E4416 V1

PAKISTAN

WATER AND POWER DEVELOPMENT AUTHORITY (WAPDA)

Dasu Hydropower Project

ENVIRONMENTAL AND SOCIAL ASSESSMENT

Reviewed Draft

Report by Independent Environmental and Social Consultants

January 2014

Contents

List of Tables

List of Figures

List of Acronyms

AP	Affected Person
amsl	Above mean sea level
BDF	Basic Design Flood
BHU	Basic Health Unit
BP	Bank Procedures
CCA	Community Conservation Area
CIIA	Cumulative and Induced Impact Assessment
CITES	Convention on International Trade in Endangered Species
CSC	Construction Supervision Consultants
CVC	Conventional concrete
DBP	Diamer-Basha Project
DCO	District Coordinating Officer
DG	Director General
DHC	Dasu Hydropower Consultants
DHP	Dasu Hydropower Project
EA	Environmental Assessment
ECA	Employment of Child Act
EIA	Environmental Impact Assessment
ECP	Environmental Code of Practices
EHS	Environment, Health, and Safety
EMAP	Environmental Management Action Plan
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
EPD	Environmental Protection Department
ESA	Environmental and Social Assessment
ESM	Environmental and social monitor
ESMP	Environmental and Social Management Plan
ESMU	Environment and Social Management Unit
ESS	Environment and Social Supervisor
EU	Environment Unit
FGD	Focus group discussion
FSL	Full supply level
GAP	Gender Action Plan

GDP	Gross Domestic Product
GHG	Greenhouse gases
GLOF	Glacial lake outburst flood
GoP	Government of Pakistan
GT Road	Grand Trunk Road
HIV/AIDS	Human immune-deficiency virus/ acquired immune-deficiency syndrome
HSE	Health, Safety, and Environment
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
IRR	Internal Rate of Return
IUCN	International Union for Conservation of Nature
KCGR	Kaigah Community Game Reserve
KKH	Karakorum Highway
KP	Khyber Pakhtunkhwa
LLO	Low Level Outlet
LOS	Laws of Seas
LPG	Liquefied petroleum gas
M&E	Monitoring and Evaluation
MEA	Multilateral Environmental Agreement
MMT	Main Mantle Thrust
MoE	Ministry of Environment
MoWP	Ministry of Water and Power
MSDS	Material Safety Data Sheet
NCS	National Conservation Strategy
NEAP	National Environmental Action Plan
NEP	National Environmental Policy
NER	Net enrolment rate
NEQS	National Environmental Quality Standards
NGO	Non-Governmental Organization
NOC	No Objection Certificate

NTDC	National Transmission and Dispatch Company
NWFP	North Western Frontier Province
O&M	Operation and maintenance
OHS	Occupational Health and Safety
O&M	Operation and Maintenance
OEAP	Operation Environmental Action Plan
OP	Operational Policy
Pak-EPA	Pakistan Environmental Protection Agency
PATA	Provincially Administrated Tribal Areas
PD	Project Director
PEPA	Pakistan Environmental Protection Act
PEPC	Pakistan Environmental Protection Council
PKR	Pak Rupees
PM	Particulate matter
PMU	Project Management Unit
POP	Persistent Organic Pollutants
PPE	Personal protective equipment
PRA	Participatory rural appraisal
RAP	Resettlement Action Plan
RCC	Roller compacted concrete
RHC	Rural Health Center
SA	Social Assessment
SCF	Safety Check Flood
SDF	Social Development Fund
SIMF	Social Impact Management Framework
SRMP	Social and Resettlement Management Plan
SRU	Social and Resettlement Unit
SSESA	Strategic Sectoral Environmental and Social Assessment
TMP	Traffic Management Plan
ToRs	Terms of reference
TV	Television
UIB	Upper Indus Basin
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
US-EPA	United States Environmental Protection Agency

USD	United States Dollars
WAPDA	Water and Power Development Authority
WB	World Bank
WBG	World Bank Group
WCAP	Water Sector Capacity Building and Advisory Services Project
WEC	WAPDA Environmental Cell

Units of Measurements

µS/cm	micro Siemens per centimeter
BCM	Billion cubic meters
Btu	British thermal unit
C	Centigrade
C. ft.	cubic feet
dB	decibels
g	gram
GWh	giga watt hour
ha	hectare
kanal	one eighth of an acre
Kg	kilogram
Km	kilometer
KV	kilo volts
KWh	kilo watt hour
l/m	liters per minute
m	meter
m/s	meters per second
m^3/s	cubic meters per second
mg/l	milligrams per liter
mmbtu	million British thermal units
MW	mega watt
Sq. ft.	square feet
TJ	tera Jules

1. Introduction

The Dasu Hydropower Project (DHP) is a major investment project proposed by the Government of Pakistan (GoP) with support of the World Bank to modernize and expand the energy sector of the country, while shifting from thermal generated electricity to low cost and high reward, clean 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; see **Figure 1.1** for the project location. In the present document the potential environmental and social impacts of the project are described, including measures to prevent, mitigate or reverse possible negative impacts.

1.1. Background

1.1.1. The Energy Sector in Pakistan

Access to electricity in Pakistan is atpar with other countries of similar income.The number of electrified households has risen from nearly half of Pakistani households (7.8 million) in 1996 to two-thirds (13.4 million) in 2006 and three-quarters (19 million) in Lin2011[1]. The major electricity consuming sectors of the country (based on 2011-12 data) are: residential (45.3 percent), industry (29.2 percent), agriculture (11.3 percent), commercial (7.6 percent), bulk (4.7 percent) and others (1.9 percent).

Although access to electricity has expanded, service is unreliable. The electricity sector faces a large gap between supply and demand, and widespread load shedding is prevalent. Annual per capita electricity consumption in Pakistan 433 Kilowatt-hours (kWh) is lower than lower middle income country standards, which on average consumed 643 kWhs per person per year in 2008.[2] Moreover, electricity consumption in Pakistan grew by only about 73 percent since 1990 compared to 187 percent in Malaysia and 300 percent in China. Neighboring countries in South Asia such as Bangladesh, Nepal and Sri Lanka witnessed a growth in electrical consumption by about 221, 129 and 159 percent respectively over the same period (World Development Report, 2010).

Generation is only two thirds of peak demand and 6-8 hours a day of load shedding is common. Such shortages have significantly affected the ability of businesses to operate efficiently while also disrupting daily routines for the general population, and have given rise to unrest and violence in the major cities.

Power shortages result in long hours of load shedding, impacting households, industrial and commercial activities. Lack of power affects people's quality of life: summers are uncomfortable, children often have no light to study, people cannot watch TV, food cannot be cooled, and so forth. But the impact of the energy crisis extends far beyond the daily life. It affects schools, colleges, clinics and hospitals; it affects shops and businesses, reducing sales and revenues; and it affects industry, reducing productivity. It also deters investment. This means, on a macro level, reduced economic growth which translates into loss of livelihoods, jobs and income.

[1] However, according to household income and expenditure survey (see Pakistan Social and Living Standards Measurement Survey 2011) 91% of households report electricity as the source of lighting.
[2] *World Development Indicators.* Annual per capita consumption is 3,388 kWh for Malaysia and 2,040 kWh for China.

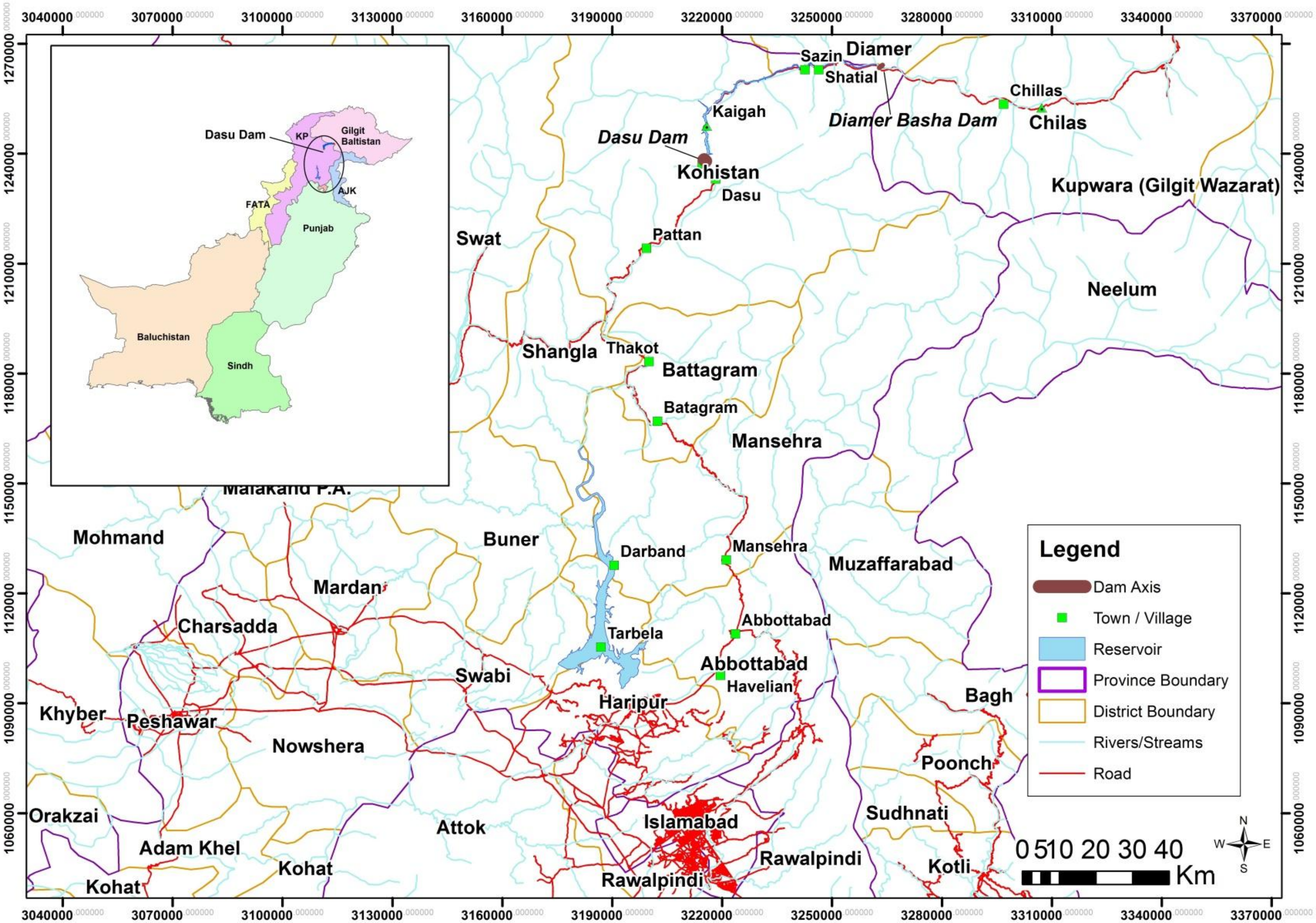


Figure 1.1: Location of DHP in Pakistan

The financial impact of load shedding has been estimated at 3 percent to 4 percent of GDP, costing about USD 10 billion a year. This situation is causing serious economic losses to the country and is responsible for increased unemployment and poverty.

The country needs additional generation capacity. Installed capacity essentially stagnated over 2000–2008. By comparison, installed capacity increased by 40 percent in Bangladesh, and 46 percent in India over the same period. After 2008, around 3,000 MW were added, taking capacity to about 22,500 MW by end-2011. But around 10 percent of total installed capacity is unavailable, however, because of lack of maintenance and lack of fuel. From a peak of 26 percent of total investment and 51 percent of public investment in the mid-1990s, the share of energy (including power) investments had declined to 4 percent and 26 percent, respectively, by 2009/10. During this period, private investment was essentially zero.*Generation costs are now very high.* Capital and operational constraints meant that the country was not able to undertake new investments in hydropower. To address continuing energy shortages in the 1990s, Pakistan launched an extensive program to mobilize private sector investments in power generation. These were primarily concentrated on thermal generation, which typically require smaller investments and have a faster gestation time. As a result, generation mix shifted from two-thirds hydro and one-third thermal in the 1980s to only 30 percent hydro and 70 percent thermal today. The new plants rely on higher priced, dirtier furnace oil.

Atlerntative Projects: The economic analysis shows that DHP has net benefits greater than or equal to those of mutually exclusive project alternatives. In Pakistan there exist a series of options such as demands 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 to address these issues, Projects such as energy conservation and energy efficiency are complements to, rather than mutually exclusive substitutes for, DHP and will be implemented regardless of whether Dasu is built or not. Alternate renewable sources such as wind and solar cannot be developed to a scale comparable to DHP since they will be three times more expensive than DHP. Both of these options need to be developed to the extent technically and financially feasible. They are complementary, but not substitutes for DHP.

Hydro is by far the cheapest generation type for Pakistan and less than a fifth of the cost of generation from heavy fuel oil which predominates now. New large hydro plants can generate power for Rs 2.50-3.50 per kWh, compared to Rs 4.5 per kWh for domestic gas combined cycle plants, Rs 4.2 for nuclear, Rs 8.1 per kWh for coal, Rs 16.75 per kWh for fuel oil, and around Rs 21 per kWh for diesel. The project proposed in this PCN will have a major impact on sector performance and finances. It is expected to bring down the average cost of generation for the entire country by 5-12 percent.

1.1.2. The Vision 2025 Program

During the 1980'sseveral studies were carried out to identify new water storage and hydropower projects. The total identified capacity of hydropower was estimated at some 46,000 MW. Nine of the projects identified were located in the Upper Indus basin. On basis of these studies, the Water and Power Development Authority (WAPDA) prepared at the end of the millennium its "Vision 2025" program.

The Vision 2025 was designed to cope with the increasing water and power demands of the country. The program had a dual purpose: to increase the hydropower generation capacity in the country, and meanwhile optimizing the water supply to the Indus irrigation system. The program was approved by GoP in 2001. It included an ambitious development program with short-term and long-term hydropower projects to be constructed in three phases until the year 2025 to generate an additional 16,000 MW. The Dasu Hydropower Project (DHP) was included in this program as one of the priority projects under phase 3 (2011- 2025). On the priority list DHP ranked second.

A least-cost capacity optimization plan was included in the National Power System Expansion Plan 2011-2030 (NPSEP), prepared for the National Transmission and Dispatch Company (NTDC) by SNC-Lavalin. The NPSEP confirms the presence of Dasu in the least cost expansion plan.The screening curve analysis of this Plan demonstrates the large cost advantage of the large hydro projects – which is independent of the thermal project load factors. DHP has generation costs (using NPSEP assumptions) of $39/MWh, less than half of the best thermal option, and regardless of load factor. Moreover, this cost comparison does not include the environmental externalities of thermal generation. Large hydropower projects are known for significant environmental and social issues. However, DHP has limited social and environmental impcts primarily because of having a small reservoir. The DHP, in turn, has least cost when compared to the various ongoing and planned hydro schemes in the country, including – (i) public and private, (ii) run-of-river and storage, (iii) up- and down-stream of DHP, and (iv) on rivers other than the Indus (Jhelum and Swat).

Indus Cascade

The GOP energy strategy (2013) emphasizes the development of the Indus Cascade (see **Figure 1.2**) to add hydropower to the system to bring down the cost of generation which is crucial for the sustainability of the sector. In that context, the GOP is now increasingits investments in hydropower development.

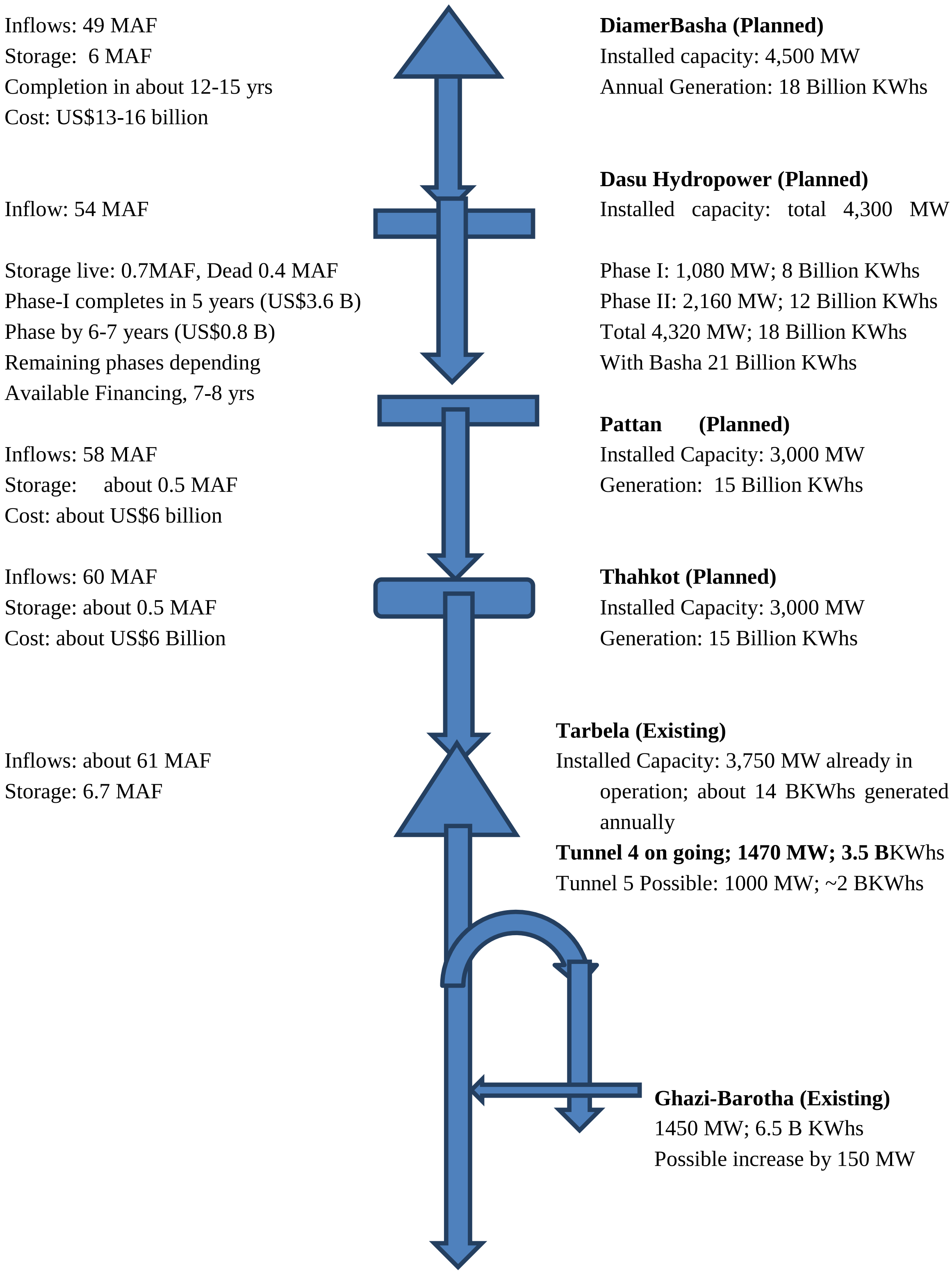
Over the next 15-20 years Pakistan plans to develop the Indus Cascade between Tarbela and Diamer-Basha (DB) thus adding about 12,000 MW or about 71,000 GWhs of electricity generation annually. Dasu Hydropower Project (DHP), one of the projects in this cascade is relatively low costand fast to undertake with a low gestation period.

1.2. The Proposed Project

1.2.1. Location

The Dasu Hydropower Project is located on the Indus River at a site about 7 km upstream of Dasubridge near the small town of Dasu, the capital of Kohistan district in KP province (see **Figure 1.1**). At this site the river Indus flows in a deep and narrow valley (elevation 750 - 800 m). The valley is strongly incised into the lower Himalayan mountains, which have an average altitude between 2,000 and 4,000 m. The project area is accessible through the Karakorum Highway (KKH), which is the single and strategic road connection between Islamabad (at 350 km distance from Dasu) and the north of Pakistan (Gilgit-Baltistan province) and with China (Kashgar). About 74 km further upstream distance from the Dasu dam another structure in the Indus valleyis planned under the “Vision 2025” program: the Diamer-Basha Project in Chilas district.

Figure 1.2: Indus Cascade - Water, Hydropower and Economic Growth of Pakistan



Total cascadeinstalled capacity: about 22,000 MW; generation: 85 billion KWhs. Over next 15-20 years, with 10,000 MW new capacityand72billion KWhs thus substantially shifting the mix to **hydropower**.

1.2.2. Main Structure

The DHP includes the construction of a 242 m high concrete main structure in a gorge like valley of the upper Indus River basin. The water retained by this structure will provide sufficient “head” to generate electricity in an underground powerhouse, housing 12 turbines - at its final stage - each of which will produce 360 MW of power.

Behind the main structure there will be a 73 km long reservoir (at full supply level of 950m above mean sea level - amsl) with an average width of 365 m and a total surface area of about 2400–ha. The total maximum generation capacity will be 4,320 MW. After full completion, the Dasu Hydropower Project is estimated to generate about 21,000GWh of energy per annum. This would significantly alleviate the shortage of electricity in the country.

1.2.3. Karakorum Highway, Access Roads

Apart from the hydraulic and electrical infrastructure needed, the project includes the realignment of about 62 km of KKH at a higher level in the alley due to submergence of the current road on the left bank of the Indus. The relocated road section also requires the construction of 8 new bridges and a link road of 3 km between the relocatedKKH and the existing KKH near the dam site. In addition, an access road with a length of about 12 km from the town of Komilla (right bank opposite to Dasu) will connect the existing KKH on the right bank with the dam site. Similarly, on the Indus right bank upstream of the dam local access roads will be constructed to provide access to small resettlement villages on the right bank of the reservoir. The project also includes the construction of a new suspension bridge on Indus near Kandia River connecting left and right banks.

Also included in the project is the construction of a 132 kV transmission line between Dubair grid station (near Pattan) at some 45 km downstream of the project site. The transmission line will provide the project and the residential colony with electricity during the years of construction. The environmental and social impacts of the construction of the transmission line and their mitigations are also included in this report.

1.2.4. Transmission Line for Power Evacuation

Two parallel running 500 kV transmission lines will be constructed to connect DHP with the 500 kV grid station located at a village Pathar Garh near Hassanabdal (District Attock) to evacuate power from the project. The 250 km long transmission line traverses along the Indus river from Dasu project to Pattan and then passes through Palas valley, enters into Mansehra and Abbotabad districts and finally enters to District Attock in Punjab after passing through District Haripur in KP. The National Transmission and Dispatch Company (NTDC) is responsible for the construction of the transmission line and the company has already started the project planning work. Different alignment alternatives are proposed and they are under further analysis. Along the areas of the alternatives, NTDC has subsequently completed a study on environmental assessment and an Environmental Assessment and Review Framework (EARF) has been submitted to the Bank for its clearance. NTDC completed the Framework by hiring environmental consultants who worked with its Environmental and Social Impact Cell to do the surveys and consultations. NTDC has also carried out a socioeconomic profiling exercise and a screening of the possible social impacts under the transmission line. Key environmental and social feature of the EARF have been presented later in the present document and also in the Executive Summary of ESA while the EARF and the social impact screening are presented as stand-alone volumes along with the main ESA report covering Dasu project and Karakoram Highway (KKH). NTDC has received a technical assistance support from Asia Development Bank and has developed a Land Acquisition Resettlement Framework (LARF) for NTDC in line with relevant ADB and government policies. The LARF was endorsed and adopted by NTDC management for all its investment opeations to be supported by international financial institutions. The LARF was reviewed and approved by ADB for compliance with its resettlement policy under its sector program lending operation. The World Bank has reviewed and cleared the LARF, with further revisions, for compliance with OP 4.12, for CASA 1000 Transmission Line Project. The same LARF will apply to Dasu Transmission Project.

1.2.5. Project Ancillaries

In addition to the main components described above, the project will also include the following permanent and temporary ancillary investments (further discussed in **Chapter 3**):

- Permanent ancillaries including the WAPDA colony with staff housing, sites and services, offices, access roads from KKH to Colony and on right bank providing access to villages, a new suspension bridge over the Indus at Kandia and several smaller bridges;
- Temporary facilities such as labor camps, construction yards, quarries and borrow areas, stockpiles, spoil disposal sites (69 ha), workshops and stores needed for the construction of the main project;
- Temporary facilities for the construction of the 500 kV (250 km) and 132 kV transmission lines (45 km); and
- Sites and services for the people to be resettled by the project, including supporting infrastructure (water supply, sanitation, roads, agricultural terraces, mosques, schools, and health clinics).

1.2.6. Phasing of the Project

The project will be completed 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 will include installation of the remaining six turbines and will be implemented after the completion of Diamer Basha project (see **Table 1.1**). The total project investment is estimated at USD 5.98 billion.

Table 1.1: Staged development of DHP in relation to Basha

	Stage 1		**Stage 2**	
	Phase-1	**Phase-2**	**Phase-3**	**Phase-4**
Works	Dam & three turbines	Three turbines	Three turbines	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 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;

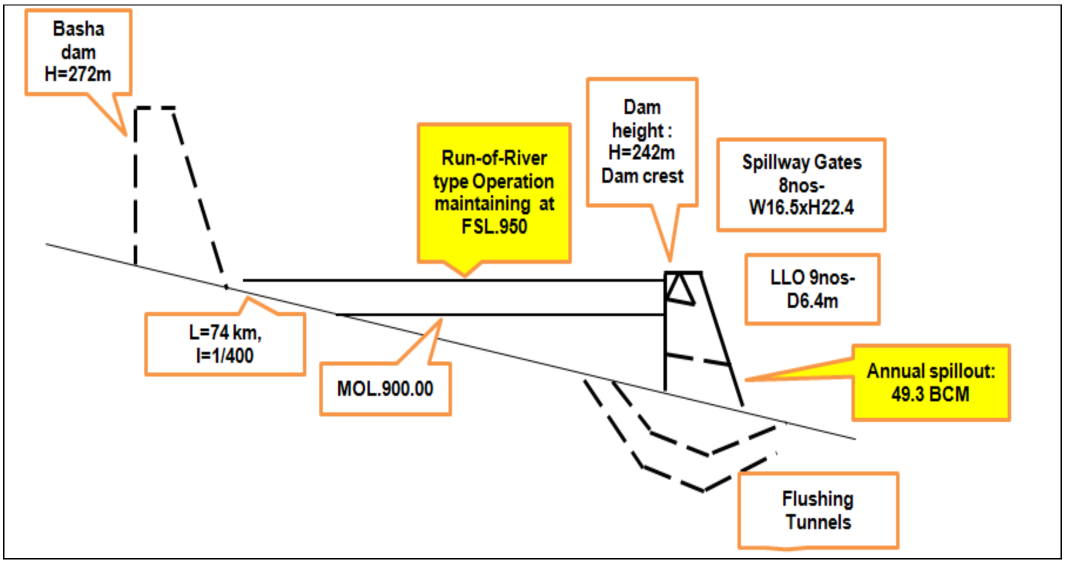
DHP-Stage 2 will be started after the completion of DB, and would take four years to complete;

DHP Stage 1 will be completed in seven years; the first unit will start generating after five years.

1.2.7. Run-of-river

The Dasu Hydropower project is a "run-of-river" project exclusively used for power generation. Water flowing into the reservoir and stored behind the dam will be always be kept at a permanent water level of 950 m to maintain sufficient "head" for power generation. Whatever additional water is flowing into the reservoir will be diverted through the intakeand power tunnels towards the turbines installed in the underground powerhouse. All water used for power generation will be re-diverted to the river through tail race tunnels. Therefore, there will be no consumptive use of water in the project with the exception for some evaporation from the relatively small reservoir (about 2,400 ha), where a slow flow will be maintained. During high flows/floods excess water will pass through low level outlets and/or spillway. During low flow seasons, there will be reduced flows between the dam and tailrace outlet (4.4 km dewatered section). Downstream of the tailrace outlets, the river flows remain unaffected by the dam. In this way the project is not expected to adversely affect the water availability downstream, including the water sharing between the four provinces of Pakistan as agreed in the 1991 Water Accord. The principle of the base-load operation of a Run-of-River project is schematically shown in **Figure 1.3**.

Figure 1.3: Operational Concept of DHP as Run of River Type (Base-load Operation)



1.2.8. Preparatory Studies and Planning of DHP

A feasibility study for the DHP project was carried out between 2007 and 2009. During this study the location of the project was identified and preliminary engineering designs and cost estimates for a project with generating capacity of 4,320 MW and an annual energy generation of 21,300 giga watt-hour (GWh) were prepared. The preliminary design was prepared on the assumption that the Diamer-Basha Project (DBP) will be constructed prior to DHP. A preliminary environmental and social impact assessment was also included in the feasibility study. On basis of these studies a preliminary 'no objection certificate' was obtained from the Environmental Protection Agency (EPA) of KP province in 2011. The current location and detailed designs are largely based on the results of the feasibility study.

The detailed design of DHP subsequently has been prepared by an international consortium of consultants: the Dasu Hydropower Consultants (DHC). The design is prepared on basis of the concept that the Diamer-Basha (DB) Project will take longer to implement and first two phases of the DHP that is Stage 1 will start operation before the completion of DB. This is a major conceptual shift as compared with the initial feasibility study. Financial assistance for the design studies has been given by World Bank under the Water Sector Capacity Building and Advisory Services Project (WCAP) and Tarbela 4 Extension Hydropower project (T4HP).

Subsequent to the completion of detailed design of the project, the tender documents for the Stage 1 have also been prepared. Furthermore, the pre-qualification process for the preparatory works (KKH relocation, WAPDA colony, and 132-kV transmission line for construction power supply) has also been initiated.

1.3. Scope of the Project and Nature of Impacts

Project interventions may have direct or indirect impacts on the physical, natural, socio-economic and cultural heritage. The anticipated impacts may bring positive or negative changes or alterations in the area. Some impacts, such as dust and noise pollution might be temporal and restricted to the construction period. Other impacts might be more permanent. Some of the impacts can be easily predicted, others are difficult to predict and should be closely monitored during implementation and operation of the project.

1.3.1. The Project Area

The project area for the present ESA is the “direct footprint” of the project and includes those areas where the direct impacts of the project are observed or felt. This is the area to be acquired for the reservoir, the project infrastructure and ancillaries, the resettlement sites, including the areas used for contractor facilities such as labor camps, workshop, disposal areas, borrow pits, and quarries.

The impact area area of the project could be defined as follows:

- The Indus river and lower valley slopes betweena point at some 74 km upstream from the dam until a point 12 km downstream from the dam, and including the left and right bank of the Indus valley up to an elevation of 1500 m amsl (including the KKH section to be relocated);
- The (twin) towns of Dasu (left bank) and Komilla (right bank);
- Quarry/borrow areas;
- Haulage routes routes for project equipment and supplies;
- The corridor of the transmission line to be constructed providing electricity to project during construction, connecting Dubair grid station with the project (45 km); and
- The 250 km long and 500 m wide corridor of 500 kV transmission line from Dasu hydropower to village Patthar Garh in District Attock.

1.3.2. The Area of Influence

The project will be implemented in the gorge-like valley along the Indus. Project construction activities and erection of temporary facilities will directly affect a narrow corridor extending from Dasu bridge towards Kaigah, a small village situated at the left bank, 18 km north of Dasu. Direct influence of reservoir will be from the site of the main structure towards a point 73 km upstream, at 1 km distance from the projected site of the

Diamer-Basha (DB) dam. Other direct and indirect impacts will occur in the immediate surroundings of borrow areas and quarries for construction materials.

Vertically all land situated between the Indus river bed near Dasu at a level of 750 m up to 959 m (which is the safe flood level of the reservoir) and higher uphill including the zone between 1000 and 1500m, where people will be resettled, will be affected by the project. Implementation of the project will mean that 34 small villages and hamlets will have to be abandoned, requiring the resettlement at higher levels of some 6,860 persons.

The area of influence is much larger and can be described as the area where the indirect (induced) impactson the physical and social environment are felt. This includes amongst others:

- The KKH from Thakot bridge to the project area (traffic and transportation);
- The Indus river downstream until Tarbela dam (water quality and discharge)
- The neighboring mountain uplands on both sides of the Indus valley above (el. 1500 m) characterized by a high biodiversity; and
- The population in and around the project area which is not directly affected, but living in the area.

1.3.3. Cumulative Impacts

The combined and cumulative impacts of construction of DHP and other projects in the area could be quite significant. Often these impacts are associated with the connectivity of a road or a river, but also an indirect result of resettlement as well as influx of people. For instance large scale transport of project and building materials along the KKH during a long period (years) may influence the capacity of this important road considerably. This might have significant positive and negative social and economic impacts. The river hydrology and sediment transport of the Indus might also be affected by the project, as well as fish habitats. This might have positive as well as negative induced impacts further downstream, at least until the Tarbela dam and possibly beyond. Construction of a cascade of dams in the Indus might lead to resettlement of people on higher elevations resulting in increased pressure on land resources, forests and biodiversity in the higher mountain plains.

Cumulative impacts from the implementation of other hydro-projects situated in the Upper Indus Basin might give both positive and negative impacts on the physical and social environment in the Dasu area and further downstream. Examples are the positive impacts of the completion of DBP and DHP together on life expectancy of the Tarbela reservoir due to the trapping of sediment. Also the water availability for irrigation during early kharif growing season in the plains could be improved through coordinated operation of water releases of both projects to Tarbela reservoir. Some other potential cumulative downstream effects of a changed and largely controlled river regime will depend to a certain extent on the operational system selected for DHP (power generation based on base load or peak production).

The impacts of the operation of the project will be examinedin more detail in Chapter 7, while cumulative assessment (CIA) is discussed in Chapter 8.

1.4. Purpose and Methodology of the Environmental and Social Assessment

This report describes the potential environmental and social impacts of the DHP project. The environmental and social assessment (ESA) is an important tool for decision making. In the ESA the social and environmental risks and impacts of the project are evaluated.

The ESA process for the DHP started early during the feasibility stage and a preliminary environmental and social assessment was carried out as described in **Section 1.2.8** earlier. Subsequently in 2011, WAPDA engaged the Dasu Hydropower Consultants to prepare the detailed design of the project. During this stage WAPDA also engaged the services of independent consultants to carry out the environmental and social assessment with the assistance from DHC and to prepare the present ESA report. The key objective of the ESA was to ensure that the activities carried out under the proposed project are (i) environmentally sound and sustainable in the long run, and (ii) consistent with the environmental and safeguard laws,regulations and procedures of the Government of Pakistan, as well as the policies ad guidelinesof the World Bank.

The key steps carried out during the ESA included detailed field investigations and literature review to study in depth the existing environmental and social conditions of the project area, several rounds of comprehensive consultations with different types of stakeholders to disseminate project information to them and to ascertain their concerns and recommendations, analysis of alternatives to evaluate various options available during the design and construction stages, determining the compliance status of the project with respect to the national regulatory and WB safeguard policy requirements, and most importantly, carrying out assessment of environmental and social impacts and determining appropriate mitigatory and or compensatory measures to reduce if not completely eliminate these impacts.

1.4.1. Composition of Study Team

Independent Consultants

WAPDA engaged a team of independent consultants - Mr. Reitse Koopmans, Mr. Mohammad Omar Khalid, and Mr. Hans van Zon –to assess the potential environmental as well as social impacts of the project, to prepare the environmental and social management plans, and to prepare the main ESA report as well as the Summary ESA report. The independent consultants commenced working from the start of the project design around August 2011 and they were authorized to recruit/access professional expertise as required for carrying out the independent ESA. During the ESA process, the independent consultants regularly interacted with the DHC'sdesign team providing technical advice and recommendations, carried out their own field visits, participated in the consultations, and conducted their independent analysis and impact assessment. Where found suitable the independent consultants obtained information from the design consultants concerning the technical aspects of the project, and asked to collect environmental and social information from the field through surveys and collection of data by their staff. The assessment and analysis about the impacts as well as proposed management plans have been based on the recommendations and professional judgment of the independent consultants.

Environmental Study Team

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

Social Study Team

The national members of the social and resettlement team included Maqsood Ahmed, Dr. Ramzan Chaudhary, Awais Hassan Khan (Resettlement Specialists), Anwar Fazal Ahmed, Arslan Tariq (Sociologist), SaimaRaoof and UjalaSaleem (Gender Specialists), Rana Muhammad Saleem (Consultation Specialist), Ahmed Saleem (Communications Specialist), Noorul Hadi (Livelihood Specialist), and Dr. IlyasQuershi (Public Health Specialist). The international experts included Dr Mohammad Zaman, Dr. Sunil Gonnetilleke and Dr. Haimin Wang (Resettlement Specialists), Dr. IffatIdris (Social/Conflict Analyst), and Dr. Bernhard Eder (Public Health Specialist).

International Panel of Experts

WAPDA has also engaged an international panel of experts (IPOE) consisting of renowned specialists including Mr Erik Helland-Hansen from Norway (Environmental Expert) and Prof 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. These experts have so far convened during three missions (May 2012, February 2013 and November 2013). They have conducted site visits, reviewed the ESA reports and provided their respective comments which have been addressed while preparing the present report.

1.4.2. Document Structure

The ESA in Chapter 2 describes the current status of compliance with national and provincial laws, regulations and procedures, and reviewcompliance with applicable World Bank Operational Policies (OPs), policiesand guidelines. Chapter 3 provides an overall description of the project, including design considerations and concepts, construction methods, use of materials, phasing and construction cost. Possible design alternatives which have been considered and their influence on environment and social situation are presented in Chapter 4. A baseline description of the physical, biological and socio-economic environment is given in Chapter 5. This baseline is also used as a reference during the development and monitoring of the project construction and operation. Other relevant issues in the area like seismic hazards, flooding and impacts of climate change are discussed in Chapter 6. In Chapter 7 the potential negative and positive environmental and social impacts of the project are presented and their significance, determined from background data, field studies, interviews and scoping sessions. Mitigating measures to offset, reduce or compensate adverse impacts, responsibilities for implementation of these measures and the cost thereof are proposed. Chapter 8 presents an assessment of the cumulative impacts resulting from the development of DHP together with other potential hydropower projects. An Environmental and Social Management Plan presented in Chapter 9, together with the recommended institutional arrangement, the management and monitoring requirements. Finally in Chapter 10 a summary of public consultations and disclosure is given.

The present ESA has been prepared on the basis of the Environmental Management Action Plan (EMAP) and Social and Resettlement Action Plan (SRMP). The various volumes included in the EMAP and SRMP are listed below.

Table 1.2: Environmental Management Action Plan (EMAP)

Vol. 1	Executive Summary
Vol. 2	Environmental Impact Assessment (Main Report)
Vol. 3	Terrestrial Ecology
Vol. 4	Aquatic Ecology
Vol. 5	Physical and Cultural Resources
Vol. 6	Cumulative and Induced Impact Assessment
Vol. 7	Environmental Baseline Quality
Vol. 8	Environmental Management Plan

Table 1.3: Social and Resettlement Management Plan (SRMP)

Vol. 1	Executive Summary
Vol. 2	Socioeconomic Baseline and Impact Assessments
Vol. 3	Public Consultation and Participation Plan
Vol. 4	Resettlement Framework
Vol. 5	Resettlement Action Plan
Vol. 6	Gender Action Plan
Vol. 7	Public Health Action Plan
Vol. 8	Management Plan for Construction-related Impacts
Vol. 9	Grievances Redress Plan
Vol. 10	Communications Strategy
Vol. 11	Downstream Fishing Communities: Baseline and Impact Assessments
Vol. 12	Area Development and Community Support Programs
Vol. 13	Costs and Budgetary Plan
Vol. 14	Safeguards Implementation and Monitoring Plan.

2. Policy, Legal and Administrative Framework

2.1. General

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

2.2. Applicable legislation and policies in Pakistan

2.2.1. National Legislation

The development of statutory and other instruments for environmental management has steadily gained priority in Pakistan since the late 1970s. The Pakistan Environmental Protection Ordinance, 1983 was the first piece of legislation designed specifically for the protection of the environment. The promulgation of this ordinance was followed, in 1984, by the establishment of the Pakistan Environmental Protection Agency (Pak-EPA), the primary government institution dealing with environmental issues. Significant work on developing environmental policy was carried out in the late 1980s, which culminated in the drafting of the Pakistan National Conservation Strategy. Provincial Environmental Protection Agencies (EPAs) were established at about the same time. The National Environmental Quality Standards (NEQS) were adopted in 1993. The enactment of the Pakistan Environmental Protection Act (PEPA), 1997 provided broad-based enforcement power to the provincial EPAs. The publication of the Pakistan Environmental Protection Agency Review of IEE and EIA Regulations in 2000 provided the necessary details on the preparation, submission, and review of initial environmental examinations (IEE) and environmental impact assessments (EIA). In addition to the Pakistan Environmental Protection Act, 1997, Pakistan's statute books contain a number of other laws that include clauses concerning the regulation and protection of the environment.

Eighteenth Amendment Act, 2010

Amendment XVIII (the Eighteenth Amendment) of the Constitution of Pakistan was passed by the National Assembly of Pakistan on April 8, 2010. According to this amendment, the Ministry of Environment has been dissolved and the provinces have been authorized to make the laws and regulations regarding environment. The powers of Pak-EPA have now become the powers of Provincial EPAs. Every province is making its own environment protection act. Although, work on this has initiated however, to date law has not been enacted in KP and PEPA 1997 continues to be the prime legal instrument for environmental protection. Based on consultation with KP EPA, it is understood that they are still drafting the act based on the PEPA 1997 and the whole text of PEPA, 1997 will remain almost same with following amendments:

- for the words "Federal Government", wherever occur, the word "Government" shall be substituted;
- for the words "Federal Agency", wherever occur, the words "Provincial Agency" shall be substituted;
- for the word "National", wherever occurs, the word "Khyber Pakhtunkhwa" shall be substituted;

- for the word “Pakistan” wherever occurs, the word “Khyber Pakhtunkhwa” shall be substituted; and
- The Government shall, by notification in the official Gazette, establish a Council to be known as the Khyber Pakhtunkhwa Environmental Protection Council consisting of Chief Minister, Provincial Environment Minister and members.

Pakistan Environmental Protection Act, 1997

The Pakistan Environmental Protection Act (PEPA) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, industrial liquid effluent, soil, marine, and noise pollution, as well as to the handling of hazardous wastes. In context of the Act "environment" means- “(a) air, water and land; (b) all layers of the atmosphere; (c) all organic and inorganic matter and living organisms; (d) the ecosystem and ecological relationships; (e) buildings, structures, roads, facilities and works; (f) all social and economic conditions affecting community life; and (g) the inter-relationships between any of the factors in sub-clauses (a) to (f). The following key features of PEPA have a direct bearing on the proposed project:

- Section 11 (Prohibition of Certain Discharges or Emissions): states that “Subject to the provisions of this Act and the rules and regulations made there under, no person shall discharge or emit, or allow the discharge or emission of, any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the NEQS”.
- Section 12-I (IEE and EIA); requires that “No proponent of a project shall commence construction or operation unless he has filed with the Federal Agency an IEE or, where the project is likely to cause an adverse environmental effect, an EIA, and has obtained from the Federal Agency approval in respect thereof.”
- Section 12-2b (Review of IEE and EIA): The Federal Agency shall review the EIA report and accord its approval subject to such conditions as it may deem fit to impose, or require that the EIA be re-submitted after such modifications as may be stipulated or rejected, the project as being contrary to environmental objectives.
- Section 14 (Handling of Hazardous Substances); requires that “Subject to the provisions of this Act, no person shall generate, collect, consign, transport, treat, dispose off, store, handle, or import any hazardous substance except (a) under a license issued by the Federal Agency and in such manner as may be prescribed; or (b) in accordance with the provisions of any other law for the time being in force, or of any international treaty, convention, protocol, code, standard, agreement, or other Instrument to which Pakistan is a party.” Enforcement of this clause requires the EPA to issue regulations regarding licensing procedures and to define ‘hazardous substance.’
- Section 15 (Regulation of Motor Vehicles): Subject to provision of this clause of the Act and the rules and regulations made there under, no person shall operate a motor vehicle from which air pollutants or noise are being emitted in an amount, concentration or level which is in excess of the NEQS, or where the applicable standards established under clause (g) of subsection (1) of Section-6 of the Act.
- Section 17 (Penalties): Whoever contravenes or fails to comply with the provisions of section 11, 12, 13, or section 16 or any order issued there under shall be punishable

with fine which may extend to one million rupees, and in the case of a continuing contravention or failure, with an additional fine which may extend to one hundred thousand rupees for every day during which such contravention or failure continues: Provided that if contravention of the provisions of section 11 also constitutes contravention of the provisions of section 15, such contravention shall be punishable under sub-section (2) only.

Review of IEE and EIA Regulations, 2000

The Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000, prepared by the PEPA provide the necessary details on the preparation, submission, and review of the initial environmental examination (IEE) and the environmental impact assessment (EIA). Under these Regulations projects are classified on the basis of the expected degree of adverse environmental impacts. Project types listed in Schedule II of the regulations are designated as potentially seriously damaging to the environment, and those listed in Schedule I as having potentially less adverse effects.

Schedule-I projects require an IEE to be conducted, rather than a full-fledged EIA, provided that the project is not located in an environmentally sensitive area. The projects listed in Schedule-II are generally major projects and have the potential to affect a large number of people in addition to significant adverse environmental impacts. For Schedule II projects conducting an EIA is obligatory. Dams and reservoirs with a maximum storage volume over 50 million m3 or a surface area greater than 8 km^2 and hydroelectric power projects generating over 50 MW fall under Schedule-II. DHP falls in Schedule II as per EPA classification, because the power generation is 4320 MW and the reservoir area is 23.8 km^2 with a reservoir volume 1,410 million m^3.

The prescribed procedure for review of EIA by the EPA is shown in **Figure 2.1**.

2.2.2. Other Relevant Legislation

Pakistan Penal Code, 1860

The Pakistan Penal Code deals with offences where public or private property and/or human lives are affected due to the intentional or accidental misconduct of an individual or body of people. In the context of the environment, the Penal Code empowers local authorities to control noise, toxic emissions and disposal of effluents.

Pakistan Explosives Act, 1884

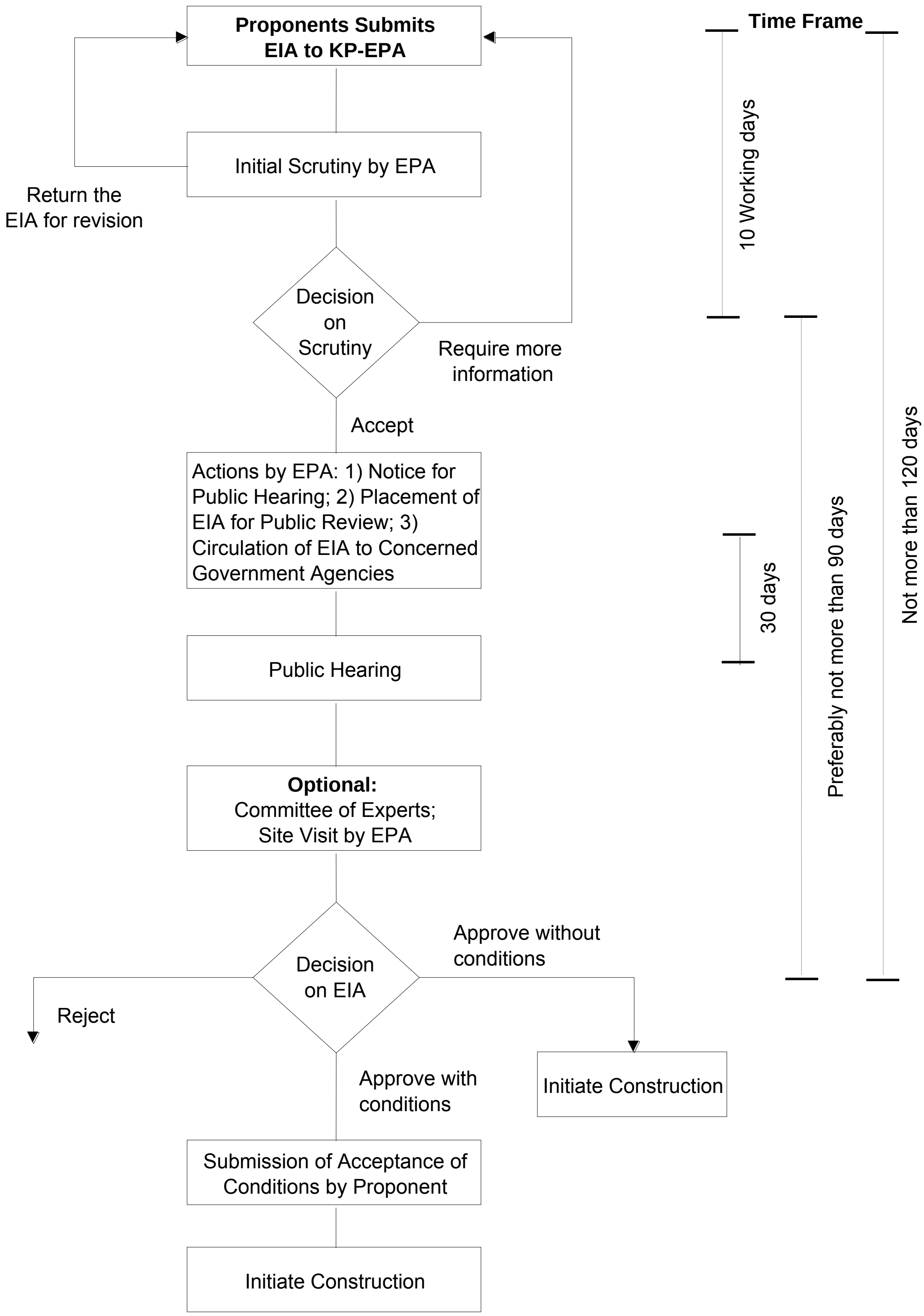
This Act provides regulations for the handling, transportation and use of explosives during quarrying, blasting and other purposes. The construction of the new power house may require blasting at rocky areas making these regulations applicable for this project.

Forest Act, 1927

This Act authorizes provincial forest department to establish forest reserves and protected forests. The Act prohibits any person from: setting fires in the forest; quarrying stone; removal of any forest produce; or causing any damage to the forest by cutting trees or clearing areas for cultivation or any other purpose.

Hazara Forest Act 1936

An act to consolidate and amend the law relating to reserved forests and waste lands in Hazara District. This act applies only to the left bank of the project, which is a part of Hazara Division.



Source: DHC, EMAP, Volume 2

Figure 2.1: Review and Approval Process of EIA

Protection of Trees Act, 1949

This Act prohibits cutting or lopping of trees along roads and canals planted by the Forest Department, without permission of the Forest Department. Within the project area there are no planted forests reserves and hardly any road side trees available, apart from some planted trees along KKH.

Land Acquisition Act, 1894

This Act is the primary law for acquisition of land and built-up properties for public interest in Pakistan and also sets out the procedure and rules for acquisition and compensating the land owners, including for any damage caused to their properties, crops and trees by a project, however it lacks the mechanism to address the complex issues of resettlement. The Act comprises 55 sections dealing with area notifications, surveys, acquisition, compensation, appointment awards, disputes resolution, penalties and exemptions. For DHP, WAPDA will acquire land broadly following the procedures prescribed by this Act, while also complying with the WB safeguard policies (discussed later in the Chapter).

Factories Act, 1934 (as amended to 1997)

The clauses relevant to the project are those which concern health, safety and welfare of workers, disposal of solid wastes and effluents, and damage to private and public property. The Factories Act also provides regulations for handling and disposal of toxic and hazardous materials. As construction activity is classified as 'industry', these regulations will be applicable to the construction contractors. Particular sections of the act applicable to DHP project are:

- Section 13(1): Every factory shall be kept clean and free from effluvia arising from any drain, privy or other nuisance.
- Section 14(1): Effective arrangements shall be made in every factory for the disposal of wastes and effluents due to the manufacturing process carried on therein.
- Section 16(1): In every factory in which, by reason of the manufacturing process carried on, there is given off any dust or fume or other impurity of such a nature and to such an extent as is likely to be injurious or offensive to the workers employed therein, effective measures shall be taken to prevent its accumulation in any work-room and its inhalation by workers and if any exhaust appliance is necessary for this purpose, it shall be applied as near as possible to the point of origin of the dust, fume or other impurity, and such point shall be enclosed so far as possible.
- Section 16(2): In any factory no stationary internal combustion engine shall be operated unless the exhaust is conducted into open air and exhaust pipes are insulated to prevent scalding and radiation heat, and no internal combustion engine shall be operated in any room unless effective measures have been taken to prevent such accumulation of fumes there from as are likely to be injurious to the workers employed in the work-room.
- Section 20(1): In every factory effective arrangements shall be made to provide and maintain at suitable points conveniently situated for all workers employed therein a sufficient supply of whole-some drinking water.
- Section 26(1) d(i): In every factory the following shall be securely fenced by the safeguards of substantial construction which shall be kept in position while the parts of machinery required to be fenced are in motion or in use, namely – (a) every part of an electric generator, a motor or rotary convertor.

The West Pakistan Board of Revenue Act 1957

This act is to provide for the constitution of a board of revenue for West Pakistan. The Board shall be the controlling authority in all matters connected with the administration of land, collection of land revenue, preparation of land records and other matters relating thereto. This task has been now been devolved to the Provinces following the Eighteenth Amendment Act 20120 of the Constitution.

Pakistan Water and Power Development Authority Act, 1958

The Act provides for the unified and coordinated development of the water and power resources of Pakistan. This Act authorizes WAPDA to develop water and power resources in the country through construction and operation of water storages and power houses and erecting electrical transmission lines. The responsibility for erecting transmission lines and operation of the distribution network now rests with the National Transmission and Dispatch Company (NTDC). WAPDA still has the powers and obligations of a licensee under the Telegraphy Act of 1910. This Act also establishes policy for land acquisition and compensation, as well as the degree of liability of WAPDA for damages sustained by landowners or other parties. WAPDA is the owner of DHP and its development is covered under this Act.

The West Pakistan Firewood and Charcoal (Restriction) Act 1964

This act is to prohibit and regulate the burning of firewood and charcoal in West Pakistan. This act extends to the whole of the province of West Pakistan, except the tribal areas. Use of firewood is still very common in the area and for this reason the act is applicable for the entire project area.

Motor Vehicle Ordinance, 1965 and Rules, 1969

The Motor Vehicles Ordinance, 1965, has been extended with effect from March 05, 1978, to the whole of Pakistan. It deals with the licensing requirement for driving; powers of licensing authority, Regional Transport Authority and those of Court vis-à-vis disqualification for license and registration requirements to control road transport; compensations for the death of or injury to a passenger of public carrier; powers of Road Transport Corporation; traffic rules, power to limit speed, weight, use of vehicles; power to erect traffic signs; specific duties of drivers in case of accident and powers of police officers to check and penalize traffic offenders. All vehicles used on DHP by WAPDA, Consultants and the Contractor will be subject to this Motor Vehicle Ordinance 1965 and rules 1969.

