is needed to fill the reservoir. If the operation is implemented at the start of the high flow season, the reduction in annual water flow will not be noticeable and is not expected to affect the downstream water flow, aquatic habitats, fisheries and irrigation requirements. Once the fsl (950 masl) is reached, the LLO will be closed and additional water coming into the reservoir will be diverted through the intake tunnels to the powerhouse and after power generation released through the tailrace tunnels. At this stage the "run-of-river" operation is reached, which means that the flow downstream reflects the natural flow conditions of the river. The impact of first filling of the reservoir and the subsequent operation of the plant on the hydrological regime of the river thus are minimal. During the high flow season (June-September), when water will enter the reservoir at a rate greater than the water diverted through the power inlets (2600 m^3/s), the additional water will pass over the spillway.

Barrier Effect on Migration of Fish: By building the main structure on the Indus, a barrier will be created that impairs the ecological connectivity in the river, including the movement of biota and the migration of fish. Fish production in the Indus River within the project area is low, the main reasons being the fast torrential stream, the cold, glacier-fed water, the high sediment load, and the low trophic level of the water. No long distance migratory fishes are present in the project area that could be affected by the dam. Snow carp migration is within the tributaries and hence will not be affected by the dam. Further studies will be carried out (during pre-construction/construction) to strengthen existing knowledge on fish biology and the ecological baseline for the Indus corridor between Raikot and Tarbela, in order to better understand and mitigate the impacts of the project and to prepare adequate offsetting measures for fish and fisheries in the DHP. This knowledge will also serve for other hydropower projects in the UIB such as DB.

Reduced water flows between dam and tailrace: The river reach from dam-axis to tailrace discharge point is about 4.8 km (Zones A and B in **Figure 5**).

Figure 5: River Profile and Water Levels Downstream of the Dam Site



From June to September, when the average river flow is higher than 2600 m^3/s (the flow required to run all turbines), the excess water will be discharged through the spillways/LLOs thus maintaining (a minimum of 165 m^3/s in September to a maximum of 3,980 m^3/s in July) flow through Zones A and B. However, from October

to May, when the average flow is less than 2,600 m^3/s, there will be no water released downstream of the dam and all water will be diverted to the power house and will be released to the river through the tailrace outlet. A small tributary - Sieglo stream - joins the Indus in this reach (about 1.2 km downstream of the dam). The average annual runoff from this stream is 1.7 m^3/s with average runoff less than 0.5 m^3/s during low flow season, which indicates that most of this section will be dry during low flow season. Nearly 0.4 km of this section are included in the dam structure and plunge pool. Thus the distance from the plunge pool to the tailrace is about 4.4 km. The reduced flow in this section could potentially cause significant impacts on the aquatic fauna and overall ecology of the river in this reach. However, due to a favorable profile of the riverbed (**Figure 5**), a section about 3.2 km long (Zone B) upstream of the tailrace could permanently receive water from backwater flow from the tailrace during run-of-river base-load operations. This leaves only 1.2 km of river below the main dam (Zone A) that is at risk of drying up during the low flow season. However, in case of peaking operations in low flow season (in Stage 2), the entire stretch of 4.4 km would be affected during reservoir storage period of 18 to 20 hours.

Need for Environmental Flow: An environmental flow is the volume of water that is needed to sustain the aquatic ecosystem of the river and to cover the downstream requirements such as domestic use, irrigation, groundwater, etc. There is no human use of water (e.g. drinking, irrigation, cultural use, etc.) in the river section between dam and tailrace. All villages in the project area depend on tributaries for drinking water and irrigation requirements. The only ecosystem that is likely to be affected in this river section due to reduced flows are the low flow season (wintering) habitat of snow carps, especially near the confluence with the Sieglo. Maintaining an environmental flow downstream of the dam could mitigate potential impacts on the habitat of snow carps. To mitigate these impacts, WAPDA will ensure environmental flows of 20 m^3/sec from the dam and 222 m^3/sec from the tailrace (releases from operation of one turbine). Two approaches were followed in determining these recommended environmental flows. The first is the experience from the Ghazi Barotha hydropower project located on the Indus 10 km downstream of Tarbela. The second is based on hydraulic modeling to determine the required water flow needed to sustain the snow carp habitat. A 5-year monitoring program conducted by WAPDA Environmental Cell (WEC 2009, Social and Environmental Monitoring assessment of Ghazi Barotha Hydropower Project) concluded that an environmental flow of 28 m^3/s is sufficient to meet the requirements in this project (aquatic habitat, irrigation and drinking water). On the basis of these findings, an equivalent flow of 20 m^3/s is needed at DHP. The hydraulic modeling study was also conducted to simulate the environmental flows of 20 m^3/s from the dam and 222 m^3/s from the tailrace with respect to the hydrological features of the Indus (wetted perimeter, water depth and water velocities) at various locations between the dam and tail race (Zones A and B in **Figure 5**) and comparing these with the requirement of snow carp habitat, especially at the confluence with Sieglo nullah. The model shows that the flow will maintain adequate depths (0.5 to 0.6 m) and velocities (1 to 2 m/s) to support the winter habitat of snow carps.

During peaking operations in Stage 2, one turbine will always be operated to release the environmental flow of 222 m^3/s from the tailrace, in addition to 20 m^3/s through the dam. These environmental flows will maintain about 44 percent of average winter flows and 72 to 95 percent of average winter wetted perimeter in Zone B (3.2 km long). In Zone A (1.2 km long), they represent 4 percent of average winter flows, 20 to 25 percent of average winter depth and 34 to 45 percent of average winter wetted perimeter. A downstream environmental effects monitoring program will be put in place to enable assessment of changes in ecological components and adjustments in the environmental flows if required. The IPOE, during its third mission in November 2013, has carefully reviewed the above approach to assess the environmental flows and approved the recommendations.

Impact on downstream fish due to changes in water flows and quality: Generally water quality in reservoirs will deteriorate due to thermal stratification, eutrophication and depletion of dissolved oxygen at deeper levels. Average water retention time (residence time) in the reservoir (volume/flow per unit time) is an important determinant of the extent of the change in water quality. Average retention time in Dasu reservoir will be very short, varying from one to six days during the high flow season, and about 19 days during low flow season. The impacts on water quality are estimated to be minor due to the relatively short retention time. Some changes in water quality may occur over short distances downstream of the dam, but these are not expected to have significant adverse effects. Changes in downstream sediment quantities are not expected to negatively affect downstream aquatic life and may favor species that will benefit from reduced amounts of sand and gravel in seasonal deposition and scouring cycles. About 98 percent of the sediments are transported in the Indus River from June to September, when the high flows pass through spillways, LLOs and turbines. Sediment trap capacity of DHP is about 60 percent, which means about 40 percent of the annual sediment load will continue to be transported downstream of the dam; sediments also will continue to enter the main stem through tributaries located downstream of the dam. The first major tributary below the dam site is Jalkot, about 9 km

away. A downstream environmental effects monitoring program will be put in place to enable assessment of changes in ecological components.

Impact of sedimentation on reservoir area: Annually some 200 million tons of sediment will enter the reservoir area. After completion of the Dasu structure, the reservoir will be filled and flow velocities in the reservoir strongly reduced, causing most of the sediment to be deposited in the reservoir. The coarser sandy sediments will settle near the upper reach of the reservoir and the finer sediments will settle in the middle and lower reaches. This sedimentation will reduce the reservoir storage capacity over the years to come. If sediments were not flushed, the inlets of the LLO and power intake would be blocked within 20 to 25 years. To prolong the life of the reservoir (at least to 40 years) it is estimated that annual flushing should start after 15 years. Before that time, the impact of sedimentation on potential development of commercial fisheries is expected to be minimal, provided that stocking of the reservoir is carried out with suitable native non-migrating fish species adapted to the circumstances in the reservoir. The situation will be similar to that at the Tarbela reservoir. Habitat conditions along the 73 km length of the reservoir (at fsl) will be characterized by a transition from the fast-moving river-like flow in the upstream end of the reservoir (water velocities ranging from 0.6 to 3.1 m/sec) towards a deep slower moving flow (0.02 to 0.14 m/sec) in the downstream end. Water velocities along the length of the reservoir will generally be less than pre-reservoir river conditions but still relatively high. This suggests that conditions may be mainly compatible for riverine fish species, particularly along the reservoir shoreline.

Impact of flushing on fish production in the reservoir during base-load operation of plant: The current plan is to use the reservoir for base-load generation during the first stage of the project, estimated at 15 years. After this period the reservoir should be flushed annually during one month (mid-May to mid-June) when discharges of the Indus are high, since flushing is most effective in the high flood season. During the flushing operation the water level in the reservoir will be lowered from 950 to 830 masl (level of the LLOs). This will be achieved at an estimated rate of 3 m/day and takes about 40 days. After this lowering period the sediment will be flushed over a period of 30 days. When the gates in the dam are closed the water level in the reservoir will start to rise again, at an average of 4 m/day and will reach fsl some 30 days later. The whole operation will require about 100 days (1 April-10 July). During this period it is expected that specific fisheries management will be required to sustain the population of fish in the reduced reservoir area during flushing, possibly followed by re-stocking afterwards. There are considerable uncertainties with respect to expected losses of fish harvest during flushing and the appropriate mitigating measures. These issues have to be studied in more detail during the operational stage of the project.

Impact on downstream fish during flushing operation: The potential impacts on the downstream during flushing operations are turbulent habitat conditions, release of high sediment load and altered water quality from the reservoir. Flushing events should not occur earlier than the planned early summer period to prevent possible adverse effects, especially during the winter low-flow period. Release flows during flushing should be within limits of historical flows for the season (currently planned for mid-May to mid-June). As explained earlier, the impacts on water quality in the reservoir are estimated to be minor due to the short retention time. However, if low oxygen conditions are evident during monitoring prior to flushing a lead-in period may be required, whereby the LLOs are used to release low oxygen-concentration water from the lower elevation in combination with spillway releases, so that the water downstream of the plunge pool is adequately oxygenated. Ramp-down rates should be determined (tentatively recommended at 5-10 cm/hr, measured at tailrace outlet) and these rates can be refined on the basis of monitoring results. Upon completion of flushing during reservoir refill, downstream flows should be released through the LLOs.

Impact of daily reservoir operations on fish and aquatic biota during peak production: After commissioning of the DB project (expected in 2035), DHP will depend on the guaranteed water releases from the DB reservoir. During this stage it will be possible to operate the Dasu plant as a peaking facility during 4-6 hours per day to cover the peak demand for electricity in the country. There will be a daily storage-release cycle during the winter low-flow period, with strongly fluctuating water levels. During storage/peaking operations (in Stage 2), the situation will be totally different from the run-of-river operation of the facility. In this case there could be periods of no inflow in the river below the tailrace outlet during the low flow season. Downstream habitat and biota will be significantly adversely affected as a result of the daily retention of water in the reservoir, in order to cover the needs for peak power generation. Potential effects on aquatic resources and fishing activity could extend downstream over substantial distances (depending on minimum environmental flow adopted). Smaller fish would be most susceptible to this effect. This would continue along the course of the Indus until the confluence with major tributaries. However, it is expected that potential effects would not extend as far as the Tarbela Reservoir (approximately 200 km downstream) where the commercial fishery is

located. As a mitigation measure during peaking operation, it is recommended to operate at least one turbine continuously releasing 242 m^3/s at the tailrace (including 20 m^3/s environmental flows from dam). This discharge would then be equal to about 10 percent of the average annual flow of the Indus at Dasu and 44 percent of the average winter flow. This can be adjusted based on the monitoring of impacts on aquatic ecology.

The risk of sudden flow surges has also been studied, since these may considerably affect the aquatic ecology downstream. The possibility for tailrace surges occurring after raising the number of turbines operating simultaneously has been studied and it was concluded that water level rises for different scenarios would be relatively modest and that sudden surge waves downstream of the tailrace outlet are not expected. An operational protocol should be designed to reduce the rapid water level and flow variations due to peaking and thereby minimize the downstream impact.

Risk of bird collisions and electrocution with 132 kV transmission cables: The Indus valley is a major fly-way for bird migration. Huge flocks of migrating birds follow the fly-way twice a year in autumn and in spring, passing through the narrow Indus valley. Fatal collisions occur mostly with cables hanging perpendicular to the flight direction, particularly with the top neutral conductor because of its poor visibility. The 132 kV transmission line from Dubair to Dasu will mainly be located along the lower altitude slopes of the Indus valley, not perpendicular to the flight direction of the birds. At one location, near Jalkot, the 132 kV transmission line would cross the Indus River from right bank to left bank and hence this location could form a potential hazard for large-scale bird collision. Visibility enhancement objects such as marker balls, bird deterrents, or diverters will be attached to the 132 kV transmission line at the Indus crossing to reduce the risk of bird collision. Birds with a large wingspan such as storks, cranes and raptors are potential victims of electrocution with transmission cables. A design maintaining 1.5 m vertical distance and 3 m horizontal distance between the transmission line conductors is recommended based on the avian risk assessment of birds recorded in Kohistan. The current design is based on much larger distances (respectively 4.1 m and 6.8 m) and hence no bird electrocution is expected. Another mitigating measure is to cover and insulate the exposed parts of the structure.

7.9. Social Issues during Operation and Maintenance Stage

Development of reservoir fisheries: Development of reservoir fisheries could create employment. Based on experience from Tarbela, it is estimated that there could be potential for development of reservoir fisheries in the Dasu reservoir. For optimum exploitation of new fisheries opportunities, a specific fisheries management program will have to be developed. Implementation of such a program would substantially increase the employment opportunities in the area as well as the nutritional status of the population.

7.10 Potential Impacts identified in EARF for the Transmission Line

Potential impact of transmission line on Palas Valley: The EARF identified the crossing of the transmission line through Palas Valley as a potential environmental impact, to be studied in greater detail during the ESA. The 500 kV transmission line will run over a distance of about 250 km and will begin at the Dasu hydropower plant. The line will follow the Indus valley between Dasu and Pattan. From there, the corridor proceeds through the lower Palas Valley and passes the districts of Battagram, Mansehra, Abbottabad, and Haripur, passing east of Tarbela Dam towards Pathar Garh, situated near Hassanabdal in District Attock, Punjab. Out of the total distance, about 200 km is mountainous terrain with rocks, and covered with natural and planted forests. Only the last 50 km of the corridor towards Pathar Garh runs through relatively flat or slightly sloping terrain with cultivated lands and barren areas. The crossing through the Palas Valley could be environmentally sensitive, since this area is an Important Bird Area (IBA) declared by BirdLife International. Palas Valley is also known for its rich biodiversity and is considered to be an environmental hotspot. In the EARF, the NDTC has been recommended to consider various alternative routes for the transmission line. These alternatives will be covered under the ESA to be undertaken by NTDC later in 2014.

Potential impacts of Transmission Line on bird migration along Indus flyway: The EARF identified as another potential impact of the routing interference with the Indus flyway, or Bird Migration route no 7 along the Indus.

ESA Study: The EARF includes the Terms of Reference (ToR) of the detailed ESA to be carried out during the design of this component. There are potential alternatives available for alternate routing of the transmission line, which include complete bypassing of the Palas Valley. The study will compare the various alternatives and assess their impacts on the biodiversity of the Palas Valley. One important issue to note here is that the Palas Valley is not listed among the protected and conservation areas in KP, and hence there is no monetary support

available from the government to strengthen the conservation measures there. The biodiversity in the Palas Valley is currently under heavy stress from deforestation, firewood collection, overgrazing, over-hunting, over-harvesting of medicinal plants, soil erosion, use of pesticides, and weak law enforcement. Considering these issues, the ESA will assess the merits of passing the transmission line through the Palas Valley along with evaluating possible enhancement measures (e.g., through funding of conservation measures by the project). The ESA will also identify and evaluate various alternatives available during the design and construction phase of the transmission line, including siting and design of towers, access paths, and construction methodology. The ESA will cover the potential impacts associated with the construction and operation of the transmission line and related ancillaries, as well as all temporary and permanent facilities and resources required (e.g., including access routes, helipads if required, workshops, and equipment yards) during the construction and operation phases. The ESA will include an avian risk assessment, addressing the potential impacts of the transmission line on birds. It will also cover the cumulative impacts of this component and any other project in the area. It will include environmental management and mitigation plans that will be embedded into the bidding documents for the construction of the transmission line. The World Bank will provide funding for detailed design and the ESA study of the transmission line. **The ESA will be reviewed and cleared by the Bank before any construction on this component can commence.**

8. Cumulative Impact Assessment Framework

8.1. Background

WAPDA's Vision 2025 Program: A cumulative impact assessment framework has been prepared on the basis of WAPDA's Water Resources and Hydropower Program: "Vision 2025" prepared for planning development of water and hydropower resources in the Indus Basin. Central in the assessment is the sequential development of DHP and DB in relation to the operation of the Tarbela Dam, which at present is the hydraulic structure furthest upstream on the Indus. From it the water is divided throughout the Indus Basin Water System (IBWS) mainly for agricultural use in the fertile plains of Punjab and Sindh, the bread basket of Pakistan.

Strategic Sector Environmental and Social Assessment (SSESA): Recently the Ministry of Water and Power contracted an international consortium of consultants with financing from the WCAP to undertake a SSESA. The study has the objective to look at the whole Indus Basin for sector wide environmental and social considerations, including cumulative impacts, to help in prioritizing investments in hydropower and storage development projects. The study will provide recommendations on developing a mechanism for monitoring and evaluating the environmental and social performance of storage and hydropower projects in Pakistan. The study is at an advanced stage of completion.

Temporal and spatial boundaries: These boundaries have been based on the Vision 2025 program, which includes the development of DHP (2015-2022, phases 1 and 2) and Diamer-Basha (expected to be operational in 2035). The assessment has concentrated on possible cumulative effects of projects on: (a) river hydrology; (b) sedimentation; (c) water releases downstream of Tarbela; (d) water supply for irrigation and drinking; (e) management of floods; (f) changes in habitat from river to lake type; (g) barriers for fish movement; (h) social impacts due to resettlement, loss of livelihood and income; (i) damage to PCRs; and (j) need for realignment of the KKH. Non-hydro developments are not very likely in this mountainous and rugged terrain of the lower Himalayan and Karakoram mountain ranges. The only likely large scale development within this period could be construction of a new expressway or a railroad to improve access to northern Pakistan (Gilgit-Baltistan).

8.2. Context of DHP

The Indus Basin Water System and the Tarbela Dam: To meet increasing food production demands, Pakistan has been expanding the surface water supplies to the IBWS over time by capturing more water from the Indus and its other rivers. Within the framework of the Indus Basin Water Master Plan, the Tarbela Dam was developed during the 1970s. The main purpose of the dam initially 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 hydraulic structure furthest upstream, controlling the Indus waters and supplying irrigation water to the IWBS, including generation of power.

Post-Tarbela developments: Canal diversions after completion of Tarbela initially reached as high as 105 million acre feet (MAF).[1] However, they have declined in recent years due to reduced storage in the Tarbela

[1] 1 MAF= 1.233 BCM.

reservoir because of sedimentation and several other factors such as the state of the infrastructure and a sequence of dry years. The 2001-2010 average canal diversions have now been reduced to 94.5 MAF, and the reduction is primarily in the *rabi* (winter: October-March) season by about 8.6 MAF. This is because the diversions are close to the full potential that can be supplied. Also the declining water storage capacity of the reservoir directly affects the flow for irrigation during the winter due to the siltation problem. Further increase is only possible with heavy investment in storage dams on the Indus River, many of which are very controversial for domestic political reasons, especially inter-provincial conflicts over allocation of water and timing of releases.

Increased water stress: In the second half of the twentieth century, Pakistan successfully overcame major water resources challenges and made great achievements – tackling the issues resulting from the 1947 partition of the subcontinent and division of the Indus waters, as well as from extensive water-logging and salinity. Today Pakistan has the largest contiguous irrigation system in the world **(**see **Figure 8.1** of main report). However, the country once again faces numerous water-related challenges. These challenges are increasing water stress, with limited additional water resources that can be mobilized, coupled with the looming threat of climate change.

Development of groundwater: Pakistan has also utilized its groundwater resources, which are recharged by the surface water system. Since the 1980s, the groundwater aquifers have supplied increasing amounts of water for irrigation in areas underlain by fresh groundwater. In Punjab, about an equal amount of irrigation water comes from groundwater wells. This resource is now reaching its limits and further withdrawal is not possible without serious groundwater mining and extraordinary costs for pumping.

Indus-water related impacts downstream from Tarbela: From 1900 onwards, as development of the IBWS proceeded and extraction from the river steadily increased, the delta and coastal zone began to receive lower volumes of water, thus changing the characteristics and ecology of the area. Decreased water flows in the Indus River have caused serious adverse environmental and social impacts in the delta and the coastal zone. These impacts include the loss of mangrove forests, decreased fisheries, deteriorated water quality, and sea water intrusion. All of these factors have a direct bearing on the livelihood and wellbeing of the local population. These effects are being mitigated through the implementation of a number of programs aimed at improving water management in the delta, the provision of drainage and revival of some of the lakes using better quality drainage water and various livelihood programs. Some of these programs are supported by the World Bank.

The Indus in Sindh: The Indus in Sindh not far from the delta flows on silted up bed, like many mature rivers in the world. The embankments for flood protection were constructed after 1901. These embankments are placed about 10 miles apart, starting from the Guddu Barrage to the sea. The Indus meanders between these embankments. The original delta is on the left side of where the river is now. Here irrigated agriculture is possible by diverting and using water from Kotri Barrage, the last barrage on the river. Thus the Indus delta has seen a continuous change in its hydrology and ecology over one hundred years, but the impacts have become more pronounced as the canal diversions upstream increased.

Mitigation measures: Since 1990 the Government of Sindh has carried out a number of major projects including:

(a) **The interprovincial Water Accord of 1991** has a provision for ecological flow to be released downstream from Kotri Barrage, however this is not strictly followed. Water is generally released in years of floods and extraordinary quantities go down to the sea, whereas in other years flows are close to zero.

(b) **Preparation of a Master Plan for the Left Bank of Indus, Delta and Coastal Zone**: Under the Sindh Water Sector Improvement Project, the World Bank is assisting the Government of Sindh to prepare a regional master plan to address the flooding issues and provide proper drainage to the area on the left bank of the Indus, including the delta and the coastal zone. This would occur through appropriate structural and non-structural measures, such as measures for retention and/or safe disposal of drainage, storm and flood water; and improvement of wetlands in the delta area and in the coastal zone, recognizing their environmental importance and considerable economic potential for local communities.

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

(d) Improving Irrigation Efficiencies: With increasing population and development, the water demand in the Indus Basin is expected to increase. In future, substantial quantities of water can only come from reducing the losses in the irrigation system, which are now about 35-40 percent. A large part of the losses are in the watercourse command (over 40 percent) and the rest are field losses. To address these issues, the Bank is assisting the GoP to start an irrigation productivity improvement program under which watercourses would be improved to reduce delivery losses and high efficiency irrigation systems such as drip irrigation would be introduced. The program started in Punjab and is being expanded to Sindh and other provinces. The results in Punjab are very encouraging.

(e) Plans for Storage Reservoirs in IBWS: Pakistan has already raised the level of the Mangla Dam on the Jhelum River. This provides about 2.9 MAF of additional storage. However, this is much less than the combined storage losses due to sedimentation in the Mangla and Tarbela reservoirs. More options for increasing storage are being studied, including a storage dam in the Jhelum River. However, as noted above, building large dams is a very contentious issue.

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

8.3. Expected developments in the Upper Indus Basin

Shift in focus of water policy planning: The development of the Indus River system has the potential to provide a long-term solution for the water and electricity sectors and growth of the Pakistani economy. However, the aim of developing the Indus River needs to be shifted from merely storing and increasing water supplies towards developing water and hydropower resources and maximizing returns to these investments in the respective sectors. Given the rapidly industrializing economy, the contribution of water and hydropower has to be valued appropriately rather than merely assigning higher priority to water storage as was the case when the Mangla and Tarbela dams were constructed. The focus therefore is now on the Indus, where the most water is available, especially since the Chenab and Jhelum rivers are fully utilized. Cascades on the Indus River will allow reuse of the same water to maximize the benefits of storage and hydropower generation.

Indus cascade development from Tarbela to DB: The first step in this long-term plan is to develop and exploit the water and hydropower resources of the Indus cascades on the segment between Tarbela and Diamer-Basha (DB), followed by investments further upstream. This segment has an annual water flow of about 60 BCM and an elevation drop of about 700 meters from upstream of DB to the Tarbela reservoir. At this stage, four major structures on this segment going upwards from Tarbela Dam – Thakot, Pattan, Dasu and DB (see Figure 1.2 of main report). Two of these projects (DHP and DB) will be developed in the next 20 years, providing about 8,800 MW of newly installed capacity. The other two projects, Thakot and Pattan, are currently under consideration and feasibility studies are still underway. These projects have not been included in the assessment.

Expected development until 2030: An overview of the hydropower projects scheduled until 2030 is provided in **Table 7.** DHP (run-of-river) and DB (storage) are major hydropower projects, whereas the minor projects along the tributaries are much smaller, either run-of-river or small storage dams. DHP has a limited reservoir (24 km² only) with the only objective to generate hydropower (base-load and potentially peak-load in the future), whereas DB has the objective to improve the storage capacity in the IBWS and to alleviate flood damage on the Indus River as well as generate electricity.