KP Wildlife Protection, Preservation, Conservation and Management Act, 1975 (NWFP Act No. V of 1975)

This law was enacted to protect the province's wildlife resources directly and other natural resources indirectly. It classifies wildlife by degree of protection, i.e., animals that may be hunted on a permit or special license, and species that are protected and cannot be hunted under any circumstances. The Act specifies restrictions on hunting and trade in animals, trophies, or meat. The Act also defines various categories of wildlife-protected areas, i.e., National Parks, Wildlife Sanctuaries, and Game Reserve. The project activities will have to be carried out in accordance with this Act. The act is particularly relevant for the Kaigah private game reserve (5000 ha community managed), which is the only protected site situated within the project area. After approval and notification of the

Wildlife authorities certain amendments, including mitigation measures and changes in the boundaries of a particular game reserve are possible.

Antiquity Act, 1975

The Antiquity Act of 1975 ensures the protection of cultural resources in Pakistan. This Act is designed to protect antiquities from destruction, theft, negligence, unlawful excavation, trade and export. Antiquities have been defined in this Act as "Ancient products of human activity, historical sites, sites of anthropological or cultural interest and national monuments".

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

Under this Act, the proponents are obligated to:

- Ensure that no activity is under taken in the proximity of a protected antiquity, and
- Report any archaeological discovery made during the course of the project to the Department of Archaeology, Government of Pakistan.

Fisheries W.P. Ordinance XXX of 1961 Amended Vide NWFP Fisheries (Amendment) Ordinance 1982

This Ordinance was promulgated to amend and consolidate the law relating to fisheries in the province of West Pakistan (including KP). The ordinance was issued during West Pakistan as one unit. This was later adopted by provinces. This grants power to Director General (DG) Fisheries to issue permit to catch fish. The ordinance protects the fish against 1) Destruction of fish by explosives, 2) Destruction of fish by poisoning water. There are other clauses providing protection to fish.

The Provincial Administered Tribal Areas (Conservation and Exploitation of certain Forests) Regulation 1980

The purpose of this regulation is to provide for conservation, better exploitation and prohibition of unlawful cutting of forest in certain Provincially Administered Tribal Areas of Hazara Division. Since the Indus left bank falls under this division the Act is applicable to the project.

The NWFP Power Crushers (Licensing) Ordinance 1980

This ordinance is to provide for the licensing of power crushers in the NWFP (now KP). This ordinance will extend to the whole of KP. It will also deal with the licensing authority, registration fee of power crushers and with the penalties. It is possible that some of the construction material is required from areas outside KP province. In this case the licenses to be obtained by contractors should be according to the rules and regulations of the competent authorities in these regions.

Labor Laws

Labor laws in Pakistan are governed by several legislative tools. However, the principal labor rights are provided by the constitution of Pakistan. In addition to constitutional rights, Acts and Ordinances have been enforced for limiting working hours, minimum working age and conditions of employment. The laws will be applicable to the project construction contractors.

Employment of Child Act, 1977

Article 11(3) of the Constitution of Pakistan prohibits employment of children below the age of 14 years in any factory, mines or any other hazardous employment. In accordance with this Article, the Employment of Child Act (ECA) 1991 disallows the child labor in the country. The ECA defines a child to mean a person who has not completed his/her fourteenth years of age. The ECA states that no child shall be employed or permitted to work in any of the occupation set forth in the ECA (such as transport sector, railways, construction, and ports) or in any workshop wherein any of the processes defined in the Act is carried out. The processes defined in the Act include carpet weaving, *biri* (kind of a cigarette) making, cement manufacturing, textile, construction and others).

Highway Safety Ordinance, 2000

This Ordinance includes provisions for licensing and registration of vehicles and construction equipment; maintenance of road vehicles; traffic control offences, penalties and procedures; and the establishment of a police force for motorways and national highways to regulate and control the traffic as well as keep the highways clear of encroachments. This Ordinance will have an impact on the road network leading to the Project area during the construction phase of the project.

Local Government Ordinance, 2001

This Act empowers the Government of Pakistan and provincial governments to enforce laws for land use; conservation of natural vegetation; air, water, and land pollution; disposal of solid waste and wastewater effluents; and public health and safety, including some provisions for environmental protection. Section 93 of this Ordinance pertains to environmental pollution, under which the local councils are authorized to restrict causing pollution to air, water or land. DHP will have to follow the Ordinance with regards to pollution of air, water and land.

2.2.3. National Environmental Guidelines and Policies

National Climate Change Policy, 2012

Pakistan has prepared the National Climate Change Policy in order to ensure that climate change is mainstreamed in the economically and socially vulnerable sectors of the economy and to steer Pakistan towards climate resilient development. The Policy addresses the key issues relevant to the country including food security, water security, energy security, and extreme weather events. The Policy covers climate change adaptation with respect to water resources, agriculture and livestock, human health, forestry, biodiversity, disaster preparedness, poverty, and gender aspects, while it addresses energy, transportation, town planning, and industry with respect to climate change mitigation.

National Conservation Strategy (NCS) 1992

The Pakistan NCS is the principal policy document for environmental issues in the country, which was developed and approved by the Government of Pakistan on 1 March 1992. The NCS works on a ten-year planning and implementation cycle. It deals with fourteen core areas, as follows:

- Maintaining soils in cropland;
- Increasing irrigation efficiency;

- Protecting watersheds;
- Supporting forestry and plantations;
- Restoring rangelands and improving livestock;
- Protecting water bodies and sustaining fisheries;
- Conserving biodiversity;
- Increasing energy efficiency;
- Developing and deploying material and energy renewable;
- Preventing and abating pollution;
- Managing urban wastes;
- Supporting institutions for common resources;
- Integrating population and environmental programs; and
- Preserving the cultural heritage.

National Environment Policy

This policy was implemented in 2005 to provide an overarching framework for addressing the environmental issues facing Pakistan. It gives directions for addressing sectoral issues and provides means for promoting conservation and environmental protection in water, air and waste management, forestry, and transport. The policy aims to promote protection of the environment, the honoring of international obligations, sustainable management of resources and economic growth.

Guidelines for the Preparation and Review of Environmental Reports, 1997

These guidelines on the preparation of environmental reports address project proponents, and specify the:

- Nature of the information to be included in environmental reports;
- Minimum qualifications of the EIA consultant;
- Need to incorporate suitable mitigation measures into every stage of project implementation;
- Need to specify monitoring procedures.

Terms of reference for the reports are to be prepared by the project proponents themselves. The reports must contain baseline data on the Project area, a detailed assessment thereof, and mitigation measures.

Policy and Procedures for Filing, Review and Approval of Environmental Assessments, 2000

These policies and procedures define the policy context and the administrative procedures that govern the environmental assessment process, from the project pre-feasibility stage to the approval of the environmental report.

Guidelines for Public Consultation, 1997

The guidelines deal with approaches to public consultation and techniques for designing an effective program of consultation that reaches out to all major stakeholders and ensures the incorporation of their concerns in impact assessment.

Guidelines for Sensitive and Critical Areas, 1997

The guidelines identify officially notified protected areas in Pakistan, including critical ecosystems, archaeological sites, etc., and present checklists for environmental assessment procedures to be carried out within or near to such sites. Environmentally sensitive areas include, among others, archaeological sites, biosphere reserves and natural parks, and wildlife sanctuaries and preserves, none of which are relevant to the Project area.

2.2.4. National Environmental Quality Standards

The NEQS first promulgated under the PEPA 1997 and revised/expanded thereafter in 2010, specify the following standards:

- Maximum allowable concentration of pollutants in gaseous emissions from industrial sources;
- Maximum allowable concentration of pollutants in municipal and liquid industrial effluents discharged to inland waters, sewage treatment and sea (three separate set of numbers);
- Maximum allowable emissions from motor vehicles;
- Ambient air quality standards;
- Drinking water standards; and
- Noise standards.

The following NEQS will be relevant to the environmental aspects of the Dasu Hydropower Project[3]:

- Industrial and Municipal Effluents;
- Waste Effluents;
- Ambient Air;
- Motor Vehicle Exhaust and Noise;
- Noise; and
- Drinking Water Quality Standards.

2.2.5. Environmental Regulatory Authorities

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

Pakistan Environmental Protection Council

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

- Formulating national environmental policy;
- Enforcing PEPA 1997;

[3] These NEQS are available at the Pak-EPA website (http://www.environment.gov.pk/info.htm).

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

Climate Change Division

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

Pakistan Environmental Protection Agency (PAK-EPA)

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

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

Provincial/Regional Environment Protection Agencies

The four provinces and the two regions (Azad Jammu and Kashmir - AJK and Gilgit-Baltistan) have each their own Environmental Protection Department (EPD) and/or EPAs, which are counterparts of the PAK-EPA at the provincial/regional level. The provincial/regional EPAs are established by the respective provincial/regional governments. They are headed by a Director General. The IEE and EIA reports pertaining to projects falling within the different provincial/regional boundaries are to be submitted to the relevant provincial/regional EPA for approval. For the proposed project, KP-EPA is the relevant agency for the approval of the EIA.

2.2.6. International Treaties and Conventions

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

- Basel Convention,

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

2.3. World Bank

2.3.1. Overview

The World Bank (WB) categorizes development projects according to the type, location, sensitivity, and scale of the project, as well as the nature and magnitude of its potential adverse social and environmental impacts.

The Project has been categorized as “Category A” requiring a detailed environmental and social assessment (ESA) and development and implementation of an environmental and social management plan (ESMP). For category ‘A’ projects borrowers must consult with project-affected groups and local non-governmental organizations about the project’s environmental aspects and take their views into account. Borrowers must (a) initiate consultations as early as possible; (b) consult groups at least twice (before terms of reference for the assessment are finalized and once a draft assessment report is prepared); and (c) consult affected groups throughout project implementation as necessary to address related issues.

2.3.2. Operational Policies (OPs) of the World Bank

Governments seeking financing from the World Bank are required to comply with the applicable Operational Policies (OPs) on environmental and social safeguards. A summary of the key objectives of the relevant safeguards policies considered for the Project is provided below.

OP 4.01 (Environmental Assessment): provides the framework for World Bank environmental safeguard policies and describes project screening and categorization to determine the level of environmental assessment required. For category A and B projects the policy requires public consultation and disclosure to be undertaken as part of the Environmental Assessment process. Finally the policy sets out requirement to comply and report on implementation of any environmental management plans (i.e. mitigation measures, monitoring program etc.) The policy is triggered.

OP 4.04 (Natural Habitats):The policy recognizes the importance of natural habitat in sustaining biodiversity, and requires that projects strictly avoid their significant conversation or degradation (particularly for critical natural habitat), andminimize and mitigate impacts to them including, as appropriate, through creation of offsets and restoration measures. This policy is triggered by the project.

OP 4.11 (Physical Cultural Resources): sets out the World Bank requirement to avoid or mitigate adverse impacts resulting from project developments on cultural resources. There are important cultural or archaeological resources in the vicinity of the Project, including two beautifully decorated and centuries-old mosques and numerous ancient rock carvings dating from Stone Age to Buddhist era; hence this OP will be triggered.

OP 4.12 (Involuntary Resettlement): the World Bank aims to avoid involuntary resettlement where possible. Where necessary or acquisition of land or other assets is necessary, the policy sets out requirements for participation in resettlement planning, mandates compensation for assets at replacement cost, and expects the borrower to see that incomes and standards of living of affected persons are improved or at least restored to what they were prior to displacement. The document also identifies the need for a Resettlement Plan, an abbreviated Resettlement Plan or otherwise. Since more than 6,950 people will be resettled under the project this OP will be triggered.

OP 4.36 (Forests): this policy recognizes the need to reduce deforestation and promote sustainable forest conservation and management in reducing poverty. Pakistan has forests only covering 2.0 percent of its territory and annually the forested area decreases with 2.5 percent. North Pakistan (including Kohistan) is covered for 29 percent by forests. These forests will not be directly be affected by the project, though by increased population pressure and agricultural activities caused by the resettlement the pressure on the high altitude forests will increase. In addition, the project will include a reforestation program. Hence this OP is triggered.

OP 4.37 (Safety on Dams): this policy requires that experienced and competent professionals design and supervise construction, and that the borrower adopts and implements dam safety measures through the project cycle. It recommends, where appropriate, that Bank staff discuss with the borrowers any measures necessary to strengthen the institutional, legislative, and regulatory frameworks for dam safety programs in those countries. For large dams, the borrower must engage an independent Dam Safety Panel. The policy is triggered.

OP 7.50 (Projects on International Waterways): Projects on International Waterways - may affect the relations between the World Bank and its borrowers, and between riparian states. Therefore, the Bank attaches great importance to the riparian making appropriate agreements or arrangements for the entire waterway, or parts thereof, and stands ready to assist in this regard. A borrower must notify other riparian of planned projects that could affect water quality or quantity, sufficiently far in advance to allow them to review the plans and raise any concerns or objections. This OP is triggered, given that the Indus is a shared waterway and its use is governed by an existing binational treaty with India.

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.

2.3.3. Applicable World Bank Policies

The status of the environmental and social safeguard policies of the World Bank are provided below in **Table 2.1**.

Table 2.1: Triggering the World Bank Policies

Directive	Policy	Triggered	Comments
Environmental Assessment	OP/BP 4.01	Yes	As the Project falls into Category A, a full ESA has to be carried out. It is the basis of this ESA document.
Natural Habitats	OP/BP 4.04	Yes	The project has potential to cause significant conversion of habitat and impair associated ecological functions by: conversion of riverine habitat to lacustrine habitat through creation of a long reservoir (74 km); placement of a high dam (242m) on the river main stem effectively creating a barrier to movement of biota and impairing ecological/longitudinal connectivity along the Indus River main stem. Furthermore, the project activities can potentially have adverse effects on the natural habitat particularly at the higher elevations and in the KaigahNullahGame Reserve.
Indigenous Peoples	OP 4.10	No	Not triggered since no Indigenous People or ethnic minorities are living in the area.
Physical Cultural Resources	OP 4.11	Yes	Triggered. Two historical and beautiful decorated wooden mosques are located in the project area. One of them will be submerged by the reservoir. Part of a large endangered cluster of pre-historic and historic rock art with national and international importance is located in the Indus valley adjacent to the head of reservoir.
Involuntary Resettlement	OP/BP 4.12	Yes	Triggered. The project will require the acquisition of about 4,650 ha of land and resettlement of about 767 households including some 6,953 persons. A Resettlement Action Plan (RAP) and a SIMF is developed in line with relevant Pakistani laws and World Bank OP 4.12 to guide the planning and implementation of necessary compensatory measures.
Forests	OP/BP 4.36	Yes	Triggered. The direct impact area situated below el. 1500 m is an area consisting of steep slopes full of rubble and rocks with hardly any vegetation other than low scrubs and stunted trees. The direct impact area does not include any forests, however an estimated 21,000 individual trees were counted in the reservoir and resettlement areas, including 2,980 fruit and medicinal trees. These trees will be lost as a result of the project and a reforestation program will be created to offset the loss. The project will also have an induced impact by the expected increase in population pressure (collection of firewood, logging, and agriculture) on the high altitude forests, which are already under heavy pressure from deforestation and degradation. These forests are situated at higher elevations (2,000 -4,000 m) where the gently sloping plateaus and glacial terraces can be found.
Pest Management	OP 4.09	No	Not triggered. No perticides, herbicide or fungicides will be used in any of the project activities including forest nurseries.
Safety of Dams	OP/BP 4.37	Yes	Triggered. The dam safety policy is triggered since the project involves the construction of a large dam including associated infrastructure situated upstream of a densely populated area. An international panel of experts is reviewing the engineering designs of the dam. Dam safety monitoring equipment will be installed and regularly recorded by DHP. WAPDA’s Dam Safety Organization will annually conduct investigations. This includes the monitoring of the movement of sediment and an early warning system will be installed. An external organization will be hired to independently review dam safety during operational phase.

Directive	Policy	Triggered	Comments
Projects in International Waterways	OP/BP/ GP 7.50	Yes	The Project is located on an international waterway and will require a riparian notification consistent with World Bank.
Projects in Disputed Areas	OP/BP 7.60	No	Not triggered. All project permanent facilities are located in KP province.
Access to Information			World Bank has developed a new approach to the disclosure of information, transparency and sharing of knowledge. The public will have access to a broad range of information about projects in preparation and implementation. In the project area the ESA and RAP will be disclosed to the affected community through a public disclosure/consultation meeting. The executive summary reports will be translated into Urdu and will be made available through local government's office and also WAPDA's field office in Dasu. The reports will be made available to the general public by publication on the WAPDA website. ESA and RAP and its Summary would also be sent to World BankInfo Shop.

2.3.4. World Bank Environmental and Social Guidelines

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

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

3. Project Description

3.1. Location of the Project

The Dasu Hydropower Project is to be constructed in the Indus valley at a site about 7 km upstream of Dasu Bridge near Dasu town, the administrative headquarters of the Kohistan District, Khyber Pakhtunkhwa (KP) province. The site is about 74 km downstream of the projected Diamer-Basha Dam, another project to be developed under the Vision 2025 program. The project is located in a remote and thinly populated and mountainous area. Dasu is only accessible from Islamabad by GT Road to Hassanabdal and KKH via Abbottabad-Mansehra-Besham-Dasu. Distance to Islamabad is about 350 km, which can be covered in about 10 hours by car. The Indus between Tarbela and Dasu is fast flowing river full of sediment. The river is not navigable. The nearest railway station is at Havelian, which lies about 240 km south of Dasu along KKH. From there runs a railway link to Karachi sea port at about 1,600 km distance.

3.2. Project Components

The Dasu Hydropower Project involves the construction of a 242 m high hydraulic structure in a narrow stretch of the Indus valley. The purpose of this structure is to create sufficient potential head to generate 4,320 MW of electricity by creating a relatively small (max 24 km²) but deep (max 180 m) water reservoir. At full development the project will have an underground powerhouse housing 12 turbines, each of which will produce 360 MW power. The project consists of a number of components which are briefly described in this section. The lay-out of the project is shown in **Figure 3.1**.

3.2.1. Construction of Main Hydraulic Structure (US$ 1,397.8 m)

This component would 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 thus create energy for running the power generating turbines and generators.

Main Dam

The structure is designed to pass the probable maximum flood of 50,360m^3/s safely and with openings/tunnels to flush the sediment coming from upstream. The arch-gravity structure will be constructed with roller compacted concrete. The height of the dam would be about 242 m above the bedrock (full supply level at 950 m amsl) and a length of the crest of about 570 m. This structure would allow an operational storage capacity of 0.82 billion cubic meters (BCM), between elevation of 900 m and 950 m amsl and a dead storage of 0.57 BCM. At full supply level the reservoir will have a length of about 73 km and an average width of about 340 m, covering some 24 km² of valley.

In the lower part of the main structure (831 m) there will be nine low level outlets (LLO), which are tunnel-like openings to control the water flow. The main purpose of the LLOs is to flush sediments and to discharge floods. This will be done together with two sediment expulsion tunnels on the right bank. A downstream view of the dam is given in **Figure 3.2.**

Figure 3.1: Layout of Dasu Hydropower Project

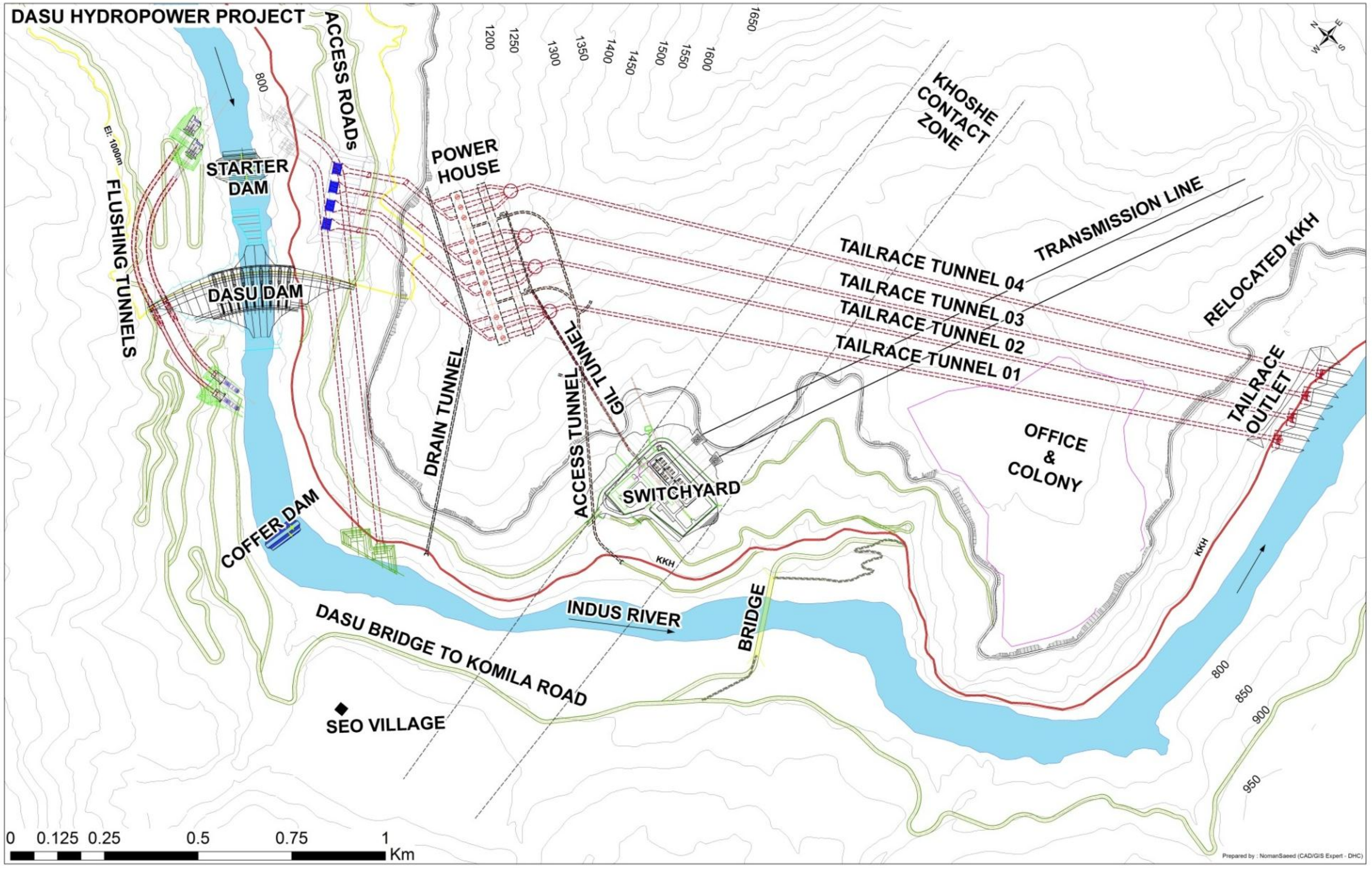


Figure 3.2: Downstream view of Dam, Spillway and Low Level Outlets (Source: DHC- Part C EMAP, Volume 3)

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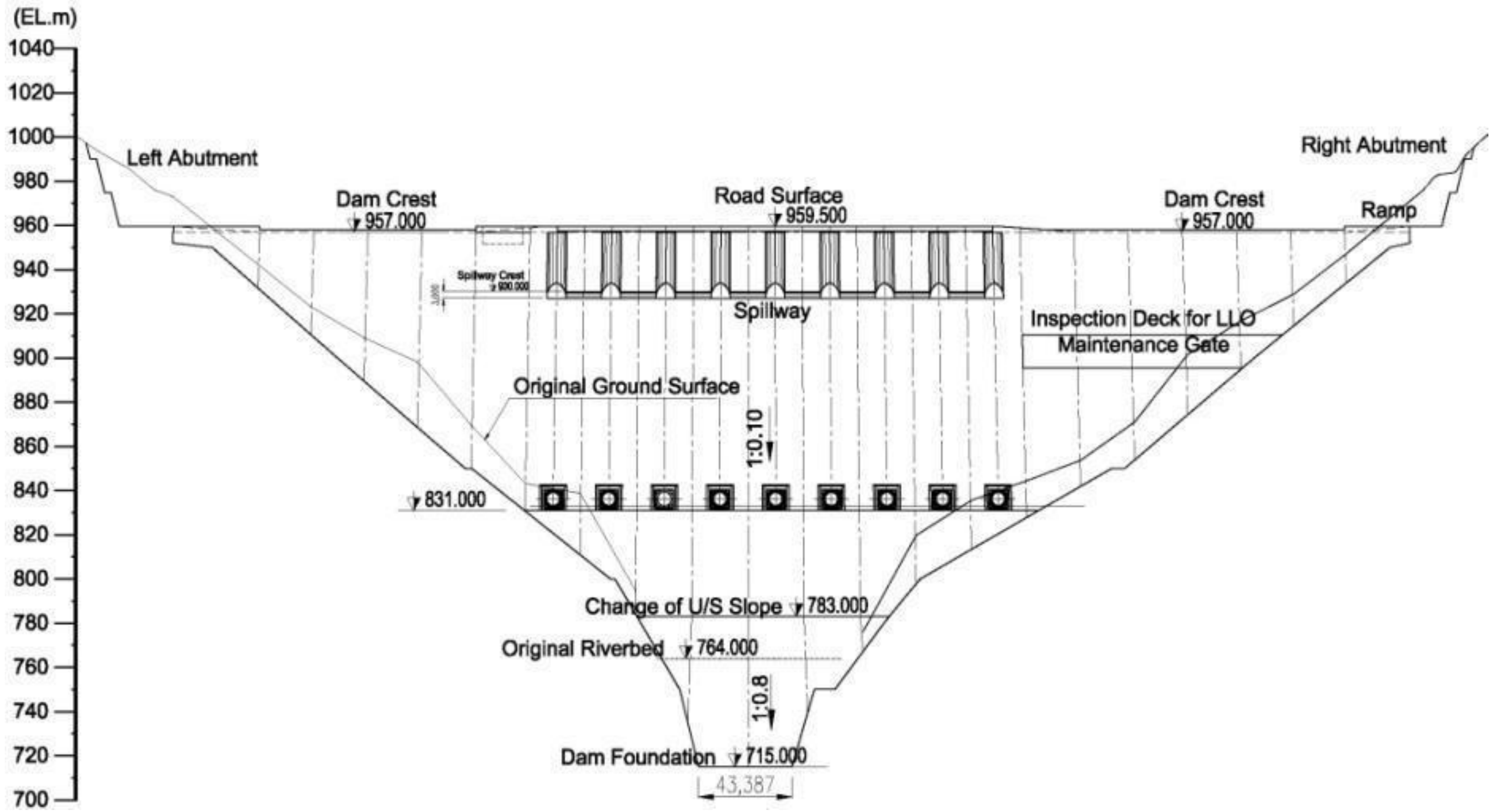


In order to cope with the high floods during summertime between May to September there will be a spillway, consisting of a radial, frontal overflow with eight bays for control of the overflowing water. The spillway has a maximum discharge capacity of 36,800 m^3/s. The spillway has a special shape to deliver flood water along its slope towards a flip bucket at the bottom of the spillway. The flip-bucket tosses the excess water flow - not used for generation of electricity- into the air. The flood water falls into a long and deep plunge pool downstream of the dam, which further absorbs the energy of the overtopping flood water. In this way damage to the dam toe by the flood water flow is avoided.

River Diversion Tunnels and Coffer Dams

During the construction of the main hydraulic structure the river water has to be temporarily diverted from the upstream side to a site downstream of the dam in order to create a dry working area during construction. This is done by constructing two 1260 m and 1100 m long diversion tunnels to transport Indus water on the left bank of the river, diverting the water to a site about one km downstream of the main structure measured along the river channel. The upstream diversion will be made possible by constructing dewatering dike and an upstream cofferdam (length 88m, height 95m) in the Indus, which will later be part of the main hydraulic structure. To facilitate the construction of the upstream cofferdam a dewatering dyke and a small starter dam will be needed. A second coffer dam (length 40 m, height 19 m) will be constructed at the downstream side of the main structure.

The capacity of the diversion tunnels is designed to divert a flood of 10,300 m^3/s, which is the peak discharge of 5-year probable flood. The diversion tunnels include inlet and outlet structures to control the water flow. They will be 17m wide and 20m high and lined with shotcrete. After completion of the main structure and before the first filling of the reservoir the diversion tunnels will be plugged with concrete on permanent basis, since river diversion is only required in the first phase when the dam is built.

Flushing Tunnels

Sediment deposition in the reservoir area will be major threat to the life of reservoir. To meet the discharge requirement of sediment flushing, two sediment flushing tunnels will be constructed on the right bank of the Indus in addition to the low level outlets constructed in the main dam (see also Figure 3.1). During certain high flow periods it is preferred to operate these tunnels rather than to allow the spillway to work. Each tunnel will have a discharge capacity of 1,060 m^3/s. The tunnels will be 4.8 m wide and 9.5 m high and 820 m respectively 680 m in length. The tunnels are lined with 59 cm thick concrete and further with stainless steel. Both tunnels are gated structures.

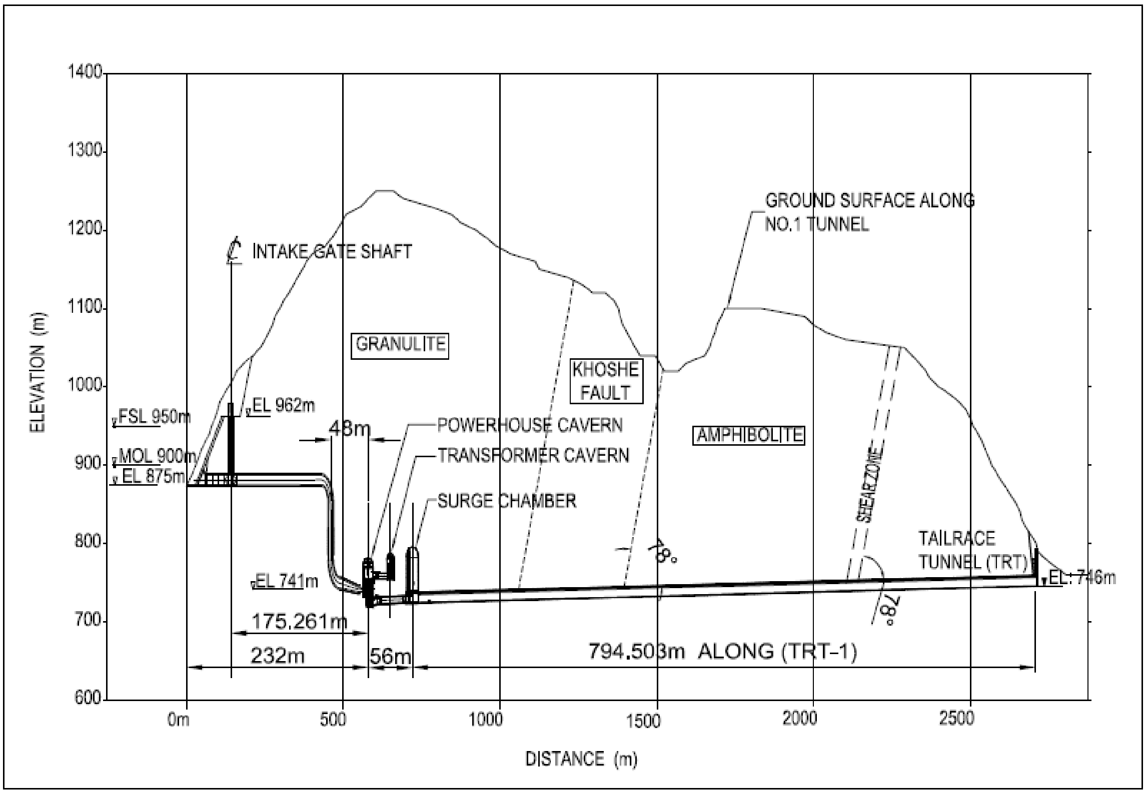
The dam and associated works such as coffer dams, river diversion works will be completed in the first phase of the project.

3.2.2. Power Generation Facilities (US$ 1,397.8 m)

Intake Structures and Waterways for Power Generation

In total four intake structures will be constructed on the left bank at the upstream site of the main hydraulic structure. In the first phase this will be one intake structure and one pressure tunnel towards to the underground powerhouse in which three turbines will be installed. The entrance of each intake is covered by a removable trash rack, in order to prevent debris entering the power tunnel. Each intake is connected with a pressure tunnel, which transports the water from the reservoir to the underground power house. In total four power tunnels (each 12 m in diameter, 450 m in length, circular shaped and concrete lined) will be constructed. Each tunnel follows a slightly different route until they reach a vertical pressure shaft (131 m long). At the bottom of each pressure shaft the tunnel is connected to three turbines located in the power house and generating electricity. From there the water returns to the river via four 2.2 km long tailrace tunnels. The tailrace tunnels are situated at the left bank and run from the underground powerhouse towards the Indus. The purpose of the tunnels is to receive the water from the turbines and to transport it to the river. Each tunnel receives the discharge of three turbines. They start at the vertical underground surge chamber with diameter of 37m and a height of 45m. The surge chamber protects the turbines for a sudden stop in power generation which may result in "water hammer". The tailrace will be equipped with gates so that the tunnel can be isolated from the water for inspection and maintenance. The outfall structures of the tunnels will be below the water level in the river. In the first phase of the project only one tailrace tunnel will be constructed. A profile of tunnels and underground powerhouse is given in **Figure 3-3**.

Figure 3.3: Profile of Tunnels and Power House



Source: DHC, Part C: EMAP, Volume 2

Underground Power House Complex

The powerhouse complex is located in the left bank abutment of the main dam. At full development the four power tunnels will serve 12 vertical shaft Francis turbines each producing 360 MW of electricity, with a total installed capacity of 4,320 MW. The powerhouse complex comprises three major underground caverns, the powerhouse cavern with the twelve turbine units, a transformer cavern housing the switchyard with transformers and gas-insulated switchgears for all units and a cavern housing four surge chambers serving the tailrace tunnels. The surge chambers will protect the turbines in case there is a sudden stop in power generation which could result in “water hammer”. Through underground tunnels the power will be transported to a power yard and further connected to the transmission network of NTDC.

3.2.3. Preparatory and Other Works (US$ 344.8 m)

These works include the construction of access roads, the relocation of a part of the Karakorum Highway (KKH), the construction of a 132kV transmission line from Dubair to Dasu during construction, offices, on-site housing and an access tunnel.

Relocation of KKH

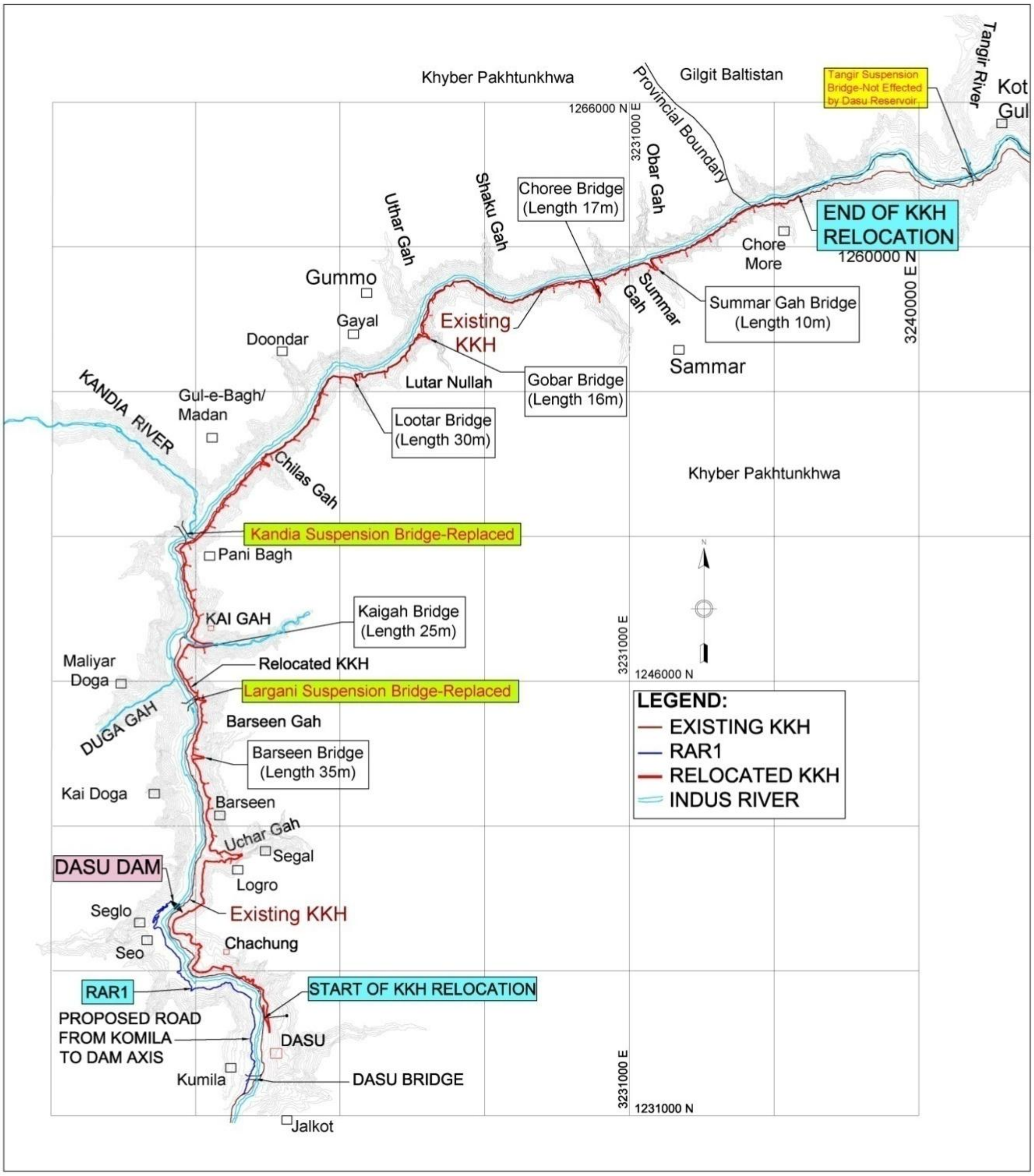
A major activity under this component is the relocation of the KKH since about 52 km of road will be inundated as a consequence of the project. Relocation at a higher level of the slopes along the Indus is required. To compensate the loss of the inundated section a total of about 62 km of new KKH will have to be constructed and about 3 km of link road (see **Figure 3.4**). The KKH is the only road connection and lifeline between Islamabad and the North of the country. The two-lane road is 810 km long with two narrow lanes and used by much heavy traffic of people and goods. Daily about 3,000 vehicles are passing the twin city of Dasu- Komilla, of which 20 percent consist of heavy vehicles. In the steep sloping project area the KKH follows the Indus on the left bank close to the river bed. The road section between Dasu and Choree Mora (47 km north of Dasu) will have to be rebuilt. This will be a major operation in difficult terrain, which also includes the construction of bridges, retention walls, culverts and local access roads. The realignment of the KKH is very critical to the project, since the traffic on the KKH should not be interrupted or affected by the project.

The relocation of the KKH is divided into two contracts, i.e. KKH-01 and KKH-02. The first contract comprises the construction of 15.6 km of new KKH, and a link road of about 3 km from the existing KKH at lower level towards the relocated KKH at higher level. This contract should be implemented with priority and serves as a bypass for KKH traffic to avoid interference in the construction activities at the dam site. The second section to be constructed under KKH-02 is the construction of 46.1 km of new KKH towards Choree Mora. The entire operation is expected to be completed between 2014 and 2016.

In addition to the road, the structures on realigned KKHwill include:

- The Section KKH-01 will involve construction of four box culverts, two bridges (20 and 30 m lengths), 29 causeways, and about 3.7 km long retaining walls.
- The Section KKH-02 will include construction of six single span RCC pre-stressed bridges, 23 box culverts 19 causeways, and retaining wall at 139 locations having a total length of about 9 km.

Figure 3.4: Realignment of KKH



Access Roads

A total of 35 km of access roads will be built for access to the dam site and for access to the villages on the right bank of the Indus. The following local access roads and tracks are foreseen under this component:

- Komilla to Dam axis: about 13 km (access road to damsite);
- Dam axis to Kandia: about 23 km (access road to villages on right bank); and

- Kandia to Utter Gah: about 18 km (minor roads and tracks giving access to villages on right bank upstream of Kandia).

The access road from Komilla to the dam site on the right bank will follow the current road from Komilla to the village Seo. From there will be a road of about 23 km towards Kandia village. A new suspension bridge near Kandia river confluence will replace the two existing suspension bridges over the Indus, which will be dismantled due to submergence. A minor access road and tracks will be constructed on the right bank from the new suspension bridge near Kandia river confluence towards the north.

WAPDA Offices and Colony

Residences and offices for WAPDA's staff (total area 32 ha) will be constructed on a river terrace overlooking the Indus valley opposite Dasu, at Choochang hill. The facilities include project offices, security offices and information center, residences, hostels, rest houses, a hospital and schools (primary and secondary), mosque, community center, club, market, bank, post office, park and playgrounds.

A water supply system will be constructed for the office and colony. The source of water supply is Dasunullah, a perennial tributary to Indus. The water supply system will include water extraction, raw water tank, slow sand filter, treatment by chlorination, and transmission and distribution system. The facilities are designed for 6,200 people (staff and their families).

The sewage system will consists of collection of sewages through concrete pipes and treatment of sewage by septicization. A surface drainage system with a disposal system will also be constructed. Solid waste management system will include segregation of waste, storage and collection, storage depots, waste processing and disposal. A sanitary land filling facility will be constructed (with appropriate landfill liners) for non-degradable, inert waste and other waste that are not suitable for recycling or biological processing.

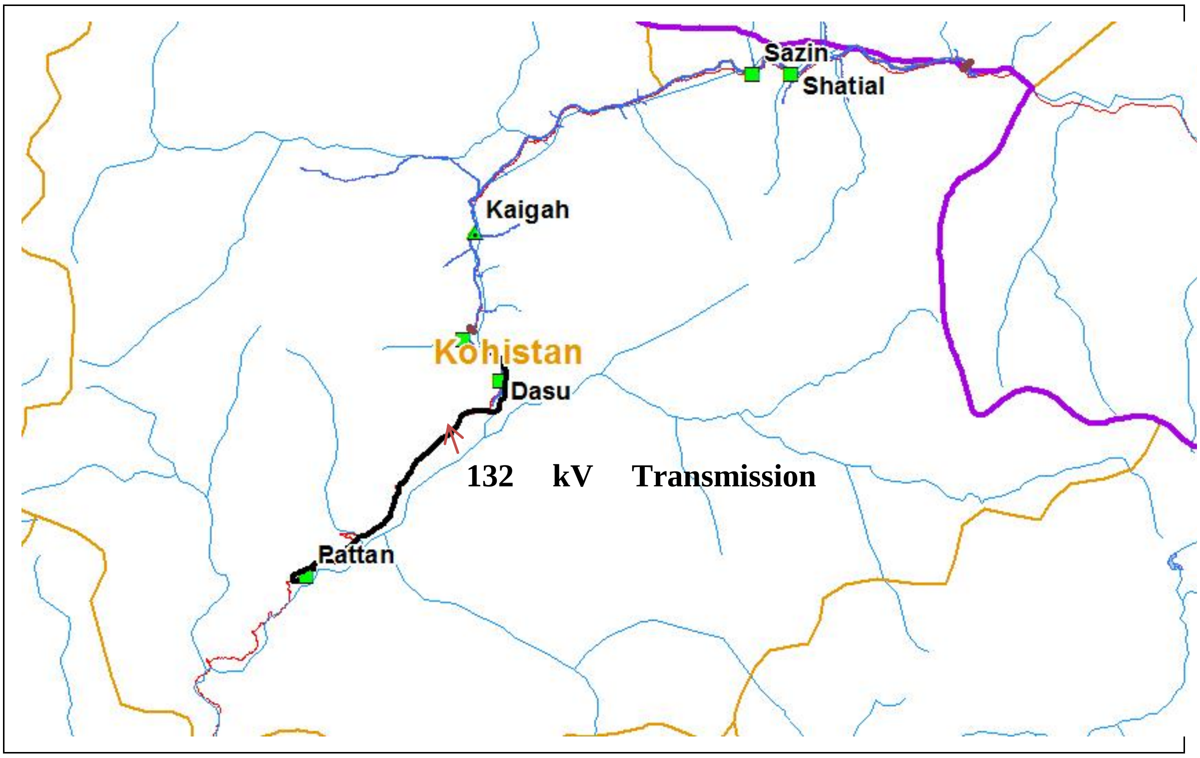
132-KV Transmission Line for Power Supply during Construction

About 30 MW of power supply is required for the construction site and the Colony. The required power will be supplied from DubairKhwar hydropower project (near Pattan 45 km downstream from Dasu) through a new transmission line to be constructed from Dubair towards Chuchang, which is a small village situated at the left bank opposite Dasu. From Chuchang grid station about 7 km of new distribution line will be constructed to the work areas.

The line will provide electricity to the Project and the Colony during the construction. The transmission line is about 45 km and will follow more or less the current KKH on the right bank (see **Figure 3.5**). For the selected alignment 233 towers have to be constructed, each about 32 m high An alternative route on the other side of the mountain was studied, but was abandoned due to technical reasons (high elevation > 2,500 m, much longer distance, difficult access). The selected alignment follows the KKH, since there is hardly any other option in the narrow valley with already two planned 500 kV transmission lines constructed higher on the slopes at the other side of the Indus. The area between Pattan and Dasu is barren with only a few cultivated areas and houses. No major environmental and social impacts are expected. Just before Dasu the line crosses the Indus to the right bank, avoiding the town of Komilla and continuing along the slope, avoiding the residential areas of towards Chuchang area, where the Colony is projected.

The Peshawar Electric Supply Company (PESCO) will operate and control the power supply. It is envisaged to dismantle the line after completion of the project.

Figure 3.5: Location of 132 KV Transmission Line for Dasu Project

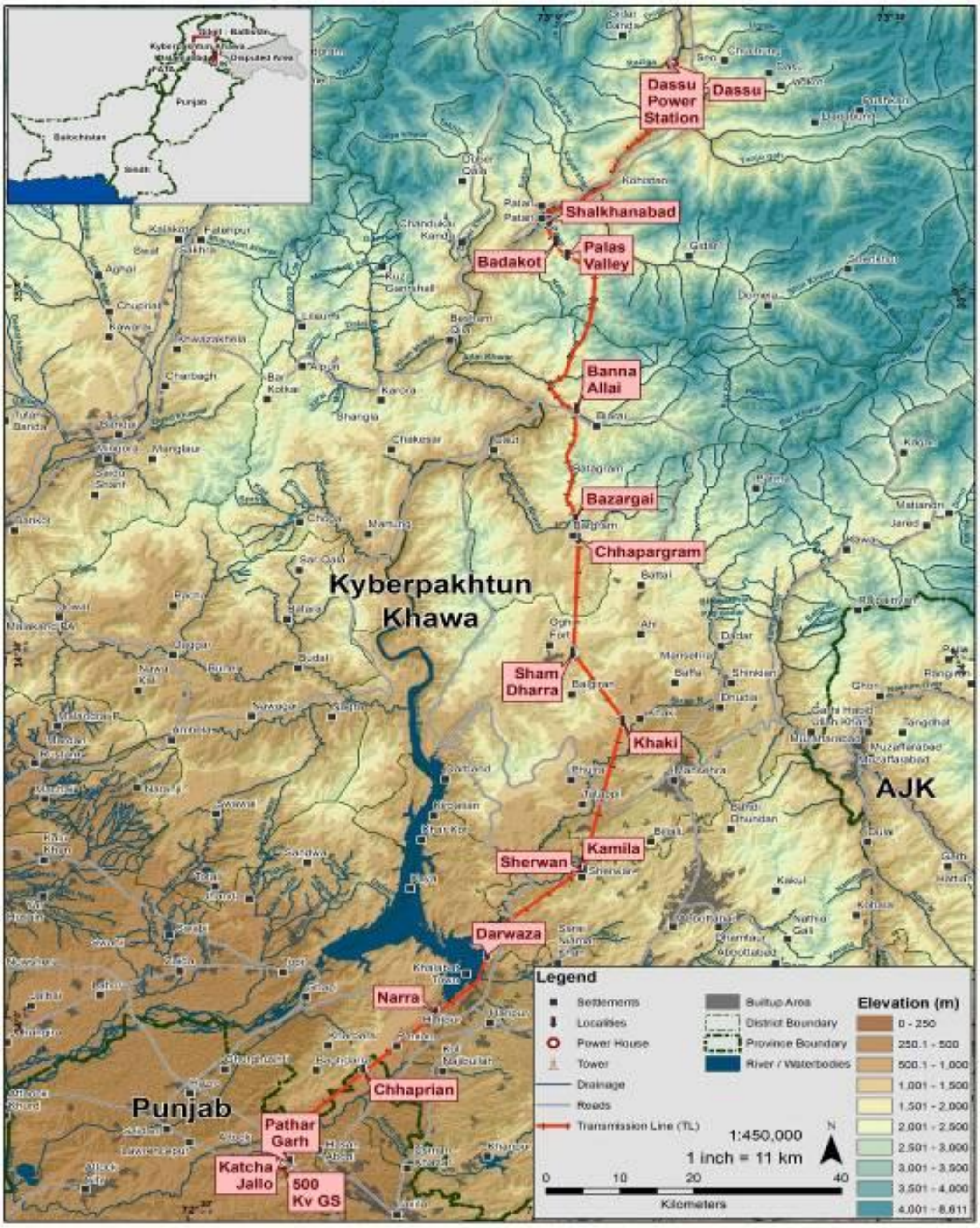


3.2.4. Transmission Line from Project to Pathar Garh (US$ 350 m)

For transmission of power a double circuit 500 KV line will have to be installed from Dasu to Islamabad (via Mansehra), that can serve two phases, i.e. an installed capacity of 2,160 MW. The two parallel running transmission lines will connect Dasu Power Station with the 500 kV Grid Station at PatharGarh (Tehsil Hassanabdal, District Attock). The transmission lines 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 Pathar Garh Grid Station in Punjab province. The lines will be constructed during Phase I of the project. The proposed corridor (preliminary) for the construction of the lines is shown in **Figure 3.6**.

The National Transmission and Dispatch Company (NTDC) will carry out the detailed design and an environmental and social assessment of the transmission line during 2014-2015. NTDC has carried an environmental and socioeconomic profiling of the project areas and a screening of potential environmental and social impacts of the construction of the transmission line. These are not part of this ESA report.

Figure 3.6: Proposed Alignment of Transmission Lines



Source: Draft EIA Transmission Lines.

3.2.5. Implementation of Social and Environmental Management Plans and Glacial, Sediment River Monitoring (US$ 503.9 m)

Social and Resettlement Management Plan (US$ 438.9 m)

The main elements of the Social and Resettlement Management Plan (SRMP) are the compensation, livelihood assistance, and relocationprogram to the affected people. In addition, the SRMP also includes provisions to support communities in the project areas for their sustainable livelihood development and broader local area development.The SRMPalso includes a public health action planto address possible health impacts under the project and a gender action plan. The SRMP includes both short-term income and livelihood measures during the construction phase as well as long-term measures that go into the post-construction phase for a period of 10 years.

Environmental Management Action Plan (US$ 54.5 m)

The Environmental Management Action Plan (EMAP) includes elements of slope stabilization, afforestation and watershed management in the upland areas along the reservoir and the reconstructed KKH, enhancement of the aquatic life and fisheries through reservoir management, preservation and protection of cultural property (petro glyphs) and unforeseen issues that need to be addressed during the project. Construction related environmental issues will be addressed in the construction contracts, thus cost of such measures are included in the construction cost. The EMAP would include those issues which are not or cannot be effectively covered under the construction contracts.

Flood Warning, Watershed, Sediment and River Monitoring (US$ 10.5 m)

Since most of the water resources of the Indus originate from glacial melt, the project includes a component to study and evaluate glacial melt in the high mountain glaciers and ice fields in the Upper Indus catchment. Guidelines for monitoring and research on glaciers and catchment areas will be developed under the project including an early warning for glacial lake outbursts and on water security control. The project would support the Glacier Monitoring and Research Center (GMRC) under the WAPDA General Manager Planning. The activities would include monitoring and research on the Upper Indus Basin (UIB) glaciers, watershed monitoring, sediment and river monitoring that would help in the operation of the DHP. The proposed GMRC would have four sections: (a) a field investigations section responsible for establishing and managing field stations. The office is proposed to be established in the upper catchment of the Indus. Links will be established with the high altitude meteorological network, surface water hydrology, and the WAPDA hydro-meteorological network.

For better management of flood waves and safe operation of DHP and other hydropower projects in the country, it is imperative to have an early warning system for these hydropower catchments. There is no existing flood telemetry network in the DHP catchment. Hence it is recommended that the existing telemetry network in River Indus will be extended to the upper catchments of River Indus. This will include installation of river level, temperature and rain sensors at 18 flood warning sites and providing them with reliable telecommunication system. The component would support works, equipment, operations cost and training for the establishment of the flood telemetry network. This will be implemented by the Hydrology & Research Directorate of WAPDA. The component would also support the monitoring and improvement of the watershed and catchment in Pakistan of the DHP and the Indus Cascade in the river sections upstream and downstream till Tarbela.

3.2.6. Construction Supervision, Monitoring and Evaluation and Social and Environmental Management Plans (US$ 99.1 m)

Construction Supervision and Implementation Support (US$ 91.1 m)

This would cover the cost of consulting and other services for Project implementation, including construction supervision and Project management support. It would also cover implementation of all activities under the Project, including: procurement, contract administration, quality control, certification of payments, financial management, preparation of any additional designs, and bidding documents and support in implementation of SRMP and RAP.

Monitoring and evaluation of Project impacts and of Social and Environmental Management Plans (US$ 8 m)

The Management Support and monitoring and evaluation activities would provide continuous feedback to the Government of Pakistan (GoP), Ministry of Water and Power (MoWP) and WAPDA on the Project's performance and impact of its various components, so that corrective actions could be undertaken in a timely manner. The component would support independent monitoring of implementation of the environmental and social management plans and Project Management support to WAPDA as owner of the project.

3.2.7. Project Management Support, Capacity Building of WAPDA, Technical Assistance and Training (US$ 72.4 m)

Project Management Support and Audits (US$ 42.4 m)

This sub-component would support WAPDA in implementing Project related activities, including support for operation of the PMU, capacity building, incremental staff salaries, operations cost and audits, etc.

Strengthening of WAPDA, Independent Panel of Experts and Technical Assistance (US$ 10 m)

This sub-component would build the capacity of WAPDA to effectively implement the Project, O&M of the dams it manages, and fully carry out its mandated functions. It would also strengthen WAPDA's capacity in developing financing plans and mobilize funding for this project, for other large water and hydropower infrastructure and other elements of the Indus Cascade. This compoenent will also support the procurement of social, environmental, dam safety and other technical experts during project preparation, construction and operational stages.