Table 7: HP Projects in the Upper Indus Basin (WAPDA Vision 2025)

	Project	Location	Storage (MAF)	Capacity (MW)	Completion date
1.	Diamer-Basha [1)]	Diamer	8.10	4,500	2030
2.	Dasu [1)]	Dasu	Run of River	4,320	2022 (stage 1)
3.	Six Minor HP Projects	From Besham to Pattan	Run of River	1,606	2011-2017

Status: [1)] Ready for construction

Objectives of Diamer-Basha Project: The objective of the DB dam is to improve significantly the storage capacity in the stressed IBWS (agriculture and environmental flow) and generate over 18,000 GWh of cheap and clean (renewable) energy to the National Power Grid. The main benefits of the project for the country include:

- Enhanced water storage capability of the IBWS by adding about 7.9 BCM of live storage at a time when online storage will have lost over one-third of original capacity of about 19 BCM;
- Increased useful life of downstream Tarbela reservoir by about 50 years (together with development of DHP) through trapping large amount of sediments;
- Optimization of water and power benefits through conjunctive operation with Tarbela reservoir;
- Alleviation of flood damage of the Indus, particularly in the reach Kalabagh to Guddu;
- Provision of about 18,100 GWh of energy per year from its installed capacity of 4,500 MW;
- Enabling about 1,100 GWh of additional generation at Tarbela due to conjunctive operation of two reservoirs.

A sizeable addition to the other two existing hydropower projects, Ghazi-Barotha and Chashma, due to routing of additional water provided by storage at DB, will be possible in future. Besides the above national benefits, a major "trickle-down effect" of the project will be significant improvement in socio-economic conditions in Gilgit-Baltistan.

Baseline conditions: The baseline conditions in the DB and DHP projects are largely comparable. Both projects are situated in the same agro-ecological zone along the Indus valley and separated by only a short distance. The smaller hydropower projects along the Indus tributaries are also found in the same zone, but 35–60 km distance downstream of Dasu. The projects downstream from Pattan are situated in an area that receives more rainfall and has well developed vegetation and natural forests along the tributaries and on the slopes. The area forms a transitional zone between the upstream zone and the zone downstream from Besham-Thakot, where the influence of the monsoon begins (Battagram-Mansehra), with much more rainfall and more agricultural development.

8.4. Cumulative impacts and trends to be expected

General: DHP in combination with the other proposed hydropower and storage projects has the potential to cause significant cumulative and induced impacts on physical, ecological and social resources in the UIB.

Most of the expected cumulative impacts relate to hydropower development, since this is the only major structural development in the area. Influx of migrants and businessmen will be lower in Dasu since there is hardly any suitable place to accommodate large numbers of people and commercial businesses. In the DB area there will be more physical space for small industries and commercial establishments to develop. A major limitation for any economic development is the poor condition of the KKH between Thakot and Raikot bridges. So far there are no plans to reconstruct this road section, which is in difficult terrain and frequently blocked for days at a time. The impacts on biodiversity and wildlife and the trends and concerns identified in DHP and DB are similar.

(a) Impacts on river hydrology

Cumulative impacts: DB is a storage project whereas DHP and the other projects are run-of-river. River flows in the Indus and its tributaries could be affected due to seasonal storage in DB and daily storage in tributary projects (for peaking operation). The objective of the DB project is different from DHP and this consequently may lead to other environmental impacts. With construction of DB, which has a gross storage volume of 7.9 BCM, the storage capability in the Tarbela reservoir could considerably be increased. Changes in river hydrology for different scenarios have been determined in a hydrological study for DB carried out by WAPDA in 2012. It has been estimated that by optimizing the operations of Tarbela, DB and DHP, about 42 percent more flow during the low flow season could be released from Tarbela and about 19 percent in early kharif period (**see Table 8**).

The changes in the river flows above Tarbela will have a positive benefit 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 impact of these extra releases will be very beneficial for irrigated agriculture in the plains. This extra flow could also mitigate the reductions in ecological flow, which is often compromised and reduced by overconsumption in agriculture.

Table 8: Percent of Change in River Hydrology (Flow Volume) 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. DHP + Tarbela	0	+10	-1
2. DB + Tarbela	+42	+9	-11
3. DB + DHP + Tarbela*)	+42	+19	-12

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

Incremental Effects by DHP Alone: The contribution of DHP to the cumulative impacts on the hydrological regime of the Indus is minimal, since it will be a run-of-river facility intended for base-load power generation. There will be minor changes in the flow, during first filling and during flushing, which will start 15 years after commissioning. During base-load operation all water entering the reservoir will pass either through the tailrace tunnels, the LLOs, or the spillway. The downstream flow will only slightly be reduced during the first filling of the reservoir. Even if this happens in the low flow season (February–March) there will be sufficient water discharged through the LLOs and diversion tunnels to downstream areas. DHP is likely to contribute to improvement in Tarbela storage by 10 percent. As long as DHP is operating as a run-of-river project there will be minimal impacts on the flow. However, this will change when DHP is operated as a peaking plant, once DB comes into operation. Peaking operations require a daily cycle of low flow (during reservoir filling) and high flow during power generation. The impacts of peaking operations have been described as moderately adverse, and discussed in Chapter 7. Mitigation of the impacts can be done by releasing sufficient environmental flow to the downstream area and through operational measures in running the turbines to prevent sudden surges.

(b) Impact on sedimentation

Cumulative impacts: The 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 in the flows downstream of the dams will be reduced. This could increase the erosive capacity of the river flows. However, retention of sediment in the reservoirs of cascades will have positive impacts on the downstream dams by allowing increased storage. The construction of DB will have a considerable beneficial impact on both DHP and Tarbela reservoirs by extending their life. The DB reservoir, which will have a large storage volume, will act as a sediment trap and the inflow to DHP will be reduced to 46 million tons of sediment (mainly fine fraction). The cumulative impacts on sediment transport from DHP and DB combined 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 by another 50 years (15 years gained from DHP sediment retention and 35 years from DB).

Incremental effects of DHP alone: Annually about 200 million tons of sediment will flow into the DHP reservoir. Sand will be trapped, but most of the suspended silt will pass through the turbines and the spillways/LLOs. Sedimentation trap efficiency of DHP is estimated to be 60 percent. Without flushing it is expected that the Dasu reservoir will be filled in 20-25 years. Once the flushing commences after 15 years (assuming DB is not completed before that time) about 27 percent of the annual sediment inflow will be trapped and 73 percent flushed through the flushing tunnels and LLOs. This will have an impact on the composition of the sediments (relatively more fine fraction) reaching downstream areas, with possibly some changes in the aquatic ecology. The reduction in sediment quantity and its composition is however not likely to have an impact on water quality in the Tarbela reservoir.

(c) Impacts on downstream water releases

Cumulative impacts: An integrated system study conducted by WAPDA showed that impacts from the completion of DHP and DB and optimized management of Tarbela would be felt downstream of Kotri Barrage, which is the last barrier before the Indus delta. During low flow season, the ecological flow at Kotri would increase by 14 percent and in early kharif by 2 percent as shown in **Table 9.**

Table 9: Impact in Percentages of Water Availability and Ecological Releases Downstream of Kotri under Different Hydropower/Storage Scenarios

Hydropower / Storage Development Scenarios	Low Flow (Oct - March)	Early Kharif (Apr-May)
1. DHP + Tarbela	0	1
2. DB + Tarbela	14	1
3. DB + DHP + Tarbela	14	2

Incremental effects of DHP alone: DHP alone will have no effect on water availability for use downstream of Kotri during the winter low flow period and will increase water availability slightly during early kharif in the years when flushing takes place.

(d) Impact on water supply for irrigation and drinking water

Cumulative impacts: Upstream of Tarbela, the changes in river flow will have no influence on irrigation and drinking water, since Indus water is not used for this purpose. Irrigation and drinking water are usually drawn from the tributary rivers or from small streams or nullahs. These water resources may be affected by the development of the minor hydropower projects planned and currently under construction. These developments are mitigated by constructing pipelines supplying water to the settlements in these areas.

Downstream of Tarbela, as shown in **Table 8**, there will be increased water availability during the low flow season and transition period of early kharif. As noted above, this is expected to increase the irrigation supplies by 42 percent during low flow and by 19 percent during early kharif. During high flow season the average flow will be 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 is high.

Incremental effects of DHP alone: DHP will generally not contribute to the cumulative impacts on water supply and irrigation releases from Tarbela. However, during flushing periods (beginning after 15 years), DHP will contribute to an increase in the Tarbela storage by 10 percent by releasing water (for flushing) during April-May. This water can be used to release more water from Tarbela during the critical early kharif season, see also Table 8. An important precondition is that operation of Dasu dam and Tarbela are optimized.

(e) Impacts on flood management

Storage of water in the reservoirs will attenuate the floods in downstream areas and save lives and property, especially of people living in the densely populated areas further downstream of Tarbela (Punjab and Sindh). The combined operation of DB, DHP and Tarbela can reduce the average high flow downstream of Tarbela during the summer season, as shown in **Table 8**. With the combined operation of these reservoirs, the flood regulating capability of these dams will significantly increase. For individual 10-daily flows, it was assessed that a maximum reduction of 60 percent could be expected downstream of Tarbela. This would be a beneficial impact, mitigating the severe floods along the lower reaches of the Indus valley in Punjab and Sindh. Over the past 40 years, the Tarbela dam has shown that it could withstand exceptional foods without damage, including the high flood of 2010. Most problems were caused by floods coming from Indus tributaries in northwest Pakistan, which joined the main Indus River downstream of Tarbela (e.g., Kabul and Swat Rivers).

Sudden waves such as those from GLOFs could cause damage in the Indus valley as far as Tarbela. However, most of the valley is deeply incised into the mountains and there are few flats in the riparian areas. That said, urban centers and built-up infrastructure situated on lower terraces along the Indus are at risk. GLOFs are a serious threat and these events should be better managed to protect both the communities and hydropower infrastructure. Currently there is no early flood warning telemetry network available upstream of Dasu. Support to the DHP and DB projects to assist WAPDA in establishing such a flood warning system would help to mitigate the potential impacts of GLOFs.

(f) Impacts on water quality, aquatic ecology and fish

Cumulative impacts: Formation of reservoirs will change the biotic and abiotic conditions in the submerged Indus and the lowest part of the tributaries. In the reservoir areas, the changes in flow velocity, water quality (less turbidity, higher temperature, and more light) are expected to modify the aquatic ecosystem considerably. The riverine ecosystem will become more lacustrine. Deposition of thick layers of sandy and fine silty sediment will alter the bottom conditions and the aquatic habitat will change depending on water depth, penetrating light and water temperature. These changes will affect fish habitat and spawning sites of both the tributaries and the Indus. Water quality will probably decrease due to thermal stratification and lower oxygen content in the deeper parts of the reservoir. Water released from the reservoirs will be different in quality from the downstream it will join due to the differences in temperature, oxygen and sediment content.

Downstream of DHP: Water quality in the Indus downstream of DHP is expected to be somewhat lower after completion of the DB dam, which has a long storage time, since the inflow of water from there may also influence negatively the oxygen content and temperature of the water in the DHP reservoir. Thermal stratification of water in the deep DB reservoir also may negatively affect the quality downstream. In addition, there may be some inflow into both reservoirs of untreated wastewater coming from settlements along the realigned KKH. The risk of decreasing water quality is smaller in the DHP reservoir, since the storage time is

relatively short (a few days). Once the flow has passed the tailrace outlet or spillway of DHP, it runs rapidly down a steep gradient for the next 80 km until it reaches the Tarbela reservoir. Water quality will improve and oxygen content and biochemical oxygen demand will recover over relatively short distances. Other dams to be developed in this river section could lower water quality, but since both Pattan and Thakot will be run-of river projects (both with low storage capacity and short storage times) no major decrease is expected. The fast flow of the river and the composition of the riverbed are positive factors for restoring water quality. Fish movement from the tributaries to Indus confluences is common during low flow season in winter. Due to release of high water flows from the DB reservoir in winter, there will be a potential impact on fish habitat near the confluences and on movement patterns between tributaries and the Indus. This will also affect fish availability and catches along the tributaries will drop. This impact will be heightened once the minor hydropower projects currently under construction along the tributaries become operational.

Incremental effects of DHP alone: Because water retention time in the DHP reservoir will be only a few days due to the large inflow of water and small reservoir area, no water quality changes are expected in the DHP reservoir. It will contribution little to overall quality changes in the Indus, but may affect the fish habitat and spawning areas in its reservoir submergence area. A compensation plan through hatchery development and fish stocking in the affected areas is recommended in the ESA. These measures could be extended to the affected areas of other hydropower projects in UIB as well, if proved feasible.

Opportunities for reservoir fishery: Development of a new lacustrine habitat in the DB and DHP reservoir areas could provide valuable opportunities for fisheries, especially in combination with the lateral tributaries of the Indus, where melt-water streams flow into the reservoir. These places could develop into important spawning areas for fish. The negative impact on loss of fish habitat can be compensated by developing fish hatcheries with suitable species (e.g., snow carp and possibly other carp species), including open water stocking in the affected tributaries and reservoirs, and by maintaining spawning areas. Fish hatcheries for snow carps are so far not established in Pakistan, but exist in India and Nepal. Further studies and investigations are required to better understand snow carp biology. Studies should be implemented to prepare a practical research program to determine the feasibility of hatcheries for native snow carp or other species.

(g) Impact of barriers for fish movement

Cumulative impacts: Major structures in the Indus will create barriers, which will impair the ecological connectivity in the river. This may influence the presence of long distance migrant species, such as the Mahaseer. Mahaseer was very common in the Indus before the construction of the Tarbela Dam, but is now an endangered fish species. Its habitat starts about 70 to 80 km downstream of the DHP dam. The fish lives in slow moving streams and rivers in the foothill regions and breeds in gravelly and sandy river beds. Mahaseer is reported to ascend the Indus River to Besham Qila and above and to spawn in Allai Khwar, which has been described as the last upstream safe-haven for the species. During fish sampling in the DHP and DB areas, no Mahaseer specimen was caught; local people also confirmed its absence. It is thus possible that the construction of both DHP and DB will have no impact on Mahaseer in the Indus.

The other migrant fish (over short distance only) is the snow carp or snow trout. This fish is common in the DHP and DB area (75 percent of catches) and lives in the tributaries and confluence area with Indus. It migrates within the tributaries, not in the main stem of the Indus. Its habitat has been discussed in Chapter 5 and potential mitigation measures to support the presence of snow carp in the tributaries of the reservoirs and further downstream of DHP are presented in Chapter 7.

Impacts on Mahaseer and snow carp might be expected from the barriers of the small dams constructed in the framework of development of the smaller hydropower projects at Allai Khwar, Khan Khwar, Dubair, and Keyal along Indus tributaries near Besham. These projects are presently under construction or planned by WAPDA. It is not known if any mitigation to facilitate migration of Mahaseer and snow carp along these tributaries will be carried out.

Incremental effects of DHP alone: Incremental impacts from DHP on fish migration are not expected since there is no fish migration along the Indus at Dasu.

(h) Impacts on forestry and biodiversity

The construction of both DHP and DB may have significant cumulative and induced impacts on the high-altitude natural forests and wildlife of the area. There will be an influx of many thousands of people, including construction workers, operational staff, and business people together with their dependents, over a period of 25 to 30 years. They will settle in the main urban centers around Dasu/Komila and Chilas. The construction of new resettlement sites for both projects at higher altitudes will also increase the rural population pressure at higher

elevations, particularly on forest resources and wildlife including a whole range of rare and endangered plants and fauna. As a result there will be more collection and commercial trade in fire wood and herbs, illegal deforestation, logging, reclamation of land for agriculture and other activities. Illegal practices such as poaching, trapping and hunting will increase. The impacts and potential mitigation measures have been indicated in chapter 7.

(i) Impacts on resettlement, livelihood and income

The nature of social impacts is largely comparable for the DHP and DB projects, although social impacts are larger for DB than for Dasu. DB requires the resettlement of considerably more people than DHP and more land is to be acquired for the project. Loss of trees, land and commercial establishments is larger since the DB project is planned in a part of the Indus valley that is much wider, more densely populated and more commercially active than the Dasu area. The impacts of resettlement, loss of land and assets are shown in **Table 10**.

Table 10: Social and Cultural Impacts of DHP and DB

Indicators	Diamer-Basha Dam Project	Dasu Hydropower Project
Location	Diamer and Kohistan Districts	Kohistan District
Displaced Population	28,650 people will be directly displaced due to project interventions	6,953 affected persons will be dislocated requiring relocation
Households displaced	4,310 from 31 villages	767 from 34 villages
Land needed for project construction	Total estimated land acquisition of 15,150 ha	A total of 4,643 ha of land will be affected
Trees	Loss of estimated 525,775 trees both fruit (283,964) and non-fruit (241.811) varieties	An estimated 21,000 trees of various species and sizes will be lost
Commercial activities	453 commercial units/objects comprising of public buildings and sites and services	197 commercial structures will be affected due to project interventions.
Vulnerable	A total of 100 socially vulnerable people	There are 10 families of Soniwal (gold extractors) tribe living in project area and several disabled and female-headed households
KKH	Submergence of about 94 km of existing KKH on the left bank	Submergence of about 46 km of existing KKH on the left bank
Suspension Bridges	7 suspension bridges are being affected	2 suspension bridges are being affected
Ethnic Minorities	There are 500 families of Soniwal tribe living in project area. They migrate along the Indus banks for extracting gold	There are 10 families of Soniwals living in project area
Cultural heritage	Submergence of 30,367 rock carvings forming part of cultural heritage	A 400-year old mosque at Seer Gayal village on right bank would require relocation
In-migrants and social Issues	Several thousand in-migrants and construction workers will move in creating cultural conflict and disruptions in community life	Deterioration of social and community life due to in-migration from other areas of Pakistan and foreign construction workers
Gender impacts	Women have lower status, very limited access to education and health due to seclusion. The poor suffer even more from malnutrition. Many pregnancy related deaths; lack of access to medical centers. Disruption of life due to loss of land and access to resources	Women have a lower status and publicly "invisible." As a result, mobility is restricted. The loss of land, houses and forests due to the project will have significant impacts on the women

(j) Impacts on Physical Cultural Resources

A large field of pre-historic and historic rock drawings and inscriptions (50,000 rock drawings and 5,000 inscriptions) can be found at 30 sites on both sides of the Indus between Shatial and Raikot bridge (near Astor) spread over a distance of more than 100 km. The rock art dates from the Stone Age (8-9th millennium BCE) to Buddhist and Islamic periods and is internationally known as the "guest book of the Silk Route." More than 30,000 of these engravings will disappear into the future Diamer-Basha reservoir and will be covered by silt. During almost 40 years archeologists of the University of Heidelberg in Germany have worked in the area and studied the rock art clusters over the entire 100 km stretch along the Indus. Currently the researchers are involved in a project to document all these engravings and rock art, which is unique in the world. There are plans to save the most valuable pieces from inundation and to display them (copies or pictures) elsewhere in a safe place.

The rock carvings around Shatial will not be submerged by DHP, but these pieces of rock art are not protected and are endangered by on-going developments from construction works and other activities along the KKH. Since this will be the only remaining in-situ area of rock art, it is recommended that DHP help to save them from further destruction and vandalism, by assisting the KP Department of Archaeology and Museums to acquire the land, and to provide proper fencing and protection measures, including some infrastructure for visitors, such as an information centre in Shatial and possibly a museum in either Chilas or Gilgit.

(k) Transport

One of the most critical social aspects of the development of DHP and DB is that both projects draw heavily on the only existing road along the Indus, the KKH. The population in Kohistan and Diamer is strongly dependent on the highway, as are the people in major towns such as Gilgit, Hunza and Skardu, as well as the rest of the province of Gilgit-Baltistan (population >1.0 million). The KKH is their lifeline and link to the rest of the world. The road, which was built during the 1960s by the Pakistan Army with Chinese assistance, is currently in very poor condition for most of the sections between Thakot and Raikot bridges. The section runs through very difficult terrain and belongs to a very dynamic and challenging environment for building roads. Average speed for cars is between 20-30 km/hr over most of this section. The road is narrow and frequently blocked by landslides after rainfall or minor earthquakes. Closure of the road is common, often for a week or longer. The section between Khunjerab pass and Raikot bridge was recently upgraded to highway standards with the help of a Chinese contractor.

The current road conditions cannot support the construction and operation of mega hydropower projects like DHP and DB, whether their development is simultaneous or overlapping or not. Under current plans, reconstruction of about 175 km of new KKH is planned to compensate for the highway sections that will be submerged by DHP and DB. The new alignment will be constructed to the prevailing highways standards, but may need to be upgraded to new and improved standards in the years to come. It is essential that the GoP prepare plans and seek assistance to upgrade the entire KKH to improved highway standards. WAPDA could play an intermediary role in these developments and bring this to the attention of responsible authorities and planning commission.

8.5. Mitigations to be implemented under DHP

Improving ecological database on Upper Indus valley: Since DHP is the first in the series of mega-projects to be developed under WAPDA's Vision 2025 Program, with relatively low environmental and social impacts compared to other projects, it is recommended to take this opportunity to strengthen the respective databases on ecology (both aquatic and terrestrial), biodiversity, fisheries and forestry. Most ecological information in the UIB area dates from the last century and very few reliable field data have been collected in recent years. One of the reasons for this lack of information is the remoteness of the area, the difficult terrain and the absence of access roads and accommodation. However, with remote sensing and GIS techniques, a lot of recent spatial information can be collected and institutions in Pakistan such as WWF/IUCN, the Islamabad Herbarium and other institutions have the facilities and expertise needed to implement surveys and studies to verify and collect reliable field data. It is suggested to concentrate under DHP on establishing a reliable database and information system on aquatic and terrestrial resources and water quality indicators for the Indus Valley section between Raikot bridge and Tarbela, including the tributaries. This database could also be used and expanded during detailed planning and preparation of the other hydropower projects along the Indus River.

Early flood warning and climate monitoring program: For public safety, improved management of flood waves and safe operation of DHP and other hydropower projects, it is imperative to have an early warning system for floods in the major sub-catchment areas of the project. The existing flood telemetry network in the Indus basin comprises 45 automatic rain and river level recording stations; there is no flood monitoring station in the DHP catchment. Hence it is recommended that the existing network be extended to the upper catchments of the river, including DHP, including installation of river level sensors (pressure transducers), temperature sensors, and rain sensors at flood warning sites connected to reliable telecommunication systems, i.e., meteor burst systems. In total the installation of 18 telemetry stations is recommended in the upper catchment areas of the Indus. Under the project, the works will be executed by the Hydrology & Research Directorate, under the administrative control of the Chief Engineer, Hydrology & Water Management, WAPDA. The Directorate will then assume responsibility for operation and maintenance. Additional staff will be hired and trained to manage the augmented network.

Integrated Watershed Development: At higher altitudes (>1500 m) a number of plantations will be established to rejuvenate forests. This will be done at selected places on both the left and right banks of the

reservoir. Communities can play an important role in planting and managing these plantations. There is experience with this type of social forestry elsewhere in the region. In addition, a comprehensive study will be undertaken under DHP, with the objective to determine the forestry status and trends in areas between 1,000 and 2,500 m in Kohistan, and to develop a general ecological management plan for sub-catchment areas of DHP as well as detailed community-led plans for at least two sub-catchment areas focusing on sustainable forest management and conservation management of wildlife. The study will be carried out by a qualified organization (e.g., IUCN or WWF) with experience in ecological and forestry management.

Fish Hatchery and Stocking: A fish hatchery and stocking of fish in the tributaries, reservoirs and downstream Indus is recommended to compensate for the loss of fish habitat and to address potential downstream impacts. This requires maintenance of an onsite fish hatchery of snow carp to produce the targeted numbers of fingerlings and their transportation to open water stocking in the river. Snow carp hatcheries do not exist in Pakistan, but are found in India and Nepal. Further studies and investigations are required for detailed understanding of snow carp biology before developing a full scale hatchery. In addition, a fish conservation and management plan in cooperation with the KP Fishery Department will be prepared and implemented for the DHP.

Physical Cultural Resources (PCR) Protection Plan: DHP will support the Department of Archeology and Museums to: (a) acquire 25 acres in which rock carvings are located; (b) fence the area; (c) provide fiberglass sheds; (d) develop tourist facilities; and (e) document the rock carvings and their translations. A detailed plan for this has to be worked out together with the various stakeholders, including the University of Heidelberg and the KP Department for Archaeology and Museums.

Review of EMPs of Minor Hydropower Projects: Footprints of other individual hydropower projects and their impacts are described in a number of EIA reports prepared by WAPDA. It is recommended that WAPDA review the mitigation measures proposed in the respective EMPs of those projects and strengthen them where necessary. For example, the EIA reports of Khan Khwar and Allai Khwar have identified the impacts on fish migration and downstream fish habitat, but no specific mitigation measures are proposed. It is also recommended that WAPDA follow best practice approaches to manage cumulative effects in the UIB through collaboration with knowledgeable specialists in environmental/resource management agencies, academia and NGOs for addressing broad considerations related to biodiversity, especially aquatic biodiversity and fisheries.

8.6. Summary of major cumulative environmental and social concerns and mitigations

A summary of the main environmental and social concerns of cumulative impacts is given in **Table 11**. The evaluation is based on the following assumptions: (a) DHP (phase 1 and 2) is implemented in the period 2015-2022 and that electricity from this project is generated from 2020; (b) DB project is commissioned 15 years from now and begins to generate electricity; and (c) by 2025 all minor hydropower projects in the tributaries have been completed and are under operation.