Future Project Preparation and Strategic Studies (US$ 20 m)

This componentwould support strategic studies to address technical, financial or management issues, , environmental and social issue, pilot projects and preparation of future projects that may be identified during Project implementation and agreed upon with the Bank, and will be will be developed in conformance with World Bank safeguard policy requirements

3.3. Project Resources

The list of the key project resources and facilities is presented in **Table 3.1** and discussed in the sections below.

Table 3.1: Ancillary Facilities

Project Facility	**Location**		
Access Roads on Right Bank	Komila to Dam site	12.96 km	Alignment finalized
	Dam site to Kandia	22.85 km	Alignment

Project Facility	Location		
			finalized
	Kandia to Utter Gha (Track)	17.84 km	Alignment finalized
Suspension Bridge on Indus	Bridge on Indus near Kandia	350 m	Location to be finalized
	Access road to above bridge from left bank (relocated KKH) and right bank	0.48 km	Location/alignment to be finalized
Power transmission	132 kV transmission line from Dubair to Dasu	45km	Alignment to be finalized
Colony and Infrastructure	Colony with necessary infrastructure (water, sanitation, roads, power distribution etc.)	31.5 ha	Location finalized
Quarry Area	Quarry area, crushing plants and storage area at Kaigah (along the existing KKH)	34.26 ha	Location finalized
	Conveyor belt for transport of aggregates (along the existing KKH up to dam site)	10 km	Alignment to be finalized
Sites for Contractors use	Material storage sites, batching plant area, construction yard (including dam site), (Sieglo area on right bank)	90.35 ha	Proposed location identified
	Contractors offices and workers camps (Kass area on right bank, downstream)	41.7 ha	Proposed location identified
	Workshops/construction yards/ workers camps on upstream of dam site (Uchar and Barseen area)	19.03 ha	Proposed location identified
	Explosive storage sites (On the Left Bank Area near Khoshe)	Part of 112.7 ha	Proposed location identified
	Fuel storage area will be near Kass area	Part of 41.7 ha	Proposed location identified
	Site for laboratories in the proposed switch yard area on the left bank	Part of 112.7 ha	Proposed location identified
Spoil disposal areas	Spoil disposal for dam, tunnel and other works (at Zal and Khoshe)	68.85 ha	Location finalized
Resettlement sites	Development of resettlement sites with infrastructure and access roads	30 nos.	Being finalized
Measures proposed in	Development of tree plantation, traffic control units, fish hatchery, protection of rock carving		To be finalized

Project Facility	**Location**		
ESMP	sites, weather monitoring, etc. (locations will be finalized later)		
Sites for Contractors use (KKH)	Contractors office, worker camps, construction yards and stockpile storage sites for KKH (at Barseen)	12.67 ha	Proposed location identified
Quarry and Borrow areas	Same as for dam works		Same as for main works
Access roads to build realignment	Four access roads from existing KKH (at Khoshe, UcharGah, Barseen and Kaigha) to new alignment	12 km	To be finalized

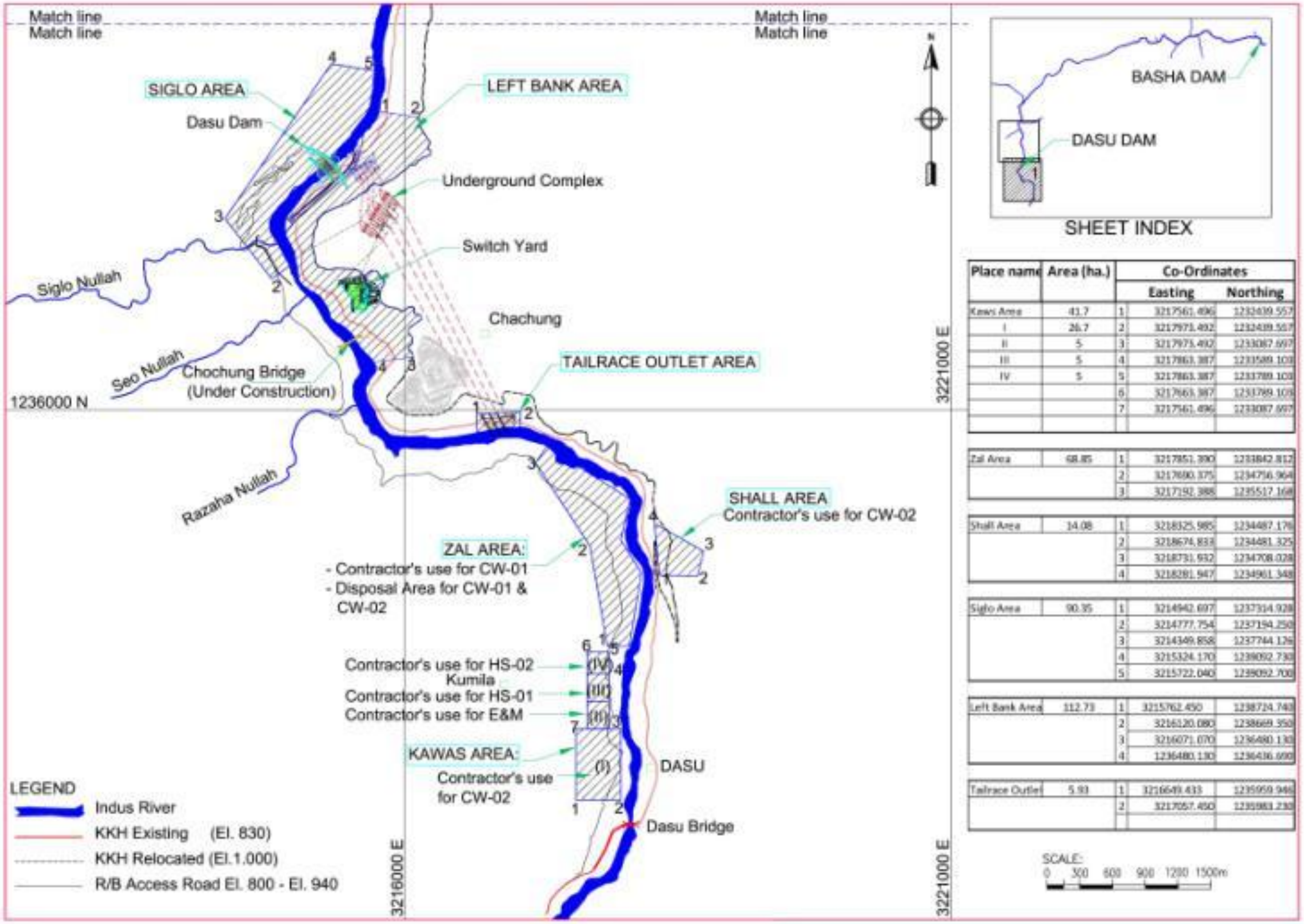
3.3.1. Temporary Facilities

Temporary facilities like construction yards, construction camps, workshops, stores will have to be constructed and areas will be designated as temporary or permanent disposal areas for the enormous quantities of rock and excavation material from the project. The project will make use of a number of quarries and excavation areas which are located within and outside the project area. The location and details of the temporary facilities are shown in **Figure 3.7** (dam site to Dasu bridge) and **Figure 3.8** (dam site to Kaigah quarry).

3.3.2. Construction Materials

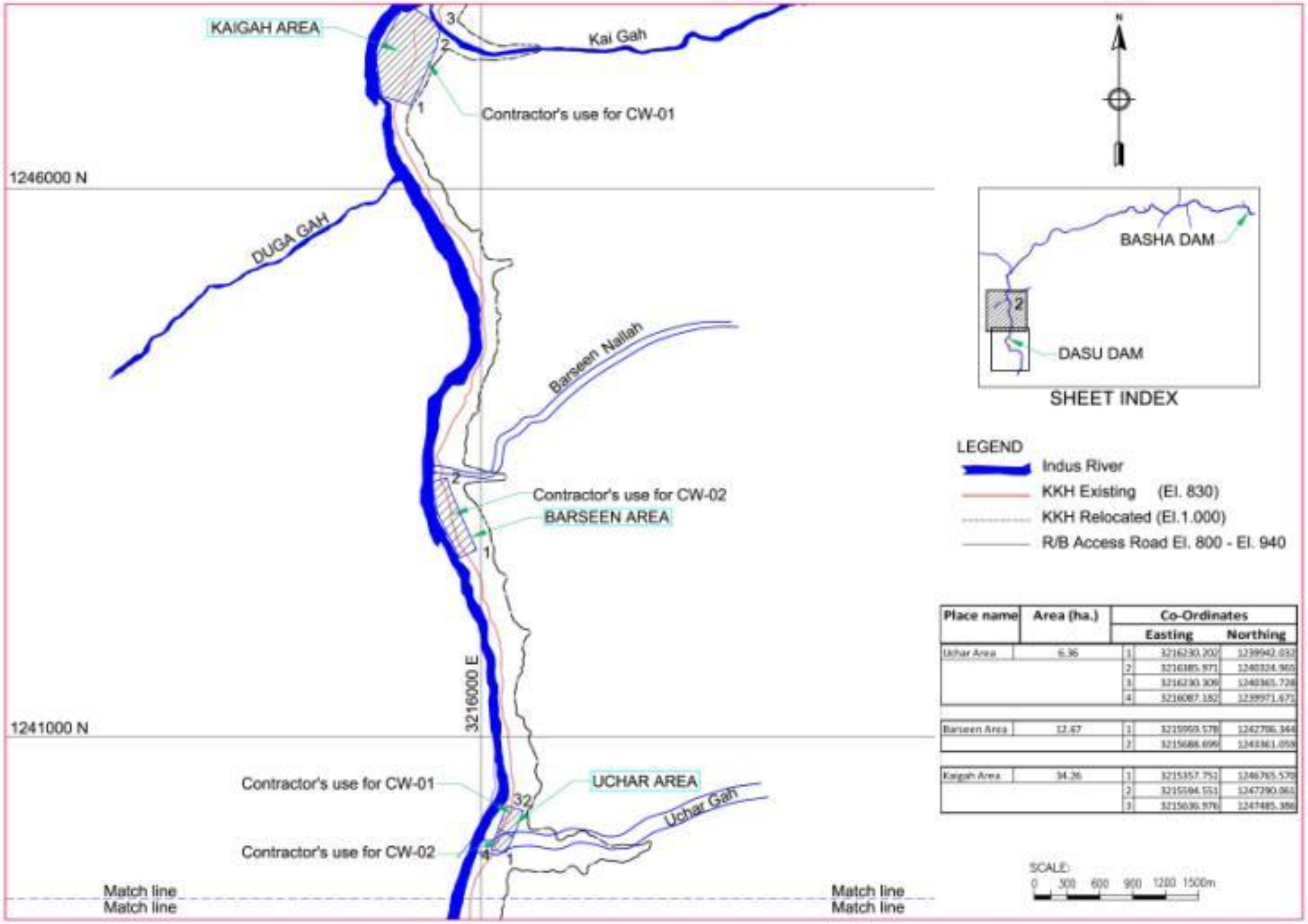
The construction materials needed for constructing the hydraulic structure, the tunnels, the powerhouse and associated facilities are as much as possible coming from the area, A large quantity of coarse aggregates might be obtained by re-using excavated rock from the underground powerhouses and tunnels, as far as these materials meet the specifications and quality needed. Another potential source of aggregates is situated at Kaigah (left bank), some 10 km upstream from the project site. The quarry at Kaigah is situated in the reservoir submergence area. Quarrying will be carried out by bench cut method with necessary drilling and blasting. A crushing plant also will be established near the quarry site. From Kaigah a conveyor belt (10 km long) will bring the aggregates to the dam site. In total 9.2 million ton of coarse aggregates (stones) and 5.0 million ton of fine aggregates, 0.6 million ton of manufactured sand is required. About 35 truckloads per day are needed for this material during construction. An estimated 0.8 million ton of cement, 150,000 ton steel, 300 million liter of fuel and 20,000 ton of explosives will have to be obtained from “down country” and be transported over the KKH to the project area.

Figure 3.7: Locations and Details of Temporary Facilities – 1



Place name	Area (ha.)		Co-Ordinates Easting	Co-Ordinates Northing
Kawsi Area	41.7	1	3217561.496	1232439.557
I	26.7	2	3217973.492	1232439.557
II	5	3	3217973.492	1233087.697
III	5	4	3217863.387	1233589.103
IV	5	5	3217863.387	1233789.103
		6	3217663.387	1233789.103
		7	3217561.496	1233087.697
Zal Area	68.85	1	3217851.390	1233842.812
		2	3217690.375	1234756.964
		3	3217192.388	1235517.168
Shall Area	14.08	1	3218325.985	1234487.176
		2	3218674.833	1234481.325
		3	3218731.932	1234708.028
		4	3218281.947	1234961.348
Siglo Area	90.35	1	3214942.697	1237314.928
		2	3214777.754	1237194.250
		3	3214349.858	1237744.126
		4	3215324.170	1239092.730
		5	3215722.040	1239092.700
Left Bank Area	112.73	1	3215762.450	1238724.740
		2	3216120.080	1238669.350
		3	3216071.070	1236480.130
		4	1236480.130	1236436.690
Tailrace Outlet	5.93	1	3216649.433	1235959.946
		2	3217057.450	1235983.230

Figure 3.8: Locations and Details of Temporary Facilities - 2



Place name	Area (ha.)		Co-Ordinates	
			Easting	Northing
Uchar Area	6.36	1	3216230.202	1239942.032
		2	3216185.971	1240324.965
		3	3216230.309	1240365.728
		4	3216087.182	1239971.671
Barseen Area	12.67	1	3215959.578	1242706.344
		2	3215688.699	1243361.059
Kaigah Area	34.26	1	3215357.751	1246765.570
		2	3215594.551	1247290.061
		3	3215636.976	1247485.386

3.3.3. Spoil Disposal Sites

The excavation activities carried out for dam, power house, tunnel and KKH construction will generate about 20 million m^3 of excess rock material. A site of 69 ha (see also **Figure 3.7**) is situated some 3 km downstream of the dam site and will be used for disposal of excess spoils (see satellite photo in **Figure 3.9**). This particular site meets the required criteria including:i) proximity to the main construction site thus minimizing the haulage distance; ii) located downstream of the dam thus avoiding its future submergence in the reservoir; iii) relatively flat area thus minimizing the possibility of the disposed material to slide in the river; and iv) minimal resettlement impacts. Spoils from KKH construction activities will also be disposed at switchyard area near Khoshe and Barseen at left bank (**Figures 3.7** and **3.8**).

Figure 3.9: Location of Spoil Disposal Area

3.3.4. Construction Machinery

For the implementation of the project construction plants, conveyor belts and equipment has to be used. All these machines and equipment has to be transported from "down country" via the KKH and assembled in the project area. These include concrete mixing plants, belt conveyor systems (for RCC, aggregates and excavated material), aggregate plants, asphalt plants, a milling plant, various silo's for storage, workshops etc. Also a large quantity of excavation, compacting and building equipment, trucks and vehicles is required.

3.3.5. Manpower Requirements

Skilled and semi-skilled construction workers are needed to construct the hydraulic and underground structures. Technicians, foremen and supervisors will be required for specialist works such as RCC placement, drilling, blasting operations. Operators for the various plants and equipment and machinery are needed. A mix of expatriate and local technicians/supervisors will be employed. It is expected that a number of skilled workers and most of the non-skilled labor will be recruited from Kohistan and surrounding districts.

The number of workers to be involved in the project activities on contract basis including staff from WAPDA and Consultants are estimated to increase from about 1,100 in 2014 until 2,700 in 2018 and gradually decreasing to 1,500 after the year 2020. It is estimated that about 60 percent of the total workforce can be attracted from Indus Kohistan and neighboring areas along the Indus valley, the majority being unskilled workers. The number of staff required for operation and maintenance after completion of the project is estimated at around 1,400 workers (including 275 technical staff).

3.3.6. Security Situation

The Kohistan district is a historicallyisolated area along the Indus, characterized by high levels of poverty and deprivation. Ownership of arms is common and every year there are a number of incidents of violence (killing and shooting incidents) in the district. In recent years the prevalence of carrying arms and the number of violent incidents has dropped significantly. This has been attributed to the influence of the increased use of the KKH opening the district to the outside world and providing more opportunities to the people to find work and schooling elsewhere in the country, mostly on temporary basis. Also the well-organized tribal governance system and strong leadership and the frequent exposure to tourists visiting the area on their way to popular tourist destinations contributed to a relatively good law and order situation in recent years.

Also the public consultations, workshop and hearings organized during social surveys and design studies in the project area have helped to avoid potential conflicts with people currently living in the area. The fact that their very genuine concerns were taken into consideration when selecting the different sites provided reassurance that the proponent of the project is serious about minimizing the adverse impacts on local people and ensuring that persons will be equal or better off as a result of the construction of the proposed project. The building of replacement suspension bridges and new access roads on the right bank of the Indus will also help in ensuring that the area can be easily accessed and made secure.

3.4. Phasing and Construction

3.4.1. Phased Approach to Development of the Project

DHP will be implemented in a two staged development, with each stage divided into two phases. Each stage is further divided into two phases of 1,080 MW each (**Table 3.2**), served by a separate tunnel running three turbines of 360 MW each. Under the DHP Stage I (DHP-I) two phases of 1,080 MW each would be developed simultaneously with gestation of first generating unit as soon as possible. The first phase is critical with higher cost US$ 3,650 million as much of the infrastructure, site preparation and social and environmental safeguards for the whole project have to be developed under this phase. The high upfront cost for Phase 1 is offset by high generation which despite the front-loading of main infrastructure and other social and environmental management costs gives good economic returns of more than 20 percent (excluding environmental benefits). The generation from Phase I is over 8,000 GWh as sufficient water flows are available in the river throughout the year to run a 1080 MW hydropower plant and thus gives a very high plant factor, over 85 percent which is extra ordinary for a hydro project. The cost of Phase II is quite low, about US$ 600 million increasing the installed capacity to 2,160

MW and annual generation of about 12,225 GWhs with a plant factor still very high, over 65 percent. The cost per unit would be even lower and ERR increases to 25 percent. The DHP-I, therefore, is transformational as it will reduce the cost of generation, foreign exchange expenditures for the country and generate cash flow that and will support the development of Indus Cascade. Stage II of the Project would be developed later when Diamer Basha project is nearing completion. Environmental and social management plans will be implemented duirng Stage 1 (See **Table 1.1**).

3.4.2. Construction Schedule

During Stage 1 (2015-2022) the major hydraulic structures and related infrastructure will be constructed and inlet and tailrace tunnels and six turbines with a total installed capacity of 2,160 MW. Also the relocation of the KKH will be completed in the year 2016. The Second Stage will include the construction of two more power tunnel and generating facilities for an additional 2,160 MW. Stage 2 would preferably be carried out after the development of Diamer-Basha dam. Construction of this dam will provide sediment control in the upstream reservoir and consequently less need for sediment flushing at the Dasu site.

3.5. Summary of Technical Specifications of the Project

Salient technical specifications of the project are summarized in **Table 3.2** below.

Table 3.2: Salient Features of DHP

Item	**Detail**
General	
- Installed Capacity	4,320 MW
- Total Energy	18,440 GWh/annum (pre Basha) 21,485 GWh/annum (post Basha)
- Catchment area at dam site	158,800 km²
- Average discharge at dam site	2,102 m³/s
- Safety Check Flood (SCF)	51,957 m³/s
- Basic Design Flood (BDF)	24,932 m³/s
Water Level	
- Flood Water Level under SCF - Flood Water Level under BDF - Full Supply Level (FSL) - Minimum Operating Level (MOL)	EL. 959.5 m EL. 951.3 m EL. 950.0 m EL. 900.0 m
Reservoir	
- Gross Storage Capacity (El.950m) - Operational Storage Capacity	1.41x 10^9m³ 0.82x 10^9m³
-Reservoir Area Full Supply El 950 m -Reservoir Area: BD Level El 951.28m -Reservoir Area : MOL El 900 m	23.9 km² 24.5 km² 11.5 km²
Diversion Tunnel on Left Bank	
- Number, Shape and Length	2 no, D-shape, 1,261 m and 1,101m
- Size and Lining	W= 17 m, H= 20 m, shot Crete lined
Main Dam	
- Type	Arch-Gravity Dam in Roller Compacted

Item	**Detail**
	Concrete(RCC) type)
- Maximum Height above foundation	242 m
- Crest Length	570 m
Spillway	
- Number of Bays, Type and Size of Gates	8 no, radial, W=16.5 m H=22.4 m
- Maximum Discharge Capacity under SCF	45,097 m^3/sec
- Plunge Pool	162m from dam toe
Low Level Outlet (LLO)	
- Discharge Capacity under SCF	2,756 m^3/s by 2 LLO at reservoir El.959.5 m 12,157 m^3/s by 9 LLO at El. 955.7 m
Flushing Tunnels	
- Number and Size	2 No 9.5 m dia, (L= 820 m & 680 m)
- Discharge Capacity under SCF	1,060 m^3/s per tunnel
Power Intake	
- Number and Shape	4 no, D=12 m, flatbed type
- Removal Trash rack	4 sets,
Power Tunnel	
- Number and Shape	4 no, circular
- Size and Lining, and average length	D=12 m dia, concrete lined, 500 m
Power Generation	
- Generating Units and Unit Capacity	12 Francis turbines - 360 MW, 167 rpm
- Powerhouse Location	Underground, left bank
- Design Head	Approximately 185 m
- Rated Discharge (12 units) and Voltage	2,670 m^3/s, 16.5 kV
Tailrace Tunnel	
- Number, shape and average length	4 no, D-shaped, 2,200m in average
- Size and lining	W=10 m, H= 12.5 m, concrete lined
- Discharge per Tunnel	650 m^3/s
Tail Water Level	
- Flood Water Level under SCF	El. 778.4 m
- Tail water level under 12-unit operation	El. 762.8 m
- Tail water level under 3-unit operation	EL. 759.2 m
Power Transmission	
- Transmission Voltage	500 kV (AC)
- Powerhouse Substation &	Gas Insulated Substation (GIS) , Underground
- Transmission Substation	Air Insulated Switchgear (AIS) , Surface
- Length and Location of Transmission Line	250 km, Dasu – Mansehra –PatharGarh (near Hassanabdal)
KKH realignment	
KKH realignment (to compensate loss of 46 km of existing KKH	62 km

3.6. Operation and Maintenance of the Project

3.6.1. Filling of the Reservoir

Once the main hydraulic structure is completed, water will be allowed to store behind the dam. The first filling of the reservoir requires a lot of preparation and careful monitoring for landslides especially in the landslide prone areas. A slow rate of filling of maximal 2 m/day will be used up to 950 m and the LLO's will be partly opened to release the required environmental flow. About 215 m^3/s rate of flow is required on average to fill the reservoir with the recommended rate of 2 m/day. The low rate of filling is maintained to stabilize the banks of the reservoir area and not to trigger any landslides. The filling can be done even in the months of February or March, when the Indus is at its lowest. There should not be any fear that there will be insufficient flow to the river downstream. Even in these months the Indus carries 380 - 400 m^3/s of water. The whole filling operation is expected to be completed in 60 days.

3.6.2. Operational Concept for DHP in Stage 1

After filling of the reservoir the water level in the reservoir will then permanently be maintained at 950 m. Any additional water coming into the reservoir will be diverted via the intake and power tunnel towards the power house. This means the reservoir and power house will be operated as a run of river of type power generation (base load plant). During the high flow season (May to September) water will mainly enter the reservoir at a rate higher than the flow diverted through the power tunnel intakes. The excess flow will pass over the spillway. During low flow season (October to April) the water level in the reservoir will also be maintained at 950 m. Any additional water will be diverted through the power tunnel intake.

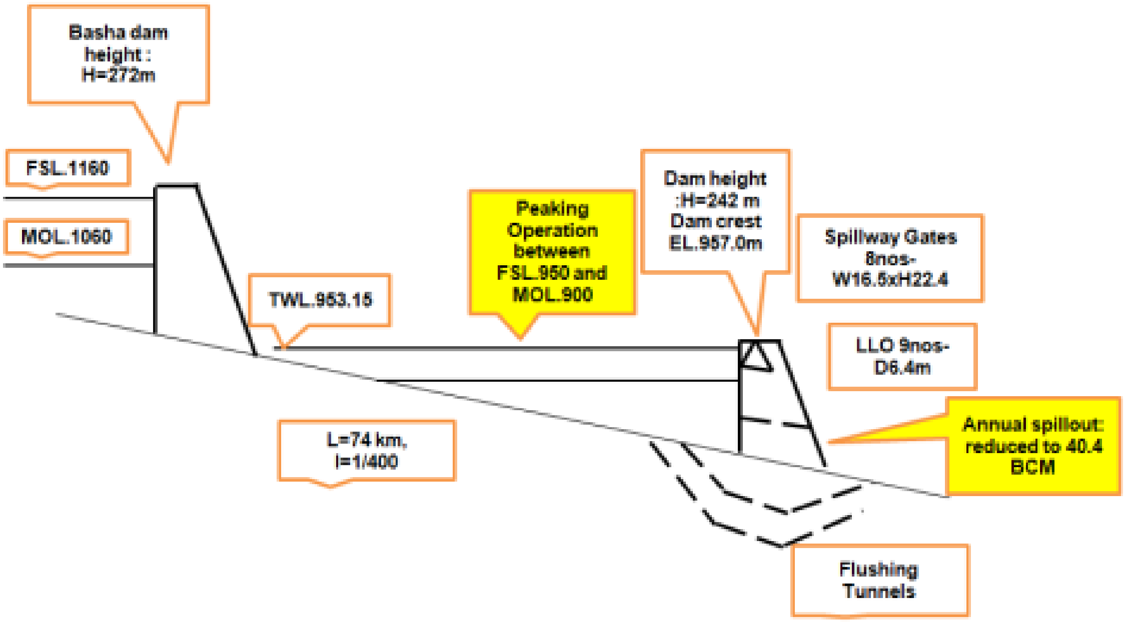
3.6.3. Operational Concept for DHP in Stage 2

Although it is recommended to run the DHP plant as a base load plant throughout its entire life, during the feasibility study the option was identified to operate the project as a peak plant. This option is feasible after commissioning of the Basha Hydropower Project, which is not expected before the completion of stage 1 of DHP in 2022. DHP as a peak plant operation would then be used in the low flow season to cover peak time requirements, by producing electricity during 4-5 hours per day to cover peak demand in the country. However, peaking operation would produce about 900 GWh of less annual energy compared to run-of-river operation. Hence it is expected that DHP will continue to work as base load plant even during Stage 2, while meeting the peak demand from thermal power plants. The possibility of Dasuoperating as a peaking plant (reservoir storage type) might be possible in the future. The operational concept of this type of operation is shown in **Figure 3.10**.

As shown in Chapter 1 (**Figure 1.3**) the water level of the reservoir during base load operation (run- of-river concept) is constantly maintained at 950 m. However with peak load operation (storage type of reservoir), the water level behavior will be entirely different.

In the peaking plant operation, water will be stored and released on basis of a daily cycle of storage during 18-20 hours followed by 4-6 hours release for power production. Reservoir levels are thus fluctuating strongly on a daily basis. But there is also a considerable annual fluctuation of the reservoir level.

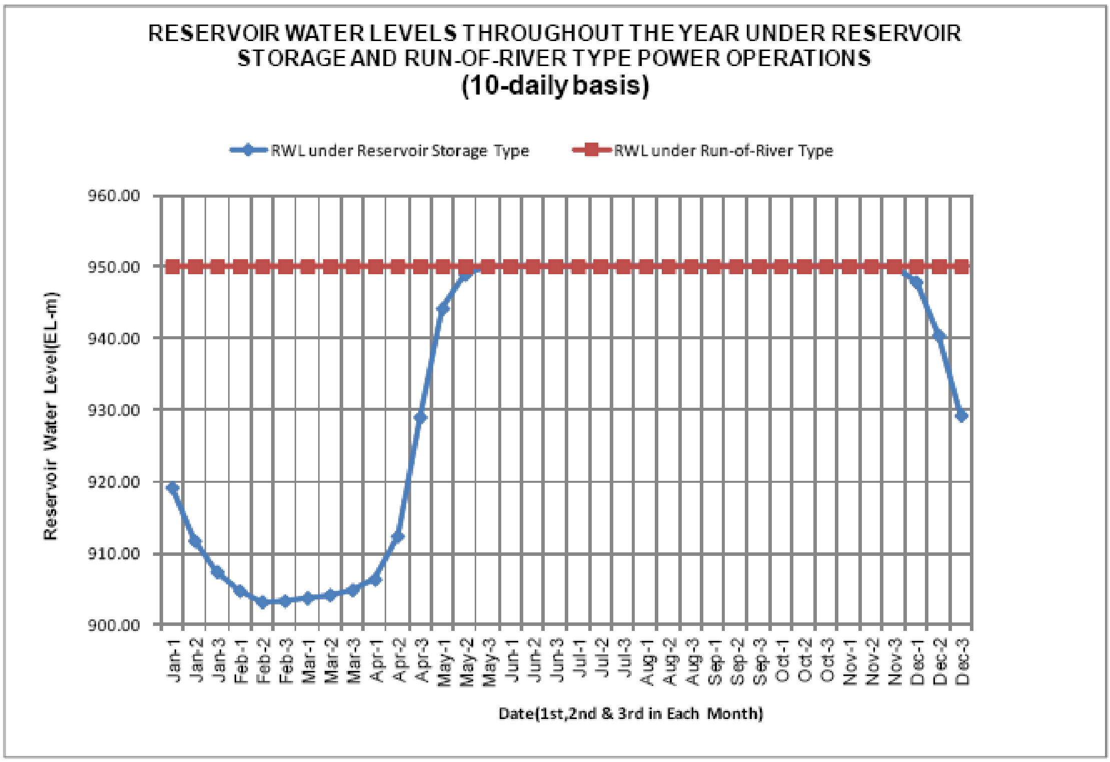
Figure 3.10: Operational Concepts of DHP as Peaking Plant



Source: DHC, EMAP Volume 2, Environmental Assessment

From early December up to April the water level drops due to insufficient inflow in the reservoir. In **Figure 3.11** the reservoir levels of the two types of power generation are compared on a 10-day basis. The required flow for a peaking operation of 4 hours in winter is 443 m³/sec. In the post-Basha scenario, the (95 percent dependable) flow at Dasu is estimated to be 661 m³/sec. The peaking operation is not feasible in pre-Basha scenario since the (95 percent dependable) flow at Dasu is lower with 348 m³/sec than required flow for peak operation.

Figure 3.11: Reservoir Water Levels - Year-round under Run-of-River Type and Peak Plant Operations



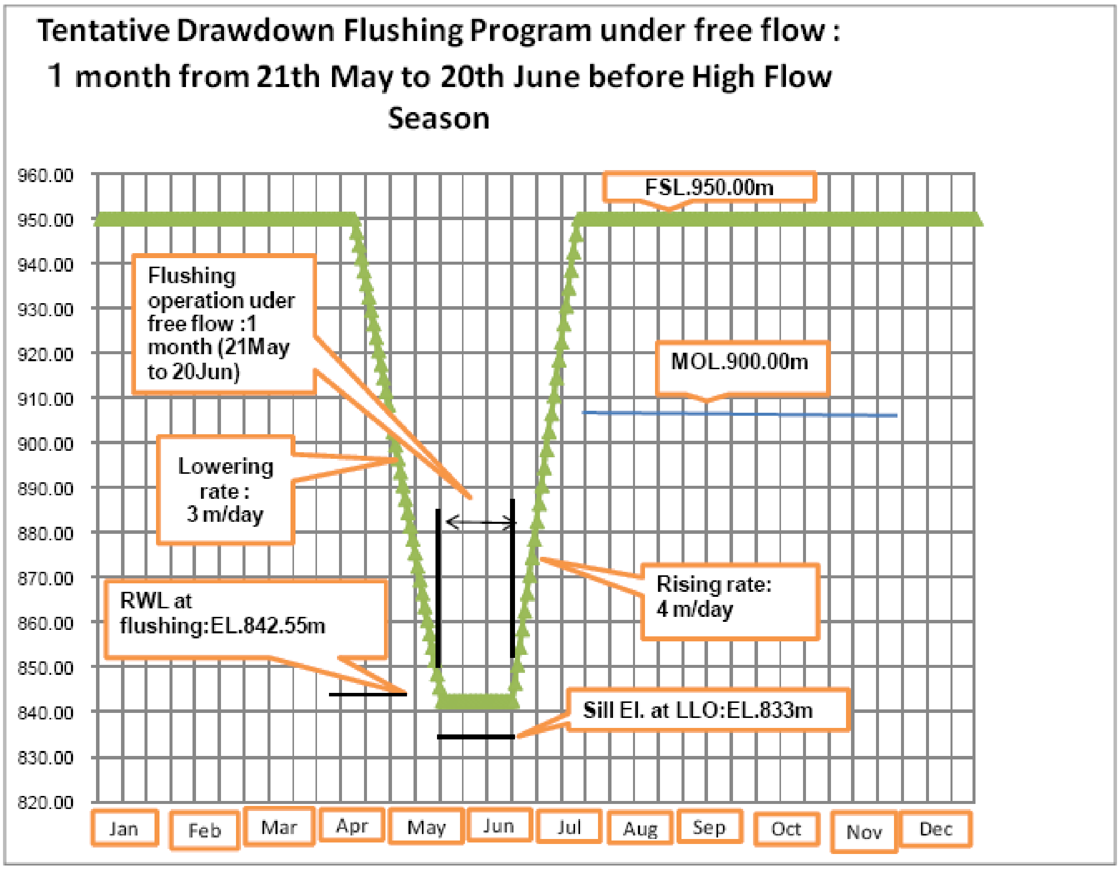
Source: DHC, EMAP Volume 2, Environmental Assessment

Sediment Flushing

About 200 million tons of sediment would flow every year into the reservoir. Hence there will be a reduction of the reservoir storage over the years due to sedimentation. It is expected that the inlets for LLO and power intake will be filled within 20 to 25 years if there is no flushing of sediments. The reservoir periodically will have to be flushed to remove part of the accumulated sediment. The frequency of flushing is yet to be finalized. However, the current plan is to flush the reservoir annually after 15 years of operation of DHP, in case Basha is not constructed by that time. When the Basha dam is constructed within 15 years after commissioning of DHP the first flushing of the sediment in the Dasu reservoir could be postponed for some 40 years, since most sediments will be trapped into the Basha reservoir.

The optimal period for flushing would be one month between 21 May and 20 June. A tentative schedule of expected drawdown of the water level of the reservoir during flushing operation is shown in **Figure 3.12**. The entire operation lasts some three months from 15 April to 20 July. The anticipated lowering rate of the water level is 3 meter per day before flushing and 4 meters per day after flushing when the reservoir is filled to full supply level (run-of - river operation).

Figure 3.12: Tentative Reservoir Flushing Program



Source: DHC, EMAP Volume 2, Environmental Assessment.

Project Cost

The estimated project costs are shown in **Table 3.3** below.

Table 3.3: Overall Estimate of Project Cost (Million Dollars)

	Stage I		Stage II		
	Phase-I	**Phase-II**	**Phase-III**	**Phase-IV**	**Total**
Dasu Hydropower	2,796	599	638	656	4,689
Transmission Line	350	0	438	0	788
Social & Environmental Management	504	0	0	0	504
Total, US$ Million	**3,650**	**599**	**1,076**	**656**	**5,981**
Cumulative Installed Capacity, MW	1,080	2,160	3,240	4,320	4,320
Generation, GWh	8,058	12,225	18,730	21,485	21,485
Cumulative Economic Retrun at US¢ 10.5/kWh as cost of alternative generation excluding environmental benefits					
ERR (avoided cost method)	21%	25%	27%	27.5%	28%
Levelized Financial Cost, US¢/kWh					
At 5% discount rate (avg. cost of borrowing for GOP)	3.36	2.68	2.31	2.26	2.26
At 8% discount rate (WACC for WAPDA in USD)	4.84	3.80	3.28	3.20	3.20

4. Project Alternatives

This Chapter presents the analysis of various alternatives considered during the feasibility and detailed design stages of the project and provides a comparative evaluation of their respective environmental and social benefits and impacts.

4.1. The Without Project Option

Energy Sector Scenario in Pakistan

Pakistan is suffering from an acute power and energy crisis, which is primarily caused by the increasing gap between the supply and the demand of electricity. The need to accelerate the production of electricity is summarized in **Table 4.1**. Between 2001 and 2011 the supply of electricity increased with an average 3.5 percent per year from 12,708 MW to 17,924 MW. The demand for power meanwhile increased with 7.6 percent per year from 12,344 MW to 25,648 MW. This resulted in an escalating gap between supply and peak demand of at least 13.1 percent per year. The peak demand is expected to grow until the year 2029 with an average 7.7 percent and the gap in demand and supply is predicted to increase to 16.4 percent with a shortfall in supply (resulting in load shedding) of 17,367 MW in 2029.

Table 4.1: Power Demand and Supply Gap (2000-2011) and Predictions (up to 2029)

	Current situation			**Predicted**	
	2001	**2011**	**Annual increase**	**2029 (MW)**	**Annual increase**
	MW	MW	percent	MW	percent
Available power	12,708	17,924	3.5	90,110	7.0
Peak demand	12,344	25,648	7.6	107,477	7.7
Gap	+364	-7,724	13.1	-17,367	16.4

Source: Basic Design Report, 2012

Another major problem in the sector is the high cost of electricity generation. In the past the country has not invested sufficiently in its huge hydropower potential and is strongly dependent on the existing thermal power plants. These plants are not running up to their full capacity, due their dependency on imported fuel. Lack of foreign exchange to pay for fuel supplies has resulted in production of electricity below capacity of the present plants.

Due to large gap between the demand and the supply, aggravated by the fact that existing thermal power plants do not produce attheir full capacity due to their dependency on imported fuel, there is load shedding up to eight hours daily throughout the year. Fuel for power plants is imported and there is a shortage of fuel due to the lack of foreign currency. For the year 2011 the amount of load shedding was estimated at 5,000 MW.

Power shortages result in long hours of load shedding, impacting households, industrial and commercial activities. Lack of power affects people’s quality of life: summers are uncomfortable, children often have no light to study, people cannot watch TV, food cannot be cooled, and so forth. But the impact of the energy crisis extends far beyond the daily life. It affects schools, colleges, clinics and hospitals; it affects shops and businesses, reducing sales and revenues; and it affects industry, reducing productivity. It also deters investment. This means, on a macro level, reduced economic growth which translates into loss of livelihoods, jobs and income. The financial impact of load shedding has been estimated at 3 percent to 4 percent of GDP, costing about USD 10 billion a year. This situation is causing serious economic losses to the country and is responsible for increased unemployment and poverty.

On a number of occasions the frequent and prolonged power cuts have caused social unrest. This included demonstrations and blocking of traffic and highways. Several WAPDA and other government offices were attacked, as people expressed their frustration caused by the prolonged and repeated power cuts. Pakistan is also planning to import electricity from Central Asia to address the summer deficit (CASA 1000).

Hydropower production as percent of total energy production declined from about 64 percent in the period 1970- 1980 to about 27 percent in recent years, despite the huge hydropower potential in the country. Since the nineties the power system in the country has steadily relied more and more upon thermal energy. In 2007 about 65 percent of the total installed power capacity originated from fossil power plants, 2 percent from the nuclear generation and the remaining 33 percent from hydropower production.This greater reliance on thermal sources also resulted in an increasing dependency on imported fuel (oil, gas and coal). As much as 85 percent of oil and allied products are imported. The imports result in high cost of power production. In the period 2000-2010 fuel prices have increased about three times (in nominal terms) at an average annual rate of 11.3 percent. During the year 2007-2008 more than US$ 1.25 billion was paid for imported fuel for power production. These high imports negatively influence the balance of payments.

In Pakistan there exist a series of options such as demands 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 to address these issues, GoP is already undertakingprojects such as World Bank funded Pakistan - Electricity Distribution And Transmission Improvement Project, and Asian Development Bank funded Energy Efficient Investment Program.

Case of "Without Project Alternative"

The “without project” alternative is not realistic, because Pakistan will build additional generating plants to eliminate power shortages. Indeed, given the increasingly prohibitive costs of fuel oil-based electricity generation, development of Pakistan’s hydro resources at a variety of scales represents the only reasonable prospect of eliminating these shortages. Indeed, until such time as power shortages are significantly reduced and system reliability increased the incremental output of Dasu would serve primarily to reduce these shortages – the benefits of which are largely the same as that of the “no project” counterfactual: i.e., substituting grid electricity for diesel self-generation and kerosene for lighting. However, these sources will not meet the required shortfall. Hence the "without project alternative" will result in more load shedding and power cuts with considerable social and economic impacts such as impeded economic growth, increased unemployment and poverty and social conflict.

4.2. Alternative Sources of Energy

The economic analysis shows that DHP has net benefits greater than or equal to those of mutually exclusive project alternatives. Projects such as energy conservation and energy efficiency are complements to, rather than mutually exclusive substitutes for, DHP and will be implemented regardless of whether Dasu is built or not.

The relevant alternative sources to the proposed DHP design fall into four categories: (i) hydro projects other than Dasu, (ii) other renewable projects such as wind and solar, (iii) nuclear; and (iv) thermal power (coal, oil and gas).

4.2.1. Alternative HydropowerProjects

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 has been utilized. The majority of the hydropower potential can be found in the Upper Indus Basin. Investing in hydropower development can provide additional generating capacity less expensively and in an environmentally cleaner manner than any thermal alternative with almost no long-term fuel cost. Development of hydropower potential can contribute in reducing the cost of electricity generation, reducing the sector deficit by injecting positive cash flow, saving foreign exchange by displacing imported fuel and reduction of carbon dioxide (CO_2) emissions.

The DHP is least cost when compared to the various ongoing and planned hydro schemes in the country: (i) public and private, (ii) run-of-river and storage, (iii) up- and down-stream of DHP, and (iv) on rivers other than the Indus (Jhelum & Swat) (**Table 4.2**). These projects are mostly on Indus River where river flows and elevations are available and some are on Jhelum River. Both of these rivers are with Pakistan according to the Indus Treaty of 1960 and their catchment is also located in the country. One project is on the Swat River which has relatively smaller inflow.

Table 4.2: Estimated cost of various Hydropower Projects

Sr. No	Name	Capacity	Generation	Unit Costs		River
		MW	Gwhs	USD/kW	Cents/Kwh	System
	Projects Under Various Stages of Constuction or Recently Completed					
1	Allai Khawar	121	463	1,345	3.73	Indus
2	Khan Khawar	72	306	1,356	3.39	Indus
3	Duber Khawar	130	595	1,477	3.42	Indus
4	Jinnah Hydropower	96	688	2,150	3.18	Indus
5	Neelam Jhelum	969	5,150	2,229	4.45	Jhelum
6	Patrind	147	633	2,463	8.29	Jhelum
7	New Bong	84	470	2,560	8.55	Jhelum
8	Tarbela 4th Extension	1,410	3,871	645	2.49	Indus
	Planned Projects					
9	Dasu Hydropower Stage I	2,160	12,225	1,968	3.69	Indus
10	Dasu Hydropower (Phased Dev.	4,320	21,485	1,389	2.96	Indus
11	Thakot	2,800	14,095	2,500	5.27	Indus
12	Pattan	2,800	15,230	2,500	4.88	Indus
13	Diamer Bhasha	4,500	18,097	2,510	6.62	Indus
14	Bunji Hydropower	7,100	24,088	1,710	5.35	Indus
15	Lower Plas valley	665	2,658	1,786	4.74	Indus
16	Lower Spat Gha	496	2,106	2,198	5.49	Indus
17	Kohala Hydrpower Project	1,100	4,800	2,757	6.70	Jhelum
18	Sukhi Kinari	840	2,951	1,356	6.70	Jhelum
19	Munda	740	2,407	1,893	6.17	Swat

Estimates based on the data collected from WAPDA Hydropower planning and feasibility, and design studies for the projects and actual concessions by NEPRA.

Projects 1, 2 and 3 (AllaiKhwar, Khan Khwar and DuberKhwar) are located on tributaries of the Indus upstream of Tarbela. Jinnah Hydropower is below Tarbela on a barrage which was constructed in 1948. These projects owned by WAPDA are either commissioned or nearing completion. Projects 11, 12, 13 and 14 (Thakot, Pattan, Diamer-Basha, and Bunji) are above Tarbela in a sequence. Projects 15 and 16 (Lower Palas Valley and Spat Gah) are on tributaries of the Indus above Tarbela.

Projects comparable to DHP provide generation of more than several thousand GW hare Diamer Basha, Bunji, Pattan and Thakot. Among them, Diamer Basha is a storage project (with a reservoir area of 150 km^2) and will have significant environmental and social impacts compared to other projects, which are run of river projects with limited reservoir area. Among these run of river projects, the engineering designs of Pattan and Thakot are yet to be undertaken. DHP has the lowest cost among the comparable hydro projects in Pakistan.

4.2.2. Other Sources of Renewable Energy

The main sources of alternative renewable energy available to Pakistan are small and medium scale hydropower, wind and solar power. These options are being actively pursued and have the same beneficial impact in avoiding the environmental externalities of fossil generation. However, the scale and nature of these resources are such that these cannot be viewed as a mutually exclusive substitute for Dasu. Both of these options need to be developed to the extent technically and financially feasible: they are complementa, not substitutes to Dasu. In order to replace 12,200 GWh of annual energy of DHP-I, at a typical 28 percent annual load factor the installed capacity of wind/solar would be 5,000 MW, requiring a capital investment of more than US$ 15 billion – over 3.5 times the total financial cost of DHP-I of $4.2 billion. Moreover, from the perspective of mobilizing the necessary finance 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 simply not available to large hydro projects. It is not anticipated that DHP would crowd out the ability of the GoP, Provincal Governments and/or private sector to finance small and medium scale investments in renewable energy.

4.2.3. Nuclear

Two nuclear power plants currently operate in Pakistan, and there exist plans for additional nuclear projects, the main justification for which is to diversity the supply mix. However, nuclear projects are designed for year-round base load operation, and cannot substitute for peaking/intermediate duty at annual load factors around 50 percent, or for projects that support the summer load peaks. Moreover, while the social and environmental impacts of large hydro projects can be mitigated with appropriate social and environmental management plans, the main environmental impact of nuclear power - the disposal of its radioactive waste - has yet to be satisfactorily solved in the Pakistan cotntext. In short, under no circumstances can nuclear power be considered a mutually exclusive alternative to hydropower in general, or to the Dasu project in particular.

4.2.4. Comparison between Hydropower and Thermal Generation

In Pakistan, the domestic gas resources are limited, oil is mostly imported and exploitation of Thar coal is still under investigation. As explained in **Section 4.1**, the present generation is highly dependent on imported fuel which is very expensive. Hydropower development can be compared with various thermal alternatives such as High Sulfur Fuel Oil, Thar Coal plant, Natural Gas plant and Combined Cycle Gas Turbine -in terms of their energy cost and CO_2 emissions (**Table 4.3**).

The CO_2 emissions from thermal alternatives vary from 6.7 to 17.2 million tons per annum, while CO_2 emissions from DHP are negligible (further discussed in **Chapter 6**).

In addition, thermal generation will emit large amounts of particulate matter (PM), sulfur dioxide (SO_2), carbon monoxide (CO), and nitrogen oxides (NOx) -adversely damaging ambient environment and public health. Thus, the health impacts of air pollution by hydropower generation are very low to negligible.

Table 4.3: Comparison between Hydropower and Thermal Alternatives

Technology		**Hydro-Power**	**Thermal**			
	Unit	**DHP**	**High Sulfur Fuel Oil**	**Thar Coal**	**Natural Gas**	**Combined Cycle Gas Turbine**
Required Capacity[1]	MW	4,320	2476	2476	2476	2476
Load Factor	percent		85	85	85	85
Annual Electricity Generated	GWh	18,440	18,440	18,440	18,440	18,440
Efficiency (%)			39	39	39	55
Calorific Value	Btu/Kg		40,216	21,844	936.8	936.8
Calorific Value	TJ/Ton		0.042	0.02		
Annual Fuel Consumption	million		4.0 tons	8.51 tons	161.3 mmbtu	114.4mmbtu
Annual CO_2 Emissions	million tons	0.0045	13.2	17.2	9.5	6.8
Annual CH_4 Emissions	tons	38	136		170	121
Annual PM Emissions	ton	0	19,078	2,202	701	497
Annual CO Emissions	ton	0	2,553		3,064	2,173
Annual NO_X Emissions	ton	0	34,043	13,277	42,554	30,175
Annual SO_2 Emissions	ton	0	240,968	26,154	5,261	3,730
Annual Total CO_2 eq. Emissions	million tons	0.0073	13.187	17.226	9.558	6.778
Unit Energy Cost	USD/kWh	0.02	0.203	0.220		0.116

Note [1]: Required capacity for thermal alternatives to generate 18,440 Gwh

Source: Economic and Financial Analysis Report of DHP Detailed Engineering Design

From the table it can be seen that the cost of electricity production per kWh of hydropower generation ismuch lower than those of any thermal alternative. Theseare a fraction of the cost of electricity from thermal plants fuelled with oil, coal, or gas.

The impacts of air pollution caused by thermal power generation are singinficat. High concentrations of NO_x can cause inflammation and reduced lung functions. High concentrations of SO_2 can also affect breathingfunctions and can cause inflammation of the respiratory tract. SO_2 also contributes to the formation of particulate matter (PM) in the atmosphere. PM can penetrate into sensitive regions of the respiratory system, and can cause or aggravate cardiovascular and lung diseases. The impacts of thermal alternatives are much more difficult and costly to mitigate than the limited health impacts from hydropower projects. Health damage cost for thermal alternatives may vary considerably as can be seen from **Table 4.4**.

Table 4.4: Health Damage and Clean Development Mechanism (CDM) Costs of Thermal Alternatives

Health Damage Cost	**Unit**	**DHP**	**HSFO**	**Thar Coal**	**Natural Gas**	**CCGT**
NOx damage cost (1,308 USD/ton)	Million USD	0	44.53	17.37	55.66	39.47
PM damage cost (1,504 USD/ton)	Million USD	0	28.69	3.31	1.05	0.75
CDM Cost						
CDM Price of CO_2 (9.5 USD/ton)	Million USD		125.11	163.65	90.72	64.33

Source: DHP Economic and Financial Analysis.

Development of hydropower project usually requires a considerable investment in overall infrastructure (dam and associated structures) in an early phase of the projectand a long period of development. For this reason a carefully scheduleddevelopment in phases can be economically beneficial in order to start generating electricity in an early stage of the project. Generally large hydropower projects generally have singnificant environmentaland social impacts due to flooding of huge terrestrial areas, changes in aquatic ecology and large scale resettlement of affected community. Though DHP is a large hydropower project, it has very limited reservoir area of 24 km^2 and hence very limited social and environmental impcts. Power density of DHP (181 W/m^2, meaning 180 MW of generation per unit square kilometer of submergence) is the highest in the world among hydropower projects of such large capacity.

4.3. Alternative Sites of the Main Structure

WAPDA conducted a study in 1981 (MONENCO, 1991) to identify potential hydropower and storage development projects in the Upper Indus Basin. The study recommended a cascade of hydropower projects between Bunji and Tarbela and identified potential locations of various dam sites. Between Basha and Dasu a relatively narrow stretch of about 10 km of the Indus valley was identified as one of such sites, somewhat upstream of Dasubridge (KKH crossing the Indus River). Dasu town according to this study would be the downstream limit of a possible dam site since the valley of the Indus after Dasu is becoming wider, which makes a dam more expensive.

The feasibility study of the project (J.V. NESPAK/ACE/Harza/Colenco in association with Binnie& Partners, 2009) was carried out in the assumption that the Dasu project would be implemented after completion of the Diamer-Basha dam. In this study several locations from 3 to 9 km upstream from Dasubridge were investigated. The initial six possible locations for the main structure were reduced during the studies on geotechnical grounds to three technically feasible alternatives. Alternative analysis of these three locations is given in **Table 4.5**. Alternative 2 (Axis 5) was finally selected after extensive consultations with the affected population. This alternative was technically and economically more feasible and had considerable lower social impacts, with lower needs of resettlement of people. An adverse environmental impact is thatin all three alternatives about 51 ha of the Kaigah private game reserve (see Figure 4-1) would be submerged by the future reservoir. The area inundated represents 1 percent of the reserve. During the field studies extensive consultations were held with the local population. The selected alternative was supported by the population since a smaller population would be affected, less land (87 percent) would be flooded and the village of Seoand its important physical and cultural resources including a 400 year old mosque and an ancient graveyard (5000 graves) would be spared.

Table 4.5: Alternatives of Dam Location (Feasibility Study)

	Alternative 1 (Axis 2)	**Alternative 2 (Axis 5)**	**Alternative 3 (Axis 6)**
Description	Located 3.9 km upstream of Dasu bridge along KKH	Located 8.2 km upstream of Dasu bridge along KKH	Located 9.3 km upstream of Dasu bridge.
Technical Features			
Geological and Geotechnical Conditions	Relatively poor compared to other alternatives, but still considered acceptable for the dam.	More preferable	More preferable Conditions are similar to Axis 5
Energy Production	Higher potential 4,320 MW 20,613 GWh (annually) This alternative produces 6 to 8% more energy than other options.	Less potential 4,280 MW 19,381 GWh (annually) However, a subsequent re-optimization of the design allowed for this alternative to have the same power output of Alternative 1 (Axis 2)	Less potential 4,000 MW 19,050 GWh (annually)
Cost			
Construction Cost for RCC dam	High 2,588 million US$ (only for dam)	Low 2,468 million US$ (only for dam)	Very high 2,651 million US$ (only for dam)
Resettlement (for Dam and Reservoir)			
Land acquisition Land required	High 7,363 acres	Less 6,439 acres	Similar to Alternative 2, but no detailed assessment was made.
Households affected	High 778 households Entire Seo village will be flooded	Less (65% less compared Alternative 1) 278 households (Seo village will not be affected)	Similar to Alternative 2, but no detailed assessment was made.

	Alternative 1 (Axis 2)	Alternative 2 (Axis 5)	Alternative 3 (Axis 6)
		(Surveys during detailed design indicate 767 households will be affected. This also imply that affected households for Alternative 1 will be much higher than 778 as the entire Seo village consisting of about 500 households will be affected)	
Population affected	7,670	3,670 (52% less compared to Axis 2) (Surveys during detailed design indicates 6,953 people will be affected)	Similar to Alternative 2, but no detailed assessment was made.
Environment			
Loss of Trees	22,149	21,000	Similar to Alternative 2, but no detailed assessment was made.
Physical cultural resources	High A 400 year old mosque, located at Seo, that is highly revered both locally and regionally will be affected. One graveyard in Seo with 5,000 graves will be affected. Another historical mosque located at Seer Gayal (said to be similar age of Seo mosque but religiously not important as Seo mosque) will be submerged.	Medium Though, there is no impact on the Seo Mosque, However another historical mosque in Seer Gayal will be submerged (this will be common for all alternatives). Unlike Seo mosque, this is a regular mosque without any specific religious importance. Being a wooden structure, the mosque can be relocated to a new location, which was agreed by the local religious leaders and community.	Medium Similar to Alternative 2
Kaigah private game reserve	Similar to other alternatives About 51 ha of private game reserve (1% of total game reserve area) will be submerged	Similar to other alternatives	Similar to other alternatives
Public acceptance	Negative The Jirga of Seo village decided against this	No opposition	No opposition

	Alternative 1 (Axis 2)	Alternative 2 (Axis 5)	Alternative 3 (Axis 6)
	alternative due to submergence of Seo mosque.		
Conclusions		Alternative 2 (Axis 5) is selected based on lesser social and environmental impacts and cost.	