Table 11: Summary of Major Environmental and Social Concerns regarding Cumulative Impacts

Valued Environmental Components	Feature	Major Concerns/Benefits	Mitigation/Management Plans
Physical environment			
Surface water	River hydrology	• Positive impact due to increased control and management of river flow	• Operational Plans for optimization of flow (WAPDA) • Improved hydrological data from UIB (telemetric network, etc.)
	Sediment transport	• Positive benefits due to prolonged life of Tarbela and Dasu dams • Changes in sediment deposition might affect aquatic ecology	• Monitoring of sediment deposition and effect on water quality
	Downstream water releases	• More water available in downstream areas during low flow season	• Improved water releases downstream (e.g., Kotri) in low flow season (WAPDA/Provinces)
	Water availability	• Improved water supply for irrigation (early kharif) • More water available for maintaining environmental flow	• Maintaining irrigation demand in early kharif season (WAPDA) • Maintaining agreed environmental flow downstream of Tarbela (provinces)

Valued Environmental Components	Feature	Major Concerns/Benefits	Mitigation/Management Plans
	Flood management	• Improved flood attenuation and control during high flow season • Improved control of GLOF events	• Operational Plans (WAPDA)
• Biological environment			
Aquatic habitat and fish	Downstream fish habitat	• Reduced flows and/or increased surges in low flow season • Changes in downstream water quality (temperature and dissolved oxygen).	• Maintaining recommended environmental flows • Monitoring of water quality downstream of Dasu
	Reservoir habitat	• Decrease in water quality in reservoir due to stagnating flow and potential risk of pollution by untreated waste water • Impacts on spawning areas of fish (Indus and tributaries)	• Study and monitoring of changes in aquatic habitat • Feasibility of hatcheries of snow carp/other species
	Barrier effect	• Migration of snow carp in Indus tributaries • Migration of Mahaseer in area downstream of Allai Khwar	• Detailed inventory of aquatic habitats and fish • Monitoring of catches
Biodiversity and forests	Natural forests	• Pressure on forests (illegal logging) by influx of workers and in-migrants	• Awareness raising of in-migrants • Updated forest inventories (GIS + field study) • Improved and sustainable forest management by communities • Forest Rejuvenation and Management Plans
	Wildlife	• Increased poaching, hunting and trapping; reduction or degradation of aquatic and forest habitats	• Awareness raising of public, schools • Expansion of community managed game reserves
	Natural habitats	• Flooding of natural habitats, degradation by increased overgrazing, firewood collection, etc.	• Inventory of terrestrial flora and fauna of downstream areas until Tarbela • Preparation of management plans for sensitive areas (Palas)
		• Lack of reliable data on terrestrial and aquatic ecology, wildlife and forests	• Implement inventories and studies on aquatic and terrestrial ecology
Social/cultural environment			
PCR	Archaeology	• Loss of more than 31,000 petroglyphs along "Silk Road" by inundation of reservoir and/or vandalism from KKH travelers	• Preparation of a salvage and management plan in cooperation with national and international archeologists • Establishment of a museum for display and information
Social behavior	Influx of migrants	• Lack of respect for cultural norms and traditions of local population	• Preparation of Migration Management Plans • Awareness raising and grievance redress mechanisms
KKH	Access to area	• Frequent blockage and poor maintenance of KKH	• Upgrading of KKH to highway standards

9. Environmental and Social Management Plan

9.1. General

Various categories of mitigating measures: The ESMP includes various categories of mitigation measures and plans: i) generic and non site-specific and project-specific measures in the form of environmental codes of practices (ECPs) presented in **Annex D** of the main ESA; ii) project specific and to the extent possible, site-specific mitigation measures discussed in **Chapter 7**; iii) site-specific and contract-specific management plans to be prepared by various contractors; and iv) management plans already prepared during the detailed design phase.

Inclusion of ESMP and SRMP in contract documents: In order to make the Contractors fully aware of the implications of the EMP and SRMP and responsible for ensuring compliance, it is recommended that environmental and social mitigation measures be included in the tender documentation. The Contractor must be made accountable through contract documents and/or other agreements for the obligations regarding the environmental and social components of the project.

Payment milestones: These should be linked to environmental, health and safety performance, measured by completion of the prescribed environmental and social mitigation measures. Contractors should be trained how to join forces with the executing agency, PMU, supervising consultants and local population for the mitigation of adverse impacts of the project. For effective implementation of the proposed mitigation and monitoring measures they should attract trained and experienced environmental management staff.

9.2. Institutional Arrangements

PMU. The overall responsibility for the implementation of the project rests with the PMU, headed by the Project Director (PD). Within the PMU there will be an Environment Unit (EU) - responsible for implementing the ESMP, and a Social and Resettlement Unit (SRU) - responsible for implementing the SRMP. The EU and SRU, headed by the Deputy Project Director-Safeguards, will include representatives of all actors responsible for ESMP/SRMP implementation.

The responsibilities of the EU and SRU will be: (i) supervising, facilitating and coordinating implementation of environmental and social plans including ESMP and RAP; (ii) ensuring that contractors follow KP-EPA regulations, World Bank Safeguard Policies, and other requirements mentioned in the ESMP and SRMP; (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.

The EU will consist of three sub-units: Environment; Ecology; and Occupational Health and Safety – OHS, whereas the SRU will have four sub-units: Resettlement; Communication and Participation; Downstream Impacts; and Gender and Community Health.

Construction Supervision Consultants (CSC) will be responsible for supervising the contractors for the implementation of ESMP and SRMP. For this purpose, the CSC will appoint dedicated environment and social staff to ensure the ESMP and SRMP implementation during the project. They will supervise the contractor for the ESMP and SRMP implementation, particularly the mitigation measures. They will also be responsible for implementing the monitoring of effects of these measures.

Contractors. Each contractor will be required to appoint adequate number of dedicated Environment/Social Officers at the site for the implementation of ESMP in the field, particularly the mitigation measures. The contractor will also be responsible for communicating with and training of its staff in the environmental/social aspects. The contractor will develop the various plans directed towards health, safety, the environment and social issues (discussed later in the Chapter), and get them approved by the CSC before the commencement of the physical works on site.

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; The Contractors will be contractually obligated to comply with these ECPs, presented in **Annex D** of the main ESA.

(b) Site-specific Plans

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

Landscaping and Replanting Plan will be prepared by a qualified landscape architect to replace or compensate the vegetation and trees lost during land acquisition and resettlement of villages, clearing of

construction sites and other areas needed for construction activities such as borrow and disposal areas, batching plants, workshops and other facilities. Landscaping, restoration, and plantation methodologies will be included in the Plan. Tree species to be selected will be natural or semi-natural, adapted to the local (micro) climate and predominant soil conditions in the area. Establishment of one or more nurseries will be considered as part of the Forestry Rejuvenation Plan for upland forest resources. The Plan will be approved by the Construction Supervision Consultants (CSC) and a landscape architect assigned by WAPDA.

Borrow Area Management and Restoration Plan for management and restoration of borrow areas will be prepared by the Contractor on the basis of ECPs 8 and 9 and other requirements described in the mitigation plans (presented later in the chapter). This Plan will aim at minimizing the environmental and social impacts during borrowing activities and restoring as much as possible the original natural situation of these sites by various measures (refill, leveling or smoothening) and removing all non-natural artifacts such as equipment parts, and sheds. Restoration methodologies will be included in the Plan. The Plan will be approved by the CSC and a landscape architect assigned by WAPDA.

Disposal Area Management and Restoration Plan for management and restoration of disposal areas will be prepared by the Contractor on the basis of ECP 8 and other requirements described in the mitigation plans. The Plan will describe the procedures for spoil management, transportation and disposal at the selected site(s). The Plan will also describe the procedures for systematically disposing of the spoil at the disposal site. This Plan will aim at minimizing the environmental and social impacts during disposal activities and restoring as much as possible the original natural situation of these sites by various measures (landscaping, leveling or smoothening). The Plan will include measures to avoid land/soil erosion and landslides. Restoration methodologies will be included in the Plan. The Plan will be approved by the CSC and a landscape architect assigned by WAPDA.

Occupational Health and Safety Plan will be prepared and implemented by each Contractor on the basis of the WBG EHS Guidelines (1997), ECP 18, and other relevant standards. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Pollution Prevention Plan will be prepared and implemented by the Contractor on the basis of ECP 1, ECP 2, ECP 11, and WBG EHS Guidelines (1997), as well as the mitigation plans given later in the chapter. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Waste Disposal and Effluent Management Plan will be prepared and implemented by the Contractor on the basis of ECP 1, ECP 4, and WBG EHS Guidelines (1997), as well as the mitigation plans. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

Drinking Water Supply and Sanitation Plan: Separate water supply and sanitation provisions will be needed for the temporary facilities, including offices, labor camps and workshops, in order not to cause shortages and/or contamination. A Plan will be prepared by the Contractor on basis of ECP 3 and the mitigation plans given later in the chapter. The Plan will be submitted to the CSC for review and approval before contractor mobilization.

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

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

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

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

Afforestation and Forest Rejuvenation Plan: In order to maintain a healthy forest ecosystem, modern management will have to be introduced, including planning of felling and rejuvenation (including nursery activities). Preparation of a Forestry Management Program by forestry consultants and in cooperation with the Forestry Department is urgently required. Implementation of such program will also create a relatively large number of jobs for forestry activities proper and for enforcement of regulations. The Plan needs to be finalized before the commencement of main construction works. The Plan will include sustainable logging systems, rejuvenation schedules, nursery, manpower implications (forestry staff, guards) and a sound financial system to make the Plan self-sufficient. The ToR of this Plan is presented in **Annex B** of the main ESA.

Ecological Conservation Plan: Under this Plan, two wildlife conservation areas will be developed as offsets to the potential impacts of the project on the Kaigah Community Game Reserve. This will be done on the basis of a thorough assessment and community engagements that will be carried out during the study on forestry and wildlife management (ToR included in main ESA volume). A mechanism will be included in the Plan, whereby the local communities will be provided with appropriate incentives to help conserve natural habitat, wildlife and forests. These conservation areas will be further complemented by ecotourism initiatives, an information centre and research.

PCR Plan: Under this Plan, the affected wooden mosques will be disassembled, transported and reassembled in new resettlement villages at higher elevations, in consultation with the community. The remaining affected mosques will be replaced with the new ones in the resettlement villages. Also covered under the Plan will be the activities required (land procurement, fencing, protection of carvings, and tourist facilities) for the protection of the rock carvings at Shatial. The Plan will include an archaeological survey to be carried out by an archaeologist engaged by WAPDA before the commencement of construction activities in the project area to identify any PCR sites/artifacts.

Fish Conservation and Management Plan: Under this Plan, specific measures will be identified and planned for the conservation of the aquatic fauna, particularly fish. The key element of this Plan will be the development of a snow carp hatchery with all the allied facilities to meet the primary objective of restocking the Indus river upstream and downstream of the DHP and the tributaries (as well as other Indus tributaries where smaller hydropower plants are being established/planned). This Plan will be developed on the basis of the aquatic (and terrestrial) baseline study that covers snow carp as well (ToR provided under the main ESA).

(c) Social Management

Resettlement Action Plan (RAP): The project will require about 4,643 ha of land, affect a total of 767 households as a result of construction of the dam and powerhouse, formation of the reservoir, and the relocation of KKH. The social impacts largely include loss of residential and agricultural land, residential, commercial and communal structures, as well as loss of income and livelihoods. To address and mitigate these relocation and resettlement impacts, the RAP has been prepared under the SRMP. 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.

Income and Livelihood Restoration Program: The ILRP has been developed with the aim of improving or at the least restoring to the earlier level the livelihood of all displaced 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 the ILRP. Hence, training and skills development and measures for income and livelihood restoration of those affected have been included in addition to compensation and resettlement benefits. An approach in two phases has been selected. Phase I (2014-2019) is a short-term program implemented during the construction of the main structure and the relocation of the affected people. Phase II will start in 2019 will start after completion of the main structure. The RAP has provisions for a Social Development Fund to finance a long-term (10 year) livelihood development program. The detailed planning of livelihood activities will be carried out with participation of the local community. The long-term program will be designed considering the sustainability of income and livelihood based on local resources, skills, and market opportunities.

Gender Action Plan: A gender assessment was conducted under the project. The assessment revealed the gaps in development status of women, analyzed the challenging environment and explored potential entry points for

gender interventions under the project. A Gender Action Plan was developed on the basis of this assessment. The Plan recommends a three-prong approach. The first is to educate project staff, including construction forces, to raise awareness and increase sensitivity on gender. The second is to educate men, such as maliks, religious leaders and husbands on the importance for women to access project benefits. The third is to identify existing and future entry points and use them as much as possible to benefit women. It is cautioned that, given the sensitivity, all interventions related to women will need to be discussed and agreed with the communities first before being implemented.

Communication and Information Plan: WAPDA has developed a communication strategy for different target groups (local communities, previously affected persons, local and provincial authorities, general public and press). During the project, regular briefings of progress will be organized for public information and for the media. The Communication and Information Centre will also have a section where complaints and grievances can be registered and addressed. A Communication and Information Specialist will be appointed for the project. WAPDA is engaging consultant experts to develop the Communication and Information Plan. This Plan is expected to be completed by end 2014.

Public Health Action Plan: A Public Health Action Plan has been prepared on the basis of an evaluation of the health situation and services in the area as well as the additional requirements of health services in terms of quality and extent during project construction. The objective of the Plan is to minimize the risks and possible harmful effects on health due to construction activities. The Plan is scheduled to be implemented over a period of seven years. In the beginning of the construction phase an information and prevention program will be carried out aimed at the resident population in the project area who will interact with the expected influx of workers during construction. The Plan will furthermore focus on keeping the construction workforce safe from occupational hazards and the health risks that arise from living together in compounds. The workforce will have easy access to clinical care in a medical facility that will be set up for the construction workers in order to minimize adverse effects and health risks. The facilities must also have the capacity to treat emergency cases and be a referral point for sexually transmitted diseases.

Migration Management Plan: This Plan outlines the approach and steps to be taken by WAPDA during construction and operation periods to manage the impacts of the influx of large numbers of migrants. The objective of the Plan is to avoid and mitigate potential adverse impacts of the influx on the local communities and project-affected persons. The Plan will also address the social dynamics between the different communities and groups and strengthen inter-cultural understanding. Finally it will help to build an integrated vibrant local community to facilitate better project management and implementation.

9.4. Overview of Impacts and Mitigating Measures

An overview of all impacts and mitigating measures, including responsibilities and monitoring requirements, is given in **Table 12** (next page).

Table 12: Overview of Impacts and Mitigation

Impacts/Issues	Mitigation Measures	Time Frame	Cost (US$ x 10^6)	Responsibility		Monitoring Indicators	Monitoring Frequency
				Implementation	Supervision		
DASU HYDROPOWER PROJECT (overall impacts)							
1 Installation of 1,080 MW hydropower plant in phased development expanded to 4,320 MW at final stage through a run-of-river structure with minimal environmental and relatively low social challenges	Desirable outcome of project	2020 and after	Total of 3,650	Contractor	WAPDA	Power generated	Monthly
2 Expansion of electricity generation with minimal carbon emission	Desirable outcome of project	2020 and after		WAPDA	GoP	% hydropower of total power production	Annually
3 Stimulation of socio-economic development of one of the least developed districts of Pakistan	Creating structures and preconditions for further development of the district	From 2015 onwards	-	Civil administration	GoP	Socio-economic development indicators	Annually
A1 - ENVIRONMENTAL IMPACTS DUE TO PROJECT SITING							
1 Change in land use and acquisition of land needed for reservoir, physical project infrastructure and construction will require the acquisition of 4,643 ha of land, including 425 ha of agricultural land	- Compensation for land acquisition paid to the affectees (767 households); - Temporary leasing of land needed for batching plant, construction workshops, labor camps and borrow areas	2014-2015	In RAP budget	PMU	WAPDA	Land acquired	Monthly until start of construction
2 Loss of natural vegetation and cutting of approximately 21,000 trees	- Replanting of 105,000 trees near resettlement sites and along roads - Promotion of alternatives for fuel wood	2014-2019	In EMP budget	WAPDA	Forest Dept	- Number of trees planted - Number of trees survived	Annually
3 Inundation of 33 mosques in affected villages	- Dismantling of wooden mosques and rebuilding in new resettlement villages - Replacement of remaining affected mosques with new ones in resettlement villages.	2020	In EMP budget	Contractor	Local community, Archaeology Dept.	Mosque rebuilt	
4 Impacts of increased traffic and transportation (congestion, noise, air) on city of Dasu and along KKH	Preparation of Traffic Management Plan and plan for by-pass road at Dasu	2015-2022	In budget of Contractor	Contractor	- PMU - Local authority	Plan prepared	At start of construction
5 Inundation of 52 km of KKH	- Realignment of 62 km of KKH to higher level above	2014-2016	KKH-1	Contractor	PMU	km of road rebuilt	Half yearly

Impacts/Issues	Mitigation Measures	Time Frame	Cost (US$ x 10^6)	Responsibility		Monitoring Indicators	Monitoring Frequency
				Implementation	Supervision		
	reservoir - Construction of 13 km access road from Komila to dam site		39,600 KKH-2 110,000				
6 Loss of 2 suspension bridges and 3 other bridges, 5 footbridges and several cable cars	Rebuilding of bridge on Indus and development of access road all along the right bank	2014-2016	In budget of Contractor	Contractor	PMU	- Number of bridges/river crossings rebuilt	Half yearly
7 Loss of 25 km of secondary access roads at right bank and other jeepable roads	Construction of access roads on right bank of river at higher level giving access to side valleys and resettlement sites	2015-2016	In budget of Contractor	Contractor	PMU	- km of access roads built - Number of resettlement sites connected	Half yearly
8 Impacts on Kaigah Community-managed Game Reserve	Development of new conservation areas Compensation of lost income due to hunting	2014- 2019	In EMP budget	PMU	Wildlife Dept in cooperation with WWF	- Number of hunting permits sold - Number of Markhor sighted	Yearly
A2 - SOCIAL IMPACTS DUE TO PROJECT SITING							
1 Land Acquisition for project (4,643 ha)	Compensation and/or resettlement according to entitlement matrix/RAP	2014-2015	In RAP budget	PMU	WAPDA	Land acquired	Monthly
2 Relocation of households from 34 villages	Compensation and/or resettlement according to entitlement matrix/RAP	2014-2015	In RAP budget	PMU	WAPDA	Number of households compensated and/or resettled	Monthly
3 Relocation of shops/commercial establishments	Compensation and/or resettlement according to entitlement matrix/RAP	2014-2015	In RAP budget	PMU	WAPDA	Number of businesses compensated	Monthly
4 Loss of various civic amenities, 31 mosques, 7 schools, 1 motel, 2 basic health units	Rebuilding of civic amenities in resettlement areas	2014-2015	In RAP budget	PMU/DCO	WAPDA	Number of civic amenities, sites and services rebuild	Monthly
5 Loss of 423 ha of farmland, grazing area and crops	- Livelihood restoration - Agriculture, Livestock and Fisheries Development Program	2014-2015	In RAP budget	PMU/DCO	WAPDA	Social development indicators	Annually
6 Increased pressure on high/altitude grazing areas and forests	- Forestry and Wildlife Management Study - Implementation of Forest Rejuvenation Plan	2015 and after	In EMP budget	WWF/Forest Dept/ Wildlife Dept	WAPDA	- Study implemented - Updated Forest Assessment (GIS) - Hectares of forest	Every 5 years

Impacts/Issues	Mitigation Measures	Time Frame	Cost (US$ x 10^6)	Responsibility		Monitoring Indicators	Monitoring Frequency
				Implementation	Supervision		
						planted/rejuvenated	
7 Impacts of construction of 132 kV power supply line for project and colony	- Compensation of owners of land; - Avoiding residential and agricultural areas and dense forest - Reduction of health hazards for community and workers	2014-2015	In EMP and RAP budgets	PMU/DCO	WAPDA	Compensation paid	Monthly
8 Generation of employment in region	- Contractor attracting local workers and technicians on basis of quota - Development of fisheries in reservoir - Livelihood restoration - Vocational training for local workers	2015-22		Contractor	PMU	Number of employed workers from region	Annually
9 Increased activity in the project area that will stimulate local economy	Indirect positive impact					Social development indicators	Annually
B1 - CONSTRUCTION STAGE: CONSTRUCTION-RELATED ENVIRONMENTAL IMPACTS							
1 Increased traffic on KKH and local access roads due to project related vehicles, also from borrow areas	Implementation of Traffic Management Plan, provision of by-passes, safety measures and damage repair	2015-2022	In budget of Contractor	Contractor	PMU	- Road status reports - Number of complaints	Permanent
2 Impact on river habitat during construction and loss of aquatic life between two coffer dams (temporarily) and in the footprint of the dam (permanently)	- Study on significance of fish and monitoring - Implementation of ECPs	2015-2020	In budget of EMP	Fisheries consultant Contractor	EU-DHP	- Study results published - Environmental flow maintained	Annually
3 Mortality of fish during downstream movement on spillway, intakes and inlets of hydraulic structures	Prevention of fish passage by acoustic deterrent methods	2015-2020	In budget of fisheries Contractor	Contractor	EU-DHP, CSC	- Number of screens placed - Amount of restocking needed	Annually
4 Potential risk of pollution of air, noise, soil, surface water and groundwater from construction areas, yards, batching plants, quarry areas, worker camps and residential areas	- Preparation of Pollution Prevention Plan; - Establishment of baseline data - Implementation of measures prescribed in ECP	2015-2022	In budget of Contractor	Contractor	EU-DHP, CSC	Usual chemical and bacteriological water quality parameters	Permanent

Impacts/Issues	Mitigation Measures	Time Frame	Cost (US$ x 10^6)	Responsibility		Monitoring Indicators	Monitoring Frequency
				Implementation	Supervision		
5 Pollution through solid waste and waste effluents from field camps and construction yards	- Waste Management and Effluent Management Plan; - Protocols and measures prescribed in ECP	2015-2022	In budget of Contractor	Contractor	EU-DHP, CSC	- Plan ready and accepted - Solid waste monitoring reports	Permanent
6 Potential loss of land by deposition of excess rock material	- Reduction of excavated rock material through re-use of material in construction works - Re-use of plan for disposal areas	2015-2022	In budget of Contractor	Contractor	EU-DHP, CSC	Area of arable land lost	
7 Impact from quarry activities	- Implementation of ECPs - Implement Borrow Area Management and Restoration Plan	2015-2019	In budget of Contractor	Contractor	EU-DHP, CSC	- Monitoring reports - Percentage of plan implemented	Quarterly
8 Impacts of noise and dust from construction and use of explosives on residential areas and workers	- No blasting and drilling during night time - Continued consultations with communities	2015-2020	In budget of Contractor	Contractor	EU-DHP, CSC	- Noise levels - Number of complaints	Permanent
9 Increased risk of landslides and collapse of slope (use of explosives, heavy rainfall) during construction	Pro-active measures to stabilize and protect slopes and to protect workers safety	2015-2019	In budget of Contractor	Contractor	PMU	Visual inspections	Permanent
10 Impacts from increased human activities on flora and fauna	- Code of conduct for workers and employees - Awareness raising	2015-2022	In budget of Contractor	Contractor	EU-DHP, Forest & Wildlife Departments	- Number of incidents reported - Monitoring reports	Quarterly
11 Risk of water pollution in area that will be submerged	- Removal of oil tanks and storage facilities of chemicals and other products	2015-2020	In budget of Contractor	Contractor	EU-DHP, CSC	Plan prepared	At start of construction
12 Shortages and/or negative effects on local water supply and sanitation	Preparation of Drinking Water Supply and Sanitation Plan based on separate water supply and sanitation for work force	2015-2022	In budget of Contractor	Contractor	EU-DHP, CSC	- Plan ready and accepted - Number of complaints	Permanent
13 Impacts of emissions of gasses and dust on air quality due to earth moving activities, vehicle and generator emissions	- Protocols and measures prescribed in ECP - Permanent monitoring	2015-2019	In budget of Contractor	Contractor	EU-DHP, CSC	- Air quality monitoring reports	Permanent
14 Impact on the ecological connectivity and composition of the aquatic fauna and migration of fish in Indus and	- Implementation of aquatic and terrestrial ecology baseline study	2014-2015	In EMP budget	Ecological NGO in cooperation with Consultant or	EU-DHP, CSC	- Monitoring of ecological parameters for	Seasonally

Impacts/Issues	Mitigation Measures	Time Frame	Cost (US$ x 10^6)	Responsibility		Monitoring Indicators	Monitoring Frequency
				Implementation	Supervision		
tributaries between Raikot bridge and Tarbela	- Monitoring of changes and recommendations for environmental flow			University		aquatic and terrestrial fauna	
15 Disturbance of visual landscape and natural habitats	- Landscaping and Replanting Plan - Establishing nurseries - Plantation of trees	2015-2022	In EMP budget	Contractor in cooperation with Forestry Dept	EU-DHP, CSC	- Acreage of nurseries - Number of trees planted	Seasonally
B2 – CONSTRUCTION STAGE: CONSTRUCTION-RELATED SOCIAL IMPACTS							
1 Safety hazards and reduced mobility due to increased traffic especially for women, children and elderly people	- Implementation of Traffic Management Plan - Recruitment of trained drivers - Adequate facilities for emergencies	2015-2022	In budget of Contractor	Contractor	Local health services	- Plan ready and accepted - Number of accidents - Number of incidents	Permanent
2 Possible conflict and tension between communities and inmigrants.	- Awareness campaign - Implementation of Migration Management Plan - Grievance mechanisms to address complaints from local community and in-migrants	2015-2022	In SRMP budget	Contractor	WAPDA/DCO/local leaders	Number of complaints	Permanent
3 Conflict due to culturally inappropriate behavior by workers.	- Awareness campaign; - Code of conduct for workers - Grievance mechanism to address complaints from local community	2015-2022	In SRMP budget	Contractor/PMU	WAPDA/DCO/local leaders	Number of complaints	Permanent
4 Reduced safety and adverse effects on health situation by interaction of construction workforce with local residents, including spread of infectious diseases (hepatitis, HIV/AIDS)	- Implementation of Public Health and Safety Plan - Safeguards and awareness raising against communicable diseases - Gender Action Plan	2015-2022	In SRMP budget		Department of Health/WAPDA	- Plans prepared and accepted - Incidence of infectious diseases - Health indicators	Permanent
5 Increased load on local services and supplies (markets, service providers, and others)	Contractor to procure the supplies in a manner not to significantly affect the availability of essential commodities in the area	2015-2022	In budget of Contractor	Contractor	WAPDA	Number of complaints	Permanent
6 Increased risk of accidents, unsafe working conditions and health risks	- Emergency Preparedness Plan - Contractor to follow IFC	2015-2022	In budget of Contractor	Contractor	WAPDA	Plan prepared and accepted	Permanent