During detailed design two other alternative sites for the main structure (near-by within a distance of 200 m) were studied, one upstream and one downstream of the recommended site from the feasibility studyThe three alternatives were compared on technical and environmental merits. It turned out that the upstream alternative (55 m upstream) required a somewhat lower volume of concrete and less excavation work with lower environmental impacts.This site was finally selected as the most favorable for the detailed design.

4.4. Alternatives Types of Structure

Three types of main structure were considered during the feasibility study, (i) a Roller Compacted Concrete (RCC) structure, (ii) a Concrete Faced Rock fill structure and (iii) an Earth fill structure. The feasibility study recommended an RCC structure on basis of lower cost and technical advantages. The possibility of an earth fill structure was abandoned at an early stage, since the selected site is very narrow and therefore not suitable for such a type of dam. The impervious material required for the construction of an earth fill dam had to be obtained from far way. A rock fill dam would be possible since abundant rocky material of good quality is available at short distance. In the technical and cost comparison between an RCC structure and a rock fill structure the first structure scored much better. Construction cost of an RCC structure is almost half of that for a rock fill dam and also the construction period is shorter. Moreover the presence of quantities of good quality of building materials (e.g.pozzolan) was identified within the reservoir area and at reasonable hauling distance further northwards near Chilas. Large quantities of these materials for buildinga RCC structure can be transported to the site with an overhead transportation system. Use of such a system will also help to reduce possible negative impacts on environment and pressure on the KKH traffic.

4.5. Alternatives for the Layout of Intake and Tailrace Tunnels

Three different types of waterways (intake and tail race tunnels) were considered during the feasibility study. The most economical alternative producing significantly more energy was selected. An alternative that produces more energy than the other alternatives was recommended. However this study did not evaluate the stability of the various types of rock and the possible impacts of the presence of the Khoshe fault, a geological dislocation near to the location of the underground power house. The Khoshe fault is not an active fault, with a weak or fractured rock structure. However its presence could possibly create water leakage from the pressurized tunnels and influence the design and construction cost of the tunnels.

During detailed design four alternatives were studied. The layout for alternative 1, in which the power house is located upstream of the Khoshe fault, was worked out further during the feasibility study. The tail race tunnels are all crossing the fault, with possible negative impacts. In alternative 2 the powerhouse is located downstream of the fault. In alternative 3 any crossing with the fault is avoided, but the tail race tunnels are curved, which is a disadvantage. Alternative 4 is a slight modification of Alternative 1, in which the tail race tunnels are straight without any bend. This alternative is selected because of higher efficiency, since the head losses in a straight tunnel are always lower because of lower friction.

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 in size and difficult to transport. It appeared that the current condition of the KKH presents an important limitation to the selection of suitable equipment. A comprehensive study was made to find out the maximum weight and width of generating equipment, which could safely pass the KKH. This was tested during trial transportations towards the Basha dam. Another factor which 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, (c) 12 units of 360 MW. Option (c) was selected as the most feasible option on basis of energy production and transportation requirements. Another advantage is that a unit with a smaller capacity could easier generate electricity even with low flow conditions. With possible river flow changes due to climate change a smaller unit is more flexible in operation.

4.7. Alternative Construction Schedules

Both WAPDA and World Bank agreed on a two staged development of DHP, with each stage divided into two phasesas this approach: (i) is less resource intensive which is very important consideration given the financial constraints the sector and the country is facing; (ii) the gestation period would be lower which has immensely positive impact on financial and economic aspects in addition to meeting the needs of energy starved economy; and (iii) revenue from the Stage 1 can be used to finance other elements of the Indus Cascade and Stage 2 of the project that would increase the benefits of the DHP and enhance its sustainability. These factors combined give optimal approach of developing the project in stages/phases instead of constructing it in one go.The development of Stage 2 is assumed to be implemented after completion of the Diamer-Basha project. The construction of this dam will largely reduce the sediment load into the Dasu reservoir and thereby prolonging the life of DHP, which is a considerable technical and economic benefit. The proposed overall development of the DasuHydropower Project is shown in **Table 4.6**.

Table 4.6: Staged Development of DHP (full development)

	Stage 1 (Pre-Basha)		**Stage 2 (Post-Basha)**	
	Phase 1	**Phase 2**	**Phase 3**	**Phase 4**
Worksto be completed	- Dam - Hydraulic infrastructure			

	Stage 1 (Pre-Basha)		Stage 2 (Post-Basha)	
	Phase 1	**Phase 2**	**Phase 3**	**Phase 4**
	- 1 powertunnel - 3 turbines	-1 powertunnel - 3 turbines	- 1 powertunnel - 3 turbines	-1 powertunnel - 3 turbines
Cumulative Installed Capacity (in MW)	1,080	2,160	3,240	4,320
Cumulative Generation (in GWh)	8,058	12,225	18,730	21,485
Total Project, including supporting transmission(in million USD)	3,650	599	1,076	656

Three alternatives for the implementation of Stage 1 have been considered. A summary has been given in **Table 4.7**. The three alternative construction schedules for Stage 1 are not very different in construction cost, but mainly differ in duration of the construction and in the timing of the production of power.

Table 4.7: Alternatives for Construction of Stage 1

Item	Alternative 1	Alternative 2	Alternative 3
Construction mode	Sequential Development Phase 2 starts after completion of Phase 1	Semi-simultaneous Development Phase 2 work start after relevant Phase 1 work finish	Simultaneous Development
Procurement of contractors	Different contractors for Phase 1 and Phase 2	Different contractors for Phase 1 and Phase 2	Same contractors for Phase 1 and Phase 2
Start of Phase 1 commissioning	5 years (60 months)	5 years (60 months)	5 years (60 months)
Start of Phase 2 commissioning	10 years (120 months)	8.6 years (104 months)	7.3 years (88 months)
Contract conditions	Use of Standard Contracts	Need of special conditions	Use of Standard Contracts
Cost	less annual disbursement	less annual disbursement	high annual disbursement
Temporary facilities	Duplication	Duplication	No duplication
Design of E/M equipment	Double work due to different contractors	Double work due to different contractors	Single work
Contract management	Simple	Complicated	Simple
Environmental and social consideations	Delayed power generation by 2.5 years will increase the environmental and health impacts from thermal power generation.	Delayed power generation by 1.3 years will increase the environmental and health impacts from thermal power generation.	Earlier power generation avoid enviornmental and health impacts from thermalaternative, and brings earlier economic grouwth, and increased employment

Economically, contractually and environmentally Alternative 3 has several advantages due to earlier generation of power in Phase 2. Early generation and distribution of hydro-generated power means that environmental impacts of thermal power generation can be reduced and brings earlier economic growth and increasedemploymentsocio-economic development of the area.

4.8. Alternative Sources of Construction Material

4.8.1. General

The project will require 4.1 million cubic meters of roller-compacted concrete (RCC) and 2.0 million cubic meters of conventional concrete. The production of standard quality and durable concrete at economical cost is therefore of paramount importance for the project. Industrial material required for the concrete such as steel (0.15 million ton) and cement (0.8 million ton) will be procured from the market, while natural material required for the concrete such as coarse aggregates (9.2 million ton), natural or manufactured sand (6 million ton) and pozzolan (0.5 million ton) will be sourced from nearby quarries. Studies have been conducted both during feasibility and detailed design to identify potential sources of natural material with required quantity and quality.

4.8.2. Sources of Coarse Aggregates

About 9.2 million ton of coarse aggregate will be required for both RCC and CVC works. The major concrete works include the main dam, the powerhouse structure, the power tunnels and different other components of the project. During the feasibility study four sites with suitable material (including six quarries) were identified, as tabulated below.

Table 4.8: Alternative sites for coarse aggregates and their suitability

	Name of site	Quarries	Location	Suitability
1	UcharNullah	2	1 km u/s Dam site	Unsuitable due to insufficient quantityavailable
2	Barseen	1	6 km u/s Dam site	Unsuitable, material suitable, but no flat area available
3	Kaigahnullah	2	8 km u/s Dam site	Very suitable, sufficient flat area available
4	Panibah	1	10 km u/s Dam site	Unsuitable due todifficult terrain

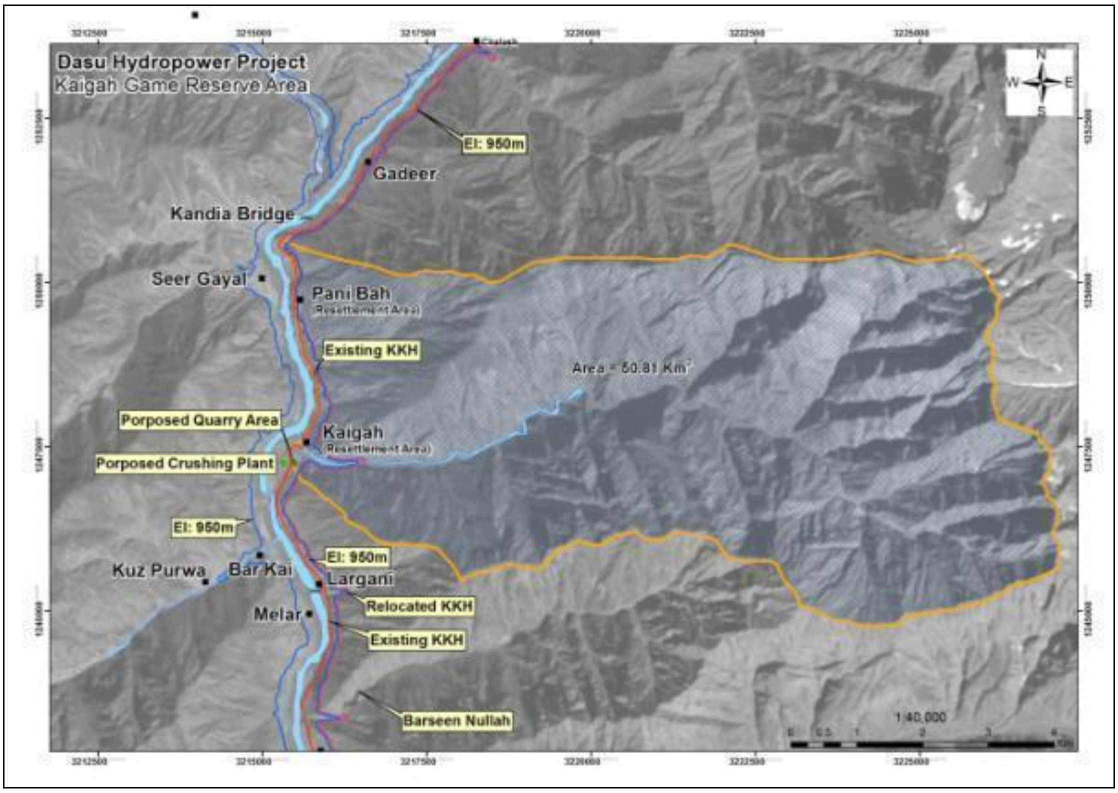
All prospective quarry sites preferably should be located in the future reservoir area, since this area already acquired for the project. Moreover downstream of the dam there is no suitable site available so close to the city of Dasu-Komilla. For geomorphological reasons all potential sites are concentrated on the left bank side, since the rightbank side of the Indus is very steep and susceptible for landslides, Moreover an important consideration is that all quarry sites should be accessible at an early stage of the project.This is not the case on the right bank (the right bank access road will only be constructed at a later stage of the first phase). From an environmental point of view it is also an advantage that the sites are situated in the future reservoir area and will be inundated after the borrowing activities are completed and will be covered by sediment. The future landscape and vegetation therefore will not be affected by the excavations. The rock quality in three sites (site 2, 3 and 4) was considered to be suitable.The Uchar Nullah site was abandoned since insufficient quantity of good quality rock is available.

Two sites, Kaigah nullah and Panibahare adjacent to the area defined as the Kaigah Nullah Community Conservation Area (5000 ha). This conservation area was established in 1993 as Private Game Reserveand is managed by the local community of Kaigahnullah.The boundaries of the Kaigah Community-led Game Reserve (KCGR) have been notified by the KP government in 2000 (see also **Figure 4.1**).

The community of Kaigah belongs to the affected people of the project, since they are living in the reservoir area and will have to be resettled. Wildlife in the area will be negatively affected during construction and possibly also afterwards during operation. The community managing KCGR will also be affected by loss of income (share of the annual sales of hunting licenses). A detailed discussion of impacts on the reserve, its wildlife and the community is presented later in the document (**Chapter 7**).

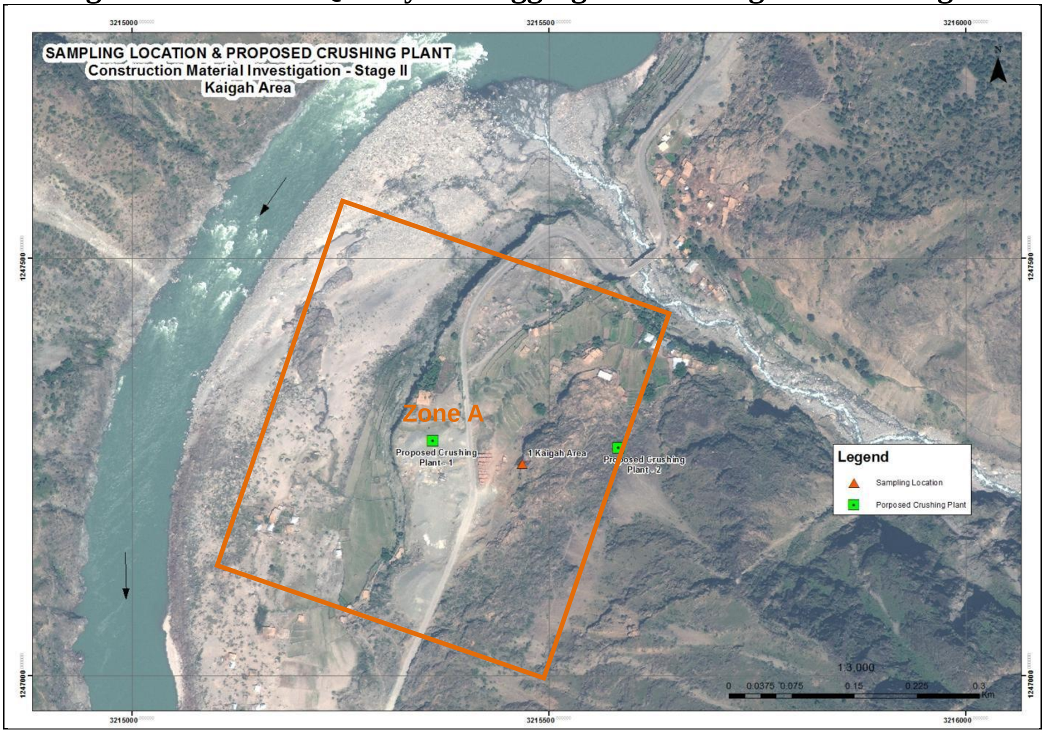
The site in Barseen is nearest to the project, but has hardly any flat terrain needed for establishing sites for crushers, equipment and for a stockpile.Also the area at Panibah was considered as unsuitable, since the quarry is situated in very rugged terrain with few level areas. No other feasible options except Kaigahmaterialized during field studies.

Figure 4.1: Boundaries of the Community-managed Game Reserve at Kaigah



On basis of these findingsDHC selected the Kaigahsite (see **Figure 4.2**) as the technically and economically most suitablesite for quarrying. However the selection of this site will have adverse environmental consequences for KCGR, the village community and biodiversity (disturbance of wildlife).

Figure 4.2: Site of Quarry and Aggregate Crushing Plant at Kaigah



Source: DHC, EMAP Volume 2, Environmental Assessment

In summary, Kaigah has the following technical and economic advantages:

- The quarry area is located in the future reservoir submergence area, thus avoiding any additional land acquisition and resettlement;
- The nearest community (Kaigahnullah village), living near to the quarry site will already be compensated and resettled on priority basis before large scale excavation work and blasting starts;
- Enough space is available in the surrounding area to establish an aggregate processing plant and for storage of processed aggregates. No additional excavation of land is required to create level areas; and
- From the existing quarry in Kaigah it will be a relatively easy and low costsolution to transport the material by conveyor belt to the damsite (about 10 km), without interference in the traffic on KKH and in a relatively environmental-friendly way (compared to transport by truck or rail).

The use of theKaigahsite along with reservoir submergence and KKH relocation will have the following negative environmental and social impacts onthe Kaigha game reserve:

- Loss of some 82 ha from the reserve caused by construction of the new alignment of the KKH and fromsubmersionby the reservoir;
- Noise and vibrations from blasting and excavation operations from the quarry (duration estimated at 2.75 year) along with 5.5 km of KKH construction within the

game reserve (duration estimated at 7-8 months) will have negative impacts on the presence of the wildlife;wildlife is expected to avoid the lower altitudes; and

- Reduction of community incomefor conservation management during the above years of construction. This income forms a share of the sale of hunting permits (trophy hunting).

The mitigation measures for the above impacts are discussed in **Chapter 7**.

4.8.3. Sources of Fine Aggregates

It is estimated that about 6 million ton of good quality sand will be required for the construction of the project. Natural sand is the ideal material to be used as fine aggregates (size from 75µ to 5 mm). During the feasibility study no significant sources of good sand to be used in concrete structurescould be found, which are located close enough to the damsite. It turned out that the river bed alluvium in this part of the Indus valley is not suitable as a source due to the fine nature of the sand and its limited availability. Two other sources of natural sand were identified in the study: Maira and Chilas Sand deposits, located respectively some 80km downstream near Thakot and 120km upstream from Dasu, near Chilas (see also**Table 4.9**). Both have good quality river sand, but both sites are far away from the project.

During detailed design, another alternative was studied. By crushing suitable hard rock or gravel fine aggregate material could be produced with similar characteristics (composition, grain size, shape) as natural sand. Detailed studies on rock material from the quarries nearKaigahconfirmed that crushed diorite was suitable to be used as fine aggregates.Kaigah is already selected for the production of coarse aggregates and the same facility can be used to produce fine aggregates. However, another crusher has to be installed.

Table 4.9: Alternative Sources of Fine Aggregates

	Location	**Remarks**	**Result**
1	Maira sand, both sides of Indus	80 km downstream of Dam site	Suitable
2	Chilas sand	120 km upstream of Dam site	Suitable
3	Manufactured sand from rock at Kaigah	8 km upstream of Dam site	Suitable

Manufacturing of sand from Kaigah is found to be a better option compared to other two options proposed in feasibility study due to the following reasons:

- Borrowing sand from Maira and Chilas will affect the aquatic ecology of Indus;
- Transportation costs can be largely reduced; and
- No negative effects on regular KKH traffic since the project is using the conveyor belt system and the internal project road network for transportation.

In addition to Kaigah quarry, more raw materials for manufacturing sand will become available from excavations for power tunnels and power house. Reuse of excavated material as aggregates production will reduce generation of spoils and associated environmentalimpacts from spoil diposal. Reuse of excavated material would also minimize additional land acqusistion for spoil disposal.

4.8.4. Sources of PozzolanicMaterial

Pozzolan is a fine material when combined chemaically with hydrated limte will form hardened compounds at normal tempratures and can be used in mortar and concrete for dam construction. It is estimated that 0.5 million ton of pozzolanic material will be required in concrete as partial replacement (about 40 percent) of cement to improve water tightness of concrete, and to improve workability and other properties of concrete, and reduce the use of chemical admixtures. Three types of pozzolanic material can be used for concrete production. They are (i) slag and fly ash; (ii) natural pozzolan; and (iii) manufactured or processed pozzolan.

The use of slag and fly ash is not feasible in this project, since local and international sources either produce insufficient quantities or are located far away from the project area.

Natural pozzolan has a volcanic origin. It is a porous variety of volcanic tuff and ashes, which gives a typical pozzolanic reaction in combination with cement. The main component is a highly porous glass.Pozzolan when combined chemically with hydrated lime will form hardened compounds at normal temperatures and can be used in mortar and concrete. The material is available in or near the project area, but the quantity found is often either insufficient or very variable in composition and quality. Potential locations in or near to the project area where natural pozzolanis found were identified during the feasibility study. The various potential locations have been analyzed on quality, distance and potential environmental/social impacts. Two sites are at larger distance (95 and 128 km) outside of the project area and the other two between the dam site and Dasu, in areas not affected by the reservoir. A summary of the findings of these tests are given in **Table 4.10.**

Table 4.10: Potential Sources of Natural Pozzolan

	Potential locations	Distance	Quality	Result
1	Seo Terrace, right bank Indus	Near to dam site	Good to poor	Suitability varies considerably
2	Tial and Maidan terrace	Near to Dasu	Poor to average	Not promising
3	Thorli- Lacustrine Deposits	95 km u/s of Dasu Dam site	Average to good	Suitable

During detailed design, two sites namely Kandia Valley (18 km upstream) and ThorliNullah (95 km upstream) were studied with the purpose to reduce the hauling distance, which is considered to have a considerable impact on regular traffic using KKH. The site in Kandia is lower in quality and difficult to reach. The Thorli site is characterized by a reasonable to good quality. The only remaining alternative would be then to import manufactured pozzolan from China, India of South Africa, but against high transportation cost and large negative impact on KKH traffic. Under the current circumstances the quarriesat Thorli and Seo seem to be by far the best alternative and nearest site. The technical members of International Panel of Experts, in their review of engineering designs in November 2013 have recommended that fine material (that can be manufactured from the aggregates at the proposed aggregates quarry site) to be used as alternative for pozzolan.

4.9. Alternative Alignment of KKH

4.9.1. Alternative Alignments Studied in Feasibility Study

During the feasibility study, two alternative alignments were studied for relocation of KKH. The Option 1 is located along the right bank and starts from Komilla and crosses river Indus at Chore More (about 11 km south of Shatial) to meet the existing KKH. The total length of Option 1 is about 69.5 km. The Option 2 follows the current alignment of the KKH on the right bank and located above the reservoir level. This alignment starts about 3 km north of Dasu town and joins the existing KKH near Chore More. Length of this alignment is about 63 km.

Locations of both Options 1 and 2 are shown in **Figure 4.3**.

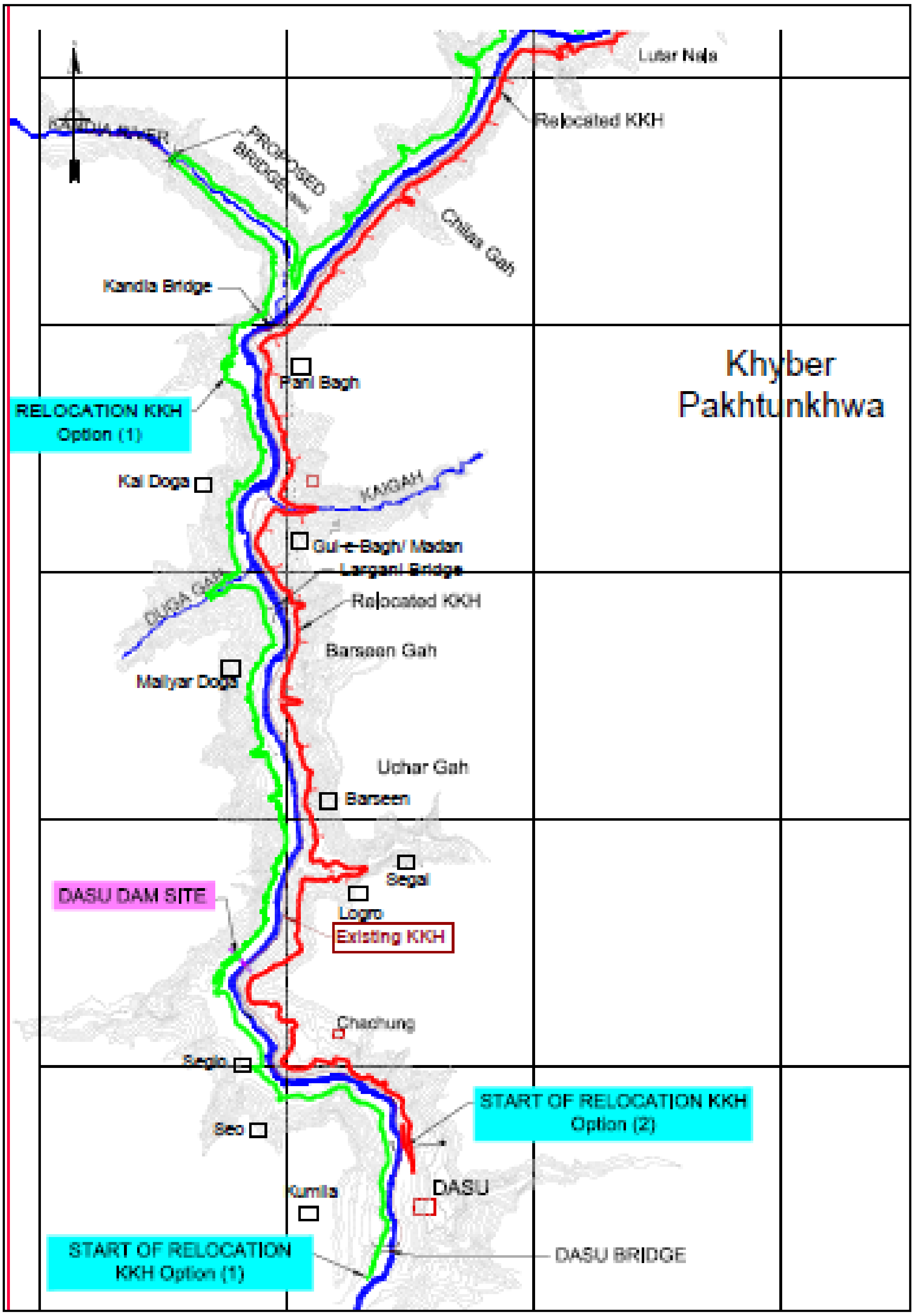
The key aspects of both of the above options are tabulated below.

Table 4.11: Comparison of Options 1 and 2 for KKH Realignment

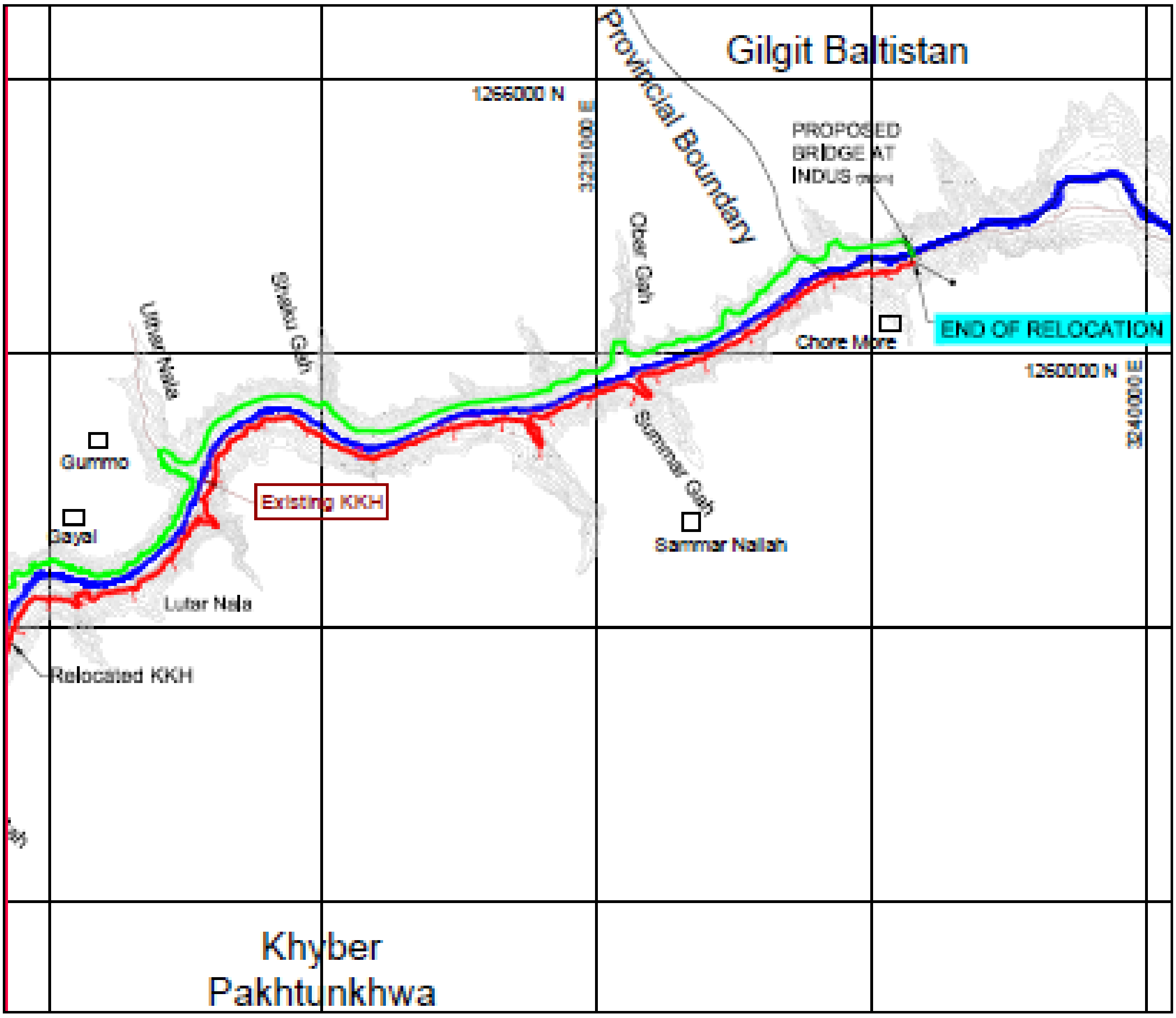
	Option 1	**Option 2**
Length	69.5 km	63 km
Indus Crossing	Needed	Not needed
Construction cost	About 3 million USD than option 1	Less expensive than Option 1
Construction schdule	About one year longer than option 1	Shorter construction schedule than Option 1
Resettlement Issues	Significant (at Komilla)	Not significant (no major settlements would be disturbed)
Environmental Issues	More significant because of construction of greater length of highway and a large bridge over the Indus River	Less significant because of the shorter length and not needing to construct a large bridge over Indus.

The Option 2 has been selected for the KKH realignment on the basis of the overall advantages tabulated above.

Figure 4.3: Options 1 and 2 for KKH Relocation
<u>Sheet 1</u>



Sheet 2



Legend: : Indus River; : Realigned KKH – Option 1;

: Realigned KKH – Option 2.

4.9.2. Alternatives in Detialed Design

During detailed design, the alignment of the KKH to be relocated has been finalized broadly following the one given in the feasibility study but with the following additional considerations:

- The alignment should be located within the reservoir buffer area (lower than 1,000 m amsl) to avoid additional land acquisition
- The alignment must meet the geometric requirements of the design.

4.10. Alternative Sites for WAPDA Colony

A project colony will be established with offices, residential quarters, appurtenant facilities such as hostels, resthouse, schools, mosques, hospital, market, clubs etc. It was preferred to locate theWAPDA colony as near to the project site as possible. However, since the Indus valley near Dasu is very narrow, gorge-like area, hardly any suitable and flat area for establishing a large colony near to the dam site wasavailable.

During the feasibility study initially a site at Tial Medan was identified as project colony. Tial Medan area (1100 to 1200 m amsl) is located on a higher mound with a sloping topography situated about seven km downstream of the damsite, near the city of Dasu. Development of the land in this location required large-scale leveling and excavations. Access roads towards and in the colony would have steep gradients including dangerous hairpin curves. Road safety would be a critical issue. The site is located away from KKH and nearly 3.4 km distance from the new access road to be constructed. The access road would have to pass along steep sloping land and along landslide prone areas. The road also would pass through Dasu town, with a high risk of congestion and hindrance. On basis of all these negative impactsa more in depth study during detailed design of potential alternatives locations was made.

During the field studies a suitable alternative for the establishment of the WAPDA colony was identified at the river terraces of Chuchang. There is a relatively large more or less level area on top of these terraces. Thesite is located adjacent to the newly relocated KKHat about three kmdistance downstream of the dam. The site is thus close enough to the project facilities, with very good accessibility and with no hindrance for the traffic and the population in and around Dasu town. From a social and urban planning point of view this would seem to be a better solution. Another advantage is that no large scale and expensive excavation works are needed for the construction of the colony. A disadvantage is that the area is partly occupied, not surprisingly in an area with almost no other flat land. Currently there are 96 houses in the area, mainly occupied by people working in Dasu or Komilla. People in the area would have to be resettled and compensated for the loss of land and property. After consultations with the local population it turned out that people in the area do not oppose resettlement to other areas, since most of them own land in other parts of the village. This all provided that they would be compensated in a satisfactory manner. Evaluation of all the concerned factors led to the conclusion that the site in Chuchangwas found to be far more suitable than the previous location in Tial Medan. Possible suitable alternatives situated within a reasonable distance were not available. On basis of these facts it was decided to prepare the detailed design for the Colony in Chuchang.

4.11. Alternatives in Operationand Management

About 200 million ton of sediment passes every year at the dam site. Without any mechanism for flushing of sediments the LLO’s and power intake will be filled within 20-25 years. The feasibility study was prepared on the assumption that the Basha dam would be constructed earlier then DHP. Most sediments would then be trapped into the Basha reservoir. Flushing of Dasu would only be required after 50 year.

But with Basha now likely to be completed after Dasu, the question is what flushing regime is required during the first few years of Dasu operation, before Basha is commissioned. If there is no flushing of sediments it is expected that the inlets for LLO and power intake of DHP will be filled within 20 to 25 years. After studying various options, the design team finally considered following three feasible options.

- Option-1: Without Basha, first 15 years no flushing and after this annual flushing;

- Option-2: Without Basha, after impounding every year flushing;
- Option-3: Basha commissioned in year 15, no flushing under Pre-Basha" and Post-Basha conditions

In **Table 4.12,** a comparison of energy production underthese three options is presented.

Table 4.12: Annual Energy Production for three O&M Options

	Annual energy production (in GWh)			
Year after commissioning	0-5	5-10	10-15	15-20
Units operating	3	6	9	12
Option 1	**Without Basha**			
	No flushing		***Flushing***	
	8,058	12,225	15,544	13,584
Option 2	**Without Basha**			
	Every year flushing after impounding			
	6,561	9,371	11,631	13,584
Option 3	**"Pre-Basha'**		**"Post-Basha"**	
	No flushing			
	8,058	12,225	18,730	21,485

Source: DHP Detailed Engineering Design, 2012

In case Basha is not constructed the flushing regime of Option 1 (annual flushing starting in year 15) is recommended since more energy is produced annually, than in option 2. This is because the turbines will not work for a period of about 60 days during flushing. After 15 years the energy production is equal in both options. When Basha is built the option 3 will generate more power and eventually flushing may not be required for a period of 40 to 50 years, since most sediments do not reach the Dasu reservoir.

The table shows the effect on annual energy production in DHP after completion of the Diamer-Basha dam. Hydrological, environmental and ecological effects of sedimentation, flushing and the different possible scenario's (base load or peak load production) will be discussed in Chapter 7. The potential impacts during flushing operations on the downstream aquatic habitat are turbulent flows, sediment load and altered water quality. Option 3 has advanatage of delaying these potential impacts associated with flushing by 35 years. Option 3 will also ensure higher power generation during these 35 years and hence ensure positive socioeconomic development in the country.

5. Baseline Description

This Chapter describes the existing, pre-project environmental and socioeconomic conditions of the project area.

5.1. Physical Environment

5.1.1. Potential Impact Area

The potential impact area of DHP includes:

- all areas to be acquired permanently for the reservoir and for construction works, housing areas, offices, and other project facilities;
- all sections to be acquired permanently for realignment of KKH;
- all areas between Dasu and Diamer to be acquired on a temporary basis for construction camps and storage of material; and
- all areas to be acquired on a temporary basis as borrow areas for construction materials.

The main direct impact area of the project covers the left and right bank of the Indus from the riverbed up to contour 1500 m amsl. The impact area extends from the upstream end of the reservoir along the Indus (few km downstream of the proposed site for the Diamer-Basha dam) to a point some 10 km downstream of Dasu Bridge where the influence of the tailrace tunnels of the project ends and the flow is "normalized".

Other direct impact areas comprise:

- a corridor 60 m wide along the 45 km long 132-kV transmission line to be constructed from Dubair Khwar to Dasu (Chuchang) in order to provide power to the dam site and the colony during construction;
- project associated borrow areas outside the project area (e.g. Kaigah quarry site);
- a corridor 500 m wide along the to-be-constructed section of the KKH over a total distance of 65 km (the environmental and social impacts of the new KKH are discussed in a separate volume).

The area that will be influenced indirectly by the project is much larger and covers the Indus River between Dasu and the Tarbela Reservoir and the KKH between Khunjerab pass and Hassanabdal as well as some of the higher mountain areas above 1500 m altitude.

Not covered under this ESA are the two 250 km long 500-kV transmission lines to be constructed from Dasu to connect the DHP to the Pathar Garh grid station near Hassanabdal (a separate ESA is being undertaken for this project).

5.1.2. Physiography

The area of Indus-Kohistan belongs to the lower Himalayas and consists (in the project area) of mountains between 2,000 and 4,000 m altitude. At some distance higher mountains can be found (> 5,000 m). On the western side there is a watershed between the catchments of the Indus and the Swat rivers, whereas on the eastern side there is a watershed between the catchments of the Indus and the Jhelum rivers. The Indus River originates from a spring called Singikabad near Manasarovar lake on the north side of the Himalayan Range (Kailas Parbat) in Tibet at an altitude of 5,500 m amsl. The distance from here to the project site at Dasu is about 1,024 km. The Indus has cut out a deep valley in the mountain piedmont plain. The river enters the impact area in 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. The valley has steep rocky slopes and stony foothills and is sparsely vegetated. The slopes on both sides show gradients of some 40-60 percent. The altitude of the riverbed is around 930 m amsl near Diamer and drops to 890 m amsl near Lootar, with a gradient of 0.3 percent. In Dasu the elevation of the riverbed is 765 m amsl. From the mountainous hinterland small lateral tributaries and nullah's (small streams) are discharging water originating from rainfall and melting snow into the main river. The Indus here is fast flowing and full of sediment.

The area is characterized by low population density. In total there are 35 small villages or hamlets, 17 on the left bank (along the KKH) and 18 on the right bank of the Indus. Dasu–Komilla is the only somewhat larger town with about 7,150 inhabitants. Most of the area is heavy sloping and very rocky. There is hardly any level or gently sloping land. Along some of the nullahs agricultural cultivation is found, usually on terraced soils on alluvial fans and old river terraces.

5.1.3. Climate

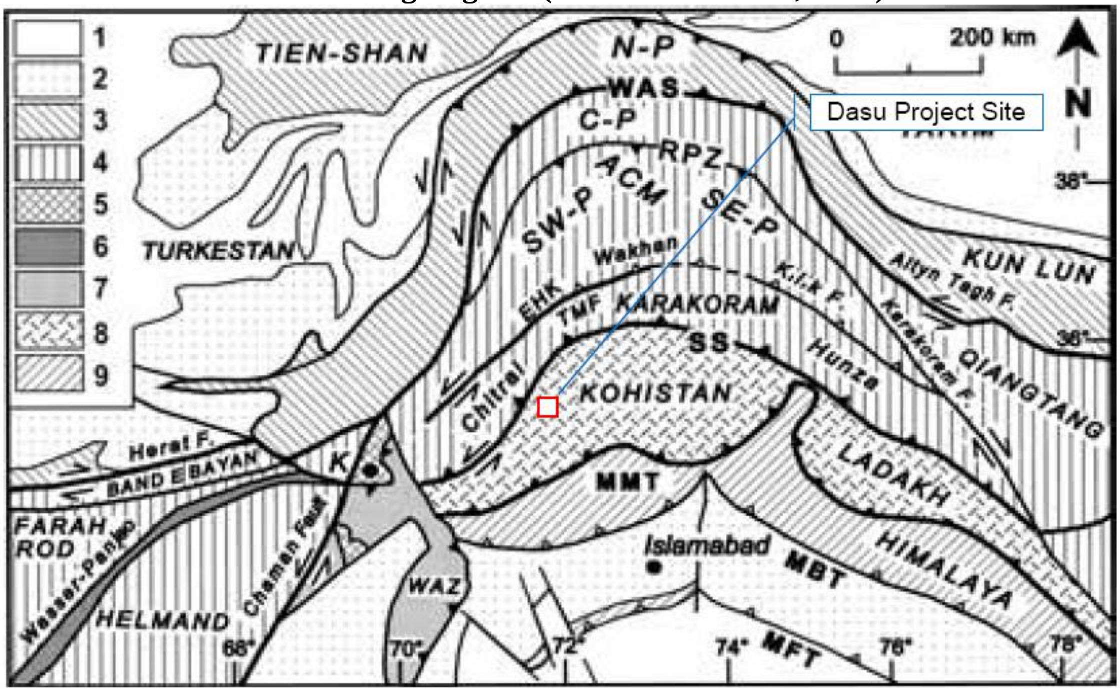
The project area is characterized by a large variation in climatic conditions, strongly varying with altitude. Commonly, the climate in the zones lower than 1,500 m is classified as "dry subtropical", whereas the higher elevated zones have a "temperate" climate. Annual rainfall generally is low with figures between 200 mm and 300 mm. 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 maximum temperature of 36 °C in August) and winters are cold (average minimum temperature of - 6° C in January). The area is not influenced by the monsoon and is lying in the rainfall shadow of the higher mountains, including the Nanga Parbat (over 8,000 m high). During winter the precipitation falls as snow. Generally the areas between 1,500 m and 5,000 m in the Upper Indus Basin 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; the dominant wind directions depend largely on the local topography.

5.1.4. Geology

Geologically, the northern Pakistan region is divided into three blocks, from north to south: Karakoram Block, Kohistan Island Arc and Indian plate. The project area is located in the southern part of the Kohistan Island Arc bounded by the Main Karakoram Thrust in the north and west (Northern Suture) and by the Main Mantle Thrust (MMT) to the south and east (Southern Suture) as shown in **Figure 5.1**.

The Kohistan Arc Complex is an area of igneous and sedimentary rocks that was formed during the mid-Cretaceous period. The area lies near to the area 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. These rock formations both date from Cretaceous period. At places the geological conditions are quite complex, with major faults, volcanic intrusions, batholites and thrusts requiring detailed investigations and testing. Near the main structure and powerhouses there is a major geological fault in the project area, which is not active any more: the Khoshe fault. This fault, running for 300 m from east to west, forms the contact zone between the granulites and the amphibolites and this fault 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. All tunnels will encounter granulite only and do not cross any faults. The underground powerhouse complex is located in coarsely crystalline dioritic granulite. These granulite rocks are generally massive to blocky, slightly foliated and strong to very strong.

Figure 5.1: Geological and Tectonic Sketch of Northern Pakistan and Surrounding Regions (after Zanchi et al., 2000)



The foundation of the main hydraulic structure will be on massive to blocky granulite. The lithology at this site is moderately to coarsely crystalline, strong to very strong, and generally fresh to slightly weathered. In most outcrops the rock has a primary homogeneous, medium to crystalline igneous texture. The rock mass is considered to be favorable for the construction of a large structure. The riverbed itself consists of a mixture of glacio-fluvial deposits, terrace material and land slide materials. Higher on the slopes some terrace remnants are found with unconsolidated moraine (glacial) deposits and landslide materials. Thickness and character of the deposits are highly variable, depending on location and origin.

5.1.5. Seismology

The Project area is located in an active seismic and earth quake zone. No earthquake monitoring was done in the country prior to last century. However, based on some historical documentation, it was evident that the region was subjected to severe earthquakes. The epicenters of three well-studied earthquakes of magnitude 5.9 or above have been recorded near the project site in respectively Pattan (1974), Hamran (1972) and Darel (1981). Another smaller concentration of epicenters of recent earthquakes (2002-2003) is located in the Raikhot area on the western flank of the Nanga Parbat-Haramosh structure. The strongest of these earthquakes had a magnitude of 5.9 on the Richter scale. 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 area. The event struck the northern part of Pakistan, causing widespread damage and casualties in Azad Kashmir and adjoining areas of KP.

For detailed design, the instrumental records of earthquakes within a 150-km-radius of the project were obtained from the International Seismological Centre in England, the National Earthquake Information Centre of the U.S. Geological Survey, the Geophysical Centre in Quetta and the Tarbela Seismic Observatory of WAPDA. A composite catalogue of instrumentally recorded earthquakes was prepared by combining these earthquake listings comprising 2,115 events having magnitude greater than 3.0. For seismic data to be used in seismic hazard analysis, the magnitudes given in different scales were converted into a uniform magnitude-scale.

5.1.6. Rock Stability and Landslides

The project area is characterized by steep and moderately steep slopes. The granulite and amphibolite rock slopes are susceptible to rock fall and block toppling along steeply inclined foliation, discontinuities and occasional wedge sliding along various combinations of inclined joints and shears. The stability of rock slopes depends largely on rock mass properties, structural discontinuities, groundwater and earthquakes. Frequent landslides are not very common in the area. However, huge moraine deposits occur on nearly vertical slopes on either side of the Indus River. In the Project area these deposits occur near Kandia, Seo and Tial Medan. These deposits are loose and during heavy rainfall landslides and road blockage may happen. A few incidents with landslides were reported from the Kandia valley.

5.1.7. 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 area 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, erosion, and landslides on unstable slopes. Erosion materials in side valleys will be transported by melted snow towards the tributaries and will finally discharge as mud flows into the Indus. The river also derives sediments from vast alluvial fields and moraine deposits formed along its banks more upstream. Moraine deposits (silty sand with gravel and boulders from glacial origin are embedded) can be found on both embankments of the Indus River, sometimes characterized by nearly vertical slopes. The sediments in the river water comprise of suspended solid and moving bed load. The annual runoff is estimated at 67 BCM and 79 percent of the flow occurs between June and September. The annual sediment load at Dasu is estimated at 221 million ton.

It has been assumed that particle size distribution entering Dasu reservoir will be the same as observed at Partab/Bunji Bridge, shown in **Table 5.1**.

Table 5.1: Particle Size Distribution of Total Sediment Load at the Project Site

Sediment Type	Percentage			Total (percent)
	Sand	Silt	Clay	
Suspended	40.0	44.0	16.0	100
Unmeasured (bed load)	10.6	0.2	0.0	10.8
Total	50.6	44.2	16.0	110.8

Sediment Type	Percentage			Total (percent)
	Sand	Silt	Clay	
Percentage	45.7	39.9	14.4	100

Source: DHC Main Design Report.

5.1.8. Soils

Geomorphologically the project area consists of mountain terraces and piedmont plains. The mountains are rugged with high relief and steep slopes. Geological erosion in these mountain areas is substantial. Rock debris is generally found at the toe of the highlands. Accessible slopes with a soil cover are terraced by the population for arable farming. The gravelly fans and terraces are of limited extent and mostly located at the bottom of mountain slopes. These are characterized by gravelly moderately coarse to medium textured soils. Most soils consist of sandy loam and silt loam. In general, the infiltration rate in these soils is moderately rapid. Water holding and nutrient holding capacity is low.

Cultivated areas are usually developed on alluvial fans and to the lesser extent by reclamation of old river terraces. The soils are generally low in clay and high in silt and sand with low organic matter content. These soils are used for the cultivation of wheat, maize, fodder and some vegetables. The soils are generally poor in plant nutrients. Soil samples (virgin soil, not used for agriculture) were collected along the valley and were analyzed for mercury. The concentration of mercury at all locations was found to be within the standard limits.

5.1.9. Hydrology

The Indus flows from the Tibetan Plateau (elevation 5,500) m in westerly direction through India and is joined in Pakistan by four major tributaries: the Shigar and Shyok rivers in Baltistan and the Gilgit and the Astor rivers before reaching Dasu. The catchment of Indus River at Dasu covers some 158,800 km^2. During the last stretch before Dasu the Indus flows in a deep narrow channel with a steep gradient of 3 m/km and bends near Kandia in southern direction. The side slopes of the river are often without any vegetation and very rocky. Several lateral river valleys are found between Basha and Dasu, including the valleys of the Darel, Tangir and Kandia rivers. These lateral rivers drain the hinterland and bring snow melt water throughout the year and with it comes fine to coarse sandy sediment. After rainfall the water of the tributaries becomes very turbid. Apart from these rivers there are some 14 nullahs flowing into the main river, see **Table 5.2**.

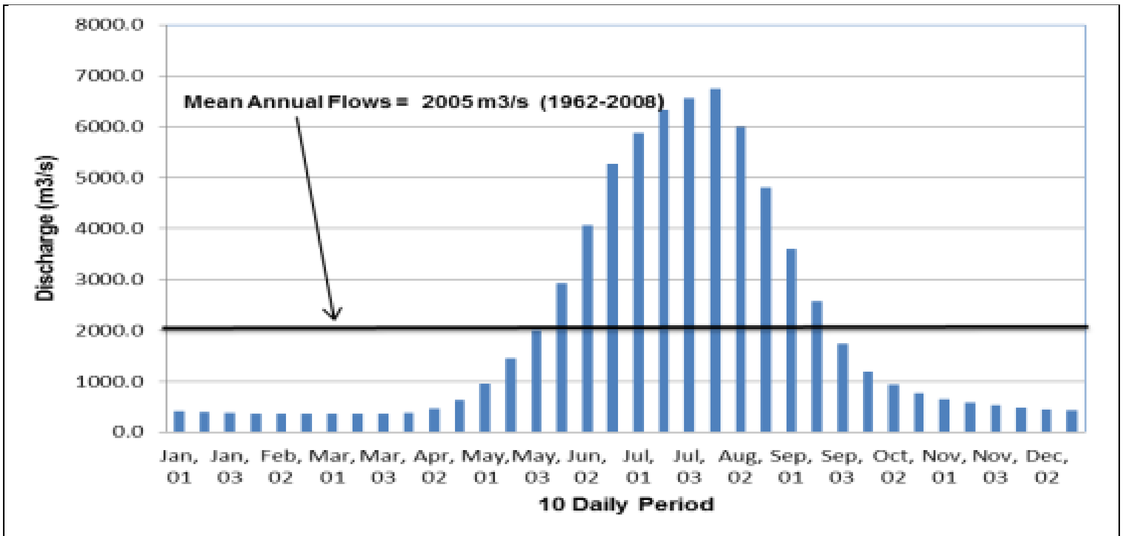
Table 5.2: Main Streams and Nullahs Flowing into the Indus in the Project Area

Stream/ Nullahs	Elevation (m)	Catchment Area (km^2)	Length (km)	Mean Annual Flow (m^3/s)
Streams located at left bank (upstream of dam site)				
Uchar	814	70.6	-	2.57
Barseen	834	15.3	2.9	0.59
Kaigah	875	43.0	13.1	1.65
Lutter	957	9.5	8.7	0.36
Summar	957	82.6	22.6	2.21
Shatial	991	9.2	7.7	0.35

Stream/ Nullahs	Elevation (m)	Catchment Area (km²)	Length (km)	Mean Annual Flow (m³/s)
Streams located at right bank (upstream of dam site)				
Duga	892	-	13.0	-
Kandia River	841	2,242	84.3	79.92
Uttar	814	28.0	10.8	1.08
Tangir	1,073	62.5	46.8	2.39
Darel	980	95.6	37.6	2.56
Streams and nullah's at left and right bank (downstream of dam site)				
Sieglo	776	4.6	12.4	1.73
Jalkot	797	247.7	30.4	-
Goshali River	753	1491.5	81.0	53.17
Palas River	700	1238	75.2	44.12
Keyal	715	15.1	22.7	4.09
Dubair	647	514	35.7	18.32

The discharge of the Indus is characterized by a high flood (or summer) season from May to September (1,015 to 6,580 m^3/s) and a low flood (or winter) season from October to April (380 to 620 m^3/s). Unlike other major rivers originating in the Himalaya (e.g. Ganges, Brahmaputra) by far the largest share (about 60 percent) of the Indus water originates from melting of snow and ice from the glaciers and ice fields of the Himalaya, Karakorum and Hindu Kush mountains. The total annual mean flow of the Indus at Dasu is slightly over 2,000 m^3/s (**Figure 5.2**) and the total annual run off is estimated at 66.7 BCM, of which 78 percent flows between June and September. The summer flow carries the greatest load of sediments towards the Tarbela reservoir (Tarbela dam is the first downstream barrier in the Indus).

Figure 5.2: Mean Annual Flows of the Indus River at Project Site (1962-2008)



Source: Main Design Report, DHC, 2012.

5.1.10. Flooding

In the upper Indus catchment area floods occur due to natural dam formation and their subsequent breakdown. Natural dam formations are either caused by landslides, or by bursting or overtopping of an ice dam, resulting in a sudden discharge of the lake behind the glacier. Dams created by massive landslides are rare but glacier dams are numerous; nearly 60 of such events have been reported since 1830. Dam break floods are characterized by a very rapid flood rise. Other causes of floods are heavy and prolonged storm runoff and intensive and extreme glacier and snow melting.

A number of historic floods are known from the upper Indus catchment area. The most recent one happened in 2010 in the Hunza Valley, when the Hunza River was blocked by an ice dam. After overtopping a considerable length of KKH near Ata-Abad was eroded away. The event created a lake which is still existing and affecting the trade with China. In February 2012 the blockage was blasted to release some 1,416 m^3/s) to lower down the lake water level and ease the situation to some extent. This resulted in a sudden raise in water level of the Indus at Dasu of about 2.5 m.

5.1.11. Groundwater

The groundwater table in the river valley is deep and limited to deeper aquifers. Groundwater was not even noticed in some of the test wells. No confining layers are expected. The ground water depth near the main structure varies between 48 m and 68 m. Groundwater level along the tunnel alignments is generally above the level of the tunnel invert; some groundwater inflow would be expected during tunneling. However, according to seepage measurements carried out during excavations the inflow will be limited to around 200 l/min. Groundwater levels in the vicinity of the underground power house complex are 250 to 300 m deep below ground surface, but probably above the level of the power house cavern, which might give some limited inflow (200 l/min) during tunneling operations.