Impacts/Issues	Mitigation Measures	Time Frame	Cost (US$ x 10^6)	Responsibility		Monitoring Indicators	Monitoring Frequency
				Implementation	Supervision		
for workforce	Performance Standards on Labor and Working Conditions - Safety training for workers						
C1 – OPERATION AND MAINTENANCE STAGE: ENVIRONMENTAL IMPACTS							
1 Adverse impacts on aquatic fauna downstream of the dam site	Maintenance of environmental flow in low flood season	2020 and after	In EMP budget	Aquatic ecologist, Fishery Dept	EU-DHP, CSC	- Aquatic biota observed - Trial catches of fish	Seasonally
2 Impacts of first filling of the reservoir on safety of people and livestock and the stability of valley slopes	- Awareness campaign to inform local population - Slow rate of filling to prevent collapse of slopes	2020	In EMP budget	WAPDA	EU-DHP, CSC	- Number of incidents - Rise in water level per day	Permanent
3 Impact of sedimentation on reservoir area	Yearly flushing after15 years in operation	2020 and after		WAPDA	EU-DHP, CSC		Monthly
4 Impact of flushing on downstream fisheries and of reservoir on fish production during base-load operations	Fish Conservation and Management Plan including restocking	With the start of flushing and after		Fisheries Contractor	WAPDA	- Fish catches - Percentage of losses	Permanent
5 Impact of daily reservoir operation on downstream hydrology during peaking production	Continuous operation of one turbine	After DB		WAPDA	EU-DHP, CSC	Monitoring of downstream flows	Permanent
6 Increased human activities at higher altitudes will increase the pressure on forests and wildlife	Rejuvenation of high altitude forests and livelihood restoration concentrated on reservoir area and lateral valleys	2015 and after	Environ-mental Fund	Dept. of Forestry & Dept. of Wildlife	EU-DHP, CSC	- Number of incidents with illegal logging, poaching, hunting - Livelihood development	Permanent
7 Risk of bird collisions with transmission cables	Design of lines with 1.5 m spacing; provision of markers, bird deterrents in transmission cables	2020 and after	In budget of NTDC	NTDC		Number of fatalities recorded	Weekly during migration
C2 – OPERATION AND MAINTENANCE STAGE: SOCIAL IMPACTS							
2 Efficient use of reservoir fisheries that will create employment opportunities	Fish Conservation and Management Plan	2020 and after		Fisheries Contractor	WAPDA	- Number of jobs+ - Fish production	

9.5. Monitoring Plan

The monitoring plan has a dual purpose. It is designed: (a) to monitor the Contractor's work during project implementation in order to check contractual compliance with specified mitigation measures; and subsequently (b) to assess the actual environmental and social impacts of the project over the years following completion of the various project components. The first type of monitoring will be carried out by the Engineering Consultant and supervised by an independent environmental management consultant. The second type of monitoring will be commissioned by WAPDA and carried out by a local organization or consultant with sufficient experience in environmental and social monitoring. The total cost of monitoring has been estimated at US$0.50 m. Monitoring indicators and frequency are shown in **Table 13**.

Table 13: Effects Monitoring Plan

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
During Construction				
Landslides	Visual inspection of stability of landslide areas	Monthly	Contractor	CSC, DHP
Top Soil	Visual inspection of stripping, storage and reuse of top soil	Monthly	Contractor	CSC, EU-DHP
Erosion	Visual inspection of erosion prevention measures and occurrence of erosion	Monthly	Contractor	CSC, EU-DHP
Operation of quarry sites	Visual inspection of quarry sites	Monthly	Contractor	CSC, EU-DHP
Surface water quality	Sampling and analysis of river water quality and waste water discharges for the parameters given in NEQS 2000	Quarterly	Contractor	CSC, EU-DHP
		Annually	External Monitor (DHP through a nationally recognized laboratory)	CSC, EU-DHP
	Spot measurements of pH, conductivity, turbidity; visual inspection of presence of petroleum products	Monthly	EU-CSC	CSC, EU-DHP
Air Quality (dust, smoke)	Visual inspection to ensure good standard equipment is in use and dust suppression measures (sprinkling) are in place	Weekly	Contractor	CSC, EU-DHP
	Visual inspection to ensure dust suppression work plan is being implemented	Weekly	Contractor	CSC, EU-DHP
Air Quality in tunnels	Spot measurements for CO and O_2 levels in the tunnels	Monthly	EU-CSC	EU-DHP
Air Quality (PM_{10}, NO_2, SO2, CO_2, CO)	Air quality monitoring for 24 hours for the parameters specified in NEQS 2000	Quarterly	Contractor	CSC, EU-DHP
		Annually	External Monitor (DHP through a nationally recognized laboratory)	CSC, EU-DHP
Emissions from plant and equipment	Visual inspection	Monthly	Contractor	CSC, EU-DHP
Noise and vibration	24 hour noise monitoring	Quarterly	Contractor	CSC, EU-DHP
	24 hour noise monitoring	Annually	External Monitor (DHP through a nationally recognized laboratory)	CSC, EU-DHP
	Spot measurements	Monthly	CSC	EU-DHP
Waste Management	Visual inspection on spoil disposal in accordance with Waste Management Plan	Monthly	Contractor	CSC, EU-DHP
	Visual inspection that solid waste is disposed of at designated sites	Monthly	Contractor	CSC, EU-DHP
Spills from hydrocarbon and chemical storage	Visual inspection for leaks and spills	Monthly	Contractor	CSC, EU-DHP
Wild life (including migratory bird)	Surveys for wildlife and migratory birds in accordance with EMP Sub-Plan on Terrestrial and Ecology Management	Half yearly	DHP through nationally recognized institute	CSC, EU-DHP
	Ensuring adherence to migratory measures proposed in the EMP	Monthly	DHP through nationally recognized institute	CSC, EU-DHP
Fish	Surveys for fish in accordance with Fish Conservation and Management	Half yearly	DHP through nationally recognized institute	CSC, EU-DHP, External Monitor

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
	Plan			
Traffic safety	Visual inspection to ensure Traffic Management Plan is implemented	Monthly	Contractor	CSC, EU-DHP,
Local roads	Visual inspection to ensure local roads are not damaged	Monthly	Contractor	CSC, EU-DHP,
Cultural and archaeological sites	Visual observation of implementation of PCR Plan	Monthly	Contractor	CSC, EU-DHP, External Monitor
Drinking water and sanitation	Ensuring construction workers are provided with safe water and sanitation facilities on site	Weekly	Contractor	CSC, EU-DHP
Safety of workers	Usage of personal protective equipment	Monthly	Contractor	CSC, EU-DHP
Reinstatement of work sites	Visual Inspection	After completion of all works	Contractor	CSC, EU-DHP
Plantation	Visual inspection to ensure plantations are growing well	Monthly	District Forest Office with support of civil society	CSC, EU-DHP, External Monitor
During Operation				
Surface Water Quality	Sampling and analysis for sediment load, DO and temperature	Half Yearly	DHP through nationally recognized laboratory	CSC, External Monitor
	In situ measurements on DO and temperature at different depths in the reservoir	Quarterly	DHP through nationally recognized laboratory	CSC, External Monitor
Aquatic biota and fish	Collection of information on presence, seasonal behavior and biotope characteristics of selected species at selected locations	Seasonally	DHP through qualified fishery expert together with aquatic biologist	External Monitor
Downstream river flows	Measurements of discharges to the downstream	Monthly	DHP	External Monitor
Migratory birds	Surveys for migratory birds in accordance with EMP Sub-Plan on Terrestrial and Ecology Management	Half Yearly	DHP through nationally recognized institute	EU-DHP, External Monitor
Fish	Surveys for fish in accordance with EMP Sub-Plan on Aquatic Ecology Management	Half yearly	DHP through nationally recognized institute	EU-DHP, External Monitor
	Monthly data on fish catches	Monthly	Fisheries Contractor	EU-DHP
Dam Safety	Monitoring of data from dam safety equipment	Quarterly	DHP	Dam Safety Organization of WAPDA
	Survey, inspection and testing	Yearly	Dam Safety Organization of WAPDA	DHP
	Survey, inspection and testing	Once in three years	External Monitor (DHP through an internationally recognized institute)	DHP

WAPDA through its PMU will select the consultants, NGOs and organizations needed to implement the ESMP and the SRMP, supervise the progress and quality of their implementation and then assume regular monitoring activities during operations and maintenance. The monitoring results will need to be reviewed and evaluated from time to time by the M&E consultants.

Third Party Monitoring: WAPDA will engage qualified consultants to conduct third party monitoring initially on six-monthly basis. The purpose of this monitoring will be to carry out an independent assessment and validation of EMP and SRMP implementation.

9.6. Capacity Building and Training

Capacity building will be aimed at strengthening the WAPDA organization in Dasu in the field of environmental management and social development. Members of the EU and SRU responsible for supervision of environmental and social mitigation measures would be trained in environmental management, environmental quality control, ecology, environmental awareness, participatory approach and social development. Training would not be restricted to WAPDA staff; selected project staff involved in construction and operation of the project would also be trained. The Contractor will also be required to provide environmental and social training to its staff, to ensure effective implementation of the ESMP and SRMP. A budget of US$ 0.6 million has been earmarked for capacity building and training. In addition to the project-specific capacity building described above, WEC will be strengthened to actively participate in environmental

and social management of WAPDA projects, with a particular focus on effective implementation of the DHP environmental and social plans, as well as the studies and plans for the forthcoming hydropower projects such as DB. Additional funds of US$ 0.3 million have been allocated to establish a GIS facility and for institutional strengthening of WEC.

9.7. International Panel of Experts

WAPDA has engaged an international panel of environmental and social experts to advise the PMU and other project entities on all environmental and social matters, including effective implementation of the ESMP and SRMP, particularly regarding unanticipated situations, impacts, and their mitigation. The Panel has started work and has so far undertaken three missions to Pakistan. Panel members had discussions with WAPDA and design consultants, carried out field visits and reviewed various reports and documents. During the preparation and construction period the Panel will continue to convene on a regular basis. It will review reports produced by the EU and SRU, CSC and Contractors; periodically visit the site to have first-hand information on the environmental and social impacts and ESMP/SRMP implementation; and provide a report to WAPDA on the overall environmental and social performance of the project. An amount of US$ 0.43 million has been included in the project cost for this purpose.

9.8. Audits

Internal environmental audits will be held with an objective to review the effectiveness of environmental and social management of the project. It is proposed that WEC carry out these audits on a six-monthly basis. External audits on implementation of the ESMP and SRMP will be carried out by a specialist consulting firm on an annual basis. These audits would be used to re-examine the continued appropriateness of the EMP and SRMP and to provide advice on any updates required.

9.9. Annual Review of ESMP and SRMP

CSC under the supervision of PMU and WEC will carry out annual review of the appropriateness and adequacy ESMP and SRMP in the light of its own monitoring and supervision as well as on the basis of the third party monitoring and audits discussed earlier. CSC will revise the ESMP and SRMP in case substantial gaps and shortcomings are identified in these plans.

9.10. Reporting and Grievances

Reporting: Proper arrangements are necessary for recording, disseminating and responding to information that emerges from the various environmental monitoring and management programs. They are also necessary for rendering the environmental management systems "auditable." However, the primary focus must remain on the pragmatic control of impacts, not the creation of complex bureaucratic procedures. The CSC will prepare monthly and quarterly reports covering various aspects of the ESMP implementation including compliance and effects monitoring, capacity building, and grievance redressal (discussed below).

Grievances: Grievances are actual or perceived problems that might give grounds for complaints. As a general policy, WAPDA will work proactively towards preventing grievances through the implementation of impact mitigation measures and community liaison activities that anticipate and address potential issues before they become grievances.

A four-tier "bottom up" system of grievance redress committees (GRCs) will be established for the DHP, comprising: (i) village level GRC; (ii) Union Council level GRC; (iii) District level GRC; and (iv) Project level independent GRC to be led by a retired civil judge. 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. 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 Union Council GRC with all documentation. Similarly, unresolved cases from this level will be forwarded to the next tier for review and deliberations. The decisions at the Village GRC and Union Council GRC levels will be made by a simple majority vote by the members, whereas the decision at District GRC and Project GRC will be based on a two-third majority as the cases may be of complex and sensitive in nature. 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 DHP for any legal and administrative fees paid or incurred pursuant to the grievance redress procedures.

9.11. Cost of EMP and SRMP

The costs of implementing the EMP and SRMP are shown in **Tables 14** and **15**.

Table 14: EMP Implementation Cost Estimates

	Description	Estimated Cost (million US$)
1	Implementation of EMP by Contractor	18.32
2	Environmental staff in CSC	4.33
3	Environmental staff in PMU	2.18
4	Internal auditing	0.20
5	External monitoring	0.50
6	IPOE	0.43
7	Capacity building, institutional strengthening	0.90
8	Monitoring of water and waste water quality	0.54
9	Spot monitoring of air, noise and water quality	0.44
10	Traffic management	1.54
11	Aquatic ecology and development of fisheries	6.22
12	Terrestrial ecology, forestry and nature conservation	6.75
13	Environmental management and enhancement of resettlement villages	2.10
14	Physical cultural resources	1.76
15	Provisional budget for ESA of 500 kV transmission line, and implementation of additional offset measures, including those for 500 kV transmission line, if required	4.98
16	Weather station in colony	0.15
17	Glacier, flood warning, climate change, watershed management	10.50
18	Contingencies	2.00
	Total	**63.84**

Table 15: Cost of Implementing ESMP

	Description	Estimated Cost (million US$)
1	Public Consultation and Participation Plan	0.71
2	Resettlement Action Plan	398.74
3	Public Health Action Plan	20.10
4	Grievance Redress Plan	2.68
5	Communications Plan	0.54
7	Downstream Fishing Communities Support Plan	6.70
8	Safeguard Implementation and Monitoring Plan	5.29
	Total Estimated Cost	**434.76**

10. Stakeholder Consultations and Disclosure

10.1. Overview

Extensive consultations were carried out during the detailed design phase of the project, primarily through community consultations, jirgas and stakeholder consultation workshops. Community consultations involved multiple methods – for example, household level interviews, participatory rural appraisal (PRA), community

meetings, and focus group discussions. Given the cultural context, key issues were largely addressed by community elders at jirga meetings. Standard participatory tools such as PRA, focus group discussions and small group meetings are somewhat constrained by the tribal political and decision-making systems. Therefore, jirga meetings are the predominant modes for disclosure and decision-making in the project area.

In total, 2,392 persons were involved in various consultation meetings at the project sites and consultation workshops (**Table 16**) between April 2012 and October 2012.

Table 16: Number of Persons Covered in Various Consultation Meetings

	Activities	No. of participants
1.	Social environmental surveys and inventory survey	1,435
2.	Jirga meetings, consultation meetings	718
3.	National consultative workshops	239
Total		**2,392**

10.2. Community Consultations

The main issues discussed with affected persons and communities, and how these issues are addressed and incorporated are shown in **Table 17**.

Table 17: Key Issues Raised in Community Consultations

Issues	Description	Action Point
Compensation for land and other assets	The compensation issues and rates are of importance both to affected persons and WAPDA. The local demands have been for the rate applied in the case of DB Dam upstream. Land acquisition notification has not been set yet by Dasu District Revenue Officer. In view of the absence of cadastral surveys/maps, it is important to prepare the maps and records first with community and jirga inputs. However, the affected communities want WAPDA to fix the rate prior to Section 4 notification. A recent jirga formed a committee to discuss this with WAPDA Project Office.	RAP has been prepared and will be implemented during project implementation.
Resettlement site development	Affected communities want to relocate to higher elevations, to sites of their own choosing in the hills with basic amenities to be built at project cost. People expressed their concerns regarding access roads to new sites at upper elevations, water, power and irrigation systems for terrace cultivation.	Resettlement sites will be developed with all basic amenities and access roads. Provisions for land development for terrace cultivation and irrigation are included in the resettlement site design.
Jobs and employment	The affected communities/sub-tribes demand full employment in the project during construction and in post-construction periods. In one of the jirga meetings, a request was made for vocational schools for boys and girls to prepare the affected persons for employment in the project. In addition, some outside employment or overseas employment opportunities are also expected by local affected people.	WAPDA has taken initiatives to conduct pilot training for candidates selected in batches from project affected households.
Livelihoods	The traditional terrace cultivation by the sub-tribes will be affected due to relocation and lack of terraced land in upper elevations. Thus, alternative livelihood after relocation must be explored since the vocational training mainly focuses on a limited number of affected people, namely, youth who have completed at least primary education.	A long-term ILRP is developed.
Environmental and social issues	Despite community-preferred relocation, there will be some disruptions, for example, schooling, access to market and to a health clinic. Two suggestions were made at meetings: (i) reforestation as an alternative livelihood after	A long-term ILRP is developed.

Issues	Description	Action Point
	relocation, and (ii) attention to the agro-ecosystem of the affected area and need for new irrigation support.	
Health and safety issues	The health and safety issues during dam construction were discussed. Local people are concerned about migrant workers for dam construction, noise and air quality issues, and heavy traffic on KKH during the construction period. It was claimed that the dam will affect community health and well-being and will impact their limited and fragile social infrastructure.	An EMP sub-plan on Traffic Management is prepared.
In-migrants and outsiders	This has been flagged in the community level meetings as a very big concern. The "outsiders" – for example, construction workers, construction material suppliers and service providers (such as chefs, grocers, barbers, etc.) are required, in addition to local human resources. However, local villagers have "mixed" feeling about the outsiders moving in to work, including potential cultural and social conflict.	A Migration Management Plan is prepared.

10.3. Consultation Workshops

A summary of comments and suggestions received in the consultation workshops is given in **Table 18**.

Table 18: Summary of Discussions in Consultation Workshops

Comments and Suggestions	Action Point/Response
Development of an agricultural terrace in the hilly areas will take several years of effort and hard work. Development of agricultural terraces to be considered for the affected households in their new resettlement areas.	Agricultural terraces will be developed in the resettlement sites.
PCRs in the area are to be properly documented.	A detailed report has been prepared on PCRs. Details are included in the PCR Plan.
The people in Kohistan have a unique social culture, which may be affected by resettlement.	The social structure of the affected people will not be disturbed and will remain the same. Relocation of the affected people will be still within their annual migration range.
There is a concern that existing health facilities will not be enough to meet local and in-migrant workers' needs.	A Public Health Action Plan has been developed. Public health issues such as safe drinking water, safe disposal of sewage, safe collection and disposal of solid waste, protection against dust and community health are considered as part of EMP.
Protection of aquatic flora and fauna should be considered in project design. Requirement of environmental flows for the sustainability of downstream habitat is to be assessed.	Environmental flows will be designed for the project. But determining how much flow will need to be released requires further studies. It is an established practice in Pakistan to design 10% of average minimum monthly flow as environmental flows. Actual assessment should be based on the habitat requirement.
KKH is the lifeline of northern areas as it is the only highway connecting northern areas with rest of Pakistan. Impact of construction traffic on KKH has to be assessed.	A Traffic Management Plan is prepared to address the traffic related issues along KKH and along the access roads to the project sites.
Impacts during demobilization of contractors are to be considered in the ESA.	Contractors' demobilization is considered in the EMP and ECPs.
WAPDA shall have an Environmental Monitoring Unit at the project site for supervision of EMP implementation.	An Environmental Unit is recommended for both DHP (WAPDA) and the CSC.
Initial filling of reservoir may affect the downstream release of water to rabi crops.	The first filling of the reservoir will be carried out slowly at the rate of 1 m/day. The rest of the river water will be allowed to flow downstream of the dam through LLO. No impact on rabi crops is expected. The first reservoir filling will take over eight months to complete.

Comments and Suggestions	Action Point/Response
Low flow seasonal operation of the dam and its impact on aquatic life needs to be considered.	The reservoir will be operated as a run-of-river project (base-load plant). There is limited storage of water in the reservoir and whatever water will be used for generating electricity will be returned to the river. In this way a guaranteed environmental flow will be maintained towards downstream habitat.
Project design shall consider geo-hazards (landslides, earthquakes and faults) in the area.	The project is designed to comply with ICOLD guidelines to deal with geological and geomorphological hazards. State of art engineering modeling was carried out for the design of the dam.
Floods from GLOFs will be a serious risk to the project. Early warning system for flood forecasting is necessary for the safe operation of the project.	Design flood (Probable Maximum Flood) of the project considered extreme flood events from GLOFs and extreme rainfall events. A flood telemetry network will be established upstream of Dasu for early warning system and better management of floods.
Security issues are to be considered during implementation of the project.	Security situation in the project area is assessed and a plan is prepared to address these issues in the SRMP volume on Hydropower Development, Conflict and Security Issues: A Perspective.
Historical and archaeological sites are to be protected. DHP should support the Archaeology Department of Peshawar for protection of Shatial rock carvings, a designated archeological site.	The PCR Plan considered the protection of Shatial rock carvings.
Impact on the community and their livelihood due to relocation to higher elevation.	A livelihood restoration program is proposed in the RAP with both short-term and long-term goals to mitigate any impacts on livelihood.
Community based conservations should be promoted. The conservancy at Kaigah where the Markhor is protected by private arrangement and sale of one trophy annually for $100,000 is a good example.	The project identified a suitable site in the project area (Kandia valley) for development of similar community based conservation.
Traffic on KKH requires careful planning if construction of DB and Bunji projects start along with Dasu.	Currently there is no confirmed schedule available on construction of DB and Bunji. This issue is further studied as part of the Cumulative and Induced Impact Assessment (CIIA).
There are no proper health facilities in Kohistan. Health and safety of construction workers and host community need to be planned.	A Public Health Action Plan has been prepared to address these issues.
Indus valley is a flyway for migratory birds from Siberia to the subcontinent. Impact of transmission line on birds' migration has to be assessed.	Bird collision and electrocution are potential threats to migratory birds. These issues will be addressed in the transmission line ESIA.
Electromagnetic waves from transmission lines and their impact on human health to be assessed.	These issues will be addressed in the transmission line ESIA.
Cumulative impacts of hydropower development on Upper Indus Basin and Lower Indus Basin should be monitored.	The present assessment limits its scope in the Upper Indus Basin (Tarbela Catchment). A detailed study is in pipeline from WCAP on SSESA of the Indus Basin.
Impact on migratory birds and important bird areas to be assessed.	The DHP reservoir may have a positive impact as staging area on the migration of birds.
Indus river ecology should be protected. Feasibility of fish ladders should be studied.	Detailed studies on terrestrial and aquatic ecology were under taken as part of environmental assessment of the project.
Climate change impacts may trigger GLOFs, high erosion and sedimentation; and finally may affect the project.	A climate change assessment study was under taken as part of the environmental assessment.
Habitat management plan for endangered species is to be	A community conservation area is proposed for protection of important fauna in the project area such as

Comments and Suggestions	Action Point/Response
proposed.	Markhor, Musk deer, Monal and Tragopan pheasant.
Lost community facilities in the affected villages are to be restored in the new resettled villages.	All basic amenities like roads, water supply, irrigation, sanitation, schools and any other facilities that were lost will be built in the new resettlement areas.
Involvement of local community in planning and development process is very important.	Consultation meeting were carried out in all the project villages through PRA techniques.
Need to ensure timely & frequently stakeholders meetings for suggestion and feedback.	WAPDA has established a full time office at Dasu which is constantly providing a forum to consult on any and all issues. An Executive Engineer of WAPDA heads the office. DCO is also involved.
Proper compensation of affected community is needed, to make it more transparent & clear; affected persons need to be provided proper guidance.	Recommended in RAP.
Capacity of WAPDA in term of human resources needs to be increased to address environmental and social issues.	Field level environmental and social units will be established in DHP.
Potential livelihood and income generation activities should be started.	Short-term and long-term livelihood restoration plans are recommended in RAP.
Education sector is very important in this area. Focus on education and health sector.	Education and health will be considered in the SRMP.
Involvement of women is very important. Livestock related livelihood activities for women should be designed.	A Gender Action Plan is prepared.
Mobilization of women for capacity building related to income generation activities needs to be more focused	A Gender Action Plan is prepared.
Invertebrate fauna / aquatic flora should be addressed.	These are part of the aquatic ecology assessment
A fish hatchery should be established.	A fish hatchery will be established, initially for research and development and later for full scale development when farming of snow carp is feasible in the reservoir.
Local people need to be provided support for terrace farming.	Recommended in RAP.
Livestock farming can be undertaken through providing quality animal breeds.	Recommended in RAP.

10.4. Disclosure

The updated ESA has been submitted to KP-EPA. A final round of consultation and disclosure of the ESA reports was carried out during February 2014. These meetings were held in Dasu, Peshawar and Islamabad, at which respectively relevant provincial and national organizations and institutes were invited. The consultation meetings were also attended by WAPDA officials, media, local representatives, and most importantly, local community members. The ESA summary has been translated into Urdu. Both the Urdu and the English versions are uploaded on WAPDA website. The Summary and the ESA document were uploaded on the website of WAPDA and disclosed at the World Bank InfoShop on 24 January 2014.