5.1.12. Water Quality

The quality of the water of the Indus and its small tributaries has been investigated during the high flow and low flow season at 20 sampling sites in order to establish a baseline for the project. Generally the water quality parameters are good to excellent and are in compliance with the national standards for drinking water quality from Pak-EPA, (NEQS) and WHO drinking-water standards, Also they were compared with the National Surface Water Classification criteria as proposed by WWF-2007. The water quality is characterized by slight alkalinity, high oxygen levels, low conductivity and very high turbidity and water temperatures varying between 6 and 21°C. Turbidity exceeds both Pak-EPA’s and WHO drinking water standard limits at several locations in the project area. However, turbidity in the tributaries was generally below recommended levels. The iron concentration exceeded the (Pak-EPA’s drinking-water standard i.e. 0.01 to 1.4 mg/l at few places, which is probably caused by iron ore deposits in the neighboring areas. The concentration of boron also exceeded US-EPA’s fresh-water standard limit i.e. 0.007 to 0.5 mg/l at 4 out of 15 sampling sites. This raised boron content could be due to various causes, but since the water is neither used for drinking (people and livestock) nor for irrigation, this has no direct impact on human health.

The water quality of the Indus and its tributaries are characterized by:

- Considerable variations in physico-chemical conditions in high flow and low flow seasons

- high water temperatures in high flow season (15 to 21°C) and low temperatures in low flow season (6 to 15°C);
- alkaline, with pH above 7;
- high dissolved oxygen (above 6.5 mg/l)
- high turbidity up to 70 NTU in high flow season; and up to 32 NTU in low flow season;
- low total dissolved solids (less than 150 mg/l) and low conductivity (325 µS/cm);
- Nitrate concentrations varying from 0.6 to 3.5 mg/l; and
- Nickel concentration which is slightly exceeding the national drinking water standards.

5.1.13. Air Quality

Along the project area 24 hour air quality monitoring was conducted during summer and winter of 2012 at 18 locations in the project area. The parameters for fine dust such as PM_{10} (24 hours) were found to be within the Pak-EPA(NEQS) limit, however fine particulate matter ($PM_{2.5}$) at 50 percent of the investigated sites (in residential areas mainly along KKH) was found to exceed the Pak-EPA's prescribed limits slightly. The possible reason could be fuel burning (coal, wood, and fuel oil), incineration (house and municipal garbage) or other causes (construction, traffic along KKH). The ambient gases (CO_2, SO_2, $NO_{x,}$ and CO_2) concentrations were found to be within the standard limits of Pak -EPA at all sampling sites.

5.1.14. Noise

Noise quality monitoring was carried out 18 locations along the project area. Noise levels are high along the valley and in most cases exceeded the Pakistan EPA standard limits. The noise levels at different locations were found to be in the range of 45-67 dB.

5.2. Aquatic Environment

5.2.1. Aquatic Field Surveys

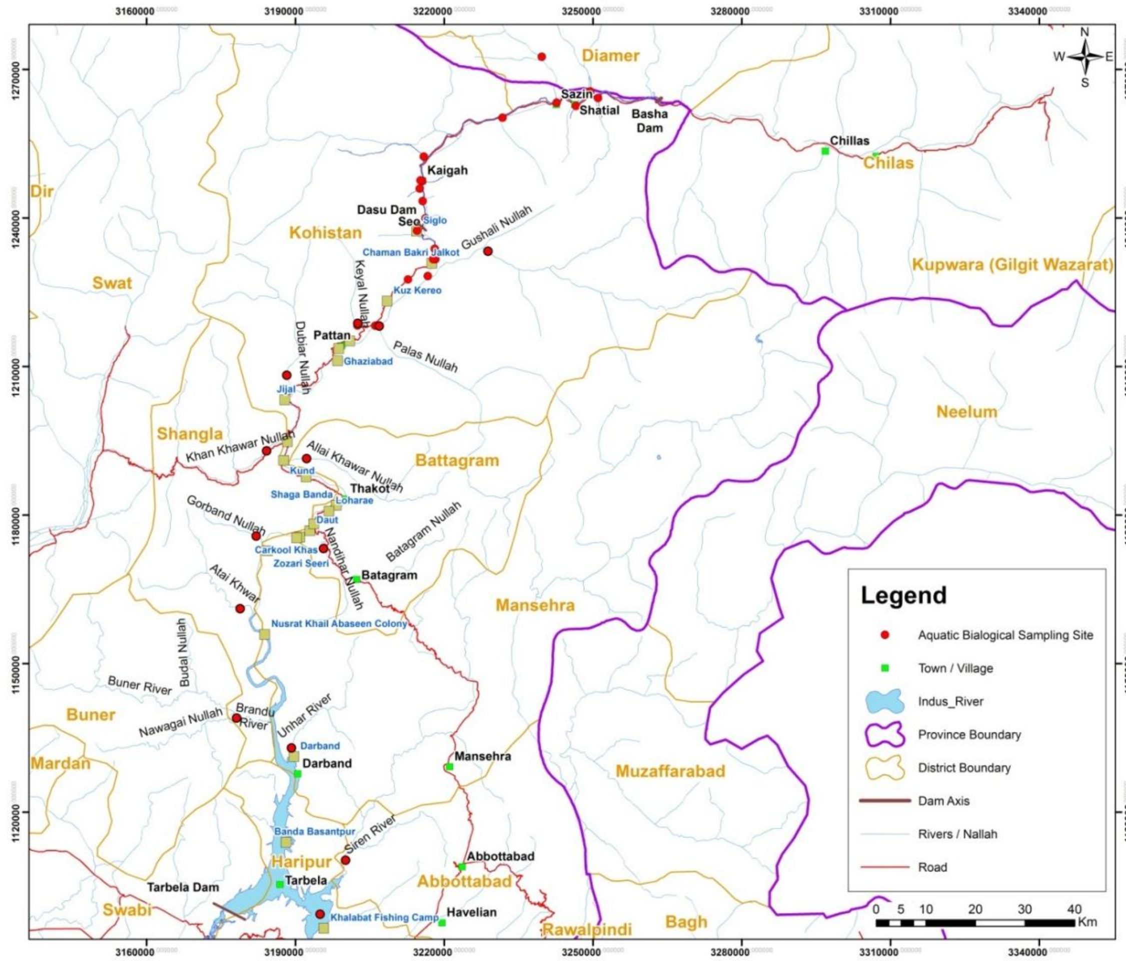
Field investigations on aquatic ecology were conducted during April and August of 2012 in the project area by Dr. William George (a former Director of WAPDA Fisheries Unit, who introduced fisheries in Pakistan) and Prof. Tahir Omer. The survey area extended from the Tarbela Dam to the upper limit of the planned Diamer Basha project reservoir. Locations of sampling sites are given in **Figure 5.3**. Field data included biological data collection, fishing techniques and practices. In addition to field observations and sampling, fish, plants and plankton were investigated in laboratories (taxonomy, morphometry, gut contents, reproduction status). In addition to the filed data, other sources of information include interviews with local fishermen and KP Fishery Department, international and national literature on the snow carp (snow trout) fish species, and EIA reports of other hydropower projects in the trans-Himalayan region of Pakistan, Nepal and India. Additional studies will be carried out to collect additional baseline data during the pre-construction/construction phase (see **Annex A** for ToRs for the studies).

5.2.2. Aquatic Ecosystems

The Indus originates in Mansorawar Lake in Tibet, is approximately 3,058 km long and drains an area of 963,480 km² before discharging into the Arabian Sea. Physical geological, meteorological and hydro-biological conditions vary substantially along the river as do corresponding important human uses of the river and dependent economic conditions. The uppermost section of the river flows east-west in the mountain peak zone for about 950 km before it reaches the Dasu Project area. The catchment in that area is mountainous and characterized by towering peaks covered with snow and glaciers. The river is mainly fed by melting of mountain snow; flow is high during summer and contribution from rainfall is very small. The mean annual flow and annual runoff at Dasu amounts to 2,100 m³/s and 68 BCM respectively, but differences between summer and winter are large: 80 percent of the water flows between June and October.

Physico-chemical conditions of river water changes between the summer and winter seasons. During summer, river water is very turbid and carries a high sediment load. Annual sediment inflow at DHP damsite is about 200 million tons and 97 percent of it occurs during high flow season of June to October.

Figure 5.3: Aquatic Biological Sampling Sites



During the 2012 April surveys the ranges of physico-chemical parameters 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. Low concentrations of NO_3 suggest mainly low nutrient levels and oligotrophic conditions. There were rather large differences in chemical parameters between sample stations, mainly related to close-by human residences.

Several river tributaries join the Indus between Basha and Tarbela. Catchment areas vary greatly. All streams pass along steep gradients through rocky areas of high mountains, exhibiting variable cascades. At confluences with other tributaries and the Indus River they discharge gravel and sand from river bed erosion. Water quality in the main tributaries was also surveyed during the summer of 2012. The water in these nullahs/streams was generally colorless, odorless, transparent and cool. Dissolved oxygen concentrations ranged from 5.0 to 10.0 mg/l and conductivity ranged from 28 to 105 µS/cm, indicating variable but generally low concentrations of dissolved solids. During winter months temperatures were reported to be substantially lower: data averaged around 8°C, against some 20°C during summer. The banks of some tributaries show patches of vegetation.

5.2.3. Fish

Fish diversity in the Indus is low compared to other major rivers. 177 fish species are reported from the Indus River system, including 12 exotic species. This is substantially lower than in other major rivers in Asia; the Ganges houses 350 fish species, the Brahmaputra and the Mekong around 400, and the Hwang 320. Fish species of Northern Pakistan is given in **Annex B**. Five species of fish are recorded in the project area. The first of two sampling trips (6 persons, 10 days) yielded only 25 fish, and the second only 50, belonging to four species: three carps and one catfish. The distribution of sexes was equal. Nearly all fish were captured in small riffles and pools of tributaries; fish caught in the Indus River were mostly from confluence areas, close to the tributaries. The main reasons for poor fish diversity and density are the long torrential upper courses in the Himalayas, glacier fed water and high sediment load or low mean discharge rate of water. Fish sampling for the Diamer Basha Hydropower Project (2006) yielded 14 species, but also this can be considered low, probably due to high-altitude tributaries, low water temperature, high water velocity, low benthic productivity and long stretches of gorges.

Most species in the project area are members of the carp family (Cyprinidae) and loach family (Noemachcilidae). The piscifauna is dominated by endemic genera of the cyprinid sub-family Schizothoricinae (snow carps or snow trouts: Schizothorax, Esocinus and Labitusspp.) and one genus of the Noemachcilidae family (Triplophysa sp.) 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. In order to enhance fish production two species of Salmonidae (brown trout and rainbow trout) were introduced in the upper part of Indus in Gilgit river and adjoining streams during the early nineties. No brown/rainbow trout was observed in any of the samples.

Downstream of the project site the number of species increases. From the area between Dasu and Pattan seven species are reported by fisheries authorities, especially from the tributaries. Prior to construction of the Tarbela dam, 35 fish species were recorded in the Indus River and tributaries around Tarbela.

Snow carp and Mahaseer are the two important fish species of cold waters of Himalayan waters. Snow carps are the major fish species in the Indus and as one moves to south to transitional or semi-cold waters, schizothoracines are joined by mahseers. The snow carp species and the two Mahaseer species (Tor putitora and Tor tor) were common and utilized as food fish. The other native fish species are resident species and have no commercial value.

5.2.4. Snow Carps Habitat, Migration and Spawning

Schizothoracines (genera Schizothorax and Schizopyge) are the major fish of cold water streams and rivers of Himalayan regions, with the dominant species being Schizothorax plagiostomus. In Dasu project area three species of scizothorax (plagiostomus, esocinus and labitus) are present. Plagiostomus is the dominant fish species in Dasu area representing more than 75 percent of total fish catch and other two species represent about 15 percent of total fish catch. None of these species are listed in IUCN Red List.

Habitat. 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 peryphyitic algae and diatoms.

During fish surveys, conducted in April and August of 2013 in the Indus and its tributaries in the Project area, fish found mainly in the tributaries, while in the mainstem they are found near the confluences. Tributaries with snow carpfish habitat on the upstream side of the dam site are Kandia, Tangir, Darel, Kaigah, Summar, and Goshali. While tributaries on the downstream side with snow carp fish habitat are Sieglo, and Jalkot.

Migration: Snow carps are short distant migrants. In the project area, they migrate within the tributaries, not along the mainstem Indus. During April to September (spring and summer, high flows), they prefer upstream head waters habitat at higher elevations. During September to April (low flows and winter), they prefer lower elevations and confluence zone with Indus. The triggers for migrations are high flows, high sediment load and low temperatures. During spring, when flows started increasing in the rivers due to melting of snow, the fish migrate upstream from April and May (within tributaries) due to high flows and turbidity at lower elevations. During autumn, when the temperatures are starts to drop at higher elevations, the fish migrate downstream from September and October.

Spawning: Female fishes 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 Indus) 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.

5.2.5. Mahaseer

Golden Mahaseer (Tor Putitora) is a long distant migratory and endangered fish species of Indus.Snow carps are the major fish species in the Indus and as one moves to south to transitional or semi-cold waters, snow are joined by mahseers. Mahaseer habitat starts about 70 to 80 km downstream of the DHP damsite. Tor species habituated in slow moving streams and rivers of the foothill regions and bred in gravels and sandy 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. The Golden Mahaseer was the primary quality food fish in the region and an attractive fish for anglers. Its economic significance was substantial. However, due to permanent deep submergence of many natural breeding grounds of Mahaseer in the Tarbela reservoir, natural propagation of the species drastically declined. Mahaseer migrated into upstream tributaries where breeders were indiscriminately fished; enforcement of protective regulations proved to be ineffective. During fish sampling in the Dasu project area no Mahaseer specimen could be caught; local people confirmed its absence from the area. In recent literature the information on the status of Mahaseer is often called somewhat exaggerated. Although a considerable impact from the Tarbela project cannot be denied, there is still a reasonable proportion of Mahaseer in total catches, especially in the rivers Haro, Soan and Korang (60-80 percent). Even in the Tarbela reservoir Golden Mahaseer maintains a share of 5-11 percent in the catches.

5.2.6. Fisheries

Fishing activity is very limited in the project area. Fishing in the project area is not supported or assisted by government or non-government agencies. Local people fish as a part time activity (about 12 percent of households), not as commercial fishermen: fish density (and thus yields) is too low to support full-time jobs. In order to catch fish in the rivers, a fishing permit must be obtained from the KP Fishery Department on payment of a nominal fee, but regularly people practice illegal fishing. There is no fish farming and no regular fisheries management in the Dasu area, although officially the KP Fishery Department is expected to plan and execute sector development strategies and promotion programs.

Both active and passive fishing techniques are being applied; due to their weak financial situation fishermen prefer to use cast nets which are handy and relatively cheap. Illegal fishing though the use of dynamite or poison is relatively common, especially in winter time, when fish hide under rocks. Application of hook and rods are also in practice. Some locals in remote areas use simple sieve cloths in shallow nullahs. Interviews of local people revealed that catches in the project area included mainly snow carp of moderate size (100-300 g). Reported catch quantities are relatively small: a three-hours fishing effort with cast nets typically yields 2-7 kg of snow carps. Gill nets are set for a whole night, catching 7-10 kg. Fish caught are brought home in sacks moistened with frequent water sprays. There are no fish processing or storing centers in the project area. There are also no fish shops or fish markets. Some owners of roadside truck-driver hotels catch fish and fry them directly on customer’s demand. All these occasional fishermen expressed the desire to apply their fishing skill if more opportunities arise in the future reservoir.

Commercial fishing activities in the study area are limited to the Tarbela Reservoir; recreation fishing is rare. Fishing in the Tarbela reservoir is properly organized; fishing rights are being leased out annually or for maximum three year period through open auctions. Fisheries control was transferred to the provincial fishery department in 2006; since 2007 the Government of KP province was managing and developing the Tarbela reservoir fisheries further. From 2008 fishing rights have been auctioned to contractors on three year lease agreements. The fishing contractors are fishing themselves and they are responsible for stocking of fingerlings in the reservoir. Some fishing contractors engage local fishermen on daily wages basis (PKR 20/kg in 2012). Some of the skilled fishermen possess their own fishing boats and nets; others hire gear from the contractors. In the Tarbela reservoir, gillnet, set nets and cast nets are applied. Yield and catches are supervised, monitored and transported to the market by contractors’ manpower. Catches are being sorted out and auctioned in Rawalpindi and Islamabad and at Peshawar fish markets. The success of Tarbela fisheries development, although still at a lower production levels than in Mangla or Chashma reservoirs due to the oligotrophic water quality, may well serve as an potential scenario for the future Dasu reservoir.

5.2.7. Other Aquatic Biota

Macro-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. Phytoplankton was dominated by Chlorophyta and Chrysophyta, indicative of oligotrophic to low-mesotrophic water. Phytoplanton identified from samples collected during field surveys are shown in **Annex B**.

Zooplankton and macrobenthos sampling revealed small numbers of species of protozoans, crustaceans (rotifers, cladocerans and decapods), insects (damselfly larvae) and mollusks (snails). The sampling intensity was too limited to allow conclusions. Detail of zooplankton is given in **Annex B**.

Sixteen species of aquatic birds were observed during surveys. No aquatic mammals are reported or sited in the project area.

5.3. Terrestrial Environment

5.3.1. Terrestrial Field Surveys

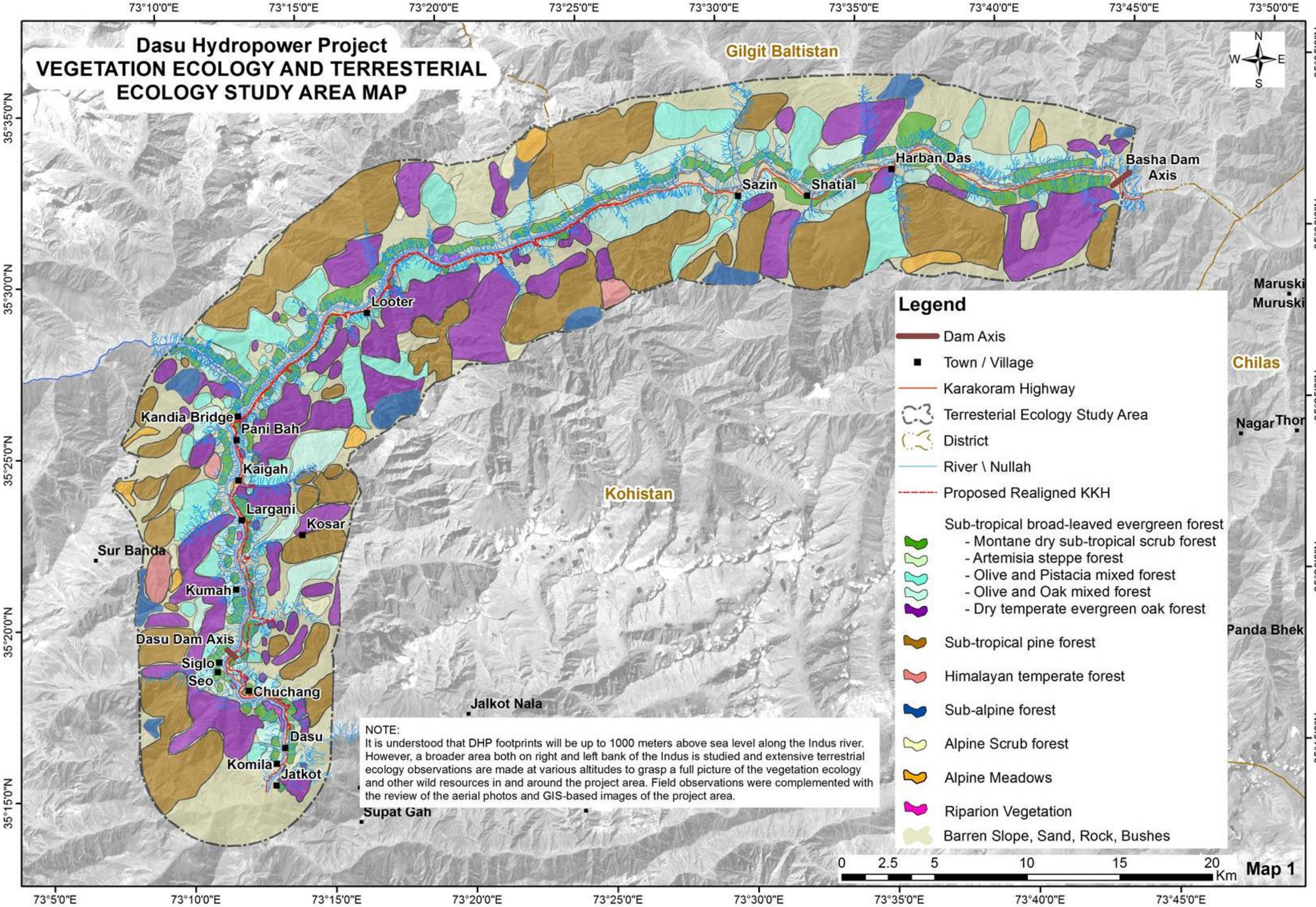
The studies for terrestrial ecology were carried out over a period of 4 months with field investigations during July to September 2012. A series of biological sampling stations was selected, so that all these different geomorphological, soil and vegetation elements were covered. Plant specimens were collected, dried, pressed and mounted on herbarium sheets and identified; their habitat was noted. Wildlife surveys were conducted at selected vantage points, point counts and line transects for representative bird species and photography. Data from the surveys and observations at those stations were complemented by data from recent literature and from local enquiries. The field investigations were conducted by Dr. Kashif Sheikh (a terrestrial ecologist and a former Pakistan IUCN Biodiversity Expert), Dr. Sajid Nadeem (wildlife expert) and Dr. Rahmatullah Qureshi (vegetation expert and associate professor at Arid Agriculture University, Islamabad). The field investigations also covered surrounding mountains (up to 4000 masl) along the project area (**Figure 5.4**). Additional studies will be carried out to collect additional baseline data during the pre-construction/construction phase (see **Annex A** for ToRs for the studies).

5.3.2. General Biodiversity

The mountain areas of Pakistan are home to unique wildlife and wilderness areas. Also the montane landscape at higher altitudes above the Dasu Hydropower Project area has a large biodiversity; but the Indus valley bottom (including the project area proper and the future reservoir area) is hardly vegetated. The available plant cover can be characterized as “scrub vegetation” with its typical low biodiversity. Trees are mainly found near human dwellings along the river and on widely dispersed plots along the nullahs. On cultivable terraces commonly maize and wheat are grown, accompanied by common weeds.

From the study area, which could be defined as the major habitats in the area up to 2,000 m in total 232 species of plants, 199 species of avifauna, 31 species of mammals and 18 species of reptiles and amphibians are recorded. None of the plants are endemic or threatened; from the animal species the only threatened one sometimes visiting close to the border of project area is the Markhor *(Capra falconeri falconeri)*.

Figure 5.4: Vegetation Ecology Map of Project Area and Surrounding Mountains



The Indus Valley's wetlands are a major wintering ground for many central and northern Asian species, but these are not present in the project area.

The project area is located along the Indus River, which is flanked by desolate valleys and high mountain ranges. The terrain is rocky and barren in nature with scattered vegetation. Due to high wind velocity, white sandy particles are deposited on the valley bottoms and adjacent mountain slopes. 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). There is extensive soil erosion along the steep slopes. The perennial flow of water from springs/streams and nullahs maintain the lifeline of the Indus River. In the valleys near the human settlements, there is frequent irrigation and cultivation along with deep soil depositions.

In summer season; cool air moves from higher elevations to the low lying valleys and terraces on both sides of the Indus. This contributes to a mild local climate in the valleys. There are certain permanent wet beds along the perennial nullahs that appear as narrow meadow strips and alluvial fans.

5.3.3. Protected and Sensitive Areas

Inside the valley of the Kaigah tributary (nullah) there is a 5,000 ha Community Game Reserve for Markhor sheep (Capra falconeri falconeri), which was established through an act of the NWFP (now KP) government in 2000. The area also provides protection to other mammal and bird species. This area, supported by WWF, was holding the largest population of Markhor in Indus Kohistan during the 2005 census (150 individuals). According to some reports the community program has been rather successful in protecting markhor by allowing a limited extent of trophy hunting and income generation for the community from the auctioning of hunting licenses. The extent of game reserve is located up to 12 km from Indus along the Kaigah valley. Within this game reserve, markhor inhabit lower elevations (located about 3 to 5 km from the proposed reservoir submergence area) in winter and higher elevations during summer.

Other sensitive areas within the project boundaries are Laachi nullah and Sazin Kot on the Indus left bank, Kandia Valley (between the villages Thooti and Aliel) and the area opposite to Shori nullah on the right bank. In all these areas, high biodiversity is only found at higher elevations (above 2,000 m); it includes the threatened Markhor and some rare species such as Common Leopard (Panthera pardus), Leopard Cat (Prionailurus bengalensis), Musk Deer (Moschus chrysogaster), Asiatic Black Bear (Ursus thibetanus), Western-horned Tragopan (Tragopan melanocephalus), and the Himalayan Monal pheasant (Lophophorus impejanus).

Palas Valley

The Palas valley supports about 1,000 of Western Tragopan (Tragopanmelanocepahalus - IUCN vulnerable), an important pheasant in the Himalayan region. The Palas Valley also supports populations of at least seven other rare bird species, including Phylloscopustytleri is classed as near vulnerable and the remaining are restricted range. The Palas Valley is listed by Birdlife International as the most important site for bird conservation in this bio-geographical zone.

Populations of most if not all of the mammals found in the Western Himalayas are found in Palas. These include Brown and Black Bears, Himalayan Ibex, Markhor, Snow Leopards, and Wolves. Inventories now being undertaken of smaller mammals and especially bats. Total area of the Palas valley is about 1400 km^2 with elevations ranging

700 m to 5200 m amsl. Both the winter and summer ranges of much of the wildlife are included within the valley. 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.

5.3.4. Terrestrial Ecosystems

On the basis of the vegetation patterns a number of ecological zones were identified. Most of the project area falls mainly in the "montane dry sub-tropical scrub zone", characterized by barren hills with steep slopes. This zone is typical for foothills and areas between 800 and 1,500 m. At lower altitudes, up to 950 m, the shrub cover is dominated by Artemisia maritima and grasses. On intermediate slopes plots of mixed forest are encountered. Wildlife does not reside here, but is reported to visit the area during winter in search of food when higher areas are snow laden.

Above 1,500 m, in the indirect impact zone of the project, a large variety of vegetation is found, characterized as "Sub-tropical pine forests", mainly between 1,100 and 1,700 m and "Himalayan temperate forests" above 1,700 m. At even higher mountainous ranges alpine vegetation types are found, including "Sub-alpine forests", "Alpine shrub", and "Alpine meadows". Especially the Alpine meadows are ecologically important: situated between high valleys and permanently snow covered mountain areas at altitudes between 3,500 and 3,800 m they present lush green pockets surrounding the mountainous watercourses. They are rich in wildlife. These higher areas were surveyed since they play an important role in the summer livelihood (grazing, forestry, hunting, firewood) of the affected population of the project area occupying the lower slopes of the valley. These higher areas are particularly ecologically very sensitive.

At lower levels, along some nullahs, small alluvial ecosystems are found on the sandy soils, intermixed with gravels. This kind of alluvial zone is also a preferable area for breeding/nesting of insects, birds, amphibians and reptiles.

5.3.5. Terrestrial Flora

A vegetation classification map from Dasu to Diamer Basha area and surrounding mountains (up to 4000 masl), prepared based on field investigations literature review and interpretation of satellite images, is given in The key vegetation on the foothills and lower slopes of the project area, the Sub-tropical pine forests, consists of thorny and small-leaved evergreen species. Typical are the Artemisia steppes (Artemisia maritima). The dense cover of Artemisia prevents the soil from drying out during summer. At altitudes of around 1,000 m mixed olive (Olea ferruginea), oak (Quercus baloot), and Pistatia (Pistatiachinensis) shrub forest is encountered, mixed with lower-growing shrubs like Capparisspinosa, Dodonaeaviscosa, Maytenusroyleanus and Rumexhastatus. Above 1,100 m the dominant species in vegetated plots is pine (Pinusroxburghii).

The evergreen Himalayan moist temperate forest above 2,000 m is mainly dominated by conifers especially Deodar (Cedrusdeodara) and Pine-nut (Pinusgerardiana) interspersed with some Oak (Quercus ilex) and various deciduous broad-leaved trees.

The alpine vegetation zones are relatively low in canopy cover. The forest plots are characterized by evergreen conifers and evergreen broad-leaved trees such as Betulautilis along with a deciduous shrubby undergrowth of Viburnum grandiflorum, Berberis spp., Rhododendron hypenanthemum, Salix spp., and others. The alpine shrubs show formations of up to 2 m high, typically consisting of Salix, Lonicera spp., Berberis spp., and Cotoneaster spp. Here and there Juniperusmaropoda and Rhododendron or Ephedra spp. are found. The vegetation composition of the alpine meadows includes mainly Poa spp., sedges, Artemisia spp., Trifoliumrepens, Drabatrinervia, Polygonum affine, Saxifragasibirica and Euphorbia kanaorica.

On wet places the vegetation is rather different; because of the availability of water this habitat is characterized by a rich plant diversity. The most common plant species include Debregeasiasalicifolia, Adiantumcapillus-veneris, Persicariaglabra, Menthalongifolia, Ailanthus altissima, Ficuscarica and Themedaanathera.

Areas that are occupied by human settlements or used for agriculture show a range of common weeds as well as grasses with potential for foraging. Common weed species include: Amaranthuscaudatus, A. ovalifolius, Portulacaoleracea, Physalisperuviana, Euphrasiahimalyica, Cleome viscosa, Trianthemaportulacastrum, Coronopusdidymus, Chenopodiumambrisoides, Euphorbia indica, Bidensechinensis, Oxalis corniculata, Achyranthesaspera, Conyzabonariensis, Oxalis corniculata, and Verbena officinale. Main grass species are Brachiariadistachya and Cynodondactylon.

None of the recorded 232 floral species are endangered, rare or vulnerable (International Union for Conservation of Nature - IUCN Red-List). A large number of these plant species are of economic or medicinal value for the inhabitants of the area. List of recorded floral species are given in **Annex B**.

5.3.6. Use of Vegetation

Many of the occurring plant species are utilized by local communities as vegetables or medicines, as animal food or fodder, for timber or fuel wood, and for harvesting their fruits. In addition to the cultivated species, edible parts from a variety of wild plants are cooked for preparing local meals, and 24 species, including 13 wild species, produce fruit. Over 60 species are reported to contain crude medicines. Fuel wood is the major source of energy for cooking and heating; some 78 species of trees and shrubs used as fuel wood source by the local communities.

The forests from higher altitudes produce substantial amounts of timber and non-timber forestry products. A large proportion of the harvested forestry products are transported southward; local people indicate to be heavily dependent on the forests and forestry products for their income. Officially, all forests in the project area are classified as "Private Forests", owned by the local community, but managed by the KP Forest Department. The Department is responsible for overseeing commercial timber extraction and timber sales. The royalty ratio is 80-20: i.e. 80 percent of the financial proceeds go to the community and 20 percent to the government treasury. Previously local communities would sell the timber on standing basis to logging contractors. The Forest Department attempted to regulate the extracted volume through the use of harvesting plans, but unofficial logging is common.

5.3.7. Terrestrial Fauna

Mammals: A total of 31 species of mammals were recorded from the region.. According to IUCN's Status and Red List of Pakistan Mammals, two species are Critically Endangered (Common Leopard (Panthera pardus) and Caracal Cat (Felis caracal); three species are Endangered Indian Wolf (Canis lupus), Himalayan Musk Deer (Moschus chrysogaster) and Markhor (Capra falconeri cashmiriensis); one Vulnerable (Asiatic Black Bear (Ursus thibetanus); three Near Threatened (Hill fox - Vulpesvelpesgriffithi), Asiatic jackal (Canisaureus), and Rhesus macaque (Macacamulatta), and one data deficient (Leopard cat - Prionilurus bengalensis). All of these were confined to the mountain tops at higher altitudes (2,000 m amsl) outside the core project area. Some of them visit parts of the riverine habitats in the project area proper occasionally in search of food; Jackals and Caracal Cats are occasionally seen in the area. The more mountainous species are included in the survey results since the summer up-migration of villagers from the project area to the high altitudes for herding of goats, sheep and cattle and for forestry activities has a negative bearing on the vulnerability status of these species. During the surveys only 10 species were recorded from the project area and list of these species are given in **Annex B**.

Birds: Overall, 199 birds species are reported from Indus Kohistan district. During the field surveys 58 species were recorded, belonging to 28 families/subfamilies. The largest family recorded is Turdidae with 11 species followed by Columbidae and Corvidae (five species each). Among the recorded birds about 62 percent species were found to be resident in the area, 24 percent are summer breeder or wintering guests and 14 percent are passing migrants. The status of 72 percent of the bird species is “Abundant and Common”.

The Western-horned Tragopan (Tragopan melanocephalus) is listed as “vulnerable”. This species is found at higher elevations (>2,000 m) only. Local communities stated that Tragopan is found in the upper reaches of Kandia, Lachi and Sazin Kot, but this could not be confirmed by the surveys. The Monal Pheasant (Lophophorus impejanus) and the Rufous-tailed Rock Thrush (Monticola saxatilis) are classified as “rare”, and the Grey-necked Bunting (Emberiza buchanani) and White-bellied Redstart (Hodgsonius phoenicuroides) as “scarce”. Analysis of interview data showed that 30-40 percent of the populations of Monal and Tragopan have decreased in the last 20-30 years. Most frequently encountered species during the surveys were White-cheeked Bulbul, Shrikes, Tits, Wagtails, Jungle Crow, Common Myna, House Sparrow, Thrushes, and Blue Rock Pigeon. The least encountered species were Marsh Harrier, Indian Roller, Common Kingfisher, White-bellied Redstart and Eagle Owl.

Reptiles and amphibians: Eighteen species of amphibians and reptiles are reported from the project area, but only five of them were observed during the field surveys. These included two types of common lizards (Agama species *Agama agrorensis*and *Laudakia pakistanica*) and one toad (Green Toad, *Bufo viridis).* Two killed snakes were found (Blunt-nosed Viper, *Macroviperalebetina* and Dhaman, *Ptyasmucosus*); it is a common practice that locals kill the snakes whenever encountered. Occurrence of the Monitor (Varanus monitor) was not observed, but a common sighting, according to the local people.

Invertebrates: In spite of their positive role in pollination, the current state of knowledge about northern Pakistan insect biodiversity and distribution is very inadequate. Various butterfly and beetle studies were carried out in the wider region, showing high variety. Multipedes, centipedes and other soil insects are common. Sand Fly is reported of causing nuisance in the project area. Detailed studies will be conducted during the construction stage to establish baseline data for these biological resources (see **Annex A** for ToRs).

5.3.8. Bird Migration

The Indus flyway is a famous route for migratory birds from Siberia to various destinations in Pakistan over Karakorum, Hindu Kush, and Suleiman Ranges along Indus River down to the delta. This flyway of waterfowl and migratory birds constitutes a famous corridor of international importance, the so-called “Indus Flyway” or

"International Green Route" or "International Migratory Bird Route Number 7". According to some estimates, 700,000 to 1,200,000 birds arrive in Pakistan through Indus Flyway every year. The southward migration begins in November, and the northward migration starts in March.

These periods may vary depending upon weather conditions in Siberia and/or Pakistan. The route offers plenty of food and a mild and hospitable climate to the birds. The Indus valley and more particularly the wetlands of southern Sindh are the major wintering grounds of migratory waterfowl. Key species using the flyway include cranes, teals, pintails, mallards, gadwalls, White-headed Duck, Houbara Bustard and Siberian Crane. The 100 km long Tarbela Reservoir is known as a staging ground for migrating birds; the creation of the large and permanent Dasu reservoir will further enhance the habitat availability for wintering and for resting of migratory birds. Some species will favor the deep areas while some will refuge on the new shoreline of the reservoir as noticed in other dam projects and reservoirs of Pakistan and elsewhere in Asia. However, due to the absence of feeding grounds in the vicinity of the Dasu project there will be hardly any winter migrants resting longer than one day in the project area.It is also recommended that in parallel to ESIA study, the project also undertakes Avian Risk Assessment study.

5.4. Social and Economic Environment

5.4.1. Kohistan District

The word Kohistan literally 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 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 in left and right bank. The KKH forms the lifeline between this isolated and remote district and the populated areas down country. Dasu lies at 350 km distance from Islamabad and about halfway between Islamabad to the Chinese border at Khunjerab Pass. The KKH is the main, transportation and trade link between China and Pakistan.

5.4.2. Demography

Since ancient times Kohistan is predominantly inhabited by Dardic and Pashtun tribes. In history the region has been invaded and contested by Persians, Greeks, Scythians, Kushans, Turks, Mughals, and the British. The community in the Dasu project is ultra-conservative and not very responsive to the main stream development concepts in communication, health and occupational opportunities.

In 2008 the total population of Kohistan amounted to 477,000 people, of which 55 percent were male and 45 percent female (a ratio of 1.24). The entire population is considered to be rural, since there are no major cities in the district. Almost all inhabitants (99.6 percent) are Muslim and belong to the Hanfi Sunni Sect. The 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.

In the project area the habitation is in small villages (nine on the right bank and ten on the left bank) and hamlets (18 on the right bank and 17 on the left bank). An average village consists of 20 to 25 household units. The settlements are administratively combined to Union Councils: six on the right bank and two on the left bank. All settlements are on sloping land. The houses are largely *katcha* (temporary, made of wood with mud walls). There are also semi-*pucca* houses and *pucca* (brick built) houses. Most villages already have a range of civic amenities. Access roads to the villages are fairly common with some having internal roads too. Two or more extended families live in one house. Thus, the basic residential/economic unit is the patrilocal joint family. Typically, this unit includes an elder's household and his married sons' families. Married sons generally live in their father's household with the latter or the eldest brother exercising authority over the extended family.

5.4.3. Education and Literacy

The literacy rate in Kohistan (measured over people above 10 year) is low with only 30 percent, compared to the national level of 57 percent. One in every three villages has a school for boys; however, rarely for girls. Low enrollment rates and even lower completion rates of primary schools are assumed to be the prime cause for the 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 the field of education, with a sizable gender gap in literacy and enrollment rates as compared to national statistics. **Tables 5.3** and **5.4** summarize Kohistan education data in comparison with the national situation.

Table 5.3: Primary Education (Percentages)

Indicator	Kohistan District	Pakistan
Literacy Rate 10+	30	57
Male	49	69
Female	3	45
Primary net enrolment rate (NER)*	37	57
Male	57	61
Female	11	54
Primary completion rate	15	49
Male	25	59
Female	1	38
*The NER shown here is for ages 5-9		

Source: UNDP 2011 Report On the Status of Millennium Development Goals.

Table 5.4: Education Levels in the Project Area

Education level	Total number of persons			
	Left Bank	Right Bank	Total	Percentage
Illiterate	824	1,007	1,831	77.0
Up to Primary	342	53	395	16.6
Up to Matric	79	6	85	3.6
Higher Education	50	2	52	2.2

Education level	Total number of persons			
	Left Bank	**Right Bank**	**Total**	**Percentage**
Professional and Post Graduate	15	0	15	0.6
Total:	**1310**	**1068**	**2378**	

Source: Field Surveys, Env.& Soc. Safeguards Study, Detailed Design 2012, DHC.

5.4.4. Health and Sanitation

Although reliable health data on Kohistan are rudimentary and/or missing, the health situation in the district can be considered very poor, especially in the remote valleys at some distance from the KKH. There are only a few and Rural Health Centers in the area. Maternal and child mortality rates are very high; around ten percent of the children die before their fifth birthday. The people in the area are particularly vulnerable to diseases 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.

The Basic Health Units are situated on union council level and meant to provide basic curative and preventative services with no inpatient facilities and no laboratory. Their main activity is the provision of basic curative services, but on a limited basis, due to lack of staff and due to cultural restrictions. They are expected to play an active role in the polio eradication (immunization) program. Some of the facilities are staffed with social mobilizers/health promoters. They interact with the community (only men) for issues on health awareness such as safe drinking water, hygiene promotion and proper waste disposal.

Access to proven clean and safe water for households is limited. The fast flowing and highly turbid Indus is not used as a water source by the population. Instead, they use water from tributaries and nullahs with lower turbidity, as well as springs. About 44 percent of the population of Kohistan’s rural areas has access to proper sanitation facilities (underground, covered or open drains) in 2006/07, but the situation in the Dasu area is worse. In Dasu village is a proper sanitation system available but in other villages and hamlets there is none. Some people discharge their sanitation water into the river and some people dig a pit and discharge there.

5.4.5. Economy and Employment

Socio-economic Indicators

According to the 1998 Census Kohistan had the country’s lowest scores in terms of socio-economic development indicators. In the Dasu area the per capita income was the lowest of Kohistan. 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 (mainly government) and 17 percent were unpaid family helpers. Still people in the area do not consider themselves poor: they see themselves as a lower middle class agrarian society. Hardly any people are landless or have no share in the forest resources. The proportion of households living under the estimated national poverty line is only 1.56 percent.

Secondary income from sales of walnuts and pine nuts (Chilghoza) as well as timber and fire wood from community forests is probably the main factor for the low level of poverty in the area. However, given the social context and the male domination, a large majority-of women live in conditions of poverty. Children are generally working following the traditional family system: they are mostly involved in herding and feeding of animals; some children of 10 years and above are working part-time in automobile workshops, wood factories, shops and hotels.

Income and Livelihood

The Kohistan district has the lowest per capita income in whole KP province. But it is interesting to note that most of the affected householdsin the project area has 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. They migrate seasonally between the low elevation areas in the valley and the high elevations and their economic activities are spread between low and high elevation areas. Overall the people of Dasu area are lower middle class agrarian society. Economically they look strong but as far as basic facilities are concerned, they are deprived of these basic facilities and are poor. People do not have schools, education, health facilities, safe drinking water and no access to their villages, except on foot. Moreover people have to pay prices for every day needs than in the urban centers of KP. These deprivations classify them as poor. In **Table 5.5** the average income per livelihood sector is given of the population affected by the project.

Table 5.5: Average Income by Livelihood Sector

Livelihood Sectors	Persons Involved	Average Annual Income (PKR)
Agriculture	511	3,269
Forestry and Business	176	24,970
Skilled Work/ Handicrafts	10	17,850
Government Jobs	60	20,344
Private Jobs	27	11,944
Agri. Labor Permanent	1	30,000
Livestock Rearing	81	7,293
Labor	156	10,615
Soniwals (gold extractors)	28	10,417
Others	36	13,447
Overall	1086	9,981

Source: DHC, Socio-economic baseline study

Agriculture and livestock holding

Livestock holding with agriculture (mainly subsistence farming) is the main source of income, together with some income obtained from the sales of forest products. 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 and double cropping (predominantly maize, rice and vegetables) is possible on the lower valley terraces. Livestock holding with goat, sheep, cattle, bullocks and some poultry is the main activity and more important than farming, due to the scarcity of cultivable land. Families are in principle pastoralist and most of them migrate during summer to higher altitudes in search of pastures and a cooler climate. The 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.

Income of Forests

Forests, though essentially located on high elevation, are the most important natural resource of the area. Firstly, they meet the fuel wood requirements of the local inhabitants. Secondly, forests are quite significant source of income for communities as private owners; woodchoppers; and timber cutting. Some people are involved in timber business. Another rather common business in the area is sales of sand and gravel. A seasonal source of income is the collection and sale of Pine nut (Chilghoza), walnuts, honey, mushrooms and medicinal plants and other forest products.

Tourism

The project area has a potential for development of tourism, but supporting tourist facilities are hardly available. Most tourists are passing the project area on their way to popular tourist destination in Gilgit Baltistan. There are a few hotels in Dasu and one smaller PTDA guesthouse to accommodate tourists. There is a need of upgrading tourist and hotel accommodations. The importance of the national tourism industry is growing; there are various interesting spots in the Dasu project area. Important tourist attractions in the area are archaeological remains (Rock Carvings) along a section of the Silk Road (ancient KKH) between Shatial (in DHP) and Rajkot bridge (section of 100 km along KKH), and two historically important and beautifully decorated mosques at Seo and Seer Gayal. Several locations along KKH such as the Sammer and Zaid Khwar nullah crossing provide picturesque view of Indus valley. There are restaurants at these locations.

Skilled and Unskilled Workers

The literacy rate in the project area is very low. The majority of the population is unskilled and working as self-employed worker in agriculture and livestock holding, often with different sources of secondary income coming from the sale of fuelwood, timber and various forest products. There is a lack of vocational education and training in the area. Parents are forced to send their children to work at an early stage instead of sending them to school. Young males usually unmarried are working in other parts of the country, usually in other parts of KP or in Karachi. Most of these jobs include drivers, construction workers, cleaners, cooks and others.

Government Employment

The Government headquarter in Dasu provide jobs for civil servants, contractual staff and daily-wages support staff. The Educational department is the largest employer in the entire district and the police department is second in providing job opportunities to all kind of people. Other people are employed through the Forest Department, Agriculture, District Administration, Health, Social Welfare & Women Development Department, Population Welfare, Fisheries, the National Bank of Pakistan, and Archaeology at Shatial and Meteorological point at Kandia. The government jobs contribute the income of the inhabitants to 9 percent of the total affected area.

Private Jobs

Some employment exists in the area through contractors involved in implementing the National Program for Water Management, National Data Base Registration Authority (NADRA), however, most of the jobs under these contracts are of technical nature with limited scope for locals due to the low illiteracy rate.

People of the project area are also doing private jobs. Most of the young educated people of the area are working with some national and international NGOs. These NGOs are working for the development of the local population. Some people are working in schools run by NGOs.

Soniwal

A special commercial activity is carried out by the Soniwal, which are tribes living in the northern area of Pakistan. They are earning their livelihood through gold extraction from sand which is deposited on the banks of Indus River. The vicinity of the Dasu project area has a number of Soniwal and the project area of Dasu also includes 13 households in the Daril valley just under the Shatial bridge. Soniwal extract some 6-7 tolas (1 tola = 11.78 gram) of gold in one season. All members of the family take part in extraction of gold from river sand.

5.4.6. 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 wastelands. 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 (nullah's). 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 all the land is divided among the tribes and most of the land 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.

Table 5.6 provides an overview of the land use patterns in the affected part of the project area. The main classes of land use includes river/nullah's, clumps of trees representing forest patches, cultivated or agricultural land, grazing land/pastures; barren slopes/rocks; and houses or buildings. Most of the area falls in the category of barren slopes and rocks.

Table 5.6: Land Use in the Affected Project Area

Land Use Type	Total Area in ha	Percentage
River area (state land)	1,067	23.0%
Land cultivated	143	3,1%
Grazing Land/ Pasture	280	6.0%

Land Use Type	Total Area in ha	Percentage
Barren Slopes/ Rocks	3,126	67.3%
Land under buildings	27	0.6%
Total	4,643	**100%**

Source: GIS Mapping detailed design, DHC

5.4.7. Agriculture and Local Irrigation

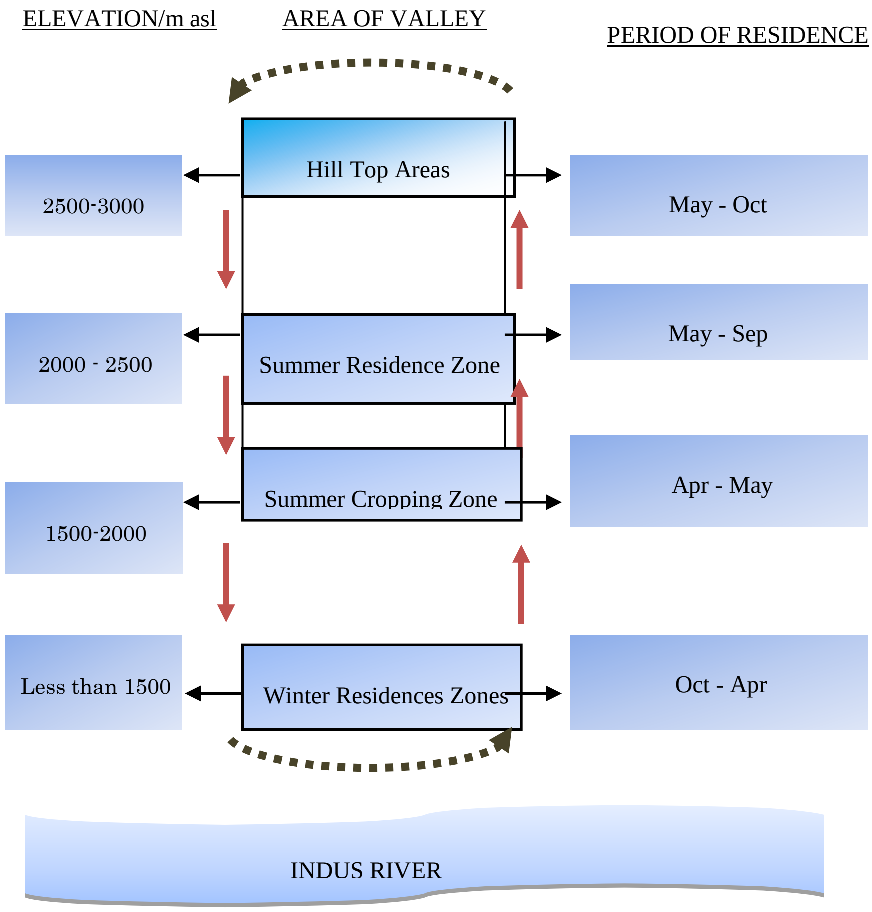
Despite the scarcity of cultivable land in the district, people practice some agriculture where it is possible. Most of the farming is subsistence farming, with the purpose to grow wheat, vegetables and other crops for home consumption and as fodder. Very few crops are grown for the market. The district is by far not self-supporting. Wheat and rice have to be imported from "down country". The kharif crops are grown in high altitude lateral valleys which remain very cold in winter. Both kharif and rabi crops are grown in 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 is found at places where mountain streams easily can be tapped and utilized. Almost all the valleys have gushing streams (nullah's). The lands along the banks of streams, which can be commanded, are being irrigated through small channels constructed by the people. In some areas land is also irrigated from springs.

5.4.8. Seasonal Migration

Seasonal migration is very common in Kohistan and people practice it for a variety of reasons, livelihood and cultural – being the principal factors. Typically, the people commence migrating to higher elevations in May and start moving back in mid-October. In most cases, people in the Project area thus have two houses at various levels or altitudes of the mountains. The "permanent" houses are on the lower altitudes of the mountains along the river banks. They migrate to temporary houses at higher elevations of the same mountains during summer to avoid the heat and to feed their livestock. At higher elevations, the families own and/or have access to more grazing lands and forests. They prefer housing is at higher elevations but those who have jobs or businesses at lower elevation stay year-round in their lower elevation houses. This cyclical seasonal transhumance is common all over the valleys in Kohistan (see **Figure 5.5**).

In winter people live near the river; this is where they have their more permanent 'winter residence'. Below 1,500 m asl two agricultural crops are possible, but there is little suitable land available for farming. Hence farmers cultivate higher land (2,000- 2,500 m), where only one crop is possible due to climatic reasons. This is where they build their "summer residence". The pastoralists herd their livestock in summer at higher altitudes (2,500- 3,000 m) and have "temporary shelters". They come down in winter together with their cattle. Those who are shepherds have a fourth house at the top and move there to graze their livestock. In sum, there are four ecological zones in the mountains that largely define live and livelihoods of the affected populations. The dependence for livelihoods is more on the higher elevations where there are terrace land, forests and grazing fields for the herds.

Figure 5.5: Seasonal Migration Pattern of People in the Project Area



5.5. Social and Cultural Aspects

5.5.1. Customs and Traditions

Kohistan is a deeply conservative society, and religious values prevail. However, due to lack of education and literacy, local interpretation of religious teachings can be inconsistent with the true spirit of Islam. Religious practice is generally confined to prayer and fasting. It is reported that, often more priority is given to tradition than religion. There are no religious tensions within the local population because all people are followers of the Sunni sect.

The tribal people of Kohistan have a social structure which is rooted in strong traditions and local customs. People consider themselves different from the majority of 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 for few people. Information disseminated by imams is considered to be more reliable. Printed material is hardly used, because of the low literacy. There prevails a sense of suspicion that outsiders, particularly NGOs, have a hidden agenda of social change detrimental to their religious and cultural practices and traditions prevailing in the area; outsiders are not always welcome in the area.

5.5.2. 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. In joint families all family members pool together their incomes and share collectively their expenses on food, clothing, education, health, births, marriages and funerals. 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 belongs also to 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. Men still make every effort to prevent women from being influenced by the outside world. Televisions (TV) and dish antennas have become slightly more common, but watching of TV is restricted to rooms with access for men only.

The restrictions on women mean that vital positions in the health and education sectors are not filled, with a corresponding negative effect on women's access to these services. There are currently around 20 Lady Health Visitors on the payroll of the Health Authorities, but these cannot do any field work because of the strict purdah requirements for women.

5.5.3. 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 parts have their own history, culture and language. In both parts different tribes are living in the valleys of the tributaries of the Indus. 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 jirgas process described below.

5.5.4. District Administration and Traditional Governance System

Kohistan is since 1976 a district administered under the Provincially Administrated Tribal Areas (PATA) 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. Jirga's 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 be including the 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/her representative.

5.5.5. Land Titles

In the specific requirements of the DHP project, given the absence of a cadastral data and land records, the establishment of land tenure and acquisition are completed with the help of the local communities, maliks and the jirga system. With the help of this traditional and accepted system conflicts related to land titling will be resolved. The traditional system will be also useful during the project implementation to organize participatory planning and monitoring and for establishing a grievance redress mechanism process.

5.6. Physical Cultural Resources

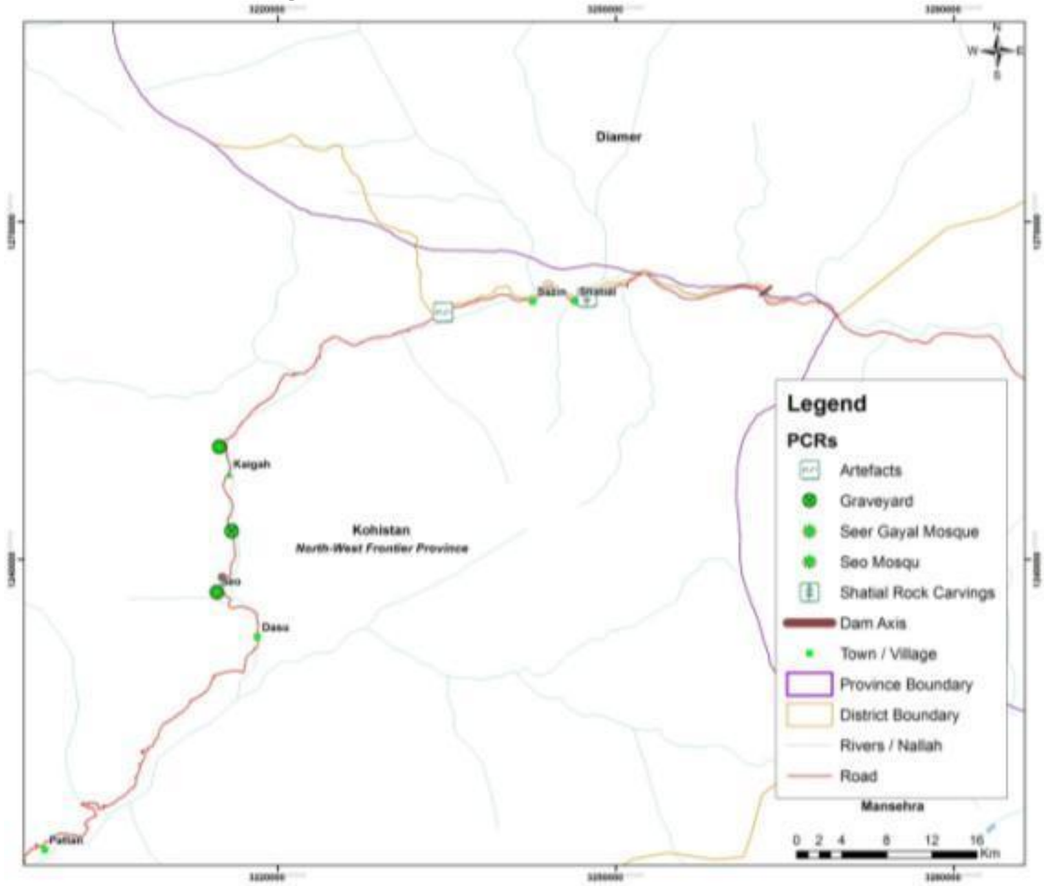
The field survey of Physical Cultural Resources (PCR) was carried out by two PCR specialists (Prof. Ihsan H. Nadiem and Irshad Ahmad Soomro) together with Dr Bakht Muhammad from the KP Directorate of Archeology and Assistant Curator of the Peshawar Museum, and also with representatives of the local government. In view of the rugged terrain conditions it was decided that the most effective way of collecting information was using questionnaires and interviewing maliks and elders of the affected villages in the project area. Through the Directorate of Archaeology and Museums background information on the archeological studies carried out in the region. Most work on archeology in the area has been related to the studies of the Heidelberg University from Germany, who has studied a large field of petroglyphs the Indus valley between Dasu and Chilas since 1978. During two EIA workshops in Islamabad and Peshawar the preservation of physical cultural resources has been extensively discussed in the presence of provincial and federal archeological institutions. A request for assistance from the project for the preservation of rock art near Shatial was received from the Directorate of Archaeology and Museums.

The Indus valley in pre-historic and historic periods has always been the only connection between China and the subcontinent on the other side of the Himalayan and Karakorum mountains in this part of the world. Traders, armies and caravans have used this road through the dangerous and rugged terrain following the Indus River. The 50,000 rock drawings and inscriptions found over a stretch of more than 100 km west and east of Chilas give evidence. There is proof that part of Alexander the Greats' Greek army has passed northwards (without Alexander who sailed down the Indus after reaching Attock in 437 BC). The area also witnessed the rise and fall of the Buddhist culture (1st – 9th Century) for which evidence is found at many places in Kohistan (Reference: Rock art in Northern Areas of Pakistan, Heidelberg Academy, 2009) and in the 8th – 12th Century the road was known as Silk Road, the main artery of trade and exchange of culture and goods between China, the Indian Subcontinent, the Middle East and also Europe.

A number of Physical Cultural Resources (PCRs) were identified in the study area. They are the following: (i) rock carvings near Shatial, (ii) two about 400 year old historical and beautiful decorated mosques at Seo and Seer Gayal, one of them (Seo) will remain, but is very near to the working area, and the other smaller mosque at Seer Gayal will be submerged by the reservoir, (iii) older and more recent graveyards and (iv) moveable artifacts. Locations of these PCRs are shown in **Figure 5.6**.

The rock carvings around Shatial will not be submerged, but they are rather unique for the Buddhist period and should be saved. They are unprotected now and endangered by threats by developments related to construction works and other activities of the project. Since another 20,000 of these engravings of often older periods (up to 5000 year BC) will be lost due to submergence from the Diamer- Basha reservoir a joint implementation plan to document and partly save these artifacts and rock art is needed. It is important to realize that after completion of both Basha and Dasu project the rock carving cluster near Shatial is the only site where petroglyphs are found in the original condition without any compromise with their authenticity. Therefore these sites should be preserved.

Figure 5.6: Location of Identified PCRs



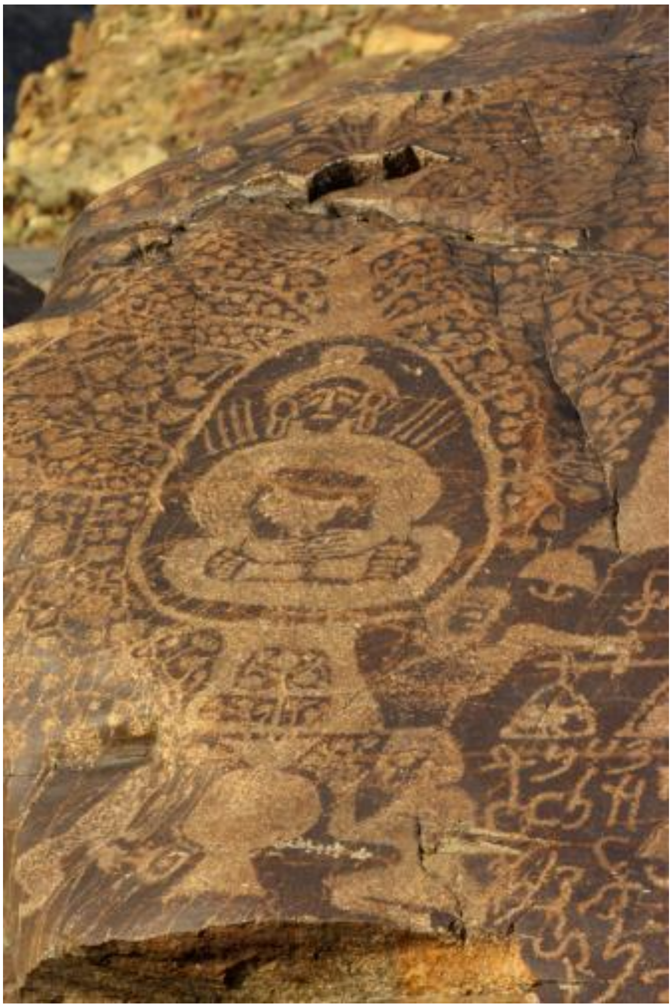
5.6.1. Rock Carvings at Shatial

Shatial is located about 52 km upstream of DHP damsite. Rock carvings located near Shatial between the Indus and the KKH is a designated archaeological site. It consists of 46 major rock boulders with carvings representing a wide variety of images ranging from simple line drawings of humans and animals such as mountain goats, including ibexes and markhors to a very unique and sacred depiction of the life of Buddha (see also **Figure 5.7**). Most zoomorphic images are drawings of characterized by long exaggerated horns. These rock carvings belong to 1st to 7th century AD. These are of interest, in addition to the scholars, to local and foreign tourists particularly the Buddhists for their religious significance.

Rock carvings at Shatial are a part of a large complex of over 30,000 petro glyphs and 5,000 inscriptions, spread over 30 sites stretching over 100 km from Shatial to the Raikot Bridge (located outside the study area).

The boulders on which these carvings have been made are presently not in good state of preservation. Many of them have developed cracks while almost all of them bear the adverse weathering effects. The surface of rock at most of the places is eroded and the inscriptions are not readable. The rock carvings are located in a private properly and are not protected with fencing or security, and hence are subjected to vandalism. Some of the carvings had already been deformed by vandals. Assistance from DHP has been requested by the provincial Directorate of Archeology and Museums to purchase about 25 ha of land in this area to do proper fencing, provide some infrastructure and protection of the objects.

Figure 5.7: Rock Carving Depicting Tale of Sibi Jataka (From Life of Buddha)



5.6.2. Seo Mosque

The Seo mosque is a widely revered mosque in the region. The mosque is located in Seo village, about 1.2 km downstream of the Dasu dam and within short distance of 500 m at higher grounds in the village from the proposed disposal site. According to the local tradition the mosque is approximately 400 years old. The mosque is constructed in dressed timber trunks placed one over the other. This religious building is currently in use for prayers and imparting Islamic religious education. Muslim visitors to Dasu visit this mosque in reverence. The building and surroundings also attract common tourists for its ancient style of building and remarkable wood carvings (see also **Figure 5.8**) and attractive environment.

Figure 5.8: Seo Mosque showing Wooden Pillar and Brackets

5.6.3. Seer Gayal Mosque

The mosque at the village Seer Gayal like the Seo mosque is over 400 years old. The wooden mosque has the same articulate carved motifs as those found in the Seo mosque, which suggest their origin in the same period. The mosque is also decorated with beautiful carvings on its wooden columns, door or other decorative elements, like brackets. The structure of the Seer Gaya mosque is in good state of preservation. Religiously the mosque has less significance compared to the Seo mosque and is frequented only by the local community.

5.6.4. Moveable Artifacts

The area has never been intensely explored by any archaeological study team or survey, with the exception of the area north of Shatial where the University of Heidelberg (Germany) has done research on rock carvings. Since it might be expected that the roads and tracks along the Indus river apart from the already surfaced pre-historic and historic evidence (Silk Road) may feature many other archeological objects and sites, the possibility of unexpected chance-finds will be high. Recent findings of the local community include an iron sword with handle (possibly from period of Sikh rule of Kashmir), which was in good state of preservation and pottery objects, possibly from the Mughal period.

6. Other Relevant Issues

6.1. Risk of Earthquakes

The Dasu project site is located in a zone with high seismic activity. According to the Geological Survey of Pakistan the area is part of a larger area which is classified as 'Serious Seismic Danger Zone'. From historical documentation there is already sufficient evidence of earthquakes in Kohistan in the past. Regular earthquake monitoring started in the first half of the 20th century. The intensity of the earthquakes measured in the epicenter is estimated to be not greater than class VIII on the Modified Mercalli scale. For the design of DHP the records of all earthquakes in a 150-km-radius of the dam were collected from different international and national sources. This resulted in a list of 2115 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 (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 also the risk of reservoir-triggered earthquakes was considered. A committee of international panel of experts recruited by WAPDA finally 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 established at the dam site for continuous seismic monitoring.

6.2. Risk of Landslides

Landslides are common and natural phenomena in the mountain slopes along the Indus. Natural landslides can occur due to lubrication of rock support structure by rainfall or by water seepage. The use of explosives to break rocks may cause vibrations which easily can trigger a landslide. Earthquakes and tremors can also trigger landslides. 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 would be exercised to protect workers and the public from the dangers of sudden landslides, which may occur during excavation and blasting works. Particularly during monsoon periods there might be increased risk of such incidents. Another critical period might the period of first filling of the reservoir. The risk assessment of the reservoir slopes already revealed that a slow rate of filling is required of max 1-2 m per day in order to saturate and stabilize slopes as much as possible with water from the reservoir. During filling but also in other periods regular monitoring of the high-risk slopes is required.

6.3. Risk of Flooding

Although the risk of flooding in the Indus Basin might increase in the coming years due to rising air temperature, shift in rainfall pattern and increased melting of glaciers in the upstream regions the risk of flooding and related damage in the area is low. Large floods as occurred with the unprecedented catastrophic flood events in July 2010 are not very likely to occur, since the Upper Indus Basin is outside the influence of the monsoon rains. Most of the Indus water results from snow and ice melt. Moreover the Indus valley is narrow with steep slopes. The riverbed is always cut into the embankments and therefore no flooding will occur. However erosional forces may undermine the 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 upper part of the Indus catchment are not exclusively associated with extreme rainfall events, but they can also occur after landslides and creation of river-dams and subsequent flood waves. However these flooding events are usually restricted to tributary areas and may have impacts on the upper Indus valley. Formation of river dams can occur through landslides, but these events are rare. More often 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. About 60 Glacial Lake Outburst Floods (GLOFs) have been reported in North Pakistan since 1830.

6.4. Climate Change

6.4.1. Research Done

During the last decade substantial research is 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 (GCISC, 2009, Planning Commission, 2009) are:

- between 1980 and 2005 the frequency of heat waves (T >40 °C) has been increased in north-western 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 2.8 °C to 4.2 °C in the year 2080 for northern Pakistan;
- more heavy rainfall events during monsoon season will occur over north-western Pakistan instead of over the north-east 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 (rabi season);
- a shift has been observed in the rainfall pattern with monsoons starting 1-2 weeks earlier and winter rains confined towards February. The predictions of changes in precipitation however are much less certain than those in temperature. A general conclusion is that precipitation in the form of rainfall and snow is likely to increase in summer (2- 7 percent) and decrease (2-4 percent) in Northern Pakistan in the year 2080 (GCISC, 2009)

Other studies (IPCC, 2007, World Bank, 2006, Rees and Collins, Wallingford, UK, 2004) have been concentrated on the effects of glacial melt, especially on the Hindu Kush-Karakorum or the Western part of the Himalaya. Major issues to be investigated are amongst others:

- the importance of the contribution of snow and glacial melt on the hydrology of the Indus;
- the observed changes in the extent of the glaciers;
- the effects of climate changes on the amount of melt-water.

From these studies it has been concluded that glaciers in the Himalaya and Karakorum are receding faster than happens in any other part of the world. From digital terrain models and satellite observations it might be concluded that the reduction of the thickness of ice in the Western Himalayan glaciers ranges between 0.50 to 0.90 m per year, although in some areas in the Karakorum an extension and increase of glaciers has been reported. A recent study (Immerzeel et al, 2010) suggests that 60 percent of the discharge in the Indus catchment is fed by melting of glaciers and snow. This is a very high percentage as compared to other major rivers originating in the Himalayas, such as Brahmaputra, Ganges and Yellow River. In a likely scenario of global warming based on IPCC predictions the reduction of the share of melt-water in the Indus discharge has been estimated at 8.4 percent. However this could be (over) compensated by an expected increase of precipitation in the downstream areas (in the NW of the country) which are under influence of the monsoon.

The relation between climate change and hydrology is extremely complex. This is especially the case, since the high variability in data on climate and hydrology, requiring long time series and proper monitoring. Moreover regional circumstances might vary considerably, especially in high mountain areas. This often leads to conflicting data. More studies and more reliable data should be collected in the coming years.

6.4.2. Support to Glacier Monitoring and Research Centre (WAPDA)

Continued monitoring of glaciers is crucial for the water security of the country, and useful for developing the knowledge base for the operation of the dam and for planning future hydropower investments in the Indus Basin. A glacier monitoring program is recommended in DHP. This program would support the Glacier Monitoring and Research Center (GMRC) under the WAPDA General Manager Planning for monitoring and research on the Upper Indus Basin (UIB) glaciers. The program is intended to examine and monitor the characteristics and movements of these glaciers with the help of satellite data and also to provide early warning for glacial lake outbursts. The proposed GMRC would have four sections: (a) a field investigations section responsible for establishing and managing field stations. The office is proposed to be established in the upper catchment of the Indus; (b) a remote sensing and modeling section located in Lahore to carry out remote sensing and modeling studies; (c) a forecasting section; and (d) a data management section to maintain and upgrade data management systems and carry out data analysis and research activities. It would also link up with the high altitude meteorological network, surface water hydrology and WAPDA’s hydro-meteorological network. It is recommended that DHP contributes with UDS 4.0 million to support the program of GMRC.

6.4.3. Telemetric Network

A flood warning telemetry network is proposed by WAPDA to be developed for the Indus basin. Such a system would strengthen the flood forecasting system in the country and complement the above Glacier Monitoring Program. Floods were worst in the country’s history with large amount of damages in human lives, livestock and agricultural destruction. For safety of public and better management of flood waves and safe operation of DHP and other hydropower projects in the country, it is imperative to have an early warning system for these hydropower catchments.

The existing flood telemetry network in the entire Indus basin comprises 45 automatic rain and river level recording stations. There is no existing flood monitoring station in the DHP catchment at this moment and very few in the upper catchments of River Indus and this needs expansion in order to provide realistic and accurate data. At the moment all automatic rainfall and river level recorders are situated at low-level stations. Since rain (snow) fall generally is much higher at higher altitudes and rain- and snow fall are not recorded. Expansion of the telemetric network to strategic locations along the Indus and its main tributaries and possibly higher upstream in the main catchments is therefore essential.

WAPDA has proposed the installation of 18 telemetry stations, most of them in the Indus catchment area. Under DHP currently a budget of USD 2.5 million is proposed for the installation and operation (10 year) of these telemetric stations, including the training of staff. The works will be implemented by the Hydrology & Research Directorate under the administrative control of the Chief Engineer, Hydrology & Water Management, WAPDA.

Apart from this it is recommended to establish a permanent hydro-meteorological station at the Das u dam site to monitor the complete set of hydro-metrological parameters such as rainfall, temperature, wind speed/direction, evaporation etc. The budget for the proposed hydro-meteorological station is included in the civil works.

6.5. Net Greenhouse Gases Emissions

Net greenhouse gas (GHG) emissions from Stage 1 implementation of DHP (12,225 GWh/year) are estimated using the World Bank "Guidance Note: Greenhouse Accounting for Energy Investment Operations, Ver 1.0, June 2013 (hereinafter "Guidance Note") and IPCC 2006 guidelines. The emissions from the Project and baseline emission of the nearest least-cost alternative (CCGT) estimated over 50 year.

Project GHG Emissions

Four sources of emissions are considered for accounting GHG from the Project. The sources and the estimates are given below.

1. Reservoir Emissions. When a river is dammed, the flow dynamics are changed, riverine sediment and organic material are trapped, and terrestrial ecosystems are flooded. This alters the previous cycle and fluxes of CO_2 and other GHGs within the reservoir area. The main contributions to emissions are decomposable parts of flooded soil and vegetation in terrestrial zones and removed sinks from cleared biomass growth. GHG emissions from new aquatic systems will occur during the full lifetime of the reservoir, but will exponentially decrease as the flooded organic material is decomposed and as biochemical conditions change.

The power density of the Project in Stage I is 91 MW/km^2. The Guidance Note includes a methodology to estimate default emission factor from reservoirs based on three key parameters: power density, plant factor and climate. From Table 4B1 of the Guidance Note, reservoir emissions for plants with power densities greater than 40 MW/km^2 located in temperate areas are negligible and can be assumed to be zero.

However, according to IPCC guidelines, the flooding of lands in warm temperate dry areas produce a median CH_4 emissions of 0.044 kg/ha/day and CO_2 emissions of 5.2 kg/ha/day. These diffusion values are considered for reservoir emissions of the Project. The emissions of CH_4 are converted to CO_2 equivalents using a global warming potential of 72. Annual CO_2e emissions from DHP reservoir are 7284.6 tons.

According to the World Bank Guidance Note reservoir emissions are assumed to have a standard 100 year time horizon. But reservoir emissions from the DHP are expected to be limited to first few years due to (i) run-of-river nature of the project, (ii) 60 percent of the reservoir area is barren, and (iii) large volume of water inflow with respect to limited reservoir area (which limit the residence time of inflowing water in the reservoir, 1 to 6 days during high flow season and about 19 days during low flow season). Hence a time horizon of 10 years is considered reasonable for the Project. Hence, Total Project Reservoir Emissions are estimated as 0.073 million tCO_2e.

2. Emissions from Land Clearing for Civil Works. Construction of dam, power facilities, access roads, offices, and some other project facilities require permanent land clearing. Emissions from land clearing can be calculated as a one-time emission of CO_2 based on the available dry biomass carbon for the total cleared areas for construction, according to IPCC guidelines. According to IPCC guidelines, Temperate dry climate has 100 tons/ha of dry biomass, of which average carbon content is 47 percent. Total land clearing emissions for 6 km^2 are 0.103 million tons CO_2e.

3. Embodied (Life Cycle) emissions in construction materials. The construction of Project consumes about 400,000 tons of cement, 60,000 tons of steel, metals, and other electro mechanical equipment. All of these materials have embodied emissions as a result of the energy used to produce them, meaning that the implementation of the Project creates some upstream emissions in the manufacture of the materials used. The Guidance Note recommended a mean value of 2.9 $kgCO_2e/MWh$ per hydropower as a default factor if no other information is available. Total Embodied (Life Cycle) Emissions are 1.772 million tCO2e.

4. Emissions from Energy Use in Construction. Diesel fuels are mainly used by the construction vehicles and equipment. GHG emissions from Project vehicles and equipment are estimated by EIA during 88 months of construction period. Total Construction Emissions = 0.158 million tCO2e (source: EMAP). The Project emissions from all the above four sources is 2.11 million tCO2e.

Baseline Emissions

Two sources of emissions are considered for estimations of baseline emissions.

1. Baseline Generation Emissions. These are GHG emissions resulting from same amount of electricity generation using other alternate feasible energy sources. This feasible alternative should be realistic in terms of economic, technical, financial, legal and regulatory aspects. The economic and least cost analysis of the Project described CCGT is the most feasible alternative to the Project. Emission Factor for CCGT = 367.56 gCO_2/kWh (source: EAMP). Total Baseline Generation Emissions for 50 years = 224.67 million tCO2e.

2. Baseline Construction Emissions. According to the 'Guidance Note', the default value for one-off emissions for thermal gas power is 503 kgCO2e/kW of installed capacity. The corresponding plant factor is 85 percent. For the installed capacity to produce 12,225 GWh/year requires 1,642 MW of thermal gas power. Total baseline construction emissions are 0.83 million tCO2e. Therefore, the total baseline emissions from above two sources are 225.50 million tCO2e.

Net Emissions

The net emissions (Project Emissions - Baseline Emissions from CCGT) of DHP are minus 223 million tons of CO_2 equivalent.

7. Potential Environmental and Social Impacts and their Mitigations

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 number of 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. In total about 4,643 ha of land will have to be acquired for the project, including some 423 ha of agricultural and grazing land. Other adverse impacts will be mainly of temporary nature during the construction of the project. However, the permanent presence of the Dasu hydropower plant, including all its facilities and 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 impacts of the project will be a major contribution in the energy production in Pakistan in an environmental friendly and clean manner with minimal carbon emission. The final installation of 4,320 MW in additional generating capacity will be experienced countrywide.

7.2. Impact Assessment Methodology

Potential environmental and social impacts were identified on basis of the earlier feasibility study (2009) and the preliminary EIA carried out during that stage, assessment and judgment of the independent consultants, specialists involved in the present ESA, and IOPE members (see **Section 1.4.1**), and the focus group discussions as well as stakeholder consultation workshops which were held in Peshawar, Lahore, Karachi and Islamabad. The significance of potential impacts was assessed using the criteria and methodology given below.

Impact Magnitude

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

The magnitude of potential impacts of the Project has generally been identified according to the categories outlined in **Table 7.1**.

Table 7.1: Parameters for Determining Magnitude

Parameter	Major	Medium	Minor	Negligible/Nil
Duration of potential impact	Long term (more than 35 years)	Medium Term Lifespan of the project (5 to 15 years)	Less than project lifespan	Temporary with no detectable potential impact

Parameter	Major	Medium	Minor	Negligible/Nil
Spatial extent of the potential impact	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project boundary	Specific location within project component or site boundaries with no detectable potential impact
Reversibility of potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains constant
Legal standards and established professional criteria	Breaches national standards and or international guidelines/obligations	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to occur

Sensitivity of Receptor

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

Criteria for determining receptor sensitivity of the Project's potential impacts are outlined in **Table 7.2**.

Table 7.2: Criteria for Determining Sensitivity

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

Assigning Significance. Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor has been determined and the significance of each potential impact established using the impact significance matrix shown below in **Table 7.3**.

Table 7.3: Significance of Impact Criteria

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

7.3. Summary of Assessed Impacts

The project's potential impacts and their significance have been assessed using the methodology described in **Section 7.2** above. These impacts are discussed in the following Sections; a summary of these impacts and their significance is presented in **Table 7.4**.

Table 7.4: Potential Impacts and their Significance

Impact	Project Component	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Environmental impacts during pre-construction phase					•	
Changes in physiography and landform	Main works; KKH, Colony, Resettlement sites, Access roads, Quarry; Disposal area;	Mild	Major	Moderate Adverse	• Develop and implement a landscape plan in the project footprint areas	Low Adverse
Change in land use (7,800 ha) and acquisition of 4,643 ha of land by WAPDA	Main works; KKH, Colony, Resettlement sites, Access roads, Quarry; Disposal area;	Severe	Major	High Adverse	• Compensation for lost assets of affected households and persons according to eligibility matrix of Resettlement Action Plan	Low to moderate adverse
Loss of natural vegetation and trees	Main works; KKH, Colony, Resettlement sites, Access roads, Quarry; Disposal area;	Mild	Minor	Moderate adverse	• Planting of native trees near resettlement villages and along roads • Promote the use of alternatives for fuelwood • Plan for rejuvenation of forests at higher altitudes	Low Adverse
Inundation of 400 year old mosque in Seer Gayal	Main works (reservoir area)	Severe	Medium	High adverse	• Disassembling and rebuilding of mosque at higher resettlement village	Negligible
Impact of increased traffic and transportation on KKH	All contracts	Severe	Medium	High adverse	• Traffic Management Plan, including awareness raising and safety measures	Low to moderate adverse
Inundation of 52 km of KKH -	KKH realignment	Very Severe	Major	Critical	• Realignment and construction of about 62 km of new KKH at higher level	Negligible
Loss of bridges and access roads connecting villages on right bank	Main works	Severe	Major	High adverse	• Building of a new suspension bridge over the reservoir and construction of new access roads on the right bank	Negligible
Adverse impacts on Kaigah	Main works and	Severe	Major	High adverse	• Study, selection and implementation of minimum two community-led	Low to moderate

Impact	Project Component	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Community-led Game Reserve	quarry operation				conservation activities in the DHP sub-catchment areas • Supporting and promoting conservation activities in Kaigha game reserve • Compensation of community for any loses from sales of hunting permits during construction stage	adverse
Social impacts during pre-construction phase					•	
Land acquisition of 4,643 ha for the project	Main works; KKH, Colony, Resettlement sites, Access roads, Disposal area;	Severe	Major	High adverse	• Implement Resettlement Action Plan (RAP); temporary lease of land needed for construction facilities	Negligible
Resettlement of 767 households, totaling 6,953 people	Main works; KKH, Colony, Resettlement sites, Access roads, Disposal area;	Severe	Major	High adverse	• Compensation, resettlement and livelihood restoration of affected households/persons according to RAP	Low to moderate adverse
Relocation of shops/commercial establishments	Main works; KKH,	Mild	Medium	Moderate adverse	• Compensation for lost assets and commercial enterprises. • Assistance and livelihood restoration of affected persons according to RAP	Low to moderate adverse
Loss of civic amenities -	Main works; KKH,	Mild	Medium	Moderate adverse	• Rebuilding of civic amenities by project	Negligible
Loss of 143 ha agricultural land and 280 ha grazing land	Main works; KKH, Colony, Resettlement sites, Access roads, Disposal area;	Severe	Medium	Moderate adverse	• Compensation for lost land, crops and fruit trees according to RAP • Agricultural, Livestock and Fisheries Development Plan	Low to moderate adverse
Impacts of construction of 132 kV power supply line for Project and Colony	132-kV transmission line	Mild	Medium	Moderate adverse	• Compensation of owners of land; • Avoiding residential and agricultural areas and dense forest • Reduction of health hazards for	Negligible

Impact	Project Component	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
					community and workers	
Increased pressure on high altitude forests and grazing areas	Main works; KKH	Mild	Medium	Moderate adverse	• Forest Management Plan, including forest rejuvenation	Low adverse
Generation of sustainable employment	All components	Mild	Medium	Moderate beneficial	• Fixed quota for local workers and technicians • Vocational training • Monitoring of labor rights, workforce composition, working and living conditions	Major beneficial
Increased economic activity	All components	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	All contracts	Severe	Medium	High adverse	• Traffic Management Plan, including awareness raising and safety measures • Implementation of ECP by contractors	Low adverse
Impacts on river habitat due to construction activities and drying of river section between two coffer dams	Main works	Mild	Medium	Moderate adverse	• Control of waste water and sediment releases to river • Implement water quality management protocols in ECPs • Studies to improve aquatic baseline data • Carry out monitoring	Moderate adverse
Fish entrapment and mortality	Main works	Mild	Minor	Low adverse	• Protection measures at inlets of tunnels to deter movement of fish • Implementation of ECP by contractors •	Low adverse
Potential risk of pollution of air, noise, soil and water resources by construction works -	All contracts	Mild	Medium	Moderate adverse	• Pollution Prevention Plans to be prepared and implemented by Contractor	Negligible

Impact	Project Component	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
					• Implementation of ECP by contractors	
Risk of pollution from solid waste and waste effluents	All contracts	Mild	Medium	Moderate adverse	• Waste Management and Effluent Management Plan • Implementation of ECP by contractors	Low adverse to negligible
Loss of land in disposal areas	Disposal area	Low	Minor	Negligible	• Re-use plan for rock material • Disposal Area Restoration Plan • Implementation of ECP by contractors	Negligible
Impact from borrow activities from quarry	Quarry	Mild	Medium to major	Moderate to high adverse	• Controlled blasting • Quarry Area Restoration Plan • Implementation of ECP by contractors	Negligible
Impacts of noise and dust from construction, traffic and use of explosives	All contracts	Severe	Medium	High adverse	• No blasting during night time • Awareness raising and grievance mechanism • Implementation of ECP by contractors	Negligible
Increased risk of landslides	Main works, KKH, colony, quarry, disposal area, access road, transmission lines	Severe	Medium	High adverse	• Permanent monitoring in construction areas • Preventive measures in high alert areas • Emergency Preparedness Plan	Negligible
Impacts from increased human activities on flora and fauna	All contracts	Mild	Minor	Low adverse	• Promote use of non-wood fuels for cooking and heating; • Improvements to community forestry management • Code of conduct for workers and employees • Awareness raising of workers and protection of flora and fauna • Implementation of ECPs by contractors	Negligible
Risk of water pollution of	Main works; KKH	Mild	Minor	Low adverse	• Removal of oil tanks and other potential	Negligible

Impact	Project Component	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
storage tanks in reservoir area	realignment				sources of pollution from reservoir area	
Risk of pollution from solid waste and waste effluents	All contracts	Mild	Medium	Moderate adverse	• Waste Management and Effluent Management Plan • Implementation of ECP by contractors	Negligible
Shortages in local water supply and sanitation in residential areas	All contracts	Mild	Medium	Moderate adverse	• Drinking Water Supply and Sanitation Plan to be prepared by Contractor independent from local domestic services • Implementation of ECP by contractors	Negligible
Disturbance of visual landscape and natural habitats	Main works; KKH realignment; colony; access roads, transmission lines, disposal area	Mild	Medium	Moderate adverse	• Landscaping plan • Establishing nurseries • Plantation of trees • Implementation of ECP by contractors	Low to moderate adverse
Social Impacts during Construction						
Safety hazards due to increased traffic especially for children and elderly people	All contracts	Severe	Medium	High adverse	• Traffic management plan addressing general access • Safety and security actions and procedures to protect local community • Awareness raising among communities • Implementation of ECP by contractors.	Low adverse
Social issues due to influx of in-migrant workers	All contracts	Severe	Major	High adverse	• Awareness campaign • Develop Migration Management Plan • Grievance mechanisms to address complaints	Negligible
Lack of respect of cultural norms and values by work force	All contracts	Mild	Medium	Moderate adverse	• Awareness campaign • Code of conduct for workers • Implement grievance redress mechanism • Implementation of ECP by contractors	Negligible

Impact	Project Component	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
Reduced safety and health risks by interaction workforce with local residents	All contracts	Mild	Medium	Moderate adverse	• Public Health and Safety Plan • Safeguards and awareness raising against communicable diseases. • Implementation of ECP by contractors	Negligible
Increased load on local services and supplies	All contracts	Mild	Medium	Moderate adverse	Contractor to procure camp supplies in a manner not affecting availability of essential commodities.	Negligible
Environmental impacts during Operation & Maintenance						
Inundation of 1814 ha of terrestrial habitat	Main works	Mild	Medium	Moderate Adverse	• Planting of native trees in reservoir buffer areas • Promotion of conservation of natural habitat in Kaigha and other suitable areas (Kandia, Laachi, Sazin kot) • Further studies on terrestrial baseline (**Annex A**) during pre-construction/construction and design of additional offset measures if required • Monitoring programs	Low to moderate adverse
Effect on 571 ha river and tributaries environment on upstream by creation of reservoir	Main works	Mild	Medium	Moderate Adverse	• Developing fish hatchery with native species (snow carps) and open water stocking in the affected tributaries and reservoir • Maintenance of spawning areas • Further studies on aquatic baseline (**Annex A**) during pre-construction/construction and design of additional offset measures if required • Monitoring programs	Low to moderate adverse
Impacts of first filling of reservoir on safety of people and	Main works	Severe	Major	High Adverse	• Awareness campaign and warning signs; • control rate of filling (1 m/day);	Negligible

Impact	Project Component	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
livestock and stability of slopes					• Permanent monitoring of slopes	
No fish migration across the dam	Main works	Mild	Medium	Moderate adverse	• Study fish migration and establish baseline data; • develop fish hatchery and restock tributaries and reservoir	Low adverse to negligible
Reduced water flows between dam and tailrace (4.4 km) during low flow season	Main works	Severe	Major	High Adverse	• Release of 20 m^3/s of environmental flow from dam and 222 m^3/s from tail race • Downstream monitoring and adjustment of flows if required.	Low to moderate adverse
Impact on downstream fish due to changes in water flows and quality (temperature, DO, sedimentation) due to ROR operation	Main works	Mild	Medium	Moderate adverse	• Monitoring of downstream water quality	Low to moderate adverse
Impact of sedimentation on reservoir area	Main works	Severe	Major	High adverse	• Yearly flushing after 10-15 years of operation • Will be reduced after completion of Basha dam	Low adverse
Impact of daily reservoir operations during base load operation	Main works	Mild	Medium	Moderate adverse	• Fisheries Management Plan • Monitoring and study	Low adverse
Impact on downstream fish during flushing operation	Main works	Severe	Major	High adverse	• Flushing during high flow season (not in low flow/winter) • Develop ramp down criteria (5-10 cm/hr) • Monitoring DO and temperature in reservoir and de-stratification or simultaneous release of water from low level outlets and spillways if required. • Downstream monitoring of fish, habitats and sediments	Low to moderate adverse
Impact on downstream fish	Main works	Mild	Medium	Moderate adverse	• Continuous operation of one turbine	Low adverse

Impact	Project Component	Sensitivity	Magnitude	Significance Prior to Mitigation	Mitigation and Enhancement Measure	Residual Significance
due to changes in hydrological flows due to peaking operations					• Using remaining flow for peak operation	
Risk of bird collision and electrocution with transmission cables - (section 7.8.6)	Transmission lines	Mild	Medium	Moderate adverse	• 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 & Maintenance					•	
Loss of employment for construction workers	Main works	Mild	Medium	Moderate adverse	• Vocational training for operational and maintenance • Preference for local construction workers in other WAPDA Upper Indus projects.	Low adverse
Reservoir fisheries will create large number of permanent jobs and improved nutrition	Main works	High	Major	High beneficial	• Fisheries Management Plan • Employment of local people	Beneficial

7.4. Environmental Impacts during Pre-construction Stage

7.4.1. Change in Physiography and Landform

The physiography and landform of the Indus Valley will change gradually during all phases. During pre-construction phase the transition will be moderate only. Villages in the entire reservoir area will be dismantled and new ones rebuilt at higher elevations, trees will be cut. Priority work on KKH will be in full swing and preparation and construction of the WAPDA Colony and offices will start. Other preparations for establishing temporary facilities for workshops, labor camps and other facilities will continue until the mobilization of the contractor.

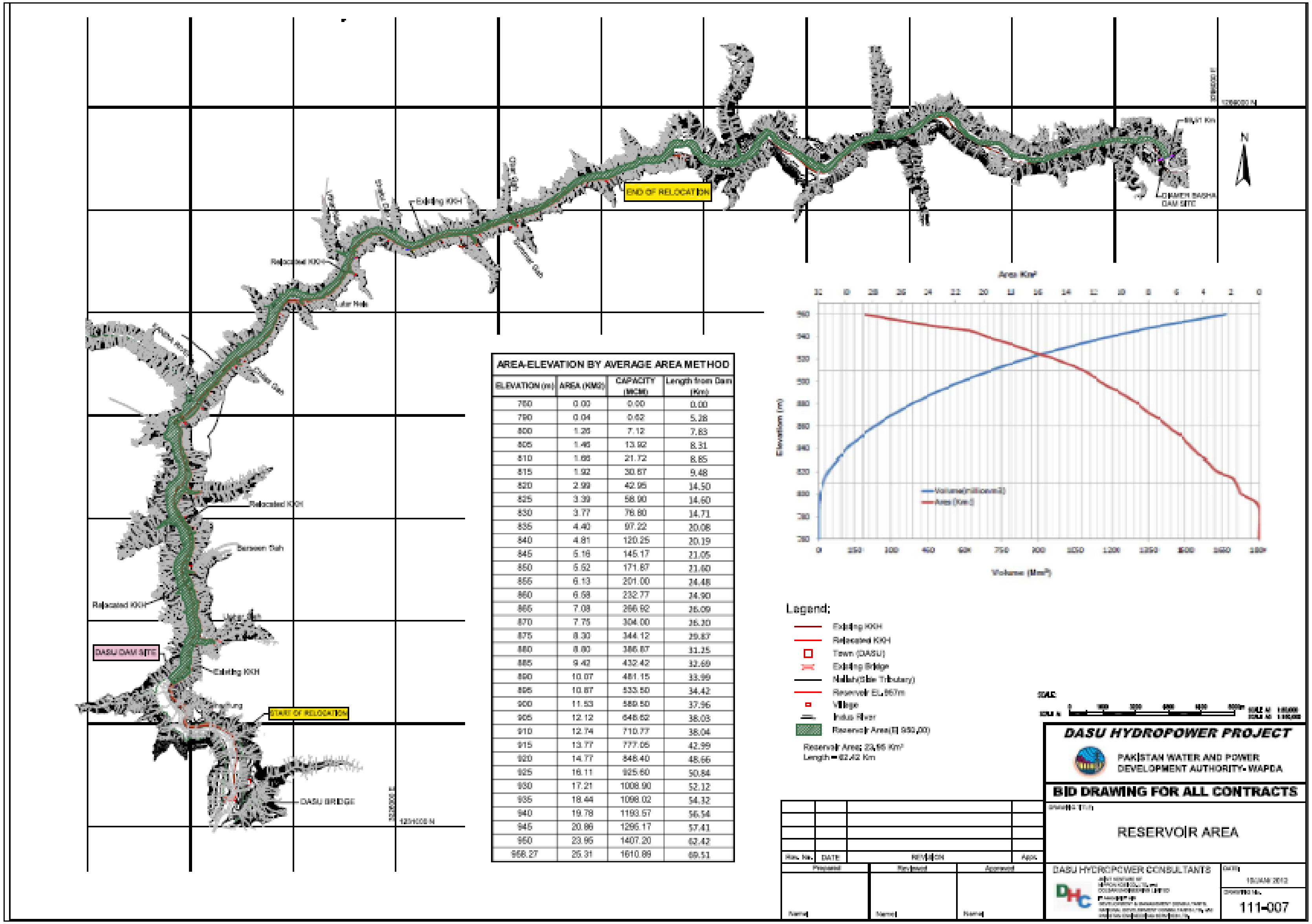
Once the contractor starts major excavation and construction works, the character of the Indus valley bottom and lower slopes will change in the area between the dam and the town of Dasu-Komilla. This will continue during the entire construction period and once the dam and tunnels have been constructed and the reservoir is filled there will be a major change of the entire valley.

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 slowly flowing water reservoir with an average width of 365 m and extending for about 73 km upstream at full supply level (fsl) (see **Figure 7.1**). The flow velocities in the reservoir are medium to slow, ranging between 0.56 and 3.08 m/sec at the head of the reservoir to between 0.02 and 0.14 m/sec near to the dam. In lateral valleys where tributaries and nullahs meet the main Indus valley the reservoir penetrates several km inland to form new natural hot-spots at the confluence of snow-fed small streams with the main water body. The reservoir is expected to rapidly decrease in size due to siltation from 73 km length towards 8-9 km in 15 year after commissioning of the Dasu dam (provided Basha dam is not commissioned in that period). Most of the reservoir (except last 9 km before dam) is expected to develop into a shallow relatively fertile freshwater swamp with riparian semi-aquatic natural vegetation and a main gully carrying Indus water in the low flow season. During high flow season most of the reservoir bottom will be inundated for most of the period, providing opportunities for spawning of fish (e.g. carp).

The new KKH follows the left embankment of the reservoir. The reservoir will be deep near to the dam site with initially depths between 100 and 175 m. New villages are built at selected sites by the affected people. Approaching the dam site, however a completely new landscape is developed over the next 8 km in the direction of the twin city of Dasu and Komilla. At full development an enormous complex of dam and associated hydraulic, mechanical and electrical infrastructure is visible over the next 4-5 km, with on the hill terrace the WAPDA Colony and offices. Part of the hydraulic and electrical infrastructure is underground but transmission lines are now dominating the Indus valley.

A new bridge over the Indus is built upstream of Dasu, which is used for the project related traffic. KKH traffic is now following the new winding KKH road above Dasu until the road is connected with the old KKH crossing the Indus at Dasu bridge like before. The impacts of the changes in physiography have been assessed as Moderate Adverse, especially in the 4 km of the project site situated between dam and tailrace outlet. Without mitigation the landscape will be bare and industrial. Mitigation should start therefore with the preparation of an overall landscape plan for this part of the valley. The plan should be worked out in more detail for the areas of the Colony, the Offices and the road infrastructure of the project.

Figure 7-1: Reservoir Area



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	1.28	7.12	7.83
805	1.48	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	76.80	14.71
835	4.40	97.22	20.08
840	4.81	120.25	20.19
845	5.16	145.17	21.05
850	5.62	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	7.76	304.00	26.30
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	1296.17	57.41
950	23.95	1407.20	62.42
958.27	25.31	1610.89	69.51

In the rest of the areas the impact on physiography and landscape is low adverse to moderately beneficial (development of reed marshes and natural riparian vegetation along reservoir). At other places most of the landscape is expected to return to the baseline condition without major mitigation measures.

Mitigation

For the project area between dam and end of tailrace and for the WAPDA Colony and Offices area a landscape plan will be prepared by a qualified landscape architect and implemented by a contractor.

7.4.2. Change in Land Use

Natural and semi-natural habitats, mainly consisting of steep rocky slopes and some farmland and grassland on river terraces and alluvial fans along the Indus will be inundated and changed into a lake with generally very steep slopes. The total area covered by the reservoir is about 2,400 ha in size. Around 425 ha of farmland on terraces, grazing areas and some orchards will be flooded and disappear into the reservoir. The loss of natural and semi-natural habitats, both with limited biodiversity is relatively minor and will be partly compensated by the creation of a lacustrine environment with potential for fisheries and some tourism development. Livelihood restoration for those affected by loss of land is a major issue.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation Measures

The following mitigation measures will be implemented:

- The loss of farmland will be compensated under the resettlement framework and where available new agricultural lands will be developed at higher altitudes. A comprehensive Resettlement Action Plan (RAP) has been prepared to address the loss of assets including farm lands.
- The total estimated cost of implementation of RAP is PKR 37,881 million (US$ 399 million), which includes about PKR 20,136 million (US$ 212 million) to be paid to the affected people for compensation of loss of land, structures and crops, as shown in **Table 7.5**. These cost estimates are based on inventory of losses complied during May-September, 2012, and current compensation rate evaluation.

Table 7.5: Summary Land Acquisition and Resettlement Budget

	COST ITEMS	Unit	Unit Rate (PKR)	Quantity	Total Cost (m PKR)	Total Cost (m US$)
1 - Compensation and Allowances						
1.1	**LAND ACQUISITIOIN**					
	COMPENSATION (2011 Base Price)					
1.1.1	Grazing/ Rakh	Kanal*	262,000	6,253	1,638.30	17.25
1.1.2	Barren (Ghair Mumkin Stone)	Kanal	100,000	47,582	4,758.16	50.09
	Barren (Ghair Mumkin)	Kanal	190,000	21,652	4,113.96	43.30
1.1.3	Agriculture	Kanal	760,000	3,138	2,385.11	25.11
1.1.4	Residential	Kanal	325,000	603.834	196.25	2.07

	COST ITEMS	Unit	Unit Rate (PKR)	Quantity	Total Cost (m PKR)	Total Cost (m US$)
1.1.5	Commercial	Kanal	325,000	112.2	36.47	0.38
Subtotal (Basic Compensation)					**13,128.23**	**138.19**
	Escalation of 2 Years at 6.5% for 2013 Rates				1,762.14	18.55
	Tax (2%)				262.56	2.76
	Service Charges (15%)				1,969.24	20.73
Subtotal (1.1)					**17,122.17**	**180.23**
1.2	**Structures**					
1.2.1	Katcha	Sq. ft	1,500	740,526	1,110.79	11.69
1.2.2	Pacca	Sq. ft	2,500	87,659	219.15	2.31
1.2.3	Semi Pacca	Sq. ft	2,000	481,413	962.83	10.14
1.2.4	Wood	Sq. ft	1,500	11,326	16.99	0.18
Subtotal (1.2)					**2,309.75**	**24.31**
1.3	**Trees**					
1.3.1	Non Fruit Tree	No.	20,000	18,317	366.34	3.86
1.3.2	Fruit Tree	No.	57,000	2,982	169.97	1.79
Subtotal (1.3)					**536.31**	**5.65**
1.4	**Crops**					
1.4.1	Maize	Per 40 kg	1,500	22,724	34.09	0.36
1.4.2	Wheat	Per 40 kg	1,600	18,592	29.75	0.31
Subtotal (1.4)					**63.83**	**0.67**
1.5	**Relocation Cost (Based on Entitlement Matrix)**					
1.5.1	Dislocation Allowance against loss of agri. Land	Kanal	20,000	2,827	56.54	0.60
1.5.2	Reconstruction Grant for Residential Structure	m^2	250	127,906	31.98	0.34
Subtotal (1.5)					**88.52**	**0.93**
1.6	**Rehabilitation Assistance**					
1.6.1	Special Assistance For Vulnerable HHs					
	Soniwals	No.	200,000	13	2.60	0.03
	Others	No.	150,000	42	6.30	0.07
1.6.2	Assistance against income loss by owners operated commercial setups for three months.	Person	30,000	76	2.28	0.02
1.6.3	Assistance for affected wage earners	APs for 3 months	27,000	137	3.70	0.04
1.6.4	Transfer Grant for relocation of business structures	m^2	100	7113.8	0.71	0.01
Subtotal (1.6)					**15.59**	**0.16**
Sum of Sub-totals of 1					**20,136.18**	**211.96**
2 - Resettlement Sites Development						
2.1	**Land**					
2.1.1	Land Leveling	Kanal	350,000	2070	724.50	7.63

	COST ITEMS	Unit	Unit Rate (PKR)	Quantity	Total Cost (m PKR)	Total Cost (m US$)
Subtotal (2.1)					**724.50**	**7.63**
2.2	**Resettlement sites Infrastructure development**					
2.2.1	Access Roads construction and land compensation	Km	10,000,000	51	510.00	5.37
2.2.2	Mosque	No.	7,360,000	4	29.44	0.31
2.2.3	Water supply Tank(30 Village)	Cu. ft	2,850	57,120	162.79	1.71
2.2.4	Water Supply Channel(30 Village)	per km	695,000	100	69.50	0.73
2.2.5	School (Middle)	No.	12,720,000	2	25.44	0.27
	School(Primary)	No.	6,360,000	4	25.44	0.27
2.2.6	Boundary Wall for Graveyard	per Graveyard	1,170,000	30	35.10	0.37
2.2.7	Dispensary(3 Structures)	per structure	920,000	3	2.76	0.03
Subtotal (2.2)					**860.47**	**9.06**
Sum of Subtotals of 2					**1,584.97**	**16.68**
3 - Livelihood Support						
3.1	Skill Development for affected Communities	per year	100,000,000	15	1,500.00	15.79
Subtotal of 3					**1,500.00**	**15.79**
4 - Local Area Development						
4.1	Infrastructure				1,235.00	13.00
4.2	Entrepreneur Support 10 Years				475.00	5.00
4.3	Capacity Building of Local Government				237.50	2.50
4.4	Training & extension support 10 Years (Services and facilities)	Years	47,500,000	10	475.00	5.00
4.5	Education Fund 10 Years (Literacy Promotion, Scholarships, etc.)				427.50	4.50
Subtotal of 4					**2,850.00**	**30.00**
5 - Institution and Management						
5.1	Building	Sq. ft	2,000	8,160	16.32	0.17
5.2	Fixtures and Furnishing	Lump sum			20.00	0.21
5.3	(a) PMU Staff Salaries	Years	36,100,000	10	361.00	3.80
	(b) PMU Costs during O&M	Years	45,600,000	5	228.00	2.40
5.4	Vehicles	No	4,200,000	10	42.00	0.44
5.5	R&M of vehicles	Years	10,000,000	15	150.00	1.58
5.6	Office Equipment	Lump Sum			10.00	0.11
5.7	Operation & Maintenance Cost	Years	250,000	15	3.75	0.04
Subtotal of 5					**831.07**	**8.75**

	COST ITEMS	Unit	Unit Rate (PKR)	Quantity	Total Cost (m PKR)	Total Cost (m US$)
6 - Planning and Designing						
6.1	Resettlement Implementation Design	Lump Sum			28.50	0.30
6.2	Resettlement Site Development Design	Lump Sum			28.50	0.30
6.3	Livelihood Support Design and Implementation	Year	28,500,000	15	427.50	4.50
Subtotal of 6					**484.50**	**5.10**
7 - Administrative Overheads						
7.1	Administrative Overhead: Land Acquisition By DRO	Lump Sum			10.00	0.11
Subtotal of 7					**10.00**	**0.11**
8 - Monitoring & Evaluation						
8.1	Independent Monitor (2 times a year)	Year	30,000,000	8	240.00	2.53
8.2	Internal Monitoring	month	250,000	84	21.00	0.22
8.3	IPOE	Per visit	3,000,000	14	42.00	0.44
8.4	MIS Development	Lump Sum	One time cost		2.65	0.03
8.5	MIS Staff	Lump sum			24.78	0.26
Subtotal of 8					**330.43**	**3.48**
9 - Training and Capacity Building						
9.1	Consulting Service Cost (Sub Projects) / Outsourcing, (If any)	Lump sum			25.00	0.26
9.2	Research	Year	15,000,000	10	150.00	1.58
9.2.1	National	Year	2,500,000	7	17.50	0.18
9.2.2	International	Year	7,000,000	7	49.00	0.52
9.3	Trainings	Year	30,000,000	10	300.00	3.16
Subtotal of 9					**541.50**	**5.70**
Total (1+2+3+4+5+6+7+8+9)					**28,268.65**	**297.56**
10 - Contingency						
10.1	Physical Contingency (@25%)				**7,067.16**	**74.39**
10.2	Price Contingency (@9 %)				**2,544.18**	**26.78**
Subtotal of 10					**9,611.34**	**101.17**
GRAND TOTAL					**37,879.99**	**398.74**

* 1 Kanal = one eighth of an acre or $506m^2$ or 0.05ha, 1$=95 PKR as per 2012 rate

Residual Impacts

Despite the implementation of the very elaborate measures included in the RAP and listed in **Table 7.5** above, the impacts associated with change in land use cannot be fully mitigated. The residual adverse impacts of land use changes have therefore been assessed as low to moderate, as shown in **Table 7.4**.

7.4.3. Loss of Natural Vegetation and Trees

In the area reserved for project facilities and reservoir a total number of 21,000 trees has been identified, including some 2,982 fruit and medicinal trees. The majority of the trees present in area where the main project facilities will be constructed has been surveyed. Per village the most dominant species are indicated (see **Table 7.6**). Generally all species present are very common and widely distributed throughout the project area including downstream of dam axis.

Table 7.6: Affected Tree Species

	Village	Habitat Types	Tree Species
1	Dooga Gah	Steep rocky slope	*Quercus baloot, Olea ferruginea* and *Cotinus coggygria*
2	Choochang	Rocky steep to moderate slopes	*Olea ferruginea, Quercus baloot,*
3	Khoshi	Gentle slope	*Olea ferruginea* and *Quercus baloot*
4	Siglo	Gentle slope	*Olea ferruginea, Quercus baloot* and *Cotinus coggygria*
5	Seer Gayal	Rocky steep to intermediate slopes	*Olea ferruginea* and *Cotinus coggygria*
6	Toothi	Rocky steep slopes	*Qurecus baloot, Cotinus coggygria* and *Olea ferruginea*
7	Seo	Rocky gentle slope	*Olea ferruginea*
8	Malyar	Rocky steep slope	*Quercus baloot* and *Olea ferruginea*
9	Panibah	Rocky gravelly	*Olea ferruginea* and *Quercus baloot*

Bushy vegetation and shrubs have been developed on the steep slopes of the Indus valley. This vegetation does not represent much natural and commercial value, other than as a source of firewood for the local communities. 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 also have an effect on the collection of firewood. People will move to higher places in order to collect. Selling of fire wood is an important business in the project area and a common practice along KKH mainly in winter season and also partly in summer season. People harvest oak, wild olive and other fuel wood trees from forests and store in the form of wood toll on the main KKH. The daily sales of firewood are very high and people can earn a large amount. The local selling rate of the firewood amounts to PKR 260 (equal to USD 2.50) per 50 Kg. It is expected that the Project will attract in-migrants (construction workers, their families and service providers). 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 even further, which are already under heavy pressure from local communities for commercial logging, firewood and grazing.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation Measures

The following mitigation measures will be implemented:

- **Tree plantation:** The loss of trees will be compensated by successful plantation of native species. The lost trees will be replaced at a ratio of 5:1 in the buffer area of the reservoir on the right bank, near to resettlement sites, around the DHP offices and residential colony. Suitable species of tree plantation are given in **Table 7.7**. The losses of the community caused by on the felling of trees will be compensated by allowing the community to cut and use the wood in addition to the monetary compensation. The communities will also play a key role in planting and watering the plantations.

Table 7.7: Recommended Species for Tree Plantation

	Family	Tree species	Local Name
1.	Anacardiaceae	Cotinus coggygria Scop.	Khakoh/Shini
2.	Anacardiaceae	Pistacia chinensis Bunge	Kangar
3.	Anacardiaceae	Rhus mysurensis Heyne.	Kasudur
4.	Fagaceae	Quercus baloot Griffith	Bani/Jaand
5.	Oleaceae	Olea ferruginea Royle	Kao

- **Alternatives for fuelwood:** The Project will support the local government to establish a market for the supply of non-timber fuels such as LPG for cooking and heating to reduce the pressure on firewood. Contractors shall also minimize the use of fuel wood and encourage the use of non-wood fuels such as LPG to the construction staff for cooking and heating purposes.
- **Forest rejuvenation and planting**: At higher altitudes (> 1500 m) a number of forest plantations will be established where forest could be rejuvenated. This will be done at selected places on both sides (left and right bank) 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 (a.o Swat Kohistan).

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with vegetation loss are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.4.4. Impacts on Physical Cultural Resources in Project Area

The 400 year old historic mosque in the village Seer Gayal will be flooded by the reservoir, together with the houses of the hamlet. In consultation with the local community it was agreed that the wooden structures will be disassembled, transported and reassembled at a higher altitude at the new location of the village. Also 16 graveyards spread over the valley will be submerged by the reservoir. With the various communities alternative proposals for mitigation were discussed. Most communities preferred to leave the graves at the place of burial, but to protect them against erosional forces of the water.

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 to the disposal areas. Also the cluster of petro glyphs (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 should be protected in consultation with the Archeological department. This complex is one of the largest fields of rock art in the world, with carvings dating from Stone Age (9^{th} millennium BC to Buddhist period).

The above impacts have been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation Measures

The following mitigation measures will be implemented:

- Archeological survey will be carried out in the reservoir area to identify any PCR sites/artifacts not identified through the investigations carried out during the ESA. In case of any discovery, a plan will be prepared in consultation with the Archeology Department for their protection and conservation.
- The mosque at Seer Gayal will be disassembled and reassembled at a new location.
- The graves will be protected by stone-pitching so that no floating and washing away of the bodies or skeletal remains occur.
- DHP will support KP Archaeological Department to (i) procure 25 acres of land for acquisition of land, in which rock carvings are located, (ii) fence the area, (iii) provide fiberglass sheds; (iv) develop tourist facilities and (v) documenting the importance of rock carvings and their translations. The CSC will prepare a detailed plan for this purpose.
- In case any artifact or site of archeological, cultural, historical, or religious significance are discovered during construction activities, the works will be stopped in that area, and the Archeological Department will be informed. Provisions for this will be included in the contracts and a qualified archeologist will be standby during the first five years of the project.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with physical cultural resources are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.4.5. Impacts due to Increased Traffic and Transportation

During design stage and during mobilization of the contractor traffic along KKH and in the twin city of Dasu-Komilla will increase and this will boost up even further as soon as construction is started. This will lead to congestion at certain places like main streets, central markets and bus stops. Apart from congestion there will be increased air pollution and noise at these places. This might result in friction with shopkeepers, hotel/restaurant owners and general public. Road safety will decrease and risk of accidents will increase.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation Measures

The following mitigation measures will be implemented:

- The contractor will prepare a Traffic Management Plan (TMP) and obtain approval from the supervision consultants. The approved plan will be implemented.
- Establishment of traffic management committee with the relevant stakeholders (traffic agencies, local governments along KKH, contractor).
- Hold a one day workshop with the stakeholders to devise a plan for traffic management along KKH during construction period.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with increased vehicular traffic are likely to be mostly addressed. The associated residual impact has been assessed as low to moderate adverse (see **Table 7.4**).

7.4.6. Inundation of 52 km of KKH

Around 52 km of the Karakorum Highway (KKH) will be submerged by the reservoir. This part of the road lies between Dasu and Shatial. About 45 ha of land will have to be acquired for road construction purposes.

This impact has been assessed as **Critical**, as shown in **Table 7.4**

Mitigation

The following mitigation measures will be implemented:

- A new alignment will be constructed at a higher level on the left bank of the Indus. A total of about 62 km of highway will be constructed including 10 km of bypass road downstream of Dasu and a link road of 3 km. Five new bridges in the KKH will be constructed crossing nullahs and small streams.
- The land required for these road segments will be acquired following the procedure defined in the RAP. The cost of this land acquisition is included in the overall resettlement budget given in **Table 7.5**.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with inundation of KKH are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.4.7. 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. The existing villages which will not be flooded and the new resettlement sites will need proper access and connectivity to the KKH.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- A new suspension bridge near Kandia will be constructed
- A total of 35 km of new access roads will be built, all at a higher level of the right bank of the Indus.

- A new jeepable track of 18 km will provide access to the villages in Kandia valley.
- All new settlement sites will be provided with good access roads.
- Other existing facilities for pedestrians to cross the river, such as foot bridges and cable cars will be replaced by appropriate alternatives. Different options for pedestrians for crossing the 73 km long reservoir will be considered since these connections are important assets and a lifeline for the remote communities at the right bank with the rest of the world.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with loss of access to villages are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.4.8. Impact on Kaigah Community-managed Game Reserve (KCGR)

The following permanent impacts have been identified that cannot be mitigated, but only compensated by other conservation measures:

- Loss of a strip of land (estimated at some 31 ha) from the KCGR due to construction of the new alignment of KKH;
- Loss of land (estimated at some 51 ha) from the KCGR due to submergence by the reservoir;

During construction there will be the following impacts:

- Impacts on Kaigah village community due to loss of income from wildlife management (share of sales of hunting permits estimated at USD 75,000 annually);
- Disturbance of wildlife by noise and vibrations from blasting and from excavation, crushing and loading operations during Construction;

Permanent impacts on the reserve may be the result of the increased population pressure from nearby DHP. This might lead to frequent disturbance of wildlife, increased poaching and hunting activities, deforestation and degradation by collection of firewood, medicinal plants and other forest products.

The impacts on KCGR have been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation and Compensation

Part of the construction related impacts can be reduced by suitable mitigation measures such as controlling access to the reserve and by limiting and reducing blasting operations below stringent international threshold values. However some of the above mentioned impacts may continue during operation of the project for some time. Monitoring of the conservation status of the KCGR is therefore important.

The following mitigation measures will be adopted:

- Monitor wildlife in the reserve in cooperation with wildlife and forest officials;
- Monitor noise levels during utilization of the quarry;
- Reduction of duration, timing and strength of blasting operations and vibrations according to internationally recognized standards (e.g. Australian standards);

- Use the 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;
- Kaigah community will be compensated for loss of income from wildlife management with other assistance activities;
- The community will be consulted and involved in the selection of alternative options to strengthen ecological conservation measures;
- A study will be undertaken to identify alternative wildlife conservation to be implemented elsewhere in the sub-catchments from DHP, possible also at the right bank of the reservoir. ToRs of the study are presented in **Annex A**.

Residual Impacts

Some of the impacts on KCGR are permanent and cannot be mitigated. These are:

- The direct loss of about 82 ha of land from the reserve;
- The disturbance of wildlife habitat and ecology through the presence of nearby population centre, colony and power plant with related infrastructure and operational activities.

The residual impacts on the reserve are estimated to be low to moderately adverse.

An adequate compensation measure for the loss in nature conservation value of Kaigah reserve will be worked out in the framework of an overall Ecological Conservation Plan for DHP catchment area, which could include forestry and improved watershed management activities including habitat conservation and restoration.

7.5. Social Impacts during Pre-construction Stage

7.5.1. Land Acquisition for the Project

A total of 4,643 ha of land have to be acquired for the project. This includes 2,778 ha of land below the 1,000 m contour that will be covered by the reservoir and its fringes, 174 ha to be used by physical project infrastructure and 205 ha for construction of roads (KKH and access roads). The area to be acquired consists of natural wastelands and some 425 ha of agricultural land such as 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 for the people affected and their resettlement at higher altitudes including assistance and livelihood restoration. According to inventory surveys and a census, a total of 767 households consisting of some 6,953 persons, more or less equally divided over both river banks will be affected by the project and will have to be resettled above 1,000 m.

Some more land might be (temporary) needed during construction for installing of construction facilities such as batching plant, workshops, labor camps and borrow areas. Also for storage of materials much space is needed.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- A RAP has been prepared to address and mitigate the impacts on the affected households, as described earlier. The objective of the plan is to improve or at least restore the income and livelihood conditions of the people to at least pre-project level. The households affected will not only receive cash compensation for land and other assets at prevailing rates for full replacement cost, but also additional assistance will be given for relocation, re-employment and livelihood restoration. A program of livelihood development will be implemented that consists of both short-term and long-term interventions to support sustainable livelihood development.
- **Table 7.5** presents the cost estimates for RAP implementation including land acquisition.
- Contractors will lease the land for construction facilities on temporary basis. Proper documentation will be carried out for this leasing.

Residual Impacts

Despite the implementation of the very elaborate measures included in the RAP, the impacts associated with land acquisition cannot be fully mitigated. The residual impacts of land use change have therefore been assessed as low to moderate; see **Table 7.4**.

7.5.2. 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. Seventeen villages are situated on the right bank and seventeen villages on the left bank. A total of 923 houses and residential structures will be lost.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- Compensation and assistance in resettlement, including development of identified resettlement sites and provision of infrastructure. The associated cost estimates are included in the overall resettlement budget (**Table 7.5**).
- Consultations with the inhabitants have revealed that most of them do not want to move away from the valley, where their present abodes are located and most of the lands remain. The main reason is that most of them are predominantly livestock holders and pastoralist used to seasonal migration to higher altitudes in the valley, where they already have one or more summer residences near to some farmlands and extensive grazing areas. The project identified 13 potential resettlement sites at higher locations. Most of the people prefer to move with their small community to a self-selected and self-managed site at a higher location in the same valley. About 10 percent have opted for relocation "down country" in more populated areas on their own.

Residual Impacts

Despite the implementation of the very elaborate measures included in the RAP, the impacts associated with relocation of hamlets cannot be fully mitigated. The residual adverse impacts of land use change have therefore been assessed as low to moderate, as shown in **Table 7.4**.

7.5.3. 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 to the KKH. The commercial enterprises on the right bank usually consist of residential houses with a small shop as annex.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- Compensation and/or resettlement assistance is worked out in details in the RAP and the Resettlement Framework.
- The associated costs are included in the overall resettlement budget given in **Table 7.5**.

Residual Impacts

Despite the implementation of the very elaborate measures included in the RAP, the impacts associated with relocation of shops cannot be fully mitigated. The residual adverse impacts of land use change have therefore been assessed as low to moderate, as shown in **Table 7.4**.

7.5.4. Loss of Civic Amenities

A survey of 27 villages out of 34 villages revealed that there are 31 existing mosques, seven schools, two basic health units, three community centers and 17 graveyards, facilities for drinking water supply and irrigation, and latrines. Most of the affected villages have direct access roads from KKH (left bank) or internal access roads (right bank).

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- The lost amenities with similar or better condition/capacity will be constructed at the resettlement sites.
- The associated costs are included in the overall resettlement budget given in **Table 7.5**.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with loss of amenities are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.5.5. Loss of 423 ha of Farm Land, Grazing Area and Crops

About 600 families that are presently involved in agriculture will lose their cropping areas (double cropping) in the lower valleys and along the banks of the Indus, wherever land is available. In high-altitude lateral valleys only one crop per year is grown during the warmer summer season. The combination of summer and valley crops is sufficient for family consumption requirements (there is no local market). Submergence of the most productive agriculture on the relatively flat areas along the river will result in severe shortage of both family employment and food. Although farmer families indicated their preference to continue with the same livelihood, the opportunities are very limited. Over 95 percent of the land is uncultivable, and the remaining small plots (terraces) are fully in use already. Adding pressure on the use of these plots by additional farmers will increase the already common land disputes. The food situation of some 300 other families, practicing part-time agriculture in and around the villages, will also weaken.

Livestock herding on higher altitudes during summer may continue, but the winter part of this activity, along the river embankments, will cease, resulting in factual collapse of the livelihood of those herders that cannot find low areas downstream of the main structure.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- A livelihood restoration program will be implemented in order to sustain and improve agriculture and livestock herding. Simultaneously, new potential opportunities will be developed such as reservoir fisheries development, a forestry management program and provision of temporary employment and additional income in clearing of vegetation and trees in the reservoir area. These programs will be introduced at an early start of the project in order to prevent further malnutrition, unemployment and impoverishment of the local pastoralist families.
- The cost associated with the above initiatives is included in the overall resettlement budget given in **Table 7.5**.

Residual Impacts

Despite the implementation of the very elaborate measures included in the RAP, the impacts associated with loss of agriculture land and grazing areas cannot be fully mitigated. The residual adverse impacts of land use change have therefore been assessed as low to moderate, as shown in **Table 7.4**.

7.5.6. Increased Pressure on High Altitude Grazing Area and Forests

Resettlement of about 3,200 people above 1,000 m altitude will mean that pressure on the mountain zone between 1,000 and 1,500 m and higher will increase. Especially the grazing areas and forests around 2,000 m are currently already under pressure, resulting in deforestation, erosion and decrease of flora and fauna. The pressure will certainly increase as a consequence of the project. Deforestation and increasing erosion will have serious consequences and will lead to further land degradation and possible flash floods after heavy rainfall. The high biodiversity of vegetation and wildlife will be under stress from agricultural use, firewood collection, overgrazing, over-harvesting of medicinal plants and forest products, poaching and poor law enforcement.

This impact has been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- A forestry management project is planned, with the objective of regeneration of forest and grazing areas at higher altitudes.
- Regeneration, rejuvenation and protection of natural forest, through a mixture of different measures including watershed management, erosion control, tree planting, improved (certified) forest exploitation. This project could be implemented within the framework of the livelihood restoration program.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with increased pressure on forests could be partly mitigated. The residual impact however will remain low adverse (see **Table 7.4**).

7.5.7. Impacts of the Construction of the 132 kV Power Supply Line to Project and Colony

The area of the new 45 km long alignment of the power supply line from Dubair Khwar (4 km downtown of Pattan) to Dasu (Chuchang area) leads through an almost barren area, with only few small hamlets or small villages with 25- 35 households on average. The alignment follows the KKH at the right bank on the side of the mountain for almost 35 km. Near to the village Jalkot the line crosses the Indus and continues further towards Chuchang along the left bank of the Indus. In this way the residential areas at Komilla and Dasu are avoided. It has been estimated that the power line will have 233 towers, each about 32 m high.

Construction of the transmission line will have the following social and environmental impacts:

Land Acquisition and ROW: The land needed for the footprint of each tower (6 x 6 m) has to be acquired from the owners of the land. The total land acquisition is low (about 1 ha is needed). No resettlement is required. However agreements have to be signed with the owners for the use by PESCO of the Right of Way (ROW) needed for operation and maintenance of the transmission line. The ROW is the corridor of 60 m wide, where land use and vegetation is restricted for reasons of safety. Tall and fast growing trees should be cut and dense vegetation removed in order to prevent the possibility of contact with the lines and the risks associated with forest or bush fires. The total area needed for maintenance is 270 ha. No acquisition of land is required for the ROW, but an adequate compensation has to be paid by PESCO for the restrictions in the land use and the utilization by the company of the ROW corridor for maintenance and repair work.

Community Health and Safety Hazards: There is a potential danger for electrocution, from direct contact with high voltage electricity or from contact with tools, vehicles, ladders that are in contact met high voltage transmission.

There could be some electro-magnetic interference in radio and communication devices, especially during periods of rain, sleet or snow and hail. This could affect radio reception. However it is not expected that electromagnetic fields will be much of a problem since the strength of magnetic fields is relatively low due to the low voltage of the lines and the low population density in the area. Also the exposure of the public to electric fields will be low, since the transmission lines avoid as much as possible the residential areas and buildings, especially schools. If required in residential areas cable shielding technique could be used to minimize electro-magnetic interference.

During installation, but also during maintenance there can be some hinder and nuisance from noise and dust resulting from transportation of materials, the installation of equipment and use of machinery.

Occupational Health Hazards of the Workers: This is an important problem since workers could be exposed to contact with live power lines during construction, maintenance and operation activities. Moreover they are working often at high altitudes in poles and structures and therefore exposed to considerable risks. Electric utility workers also have a higher exposure to EMF (electric and magnetic fields) since they are working in the proximity to electric power lines.

Impacts on Natural Habitats: There could be environmental impacts from construction work on watercourses and nullahs. About 20 nullahs have to be crossed and these sites are usually ecological hotspots.

Impacts of ROW Maintenance on Natural Vegetation: The vegetation of the ROW should regularly be monitored. Timely thinning, slashing and cutting of vegetation can prevent the outbreak of forest fire.

The above impacts have been characterized as Moderate Adverse as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- Compensation will be paid for any private land that needs to be acquired in accordance with the RAP prepared for the DHP.
- Safety hazards can be mitigated by installing warning signs, barriers, steel posts surrounding transmission towers to create barriers for people to climb in masts. Raising awareness of residents and an education program aimed at schoolchildren providing information of possible hazards and risks can help to prevent such problems. Grounding of metallic objects installed near to power lines can be recommended.
- Only trained and certified workers should be allowed to install, maintain and repair electrical equipment. Strict safety and insulation standards should be maintained, as well as minimum approach distances for people not directly associated with power transmission. Safety belts, fall protection devices and specific tools and equipment for working at high altitudes should be used by workers working in towers. EMF levels should be continuously monitored and exposure levels recorded in order to remain within the international accepted limits of exposure.
- Aquatic habitats should be spared, since these are usually important spawning and over-wintering places for fish. Critical habitats should be avoided and riparian vegetation spared. Water courses should not be blocked. Temporary roads and tracks used for construction should be provided with span bridges or open-bottom culverts or other methods at nullah crossings.
- Maintenance should be based on ecological principles, avoiding the introduction of non-native plant species and to encourage the restoration of the natural habitat with herb vegetation (e.g. Artemisia sp.) and some low shrubs. This is possible by removing fast growing trees and dense bushes. Herbicides should not be used and there should be no planting or sowing of seeds in natural habitats.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with the construction and operation of the 132 KV transmission line are likely to be adequately mitigated. The residual impact will therefore be quite negligible (see **Table 7.4**).

7.5.8. Generation of Employment in the Region

Currently only 26 percent of the population is employed, most of them are self-employed in agriculture or livestock holding or as small shopkeeper. From those working about 17 percent works as unpaid family helper. Only 12 percent of them are working as employee. The project offers good opportunities for local residents to apply for employment as unskilled and skilled construction worker. Within the construction contracts the contractor(s) would have to attract local workers and technicians on basis of agreed quota. Construction works could offer at least for a period of 10 years many opportunities for unskilled workers and technicians. 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 is already started by WAPDA**:** local youths are receiving a six-month vocational training in various lines of work to prepare them for guaranteed jobs in the project construction work. The graduates may also obtain jobs elsewhere, if they choose to. Establishment of vocational training centers for men and women will be part and parcel of the project resettlement plans. After the construction phase there will be other opportunities for more permanent functions within the project operation and maintenance. All these new opportunities for work for local residents could boost employment and improve the social and economic position of the population. This will be a major and significant positive impact of the project.

This impact has been assessed as **Moderate Beneficial**, as shown in **Table 7.4**.

7.5.9. 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. All these developments will considerably stimulate the local economy in the district.

This impact has been assessed as **Moderate Beneficial**, as shown in **Table 7.4**.

7.6. Environmental Impacts during Construction Stage

7.6.1. Increased Traffic on KKH and Local Access Roads

The KKH is the life line of northern areas and it is 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 are currently using 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 congestions and safety hazards. The access road to the project along the busy Komilla bazaar and those from borrow areas and to deposition sites are also expected to create traffic problems and safety hazards.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- The contractor will be required to prepare a Traffic Management Plan in close cooperation with the Project Management Unit (PMU) and the local authorities. This plan will include safety measures, traffic control measures, provision of by-passes at busy places and provisions for repair of damage caused by project vehicles.
- Establishment of traffic management committee with the relevant stakeholders (traffic agencies, local governments along KKH, contractor).
- Hold a one day workshop with the stakeholders to devise a plan for traffic management along KKH during construction period.
- A traffic unit at Dasu is proposed to control the construction related traffic inflow and outflow with sub offices along KKH at Hassanabdal, Haripur, Abbotabad, Chatter Plain, Thakot, Besham, Pattan, Komilla, dam site, quarry site Kaigah. These offices will be connected with telephone, fax, mobile phone and internet.
- The movement of traffic carrying cement or steel to be register at Hassanabdal (junction of KKH and GT Road). These will travel in small lots of 10 trucks. Hassanabdal sub-office will inform the next stations by phone, fax or internet.
- The weather conditions must be known before the start of the journey from Met office and drivers must be briefed before the start of the journey so that cargo may be protected from rain damage and driver may plan the journey accordingly.
- The receiving stores must be notified, who must prepare for offloading the goods. This preparation includes the location of offloading, laborers for offloading together with crane or low lift fork lifters.
- Traffic facilities, such as speed limits and signal lights, are to be strengthened from Hassanabdal to Dasu
- Support to be provided to the local traffic authorities to engage traffic police at the busy junctions.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with increased traffic on KKH are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.6.2. Impact on River Habitat due To Construction Activities in the River

At the damsite coffer dams will be placed upstream and downstream of the work areas to keep the river bed dry for about 980 m length to facilitate construction of the dam. Aquatic biological production will be eliminated from approximately 980m of stream length, part of which (the dam footprint) will be removed for the life of the dam. Pre-construction and construction activities have potential to adversely affect aquatic biota by release of high concentrations of sediment, fuels/oils and other toxic compounds, and solid waste and use of explosives. 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.

This impact has been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented to address the potential impacts described above:

- Control of waste water and sediment releases to river particularly in the section between coffer dams
- Contractor will be required to implement the water quality management protocols given in ECPs
- WAPDA will commission a study to collect additional aquatic baseline data and to prepare management plan for the aquatic resources of the area (Study ToRs are presented in **Annex A**).

  A monitoring program will be initiated for the impact of the construction activities on the aquatic habitat and key species.

Residual Impacts

Despite the implementation of the above mitigation measures, the potential impacts associated with the construction activities in the river bed are not likely to be completely mitigated. Hence the associated residual impact has been assessed as Moderate Adverse (see **Table 7.4**).

7.6.3. Entrainment and Mortality of Fish

The construction of Indus water diversion tunnels where high water velocities may develop will have impact on fish. Fish trying to move downstream in water conduits such as diversion tunnels, powerhouse intake tunnels, lower level outlets and spillways will potentially be subjected to high levels of mortality and injury.

This impact has been assessed as **Low Adverse**, as shown in **Table 7.4**.

Mitigation

Inlets should be protected either by entrainment screens or by acoustic and or electric methods in order to prevent fish to be caught by the inflow and be killed in the turbines. Under the local circumstances it is not easy to find a suitable technical solution and this should be subject of more detailed study (described in **Section 7.6.2** above) by the design team together with a fishery specialist. On basis of these studies the most feasible solution for mitigation should be determined.

Residual Impacts

Despite the implementation of the above mitigation measures, the potential impacts associated with the construction activities in the river bed are not likely to be completely mitigated. The associated residual impact therefore has been assessed as Low Adverse (see **Table 7.4**).

7.6.4. Potential Risk of Air, Soil and Water Pollution

During construction there is a high risk of accidental spills and leakages that may occur from fuel and oil tanks, vehicles and machinery and storage of chemicals used in construction areas, yards, batching plants, quarry areas, worker camps, and residential areas and from storage sites. These spills can pollute soils and contaminate surface water and groundwater in the area. Waste effluents from temporary facilities such as camps and offices can also contaminate soil and surface run off. Air pollution may occur by emissions from construction related traffic and machinery.

These impacts have been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- The contractor will prepare and implement a Pollution Prevention Plan prior to the start of the work. Proper baseline data will be collected.
- The contractor(s) will be required to implement the measures prescribed in the Environmental Code of Practices (ECP), which will be included in the contracts. Detailed ECPs are included in the **Annex C**.
- Contractor(s) will be required to take appropriate measures to avoid and contain any spillage and pollution of the soil and water resources both upstream and downstream of the dam.
- Construction equipment and vehicles will need to be well maintained, so that emissions are minimal.
- Dust generation from construction sites will be restricted as much as possible and water sprinkling would be carried out as appropriate, especially at those places where earthmoving, excavation and blasting will be carried out.
- Air quality will be properly monitored, especially near the population centers and WAPDA colonies. Protocols and measures for the use of relevant equipment and machines should be prescribed in the ECPs (**Annex C**).
- Permanent and regular monitoring will be carried out.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with air, soil and water pollution are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.6.5. 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, contaminated soil, oil filters and other waste products. The offices, residential colonies and contractor camps at the peak time of construction are estimated to produce about 1821 kg of solid waste per day (0.3 kg/capita/day). A large part of this waste is bio-degradable. In addition small quantities of hazardous waste will also be generated mainly from the vehicle maintenance activities (liquid fuels; lubricants, hydraulic oils;

chemicals, such as anti-freeze; contaminated soil; spillage control materials used to absorb oil and chemical spillages; machine/engine filter cartridges; oily rags, spent filters, contaminated soil, etc). It is imperative that such waste is responsibly disposed to avoid adverse environmental, human health and aesthetic impacts.

This impact has been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- Contractor will prepare and implement pollution prevention plan
- 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 minimal 100 m from the banks of any streams and at least 500 m away from any residential areas, cultural or archaeological sites.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with waste generation and disposal are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.6.6. Potential Loss of Land in Disposal Areas

With the construction of tunnels and underground chambers for housing 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. Part of the excavated rock can be used as concrete aggregate provided the fragmented rock meets the quality standards needed for the work. Mixing with fresh quarried rock is possible. In order to reduce the amount of rock to be disposed, excavated rock can be used in the project for different types of infrastructural works, including road construction. The remaining spoil will be disposed in designated and safe disposal areas.

These impacts have been assessed as **negligible**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- Minimize the generation of spoils by recycling the excavated rock to the maximum extent possible by using them as aggregate material in the concrete works;
- A re-use plan for the disposal areas will be prepared in advance.
- A Spoil disposal plan will be prepared and implemented
- The disposal area will be re-contoured to minimize changes in topography

- Dispose excess rock material in the designated disposal site in an orderly manner (different spots to different size rocks).

7.6.7. Impacts from Borrowing Activities

A number of borrowing areas will be used for the project. Some are near to the project, but others are located at considerable distance outside the district. Some 16 million tons of fine and coarse aggregate will be needed for the construction of the main hydraulic structures. Most of it will come from a quarry at Kaigah and transported by conveyor belt to a stock pile at 1.6 km distance at the other side of the river. Kaigah nullah is the location of a designated (Act of 15 July 2000- Government of NWFP) Wildlife Community Conservation area (5000 ha) where trophy hunting of markhor sheep is allowed. The area is bordered by the KKH and located at short distance of the proposed quarry site. In the area limited hunting on markhor sheep is allowed within the framework of wildlife management by WWF-Pakistan in cooperation with the KP wildlife department. With the proceeds of the yearly auction of hunting rights a number of community development activities are financed. Potential impacts of the quarrying activities nearby this reserve might disturb wildlife, loss of hunting opportunities and loss of income for the villagers. KKH traffic will not be affected since traffic will use the new alignment of KKH, which is higher up onto the slope. Main impact will be noise and dust from the excavation activities and vibrations and noise from blasting. People will hardly be affected, since the neighboring village has already been resettled. However wildlife will be disturbed and might move to higher altitude. In how far this will affect the hunting activities in the Community Managed Game Reserve is uncertain. Developments should be closely monitored during the operation of the quarry in close cooperation with the Wildlife Department and the community responsible for management of the reserve.

These impacts have been assessed as **Moderate to High Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- Detailed studies will have to be carried out to assess the impacts of all borrowing activities for the project in the region.
- Adverse impacts on landscape, drainage, vegetation, and wildlife will need to be as much as possible prevented
- Potential direct and indirect impacts of the quarrying activities on the Community Managed Conservation area of the Kaigah nullah reserve will be identified and closely monitored and any adverse or irreversible impacts will be mitigated or compensated.
- A land use and restoration plan for all borrow areas will be developed.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with material borrowing are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.6.8. Noise and Dust Generated by Construction Works, Increased Traffic and Use of Explosives

It has been estimated that at least 20,000 ton 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 town of Dasu-Komilla and the village of Seo are very vulnerable for increased noise and dust from traffic. Noise levels may exceed the national standards. The village Seo and nearby hamlets are close to the project and the disposal areas. These villages will be exposed to high noise levels from the project. The V-shape of the Indus valley will reinforce the noise levels. Noise of 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 could lead even to structural damage on buildings.

These impacts have been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- Continuous monitoring of noise and dust levels will be carried out,
- Continued consultations with the affected communities will be carried out
- Blasting and drilling during night time and on during Friday prayers will not be carried out.
- Dust prevention measures by contractor, e.g. regular watering of roads and tracks near to residential areas
- Measures to protect workers for excessive noise and dust
- NEQS compliance will be ensured.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with noise and dust generation are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.6.9. Increased Risk of Landslides

During construction there is an increased risk of landslides and collapse of slopes. Landslides are natural and common phenomena in the project area and along the KKH. Landslides in freshly-cut slopes can occur due to lubrication or saturation of rock support structure by rainfall or by water seepage. The use of explosives to break the rock will have the capacity to generate vibrations which can trigger a landslide. Landslide- prone areas in the project area have been identified and classified on basis of potential risks.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- Any blasting activities in these areas will be controlled and contained within defined limits.

- Pro-active measures will be implemented to stabilize and protect slopes and to protect workers safety. Early warning systems will be introduced that will indicate when cracks appear and allow any widening to be monitored. Access would be restricted during the periods that slope stability is not yet entirely secured and guaranteed by proper safety measures such as rock bolts, anchors, safety nets and gabion structures.
- Permanent monitoring by the contractor will be required.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with landslides are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.6.10. Impacts of Increased Human Activities on Flora and Fauna

Human activities during construction will strongly increase in the area with the influx of 5,000 construction workers and technicians, some of them with their families, suppliers and business men and followers. The population increase will exert a strong pressure on the local environment by increased pollution, noise, disturbance, hunting, poaching and fishing.

This impact has been assessed as **Low Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- WAPDA will commission a study for the management of forest, wildlife, and ecological resources of the area; the ToRs of this study are presented in **Annex A** of this ESA. The management plan prepared during this study will be implemented during the construction and O&M phases of the project.
- Contractors will promote the usage of non-wood fuel for cooking and heating.
- WAPDA will coordinate with the local administration for the enhanced availability of LPG in the area.
- Include information on wildlife protection in all construction related tool-box orientation briefings for new construction staff.
- A public education program will be designed and implemented to discourage cutting of trees, poaching of wildlife
- No tree-cutting, hunting, poaching, trapping, or catching of wildlife by the construction workers will be allowed.
- Contractor will enforce ECP for flora, fauna, and other natural resources.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts on flora, fauna, and other natural resources are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.6.11. Risk of Water Pollution from Storage Tanks

Through the conversion of the Indus valley into a reservoir oil tanks and underground storage containers (such as chemicals, lubricants, and pest control agents) will be submerged, with the risk of serious pollution of the water of the reservoir.

This impact has been assessed as **Low Adverse**, as shown in **Table 7.4**.

Mitigation

The potential sources of pollution will be identified and removed during the construction period and prior to the first filling of the reservoir.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts associated with reservoir water pollution are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.6.12. Shortages and/or Negative Effects on Local Water Supply and Sanitation

The influx of large numbers of workers, technicians and staff employees and their families will require well-organized drinking water supply and sanitation facilities. Various stakeholders might draw from the same available groundwater resources.

This impact has been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

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.

Residual Impacts

With the help of the above listed mitigation measures, the adverse impacts on water supply and sanitation are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.6.13. Disturbance of Visual Landscape and Natural Habitats

The project will drastically change the visual landscape at the site of project and especially at places where slopes have been excavated for construction of roads and project infrastructure, at disposal sites and in borrow areas.

This impact has been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation and Enhancement

The following mitigation measures will be implemented:

- 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.
- Landscape plans for the residential areas and the offices will be developed to create a good living and working environment.

- Tree planting will be well organized and where possible vegetation and natural habitats will have to be restored or newly created.
- For the disposal and borrow areas a Restoration Plans will be prepared to restore original landscape and vegetation.

Residual Impacts

With the help of the above listed mitigation measures, adverse impacts associated with visual landscape are likely to be somewhat addressed, and hence the associated residual impact has been assessed as low to moderate adverse (see **Table 7.4**).

7.7. Social Impacts during Construction Stage

7.7.1. Safety Hazards for Communities and Workers

The construction activities can potentially impact the residents of Dasu-Komilla 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 the access roads pedestrians, particularly elderly people and children will be more exposed to dangerous situations, which may lead to traffic accidents. Construction activities also pose safety hazards for the site staff.

The rough terrain and difficult work conditions in some parts of the area will need extra attention from contactors and project management for 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.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- Occupational health and safety procedures will be enforced at site.
- A Traffic Management Plan will be implemented that will aim at ensuring access to residential areas, and preventing of unsafe situations, especially near schools, housing areas, construction areas, camps and offices.
- Construction activities such as blasting and excavation particularly at the borrow areas may pose safety risks to the nearby population.
- Appropriate procedures will be maintained for such activities, including cordoning off the area, prior information to nearby population and liaison with the community.
- There will be appropriate medical services and a facility with the capacity to treat emergency cases and trauma patients.
- Special attention should be focused on safety training for workers to prevent and restrict accidents and on the knowledge how to deal with emergencies.
- Road signage will be fixed at appropriate locations to reduce safety hazard associated with project-related vehicular traffic.
- Liaison with traffic police will be maintained
- Project drivers will be trained on defensive driving.

- Vehicle speeds near / within the communities will be kept low, to avoid safety hazards.
- ECP-15 and ECP-18 will be implemented.

Residual Impacts

With the help of the above listed mitigation measures, any adverse impacts associated with safety hazards are likely to be mostly addressed, and hence the associated residual impact has been assessed as low adverse (see **Table 7.4**).

7.7.2. Social Conflict due to the Influx of Workers and In-migrants

The project construction will bring significant changes in the lives and livelihoods, including new opportunities for employment and income for the local people. The development also attracts thousands of new in-migrants to the project area. Through the influx of workers, business people and followers the population of Dasu-Komilla will increase more than three times within a few years. Unless properly managed this sudden influx of people could create negative aspects such as an increased crime rate, tensions and social conflicts between the various groups.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- Project has developed a pro-active approach by working out an In-Migration Management Plan. In this plan detailed solutions for a number of key issues have been proposed including issues regarding 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. In accordance with this Plan procedures and rules will be worked out by the PMU in close cooperation with the contractors and local authorities.
- Responsibilities for the implementation of the plan will rest with the local authorities, the line departments, WAPDA and the contractors.

Residual Impacts

With the help of the above listed mitigation measures, any adverse impacts associated with influx of workers and in-migrants are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.7.3. Respect of Local Cultural Norms and Values by Work Force

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 can potentially cause tension and conflicts between outside workers and local community.

This impact has been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- This situation will be addressed by an awareness campaign implemented

- The contractors would be aware of the possibility and risks of miscommunications between local residents and workers, a situation which easily could lead to social unrest. This would be prevented by raising awareness and implementation of a Code of Conduct for the workers.
- Complaints from the local community will be addressed by the grievance redress mechanism.

Residual Impacts

With the help of the above listed mitigation measures, adverse impacts associated with lack of respect of local values and norms are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.7.4. Reduced Safety and Adverse Effects on Health Situation

The influx and accommodation of a large work force will result in increased concerns for the health and safety of local population particularly women and children.

This impact has been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- These concerns would 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 spreading of sexually transmitted diseases such as HIV/AIDS.
- The medical health facilities in the project area will be facilitated to deal with such incidences.
- Measures to this end are included in a Public Health and Safety Plan that will be implemented.

Residual Impacts

With the help of the above listed mitigation measures, concerns associated with safety and health risks of the local population are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.7.5. 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 in the beginning of the project there will be a limited presence of shops, markets, service providers and suppliers of commodities. With the presence of a considerable work force in the area there could be shortage of supplies for the resident population.

This impact has been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- This potential impact would be mitigated by requesting the contractors to procure their supplies in a manner not significantly affecting the availability of essential commodities in the area for the residents.
- Grievance redress mechanism will be established to address community complaints and grievances.

Residual Impacts

With the help of the above listed mitigation measures, concerns associated with increased load on local service are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.8. Environmental Impacts during Operation and Maintenance

7.8.1. Inundation of Terrestrial Habitat

The flooding of reservoir will cause submergence of about 1800 ha terrestrial habitat, which consist of mostly steep sloping barren land covered with rocks and boulders with sparse low shrubs and Artemissia vegetation at places. The same habitat is present at higher altitude. This impact has been assessed as Moderate Adverse as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- Planting of native trees in reservoir buffer areas
- Promotion of conservation of natural habitat in Kaigha and other suitable areas (Kandia, Laachi, Sazin kot)
- Further studies on terrestrial baseline (**Annex A**) during pre-construction/construction and design of additional offset measures if required
- Implementation of monitoring programs

Residual Impacts

With the help of the above listed mitigation measures, concerns associated with loss of terrestrial habitat are likely to be somewhat addressed, and hence the associated residual impact has been assessed as low to moderate adverse (see **Table 7.4**).

7.8.2. Impact on Aquatic Habitat of the Indus and its Tributaries through the Creation of Reservoir

The character of the river Indus 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 365m) and extending for about 73 km up stream at full supply level of 950m. In lateral valleys of tributaries the reservoir penetrates several kilometers inland. About 570 ha of river and tributaries will be 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 reservoir features will be lake-like, 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 in the tributaries will be submerged and it is expected that new natural hot-spots will be developed at the confluence of tributaries with the main water body. This impact has been assessed as Moderate Adverse as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- Maintenance of spawning areas and developing fish hatchery for production of native snow carps (snow carp hatcheries are already established in India and Nepal) and stocking of fish in the tributaries and reservoirs is recommended to compensate the loss of habitat and reservoir fishery production.
- Further studies will be carried out (see **Section 7.6.2**) during construction and operation stage to establish detailed baseline data on aquatic ecology to develop additional offset measures and research on hatchery development.

Residual Impacts

With the help of the above listed mitigation measures, concerns associated with aquatic habitat are likely to be somewhat addressed, and hence the associated residual impact has been assessed as low to moderate adverse (see **Table 7.4**).

7.8.3. Impact of First Filling of Reservoir

The first filling of the reservoir is expected to start mid- June and about 1.4 BCM water will be stored in the reservoir. This will be roughly equivalent to stopping of about 2 percent of the annual flow at Dasu dam site. Since the reservoir filling is taking place in the beginning of the high flow season, the 2 percent reduction in water flows is not expected to affect the downstream water flows and irrigation requirements. The storage volume of the reservoir is 1.3 BCM (1.9 percent of total flow at Dasu), which will be released during flushing operations and will be refilled after flushing. Since both flushing and re-filling operations are expected to take place in high flow season, no impacts are expected on the downstream aquatic habitats.

Habitat upstream of the dam will be changed from current riverine habitat to lake-like habitat commencing with first-filling of the reservoir once dam construction has been completed. Physical, chemical and biological conditions along the Indus River will be altered from current conditions. However, river-like attributes, notably high water velocity in upstream segments of the reservoir will be retained. Habitat in lower portions of tributaries will be submerged and replaced in some locations by small embayments. Overall reservoir habitat, including newly formed embayments in tributary valleys, will rapidly be reduced due to sedimentation.

Reservoir taxa will reflect the mixed river-like and lake-like habitat features and changes that occur as the reservoir decreases in size over the initial operating period. Current small-scale fishing activity in tributaries and the Indus River will be replaced by tributary and reservoir fishing activity adapted to natural changes in species composition and abundance. The reservoir fishery will be enhanced with a flexible fisheries management program that will reflect expected habitat resulting from progressive decrease in reservoir size and development of wetland conditions in the remaining part, with rich natural riparian vegetation in the upstream part of the reservoir.

The entire first-filling operation will take about two months. After the filling the reservoir will reach a maximum depth of approximately 185 m (the deepest part of the reservoir will be adjacent to the dam). As physical changes take place chemical and biological conditions also will be altered. With reduced water velocities as water depth increases, a sedimentation process will commence, whereby larger sediment fractions will sequentially settle along the reservoir length.

Other potential impacts of the first filling of the reservoir are the following:

- The first filling of the reservoir may potentially induce landslides along the water line. Careful filling at a low rate of inflow therefore is required;
- Rising water may also pose safety risk for the local population and they may be caught unaware. This means that proper communication of timing and potential risks of the filling is important.

These impacts have been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

The water level rise during filling is expected to be 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, which may occur when soil/rock is getting wet causing collapse of slopes. In periods with more inflow in the reservoir then needed the water level rise will be controlled by opening the LLOs in the main structure. Maintaining a relatively slow rate of filling will also help to reduce the potential hazards for people living or herding cattle in the area and for livestock. People in the area should be warned timely for the risks and there should be a ban on entering the future reservoir area. During the entire period of filling the flow from reservoir to the Indus downstream will be largely reduced. Once after the full supply level (950 m amsl) is reached the LLOs will be closed and whatever additional water is coming into the reservoir is 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. During the high flow season (May-September), when water will enter the reservoir at a rate greater than the water diverted through the power inlets, the additional water will pass over the spillway.

Public awareness campaign will be implemented to inform the communities about the reservoir filling and associated risk of accidents. No mitigation measures are proposed for the reservoir during first-filling beyond those outlined above for the reservoir routine operations and flushing events.

Residual Impacts

With the help of the above listed mitigation measures, concerns associated with first filling of reservoir are likely to be adequately addressed, and hence the associated residual impact has been assessed as negligible (see **Table 7.4**).

7.8.4. Impacts on Fish Migration

By constructing the main structure in the Indus a barrier in the river will be created, which will impair 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 that could be affected by the dam. Snow carp migration is within the tributaries and hence will not be affected by the dam. This impact has been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

The following mitigation measures will be implemented:

- The aquatic study described in **Section 7.6.2** will also include fish migration;
- WAPDA will develop fish hatchery through which tributaries and reservoir will be restocked.

Residual Impacts

With the help of the above listed mitigation measures, concerns associated with fish migration are likely to be somewhat addressed, and hence the associated residual impact has been assessed as low adverse (see **Table 7.4**).

7.8.5. Impact of Reduced Water Flows between Dam and Tailrace

The reduced water inflow in the river section of 4.4 km length between the main dam and the tailrace outlet can 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, a section of 3.2 km length upstream of the tailrace could permanently receive water from backwater flow of the tailrace. Only 1.2 km of river below the main dam is critical for drying up during the low flow season. Sieglo stream joins in this section and brings about 0.5 m^3/s flow during low flow season. Maintaining a minimum environmental flow downstream of the dam could mitigate potential impacts on aquatic habitat and fauna on this river section including confluence with Sieglo, especially in the period between December and April. This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

Two approaches were followed in developing environmental flows – one on the experience of Ghazi Barotha hydropower project located on Indus on the downstream of Tarbela and other on meeting requirement of aquatic habitat. Ghazi Barotha has a 54 km of dewater section between barrage and tailrace and it is being compensated by 28 m^3/s, which is found to be adequate through a 5-year monitoring program by WAPDA Environmental Cell. In DHP, an environmental flow of 20 m^3/sec from the dam and 222 m^3/sec from the tailrace is recommended. These environmental flows will maintain a depth of 0.5 m and velocity of 2 m/s at Seiglo confluence which is adequate to maintain winter habitat of snow carps. On average, the recommended environmental flows (242 m^3/s) in most of the dewatered section will represents 44 percent of average winter flows and 72 to 95 percent average winter wetted perimeter. A downstream environmental effects monitoring program will be put in place to enable assessment of changes in ecological components and adjust the environmental flows if required.

Residual Impacts

With the help of the above listed mitigation measures, concerns associated with reduced water flows are likely to be somewhat addressed, and hence the associated residual impact has been assessed as low to moderate adverse (see **Table 7.4**).

7.8.6. Impact on Downstream Fish due to Changes in Water Flows and Quality

Generally water quality in reservoirs will be deteriorated to thermal stratification 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. Generally, long retention times in the reservoir will affect the reservoir water quality through changes in dissolved oxygen, eutrophication and thermal stratification. Average water retention time in Dasu reservoir will be very short varying from 1 to 6 days during high flow season, and about 19 days during low flow season. The impacts on water quality are estimated to be minor due to these short retention times. The changes may occur over short distances downstream of the dam, but are not expected to have significant adverse effects. Changes in downstream sediment quantities are not expected to negatively affect downstream aquatic resources and may favor species that will benefit from reduced amounts of sand and gravel in seasonal deposition and scouring cycles. About 97 percent of the sediments occur in Indus basin during months of high flows of June to September during which water passes through spillways, low level outlets and turbines and hence some of the fine sediment will be continued to carry out downstream and sediments will continue to enter through tributaries located downstream of the dam. Major tributaries immediately below the dam site are Sieglo at 1.5 km and Jalkot at 9 km distance. This impact has been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

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

Residual Impacts

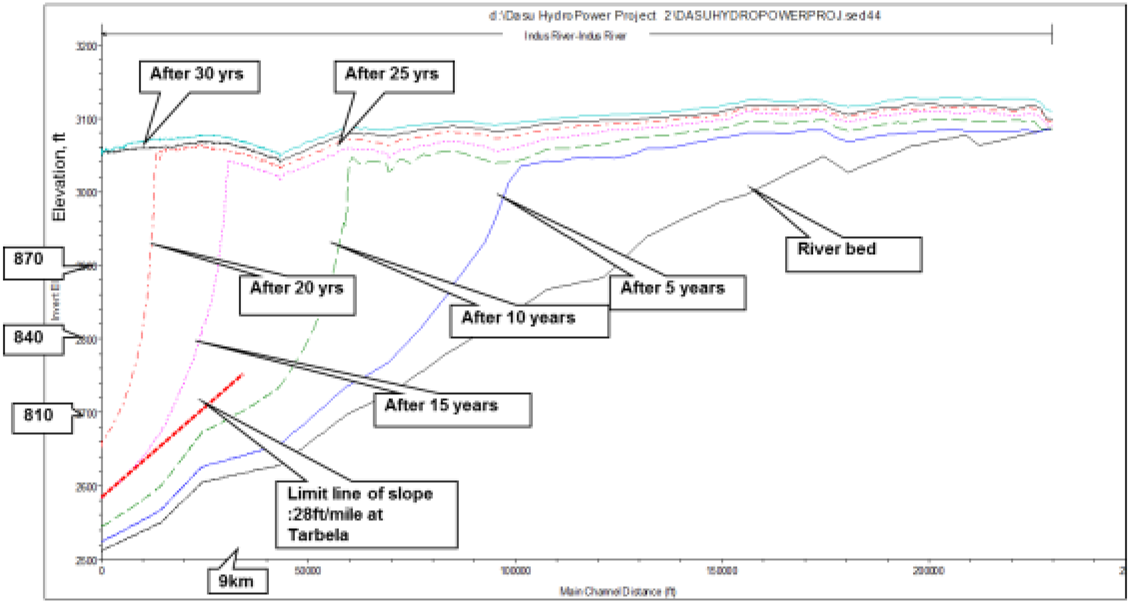
With the help of the above listed mitigation measures, concerns associated with downstream fish are likely to be somewhat addressed, and hence the associated residual impact has been assessed as low adverse (see **Table 7.4**).

7.8.7. Impact of Sedimentation on Reservoir Area

Annually some 200 million ton of sediment enters the reservoir area. After completion of the Dasu structure the reservoir will be filled and flow velocities in the reservoir will be greatly 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. It is expected that the inlets for LLO and power intake will be filled within 20 to 25 years if there will be no flushing of sediments. Longitudinal sediment profiles after every 5 years of impoundment are show in **Figure 7.2**. The sedimentation will occur over the entire 73 km length of the reservoir. Heavy bed load will settle near the head reach and the finer material will settle in middle and lower reaches of the reservoir. The reduction of the storage volume after dam construction is shown in the **Figure 7.3**. From the figure it might be concluded that the storage volume of the reservoir will be reduced by more than 80 percent and the length of the reservoir is then about 10 km (at fsl).

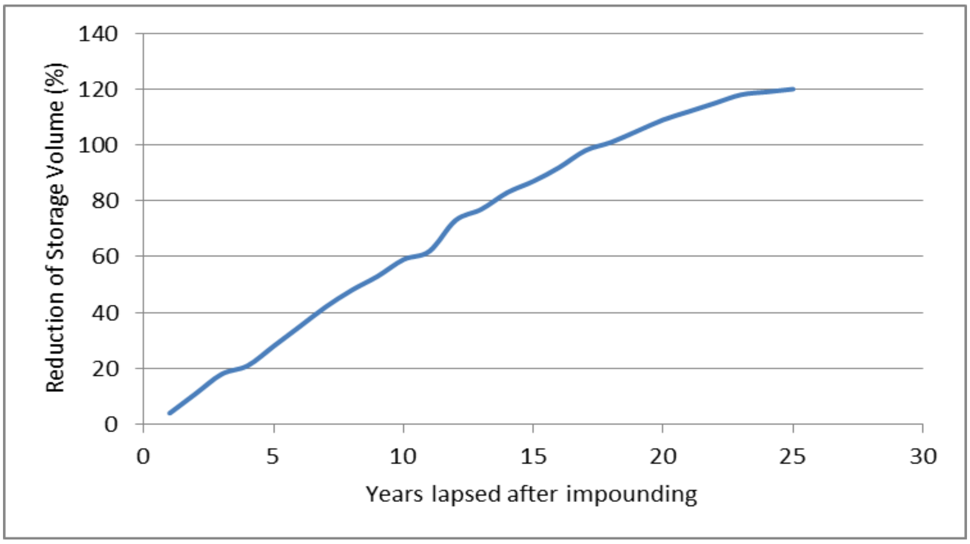
Habitat conditions along the 73 km length of the reservoir (at fsl) will be characterized by a long transition along the former river gradient featuring river-like fast-moving water in the upstream end and deep slower moving water in the downstream end. Reservoir ecology will not be typical of a natural lake environment and will undergo rapid reduction in size caused by sedimentation and changes associated with flushing operations (after 15 year) and possible transition of reservoir operation from run-of-river to peaking (notably, drawdown during cycle of water storage and release for power generation). Relatively high water velocities and narrow width will maintain river-like features along much of the reservoir.

Figure 7-2: Expected Sedimentation Profiles Over Time -without Flushing



Source: DHP Engineering Design, 2012

Figure 7-3: **Reduction of Reservoir Storage after Impounding (without flushing)**



Source: DHP Engineering Design, 2012

Water velocities along the length of the reservoir will generally be less than pre-reservoir river conditions. Although reservoir features will be lake-like 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. Water velocities along the length of the reservoir would be relatively high, ranging from 0.56 to 3.08 m/sec at the head of the reservoir and 0.02 to 0.14 m/sec at the dam.

Water velocities in deeper areas close to the dam will be mainly influenced by facility operation:

- 900-950m – relatively high water velocity; determined by intake/spillway use
- 875-900m – relatively high water velocity; determined by intake use
- 810-875m – relatively low water velocity except during periodic flushing; mainly stagnant water upstream - annual/periodic flushing will rejuvenate
- 724-810m – low water velocity; mainly stagnant water upstream

Based on the hydraulic and engineering studies DHC concluded that flushing of sediments will not be required until 15^{th} year of operation. If Basha dam is constructed by that time, flushing operations are not required for another 30 years, since Basha dam having enough storage capacity would act as sediment trap. After construction of Basha dam, annual sedimentation inflow will be reduced to 46 million tons (which will also include sediment outflow from Basha dam).

Without Basha annual flushing operations will be carried out for a period of one month. During flushing operations power generation will be stopped.

This impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

To prolong the life of the reservoir (at least to 40 years) it is estimated that annual flushing should start after 15 years. This assumption is based on the use of the reservoir to generate base load electricity. For the first 15 year period the impact of sedimentation on potential development of commercial fisheries will be minimal, provided that stocking of the reservoir is carried out with suitable non-migrating fish species adapted to the circumstances in the reservoir. The situation can be compared with the situation at the Tarbela reservoir. When flushing would start after 15 years this would mean that the size of the reservoir will be reduced to 7 km instead of the 9-10 km length of the reservoir after 15 year.

Residual Impacts

With the help of the above listed mitigation measures, concerns associated with sedimentation in reservoir are likely to be mostly addressed, and hence the associated residual impact has been assessed as low adverse (see **Table 7.4**).

7.8.8. Impact of Flushing of Reservoir on Fish Production 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. During this period there will be minimal impacts on fish production, with the exception that the volume of water in the reservoir will decrease with about 80 percent. After this period the reservoir will be flushed annually during one month (mid May-mid June) when discharges of the Indus are high. Flushing is most effective in the high flood season. During flushing operation the water level in the reservoir will be lowered from 950 m amsl to 830 m (level of the low level outlets).This will be achieved at an estimated rate of 3 m/day and takes about 40 days. Drawdown will be kept at this low rate in order to minimize the risk of landslides. After this lowering period the flushing of sediment will be carried out during 30 days. When the gates in the dam are closed the water level in the reservoir will start to rise with an average of 4 m/day and will reach fsl 30 days later. The whole operation will take about 100 days (1 April -10 July).

Fish stocks will be compressed in a reduced volume during flushing operations. There will be impacts on fish stock. There will be losses of fish during flushing operation. An unknown percentage of fish will be trapped or injured during the extreme drawdown during flushing. For mitigating these impacts the technical feasibility of protecting the inlets should be determined, either by screening of inlets or by other methods. A certain percentage of fish (to be determined) will have to be restocked annually.

The impacts have been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

In the above-mentioned period of flushing it is expected that specific fisheries management is required to sustain the population of fish in the reduced reservoir area during flushing, and 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 into more detail in the Fisheries Development and Management Program. Flow releases during reservoir flushing are not likely to have a sustained negative effect on the downstream ecosystem, as long as peak flows occur within the normal period of seasonal high flows.

Residual Impacts

With the help of the above listed mitigation measures, concerns associated with flushing of reservoir are likely to be mostly addressed, and hence the associated residual impact has been assessed as low adverse (see **Table 7.4**).

7.8.9. 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 outside the intended timing window especially during the winter low-flow period. Release flows during flushing should be within limits of historical flows for the season over which flows will be released (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 these short retention times. However, if low oxygen conditions are evident during monitoring prior to flushing a lead-in period may be required whereby the lower-level outlets are used to draw out low oxygen-concentration lower-elevation water in combination with spillway releases to provide adequate oxygen concentrations in water downstream of the plunge pool. The impact has been assessed as **High Adverse**, as shown in **Table 7.4**.

Mitigation

The following measures will be implemented to address the potential impacts associated with flushing:

- WAPDA to carry out flushing during high flow season (not in low flow/winter)
- WAPADA to develop ramp down criteria (5-10 cm/hr)

- WAPDA will conduct monitoring of dissolved oxygen and temperature in reservoir and de-stratification or simultaneous release of water from low level outlets and spillways if required.
- WAPDA will carry out downstream monitoring of fish, habitats and sediments.

Residual Impacts

With the help of the above listed mitigation measures, concerns associated with flushing of reservoir are likely to be mostly addressed, and hence the associated residual impact has been assessed as low adverse (see **Table 7.4**).

7.8.10. Impact of Daily Reservoir Operations during Peak Production

After commissioning of the Diamer-Basha project (expected in 2037) DHP will depend on the guaranteed water releases from the Basha reservoir. During this stage it has been recommended 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 strong fluctuating water levels.

Operation of DHP as a run-of-river facility will not change the hydrology downstream of the tailrace outlet during the low flow season, as has been discussed in the previous section. However, during storage/peaking operations (in Stage 2) the situation will be totally different. During the low flow season there could be periods potentially of no inflow into the segment of the river below the tailrace outlet. Downstream habitat and biota will be significantly adversely affected when flow is reduced due to 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 for a substantial distance (depending on minimum environmental flows adopted). However it appears doubtful that potential effects would extend to the south end of Tarbela Reservoir (approximately 200 km downstream) where the commercial fishery is located. These aspects should be included in the EIA for the Diamer-Basha project.

Risk of Tail race flow surges

A period of no inflow could be followed by a sudden pulse of water during peak operation. Peaking will thus cause daily fluctuations in flow and water levels in the river section downstream of the tailrace outlet. Repeated daily surges will affect the aquatic ecology.

The magnitude of water level fluctuation will vary along the river, depending on the river cross section downstream. In addition, the daily water level variations depend on the number of turbines working during that day. Just at the tailrace discharge point, the water level will change quite suddenly after a start or stop of the turbine.

Following examples give an indication of the expected changes in water level:

- If the power generation from one turbine is increased to three turbines, the water level at tailrace is expected to rise 2.8 m. During power generation with twelve units (in phase 4), the rise of water level will be 6.4 m. However, instantaneous power operation with twelve units is not practical, due to constrained load control in the power grid connected to other power plants in the country. This scenario is therefore very unlikely. A more likely scenario is that three turbines operate simultaneously. The time needed for the sequential start of three turbine units is estimated to take at least 15 minutes. The rising rate of the water level at the tail end would then be 0.8

m/minute. Therefore it is expected that a sudden surge wave may not occur in the river section downstream of the tailrace outlet.

- In case of the use of one turbine the total time before a sudden water surge reaches the tailrace outfall is estimated at minimal 23 minutes. The water level then will rise with an estimated 0.27 m/minute. The water level fluctuations will continue further downstream for longer distance. However, the fluctuations become smaller when major tributaries join the Indus.

Mitigation

During peaking operation of the plant, it will be required to operate at least one turbine and the additional flows can then be used for peaking operation. Operation of one turbine will release 222.5 m^3/s and the total flow at tailrace, including an environmental flow of 20 m^3/s, will then be 242.5 m^3/s. This discharge is equal to about 10 percent of the average annual flow of the Indus (at Dasu) and 44 percent of average winter flow. This amount can be adjusted based on the monitoring of impacts on aquatic ecology.

Residual impacts

With the help of the above listed mitigation measures, concerns associated with peak production are likely to be mostly addressed, and hence the associated residual impact has been assessed as low adverse (see **Table 7.4**).

7.8.11. Risk of Bird Collisions with Transmission Cables

The Indus valley is a major fly-way for bird migration. Huge flocks of migrating birds follow the Indus valley fly-way twice a year in autumn and in spring passing the narrow Indus valley. Especially for birds with a large wingspan such as storks, cranes, herons and birds of prey there is a risk of bird collision with transmission cables. Fatal collisions occur mostly with cables hanging perpendicular to the flight direction.

This impact has been assessed as **Moderate Adverse**, as shown in **Table 7.4**.

Mitigation

Mitigation to prevent or reduce the number of bird fatalities is possible by maintaining a minimum distance of 1.5 meters between the energized parts of the transmission line and attaching markers to the cables on places where many birds are passing through the Indus valley.

Residual Impacts

With the help of the above listed mitigation measures, concerns associated with bird collision are likely to be mostly addressed, and hence the associated residual impact has been assessed as low adverse (see **Table 7.4**).

7.9. Social Issues during Operation and Maintenance

7.9.1. Loss of Employment for Construction Workers

Local construction workers and technicians may lose their jobs at the end of the construction works and this may lead to increasing unemployment for local residents with negative consequences. The impact of the loss of employment has been estimated as moderate adverse.

Mitigation

There are good opportunities for follow-up projects which are: (a) the successive follow up projects under stage 2 of DHP (phase 3 and 4), (b) the construction of the Diamer-Basha dam and (c) possible other major works further upstream. WAPDA could develop a preferential system for local workers with good qualifications and experience at the end of the construction of stage 1. Construction workers could also qualify for positions in maintenance and operational activities. Also important is that the vocational training program for the various categories of workers will be continued together with the implementation of the Social Assistance Program.

Residual Impacts

With the help of the above measures the impact of the loss of employment opportunities could be largely mitigated.

7.9.2. Reservoir Fisheries (Enhancement Opportunity)

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. A well designed fisheries management program is an essential condition for such an enterprise, including the provision of the required infrastructure, such as hatchery, landing facilities, ice factory, craft and gear, laboratory and training facilities. Implementation of such a program would substantially increase the employment opportunities in the area as well as the nutrional status of the population. The project would support collecting detailed baseline data for aquatic resources in the area (see **Annex A** for the ToRs for this study), which would be a pre-requisite for preparing such a program.

7.10. Potential Impacts of 500 KV Transmission Line

The National Transmission and Dispatch Company has prepared an Environmental Assessment and Review Framework (EARF) for the transmission line (**Box 7.1**) (a detailed ESA will be carried out at a later stage during the detailed design of this component). The EARF has identified the crossing of the transmission line through Palas Valley as a potential environmental impact, to be studied in greater detail during ESA. The 500 kV transmission line will travel over a distance of about 250 km and will begin at the Dasu Hydropower plant. The line will run parallel to the Indus River till Pattan. From there, the corridor proceeds through the lower Palas valley and passes the districts of Battagram, Mansehra, Abbotabad, Haripur passing east of Tarbela Dam towards Pathar Garh, situated near Hasan Abdal in District Attock, Punjab. Out of total 250 km about 200 km is mountainous terrain with rocks covered with natural and planted forests. Only the last 50 km towards Pathar Gharh is relatively flat or slightly sloping terrain with cultivated lands and barren areas. The crossing through Palas valley could be environmentally sensitive, since this area is an IBA (Important Bird Area) declared by BirdLife International. Palas valley is also known by 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 TL. These alternatives should be covered under the ESA do be undertaken by NTDC later in 2014.

Potential impacts of Transmission Line on bird migration along Indus Flyway: The EARF prepared by consultants assigned by NTDC identified as another possible major impact the interference of the selected TL- corridor with the well-known Indus Flyway, or Bird Migration route no 7 along the Indus. Part of the line follows the Indus valley between Dasu and Pattan, in an area where the Indus valley is rather narrow with steep mountains on both sides reaching 2,500 – 3,000m. The Indus Flyway follows the narrow valley and especially large flocks of waterfowl, geese and ducks, cranes and herons are passing there twice a year on their way from Siberia towards their wintering grounds situated in Sindh, Indus Delta and along the coastline of the Arabian Sea, and vice-versa. To assess and better understand the interference of the corridor with the migrating birds and the risks of large scale bird collision, an Avian Risk Assessment study is proposed in the EARF. As the planning and design of the TL is at its initial stages of preparation, detailed analysis of alternatives and impact assessment should be carried out by the ESA team assigned by NTDC, which will commensurate its work when the detail design of the project is awarded to the consultants.

Box 7.1: Summary of EARF for the Construction of 500 kV Transmission Line

The National Grid for power transmission consists of a large network of High Voltage and Extra High Voltage (HV & EHV) transmission lines and grid stations. Power is supplied in an integrated manner by a network of hydropower and thermal power plants located up and down in the country. National Transmission and Dispatch Company (NTDC) is responsible for the construction, maintenance and operation of transmission lines and grid stations of 220 kV and above.

A transmission line is proposed to be constructed to evacuate power from the Dasu hydropower project (HPP). Power dispersal from Dasu HPP will be carried out by construction of two parallel running 500 kV Transmission Lines. These 500 kV Transmission Lines will extend over a distance of about 250 km and will begin at Village Seo some 10 km upstream of river Indus at Dasu Hydropower Plant in Kohistan District run parallel to the Indus River till Pattan. From there, the corridor proceeds through the lower Palas valley to Battagram district via Shrakot to Tailos and Banna in Allai Tehsil of District Battagram. From Banna, the line will pass through Karkat Nullah and will take 2,045 masl till Village Chil near Battagram. From there, with a slight southwest turn towards Oogi in Mansehra District in the vicinity of Settlement Chaprian (District Mansehra) and then to Sherwan in District Abbotabad and gradually turning south east will enter into Haripur District on the eastern flanks of Tarbela Dam near Village Darwaza (District Haripur).
Out of total 250 km, the 200 km line route from Dasu to Darwaza is mountainous, hard rocks, forests and falls in swear winter zone. The next 50 km from Darwaza to Village Pathar Garh Tehsil Hasan Abdal, District Attock is plain with rugged land with some agriculture fields. Figure below shows the proposed transmission line route.

As the design of the project component on transmission line is at initial stages, and no tower spotting or detailed engineering designs have so far been done therefore the project prepared an Environmental Assessment Review Framework (EARF), which highlights the potential environmental and social impacts and institutional arrangements to implement the project. More detailing of the environmental assets in relation to the exact alignment of the transmission line will be carried out in the follow-up environmental and social impact assessment study commensurate with the detailed design stage of this component. This study will also look into more details on the alternative of analysis particularly from the siting options, access roads, design of towers, construction technologies, etc. NTDC will also prepare environmental management and mitigation plan which will be embedded into the bidding documents for the construction of transmission line.

Further, under the EARF, for the purpose of data collection for environmental/social baseline and impact assessment, project team selected a corridor of 500 m width throughout the proposed transmission line route. From this corridor, two parallel running 500 kV transmission lines will pass having potentially a direct impact on the environment like relocation of physical infrastructure (if any), clearing of vegetation, loss of crops, etc. and indirect impacts of the project activities on forests, wildlife habitats, wetlands, etc. For the construction of 500 kV grid station, NTDC will acquire an area of about 100 acres barren land, which is privately owned by the residents of Village Pathar Garh.

8. Cumulative Impacts

8.1. Introduction

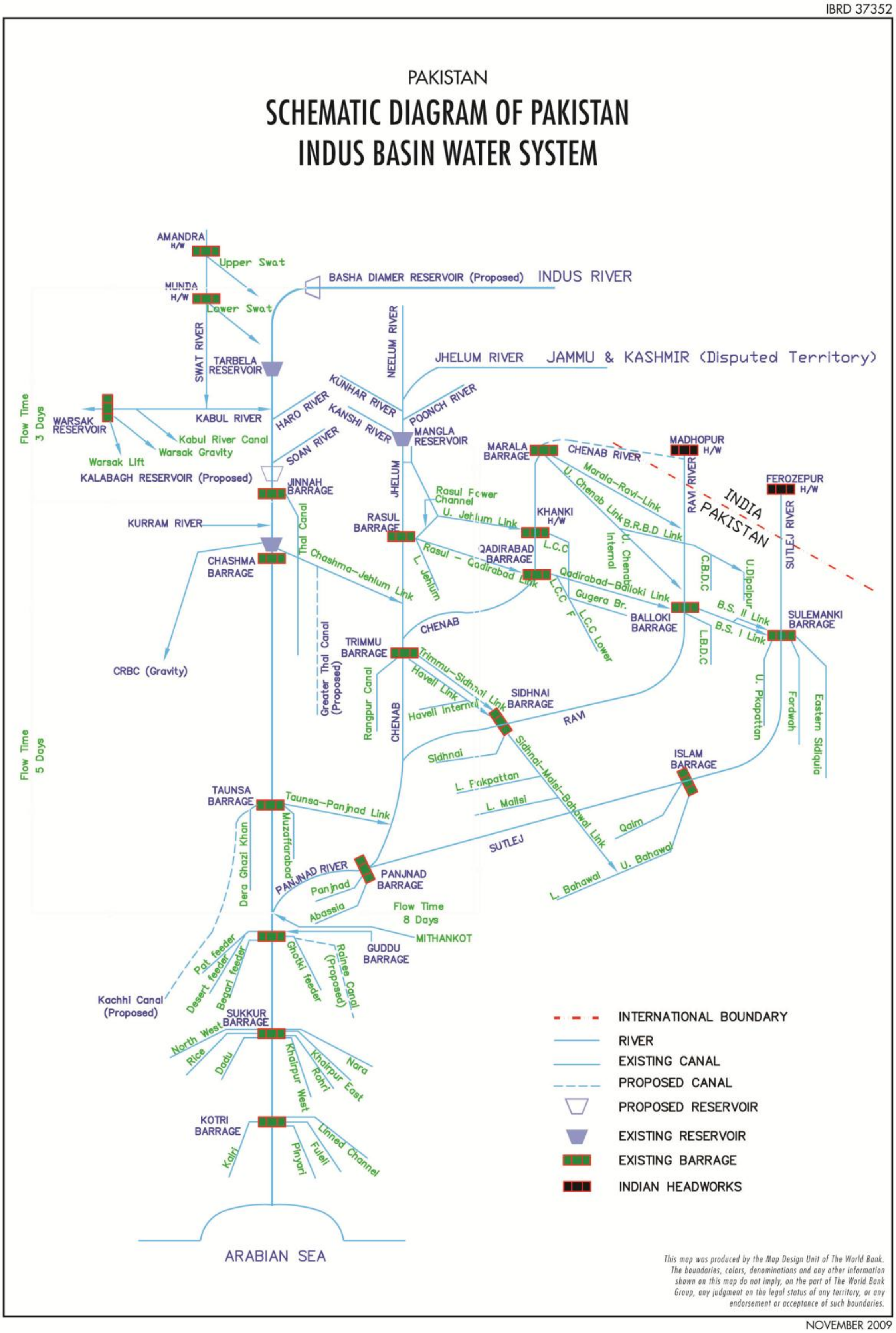
Mangla and Tarbela dam are the only major dam projects that have been constructed in Pakistan about 40-45 years ago. After this Pakistan has not constructed any major dams for irrigation or hydropower purposes. In order to harness the hydropower potential of the Indus River, WAPDA has proposed to build a cascade of projects in the Upper Indus Basin (UIB). Until the year 2025 DHP and Diamer-Basha (DB) are the first of a series of hydropower projects planned by WAPDA in the river section upstream of Tarbela until Raikot bridge (near Astor), see figure 1.2. DHP in combination with Diamer- Basha and several minor hydropower projects along Indus tributaries have the potential to cause significant cumulative impacts on physical, ecological and social resources in the basin.

Meanwhile, the Ministry of Water and Power of GOP through the World Bank funded the Water Sector Development Project (WCAP) awarded a study titled “Strategic Sector Environmental and Social Assessment” (SSESA) to an international consortium of consultants. SSESA has been launched to look at the whole Indus Basin for sector wide environmental and social considerations including cumulative impacts to help prioritize the investments in hydropower and storage development options. The study would provide recommendations on programmatic mechanism for monitoring and evaluating environmental and social performance in the management of storage and hydropower projects in Pakistan. The study considers WAPDA Water Resources and Hydropower Development Vision 2025 document as the reference document, besides Government policies on Power and Energy Conservation. It is expected that the recommendations of the study will help the Government in making strategic choices in the water resources and hydropower development, which have positive environmental and social impacts and conserve the overall natural resource base. The study is at an advanced stage of completion.

For the present ESA a cumulative impact assessment framework has been prepared based on “Vision 2025”. The spatial and temporal boundaries for the cumulative impact assessment have been defined according to an expected and realistic timeline, as discussed with WAPDA and the World Bank. DHP is the first structure upstream of Tarbela to be constructed to be followed by DB. This dam will be constructed at a site a few km from the upstream end of the DHP reservoir. The assessment framework as presented here thus is spatially limited to the Indus valley from Raikot bridge (near upper end of the Basha reservoir) and Tarbela dam, where the water is distributed over the entire Indus Basin Water System (IBWS), see **Figure 8.1**. As temporal boundaries the time between now and the year 2025 have been taken.

Potential cumulative impacts arising out of the water resources and hydropower projects likely to be developed within the next twenty years (both on Indus main stem and its tributaries) have been assessed in this stretch of river. Other developments outside the water sector have not been considered, since there are very few infrastructural and other developments foreseen in this mountainous and rugged terrain belonging to the Himalayan and Karakorum mountain range.

Figure 8.1: The Indus Basin Water System



The framework assessment has concentrated on possible cumulative effects of projects on river hydrology and sedimentation, impacts on water quality and quantity, changes in habitat from river to lake type, increase in irrigation supplies, better flood management, potential reduction in water flows downstream, change in aquatic habitat, and barriers in the fish movement and on physical cultural resources and the KKH, as major access road to the North of Pakistan. These valued environmental components (VECs) are identified and discussed through a 'CIA Stakeholder Consultation Workshop' held at Islamabad (2 October 2012), which was attended by federal (Ministry of Climate Change, Planning Commission and National Highway Authority, Dept. of Archeology) and relevant provincial government stakeholders (EPA, wildlife, fisheries, archaeology) from the provinces of Baluchistan, Sindh, Punjab and KP; international financial institutions (ADB, World Bank and JICA), Indus River System Authority, university teachers and NGOs. The key cumulative impacts and their mitigations and concerns are discussed in the sections below.

8.2. Context of the Project

8.2.1. The Indus Basin Water System

To meet the increasing food production demands, Pakistan has been expanding the surface water supplies to the Indus Basin Water System (IBWS) over time by capturing more water from the Indus and its other rivers. The Tarbela Dam was developed during the seventies of the last century in the framework of the Indus Basin Water Master Plan. Initially the main purpose of the dam was to supply irrigation water to the densely populated agricultural areas in Punjab and Sindh. For the project 120 villages along the Indus were submerged and a total of 96,000 persons had to be resettled and 33,200 ha of land to be acquired. At present the Tarbela dam is the most upstream constructed hydraulic structure controlling the Indus waters and supplying irrigation water to the IWBS, including generation of power.

Post Tarbela canal diversions in the past reached as high as 105 MAF. However, they have declined in recent years due to reduced storage of Tarbela 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 from the rivers and declining water storage capacity in the reservoirs due to siltation directly affects the flows during winter for irrigation. 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. Also, some believe that, apart from a few years of extraordinary floods, the rivers do not have surplus water to store after meeting the ecological requirements of the delta region and coastal zone.

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. However, Pakistan 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 in Punjab

The other source of water Pakistan has tapped is groundwater, which is 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 the groundwater wells. This resource is now reaching its limit and further withdrawals are not possible without serious groundwater mining and extraordinary costs for pumping.

8.2.2. 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 on the delta and coastal zone. These impacts include the loss of mangrove forests, decreased fisheries, deteriorated water quality, and sea intrusion. All of these factors have direct bearings on the livelihood and wellbeing of the local population. These effects are being mitigated through implementation of programs aimed at improving water management in the delta area, 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 Bank.

The Indus River in Sindh, close to the delta and sea, flows on a ridge, like many mature rivers in the world. The embankments to contain the river were constructed after 1901. These embankments are placed about 10 miles apart, starting from the Guddu Barrage to the sea. The Indus River meanders in a belt contained by these embankments. The original delta is on the left side of the river, around which irrigated agriculture is carried out by diverting water from the Kotri Barrage, the last one 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.

8.2.3. Mitigations measures taken

Under the mitigation measures taken by the Government of Sindh province the following major projects were undertaken:

a) **The interprovincial Water Accord of 1991**. This Accord has a provision for ecological flows to be released downstream from Kotri Barrage but, it 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. Average outflow to the sea from Kotri Barrage has been about 37.8 MAF mostly in summer, while the minimum is zero and maximum is 92 MAF. An erratic rather than regular flow each year is less beneficial for the river channel below Kotri Barrage.

b) **Preparation of a Master Plan for the Left Bank of Indus, Delta and Coastal Zone**. Under the Sindh Water Sector Improvement Project (WSIP), the World Bank is assisting the Government of Sindh (GoSindh) 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 River – including the river's delta and coastal zone – through appropriate structural and non-structural measures, 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. Four phased studies are being carried out, in consultation with the stakeholders from the beginning to the end of the process, covering the identification of the issues, and an analysis and design of solutions.

c) **Sediment Management Plan for the Basin and Tarbela**. Under the Water Capacity Building Project (WCAP) the World Bank is also assisting the GoP and WAPDA to understand the sediment management issues for the basin and at Tarbela Dam. This would help to develop plans for eventual movement of sediment downstream once the reservoir is filled. The downstream area is already seeing the impact of increased sediment flow as the trap efficiency of the Tarbela reservoir is decreasing.

d) **Improving Irrigation Efficiencies**. With increasing population and development, water demand is expected to continue to increase in the Indus Basin, which is the main food production area for the country. As noted above, Pakistan has been increasing surface water diversion and also tapping groundwater, both of which are reaching their limits. In future, substantial quantities of water can only come from reducing losses in the irrigation system, which constitute a great potential source of water, given that efficiency of the surface irrigation system is about 35-40 percent. A substantial part of the losses are in the watercourse command (over 40 percent) and via flood irrigation in the field. To address these issues, the Bank is assisting the Government to start an irrigated agriculture productivity improvement program under which watercourses would be improved to reduce delivery losses and high efficiency irrigation systems (HEIS) is being introduced, such as drip irrigation. Drip systems have about 90 percent efficiency in delivering water and helping to retain other nutrients, which are washed away or leached under flood irrigation. The program has started in Punjab and being expended to Sindh followed by other provinces. The results in Punjab are very encouraging and this program has started a new era of water conservation and productivity that would hopefully reduce pressure on scarce water resources. Estimates show water that would become available annually, with a 10 percent increase in water efficiency in watercourse commands, is more than the combined water storage capacity of two dams on the Indus River.

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 lost to sedimentation of the Mangla and Tarbela reservoirs. Also, the hydrology of the Jhelum River allows filling of this storage in about four out of five years. Pakistan has been trying to build new storage for years. However, as noted above, building large dams is a very contentious issue in Pakistan as well.

f) **Sind Coastal Area Development**. The Pakistan Poverty Alleviation Fund (PPAF) through its partner organizations has been implementing the Sindh Coastal Area Development (SCAD) program under the WB funded PPAF-II and PPAF-III projects, to address the spatial and economic isolation of the area compounded by recurring natural/man-made disasters in the form of global warming, seawater intrusion, floods, and cyclones specifically in districts of Thatta and Badin, resulting in destruction of livelihoods and widespread poverty and vulnerability leading to perpetual indebtedness and migration from the village. The program includes providing basic infrastructure such as drinking water and sanitation, rehabilitating the livelihoods of coastal communities, and developing their resilient capacity by integration of the Sindh coastal areas with the national space and economy.

8.3. Expected developments in the Upper Indus Basin

8.3.1. Shift in focus of water policy planning

The development of the Indus River system has the potential to provide the long term solution for the water and electricity sector 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 water and electricity sector. 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 it was the case when Mangla and Tarbela dam were constructed. The focus therefore is now moving to the main Indus River where maximum amount of water is available, especially since the waters of Chenab and Jehlum are fully utilized and other sources provide lesser amount of water and power. On the Indus River the same water can be used through a cascade to maximize benefits of storage and hydropower generation.

8.3.2. Indus Cascade development from Tarbela to Diamer- Basha

The first step in this long term plan is to develop the segment of Indus Cascade between the Tarbela Dam up to Diameter-Bhasha (DB) and exploit all the water and hydropower resources in this segment, followed by investments further upstream. This segment has an annual water flow of about 60 billion cubic meters (BCM) and an elevation drop of about 700 meters between upstream of DB to the Tarbela reservoirs. At this stage, this segment is planned to be developed by four major structures on the Indus River going upwards from Tarbela Dam, Thakot, Pattan, Dasu and Diamer-Bhasha (see **Figure 1.2**). This part of the cascade can be developed over the next 15-20 years, providing about 17,000 MW of newly installed capacity, 75,000 Gwhs of annual generation at round 4-5 cents/Kwhs (at the installation time that would reduce overtime when debt servicing is completed) and 10.7 BCM of storage capacity for water. This in the long term can change the fuel mix favoring hydropower and has potential to bring the cost of electricity to single digit.

8.3.3. Overview of expected development until 2025

The expected developments are shown in **Figure 8.2**. A list of hydropower projects currently designed or under construction is given in **Table 8.1**. From the table it can be seen that DHP (Run of River) and Basha (storage) are major hydropower projects, whereas the projects along the tributaries are much smaller and often also ‘Run of River’ projects or small storage dams. DHP has a limited reservoir (24 km² only) with the only objective to generate hydropower (base-load, possibly peak-load in the far future), whereas Basha has the objective to improve the storage capacity in the IBWS and to alleviate flood damage of the Indus River next to generating electricity.

Figure 8.2: Locations of Tarbela and Other Planned Hydropower Projects in UIB

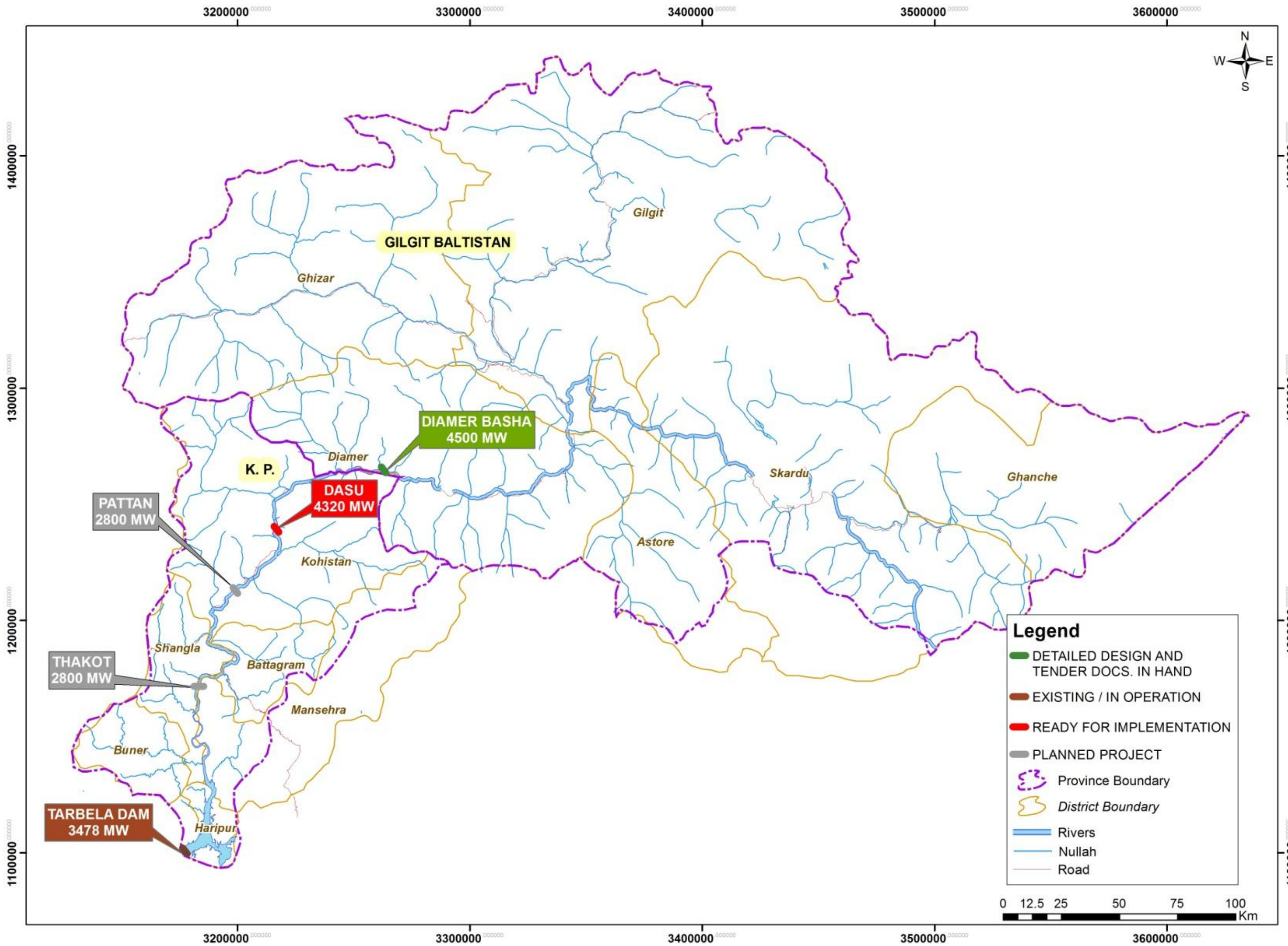


Table 8.1: Hydropower development in the Upper Indus Basin (under Vision 2025)

No.	Name of Project	River	Location	Storage (MAF)	Installed Capacity (MW)	Expected Completion Date
	Major Hydropower (storage) projects					
1.	Diamer Basha [3)]	Indus	Diamer	8.10	4500	2028
2.	Dasu [3)]	Indus	Dasu	RoR (0.67)	4320	2020
3.	**Minor Hydropower projects**					
3.1	Keyal Khawar [4)]	Indus	Besham	RoR	122	2016
3.2	Dubair Khawar [2)]	Indus	Besham		130	2013
3.3	Khan Khawar [1)]	Indus	Besham		72	2011
3.4	Allai Khawar [1)]	Indus	Besham		121	2012
3.5	Lower Spat Gah [4)]	Indus	Kohistan	RoR	496	2017
4.6	Lower Palas Valley [4)]	Indus	Pattan	RoR	665	2017
			Total	**8.77**		

Status: [1)] Existing; [2)] Under construction; [3)] Ready for construction; [4)] Detailed design

8.3.4. Brief description of Diamer Basha Project

Primary objective of DB is to improve significantly the storage capacity in the stressed Indus Basin Water System (to alleviate water shortages for agriculture and environmental flow) and to generate relatively cheap and clean (due to the renewable nature) energy to be transported and distributed by the National Power Grid. Main national benefits of the project will comprise:

- Enhanced water storage capability of the Indus River System by adding about 7.9 BCM of live storage at a time when the on-line storages 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 River, particularly in the reach Kalabagh to Gudu.
- Providing about 18,100 GWh of energy per annum from its installed capacity of 4,500 MW;
- Enabling about 1100 GWh of additional generation at Tarbela due to conjunctive operation of two reservoirs.

Sizeable addition to other two existing hydropower projects of Ghazi-Barotha and Chashma due to routing of additional water provided by storage at Diamer Basha 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. Salient features of the project are given in **Table 8.2**.

Table 8.2: Salient features of Diamer Basha Project

Element	Details / feature	Description
Catchment	Area	153,200 km²
	Mean Annual Inflow	62 BCM
	Probable Maximum Flood (PMF)	49,4170 m3/s
Location	On Indus river near Chillas (Gilgit Baltistan & K.P), 300 Km upstream from Tarbela dam and about 40 Km downstream of Chillas town	
Dam and Reservoir	Type	Roller compacted concrete (RCC)
	Crest Level	1,170 masl
	Full Reservoir Level (FRL)	1,160 masl
	Minimum Operation Level (MOL)	1,060 masl
	Length of Reservoir	102 km
	Surface Area	115.2 km²
	Storage Capacity	13 % of Inflow
	Height	272 meters (885.6 ft)
	Length	939 meters (3079.92 ft)
Spillway	Type	Ogee Type with Flip Bucket and Plunge Pool 11.5 m x 16.24 m (14 Nos.) Radial gates
Outlets	Low level	2
	Sluicing	5
Reservoir	Gross Storage	8.10 MAF (10 BCM)
	Live Storage	6.40 MAF (7.9 BCM)
Power House	Installed Capacity	4500 MW
	Location and Type	Underground, one each on right and left side
	No. of units	12, each of 375 MW (4500 MW)
Annual Energy	18,500 GWh	
Project Benefits	• Generation of Hydropower • Employment generation during construction and O&M of the project. • Uplift of socio-economic conditions. • Development of fisheries (reservoir)	
People affected	27,000 persons	
Project Cost	Rs 894.000 billion (US$ 11.178 B)	
Executing Agency	WAPDA	

Source: DBC, 2009

8.3.5. Baseline conditions

The baseline conditions in Basha project and DHP are largely comparable. Both projects are situated in the same agro-ecological zone along the Indus valley at few km distances of each other. Near Chilas the Indus is at about 1000 m and the mountain along the Indus valley rises up to 3000- 4000 m elevation. Near Dasu the Indus bed is about 800 m, whereas the mountains bordering the valley are somewhat lower with elevations between 2500 – 3000 m. The smaller hydropower projects along the Indus tributaries are also found in the same zone, but at some 35 – 60 km distance downstream of Dasu. The projects downstream from Pattan are situated in an area which receives some more rainfall and has well developed vegetation and natural forests along the tributaries and on the slopes. Altitudes vary between 800- 2500m. The area forms a transitional zone towards 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.

8.4.1. General

DHP in combination with 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 workers and migrants will be restricted in Dasu since there is hardly any suitable place to find to accommodate large numbers of people and commercial business. In the Basha project there will be more influx of followers since there is more free physical space for small industries and commercial establishments. A major limitation for any economic development is the poor condition of the KKH between Thakot and Raikot bridge (the only lifeline to the outside world), which situation is prohibitive for any further economic development in the area. So far there are no plans to reconstruct this road section which is in difficult terrain and frequently blocked during days. The impacts on biodiversity and wildlife have been described in Chapter 7 and the trends and concern identified in DHP and DB are similar, since the areas are as far as natural forests and vegetation and ecology is concerned almost identical, especially at the higher altitudes.

8.4.2. Impacts on hydrology, flooding and water availability

Hydrology

The operation of DHP as a run-of-river facility used for base load power production will essentially not change the hydrological regime of the Indus downstream. No change in the Indus flow between Dasu and Tarbela is expected. The downstream flow will only slightly be reduced during the first-filling of the reservoir. Even when this happens in the low flow season (February – March) there will be sufficient water discharged through the low level outlets and diversion tunnels to downstream areas. During yearly flushing operation, which start only after 15 years the water in the reservoir will be lowered for free flow through the Low Level Outlets of the dam during one month to flush the sediments. In case the Basha dam is constructed by that time flushing is only needed after 30 years. For the rest of the time the Run-of River flow will be maintained. Impacts of the change in flow therefore will be almost negligible.

With the construction of Basha, which dam has storage volume of 7.9 MAF the storage capability in Tarbela reservoir could considerably be increased by 42 percent during the low flow season, when this water is released into the system (see **Table 8.3**). This could alleviate the water shortages for irrigation downstream of Tarbela in the beginning of the kharif season, which is a crucial period for development of the summer crops in Punjab and Sindh. This impact will be very beneficial for irrigated agriculture in the plains and could compensate for the losses in the ecological flow (often used for agricultural purposes), which could be a beneficial development downstream. The change in river hydrology for different scenarios has been determined in a hydrological study for Basha dam carried out by WAPDA in 2012.

Table 8.3: Percent of change in river hydrology downstream of Tarbela under different hydropower and storage scenarios

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

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

Flooding

Storage of water in the reservoirs will attenuate the floods and save the downstream communities properties and lives. GLOFs are a serious threat and these are to be better managed to protect the hydropower infrastructure and community. Currently there is no early flood warning telemetry network available on the upstream of Dasu. In 2010 there was a huge landslide in the Hunza Valley, which blocked Hunza River and eroded away a considerable length of Karakoram Highway (KKH) near Attabad and also created a lake, which is still there.

With conjunctive operation of Tarbela, Diamer Basha and Dasu reservoirs, combined flood regulating capability of these dams will significantly increase. For individual 10-daily flows it was assessed that a maximum of about 60 percent reduction could be expected downstream of Tarbela.

Water availability

A system integrated study conducted by WAPDA showed that impacts from the completion of DHP and DB and optimized management of Tarbela could even be felt downstream of Kotri, especially during low flow season and in early kharif as shown in the **Table 8.4.**

Table 8.4: Impact in percentages of water availability and ecological releases downstream Kotri under different hydropower/storage scenarios

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

DHP alone will have no effect on water available for use downstream of DHP powerhouse outlets or downstream of Tarbela during the winter low flow period and will increase water availability slightly during early Kharif for the years when flushing takes place.

8.4.3. Impacts on sediment transport and water use

Sediment transport

Annually about 200 million ton of sediment are flowing into the DHP reservoir. Sand will be trapped but most of the suspended silt will pass the turbines and the spillways/LLOs in Dasu. Without flushing it is expected that the Dasu reservoir will be filled in 20-25 year. Once the flushing commences after 15 year (assuming Basha is not completed) about 27 percent of the annual sediment inflow would be trapped and 73 percent would be flushed through the flushing tunnels and LLO. 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 of the sediment quantity and composition as a result of the construction of DHP is not expected to have an impact on the water quality of the Tarbela reservoir. The construction of Basha will have a considerable beneficial impact on both Dasu and Tarbela reservoir. The Basha reservoir with a large storage volume will then act as a sediment trap and the inflow in Dasu reservoir will be reduced to 46 million ton of sediment (mainly fine fraction). The cumulated impacts of both Dasu and Basha together will have a considerable positive impact on Tarbela reservoir and may extend its life with another 50 years (15 years due to the retention of sediments in Dasu and 35 years due to retention in the Basha reservoir.)

Water Use

Downstream of Tarbela, there will be increased water availability during the low flow season and transition period of Early Kharif. The enhanced supplies downstream of Tarbela reservoir, in tandem operation with Basha and Dasu reservoirs, in low flow period is expected to increase irrigation supplies by 14 percent on average. Upstream of Tarbela, community drinking water and irrigation supplies are expected not to be affected since they are drawn mainly from tributaries, but may be affected by smaller tributary projects.

8.4.4. Impacts on aquatic ecology, fish and fisheries

Downstream of DHP

Fish movement from the tributaries to Indus confluences is common during low flow season in winter. Due to release of high water flows from Basha reservoir in winter, there will be a potential effect on the fish habitat near the confluences and movement patterns between tributaries and the Indus. This will also affect the availability of fish for local consumption. By constructing major structures in the Indus barriers will be created, which will impair the ecological connectivity in the river. However, no barrier effect on fish migration is expected since there were any long distant migrant fish species, such as Mahaseer, are not located in this section of Indus between Basha. Due to long storage time of water in the Basha reservoir, the water quality (dissolved oxygen content and temperature) in the reservoir will be affected. Release of these waters will have a potential to impact the downstream fish.

Reservoir areas

Formation of reservoir changes biotic and abiotic conditions in the submerged Indus and tributaries. In the reservoir areas the changes in the flow velocity, the water quality (less turbidity, higher temperature, and more light) is expected to change the aquatic ecosystem considerably. The riverine ecosystem will be converted into a more lacustrine aquatic habitat. These changes will affect the fish habitat and spawning sites of the tributaries and Indus. However, there could be opportunities for development of reservoir fish species due to improved water quality and reduced currents in the reservoir area. The negative impact on loss of fish habitat can be compensated developing of fish hatchery with native snow carps and open water stocking in the affected tributaries and reservoirs; and maintenance of spawning areas. These measures will also create new opportunities for employment of local community resettled people. Development of a new lacustrine habitat in the reservoir area could be valuable 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.

8.4.5. Impacts on forestry and biodiversity

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

8.4.6. Impacts on resettlement, livelihood and income

For Basha Dam project and DHP the nature of the social impacts is largely comparable, although social impacts are larger than in Dasu. DB requires the resettlement of considerably more people than DHP and more land is to be acquired for the project.

Impacts on trees felling, loss of land and commercial establishments is larger since the DB project is planned in a part of the Indus valley, which is much wider and more densely populated including more commercial activities than in the Dasu area. The impacts of resettlement, loss of land and assets are shown in **Table 8.5**.

Table 8.5: Social and cultural impacts of DHP and BD

Indicators	Basha Dam Project	Dasu Hydropower Project
Location	Diamer and Kohistan District	Kohistan District
Affected Population	28,650 people will be affected due to project interventions.	6,953 affected persons will be dislocated requiring relocation
Households	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 people socially vulnerable people	There are 10 families of Soniwal (nomad) tribe living in project area and several disabled and female-headed households
KKH	Submergence of about 94 km of existing Karakorum Highway (KKH) on the left bank	Submergence of about 46 km of existing Karakorum Highway (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 13 families of Soniwals living in project area.
Cultural heritage	Submergence of 30,367 rock carvings forming part of the 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

Indicators	Basha Dam Project	Dasu Hydropower Project
		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 death; 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.

8.4.7. Impacts on Physical Cultural Resources

A large field of pre-historic and historic rock drawings and inscriptions (50,000 rock drawings and 5000 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 Stone Age (8-9th millennium BC) to Buddhist and Islamic periods and is internationally known as the “guest book of the Silk Route”. Most of the 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 stretching out over the entire distance of 100 km 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 by the Basha reservoir 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 endangered by on-going developments from construction works and other activities along the KKH. Since this part will be the only remaining in-situ part from the entire field of almost 100 km of petroglyphs it is recommended that DHP is assisting in saving the in situ objects from further destruction and vandalism, by assisting the KP Department of Archaeology and Museums to acquire the land, provide proper fencing and protection measures, including some infrastructure for visitors of an information centre in Shatial and possibly a museum in either Chilas or Gilgit.

8.4.8. Transport

One of the most critical social impacts of the development of DHP and DB is that both projects draw heavily on the only existing road along the Indus, the Karakorum Highway. Not only the population in Kohistan and Diamer is strongly dependent, but also the population of major towns such as Gilgit, Hunza and in Skardu and the rest of the province of Gilgit-Baltistan (population > 1.0 million). The KKH is the only lifeline with the outside world. The road which was built during the sixties with by the Pakistan Army with Chinese assistance is for most of the sections between Thakot and Raikot bridge in very poor condition. 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 (8-10m wide) and in poor shape. Frequently the road is blocked by landslides after rainfall or minor earthquakes. Closure of the road is common, not only for one or two days, but often for a week or more. Currently the section between Khunjerab pass and Raikot bridge is upgraded to highway standards with the help of Chinese contractor.

However with the construction and operation of in mega hydropower projects like Basha and Dasu the status of the current road conditions is absolutely prohibitive for simultaneous or overlapping construction and development of these projects. Population in the rural areas of Kohistan and Gilgit-Baltistan is accustomed to endless delays and has learned to adapt since they have ever lived as self-sufficient farmer or livestock holder. However for the population of the major city centers the delays mean that they are entire isolated from the rest of the world during many days or weeks in the year.

In the current plans for reconstruction of roads in DHP and Basha which will be submerged by the reservoirs and about 175 km of new KKH road is foreseen. The new alignment will be improved to a relevant standard, but this will be only for the early phases of development (5-10 years). It is very essential that GOP is preparing plans and seeking assistance for upgrading the KKH to real highway standards. WAPDA could play an intermediary role in these developments and could bring this to the attention of responsible authorities and planning commissions.

8.5. Mitigations to be implemented under DHP

8.5.1. Mitigation/Enhancement Measures to be implemented under DHP

Since DHP is the first in the row of mega-projects to be developed under WAPDA's Vision 2025 Program with relatively low environmental impacts social impacts with a limited number of affected households as compared to other mega-project and with modest resettlement, it is recommended to strengthen the respective data bases on ecology (both aquatic and terrestrial), biodiversity and on 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 in information is the remoteness of the area and the difficult terrain conditions in 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 like WWF/IUCN, the Islamabad Herbarium and other institutions have facilities and expertise needed for implementing field studies to verify and collect reliable field data. It is suggested to concentrate under DHP on establishing a reliable data base and information system for the entire Indus Valley, including tributaries between Raikot bridge and Tarbela, which could also be used in detailed planning and preparation of the other hydropower projects along the Indus River.

Next to this DHP should concentrate on two major problems facing WAPDA in the Upper Indus Basin, which are measures to improve flood warning through improved watershed management and research on climate change. Watershed management is essential, but this is often difficult since all information on climate is collected from weather stations in the valley of the Indus and its major tributaries. Climatic conditions at higher elevations (3000 – 5000m and higher) are completely different from those in the valley and not recorded. Other main issues are the salvation of part of the collection of famous rock art and petroglyphs on both sides of the Indus; and a district forestry inventory of Kohistan to upgrade GIS information of forestry and deforestation, which is needed to identify suitable areas for reforestation and/or afforestation in the upland areas of the project. This study could also be used to identify suitable areas to compensate for eventual loss of the Kaigah Community-managed Game reserve. WWF-Pakistan and/or IUCN could be involved in this work.

Other issues for instance related to water quality research might come up during the first stage of the project. In the environmental mitigation measures a budget for such studies has been included. As an example the provisional Terms of Reference for a Forestry and Wildlife management study in Kohistan district and a Baseline study of aquatic and terrestrial ecology of the Indus valley between Raikot bridge and Thakot bridge is given in **Annex A**. The other measures to be implemented under DHP to mitigate and reverse negative environmental trends and also for environmental enhancement are described in the following sections.

8.5.2. Early Flood Warning and Climate Monitoring Program

For safety of public, improved management of flood waves and safe operation of DHP and other hydropower projects in the country, it is imperative to have an early warning system for early flood warning in the major 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 existing flood monitoring station in the DHP catchment. Hence it is recommended that the existing network is extended to the upper catchments of the River Indus including DHP. This component will include installation of River Level sensors (pressure transducers), temperature sensors, and Rain sensors (Tipping Buckets) at flood warning sites and hooking them with reliable telecommunication system, i.e., Meteor burst communication system. In total the installation of 18 telemetry stations is recommended in the upper catchment areas of the Indus. The works will be executed by the Hydrology & Research Directorate, under the administrative control of the Chief Engineer, Hydrology & Water Management, WAPDA. The operation and maintenance of the project will be handed over to Hydrology and Research directorate WAPDA after implementation, which is scheduled to be completed in one year. New staff will be hired and after proper training, they will be used for operation and maintenance of augmented network in conjunction with old staff.

8.5.3. Integrated Watershed Development Studies

At higher altitudes (> 1500 m) a number of forest plantations will be established where forest could be rejuvenated. This will be done at selected places on both sides (left and right bank) 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 the Indus District of Kohistan, Pakistan, to develop a general ecological management plan for sub-catchment areas of DHP, and to develop detailed community-led ecological management 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.

8.5.4. Fish Hatchery and Stocking

A fish hatchery for production of native cold water fish species, snow carps and stocking of fish in the tributaries, reservoirs and downstream Indus is recommended to compensate the loss of fish habitat on the downstream and to address potential downstream impacts. This requires maintenance of an onsite fish hatchery of snow carps for the production of the targeted numbers of fingerlings from hatchery and hauling of the fish fingerlings for open water stocking in the river. Fish hatcheries for snow carps are so far not established in Pakistan, but are existing in Uttaranchal, India (Garhwal Himalaya) and Nepal (Kali Gandaki A, Plkhra, Trishuli and Godavari). However, further studies and investigations are required for detailed understanding of snow carp biology before developing a full scale hatchery. In addition, a fisheries development and management plan in cooperation with the KP Fishery Department will be prepared and implemented for the Dasu reservoir.

8.5.5. Physical Cultural Resources (PCR) Protection Plan

DHP will support KP Archaeological Department to (i) procure 25 acres of land for acquisition of land, in which rock carvings are located, (ii) fence the area, (iii) provide fiberglass sheds; (iv) develop tourist facilities and (v) documenting the importance of rock carvings and their translations. A detailed plan for this has to be worked out together with the various stakeholders, including the Heidelberg University and the KP Department for Archaeology and Museums.

8.6. Summary of major environmental and social concerns

A summary of the main environmental and social concerns is given of the cumulative impacts is given in **Table 8.6**. The evaluation is based on the assumption that DHP (phase 1 and 2) is implemented in the period 2015- 2022 and that electricity is generated as from 2020. Diamer Basha project is expected to be commissioned after 15 years from now and starts generating electricity. Meanwhile in the period until 2025 all minor hydropower projects in the tributaries have been implemented and are under operation.

Table 8.6: Summary of environmental and social concerns of cumulative impacts

VEC	Feature	Major Concerns
Physical environment		
Surface water	Hydrology, floods and water availability	Positive Benefits due to increased irrigation flows and flood attenuation
	Sediment transport and water use	Positive benefits due to improved life of Tarbela
Biological environment		
Fish	Downstream fish habitat	Reduced flows and/or increased surges in low flow season; Changes in downstream water quality (temperature and dissolved oxygen).
	Upstream fish habitat	Formation of reservoirs and impact on spawning areas of fish (Indus, nullahs)

VEC	Feature	Major Concerns
Biodiversity	Natural forests	Pressure on forests (illegal logging) by influx of workers & in-migrants
	Wildlife	Increased poaching, hunting and trapping
	Natural habitats	Flooding of natural habitats, Degradation by increased overgrazing, firewood collection, etc.
		Lack of reliable data on, terrestrial and aquatic ecology, wildlife and forests
Social/cultural environment		
Social behavior	Influx of migrants	Lack of respect for cultural norms and traditions local population
Health & Safety	Public health	Reduced safety and health risk by interaction in-migrants with local population
KKH	Access to area	Frequent blockage and poor maintenance KKH → isolation
PCR	Archaeology	Loss of famous rock art sites by inundation and/or vandalism

9. Environmental and Social Management Plan

9.1. General

The Environmental Management Plan (EMP) and the Social and Resettlement Management Plan (SRMP) include various categories of mitigating measures. These are measures that can be grouped into three categories: (i) mitigating measures that can be included in the detailed design of the project; (ii) mitigating measures that can be included and worked out by the contractor(s) on basis of the EMP and an Environmental Code of Practices (ECP) enclosed in the Contract Documents, and (iii) stand-alone mitigation measures.

9.2. Objectives of EMP

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

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

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

9.3. Inclusion of EMP and SRMP in Contract Documents

In order to make contractors fully aware and responsible of the implications of the EMP and to ensure compliance, it is recommended that environmental measures are included in the tender documentation. The contractor must be made accountable through contract documents and/or other agreements of the obligations and importance of the environmental and social components of the Project.

Payment Milestones

Payments to contractors would be linked to environmental performance, measured by completion of the prescribed environmental and social mitigation measures. Contractors would be trained how to join forces with the executing agency, project management unit, 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 would attract trained and experienced environmental management staff.

9.4. Institutional Arrangements

9.4.1. Construction Phase

The overall responsibility for the implementation of the project rests with the Project Management Unit (PMU), headed by the Project Director (PD). Within the PMU there will be an Environment Unit (EU) - responsible for implementing the EMP, 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 EMP/SRMP implementation (see **Figure 9.1**).

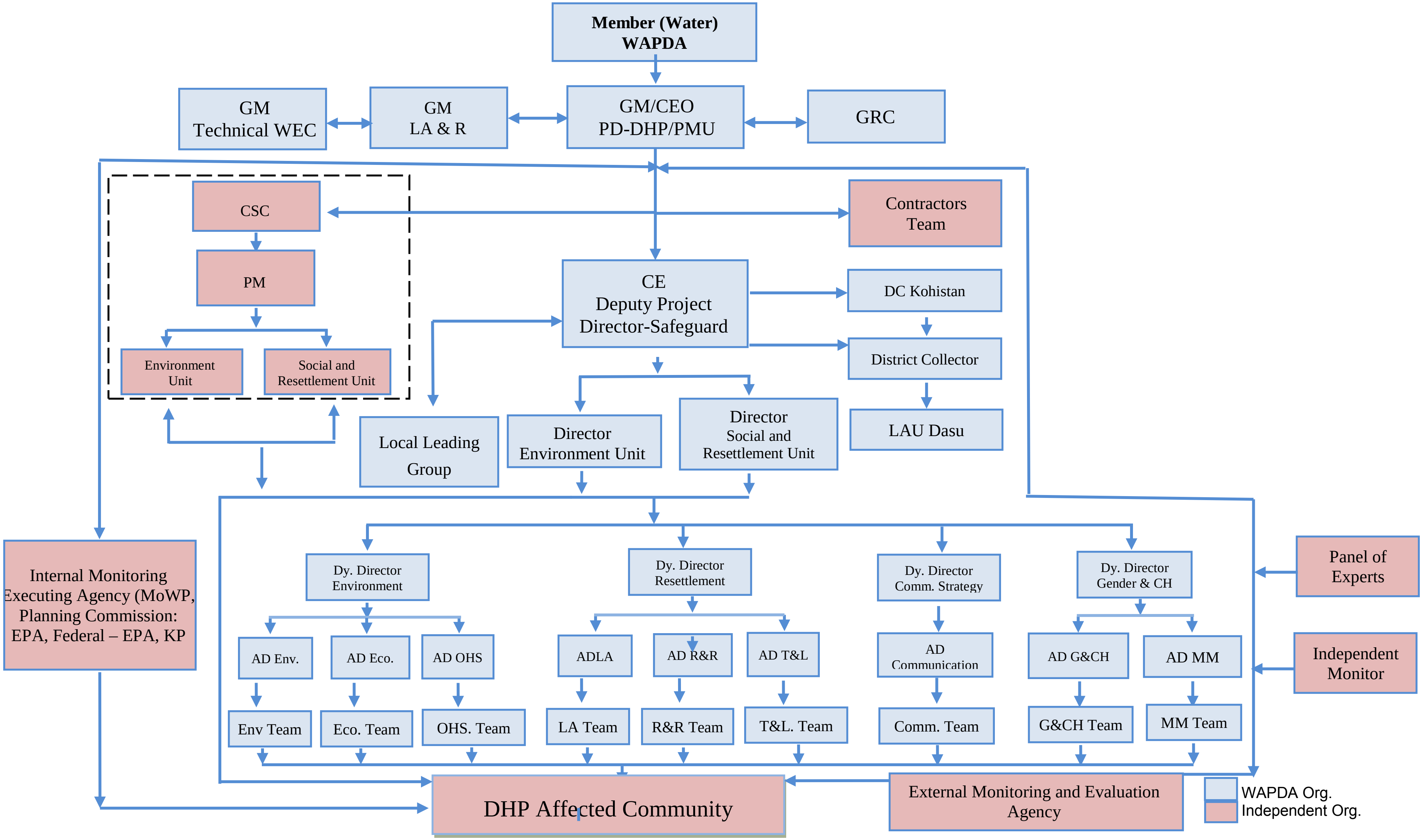
The responsibilities of the EU and SRU are: (i) supervising, facilitating and coordinating implementation of environmental and social plans including EMP and Resettlement Action Plan (RAP); (ii) ensuring that contractors follow KP-EPA regulations and other requirements mentioned in the EMP and SRMP; (iii) identifying any issues of non-compliance and report these; (iv) suggesting mechanisms to link contractor performance in relation to the EMP to the timing of financial payments, incentives or penalties; (v) interacting with stakeholders for their concerns about the construction activities; and (vi) ensuring implementation of contingency plans.

The EU and SRU will ultimately be responsible to the WAPDA Environmental Cell (WEC), stationed in Lahore. It is proposed that WEC takes a leading role in the EU and SRU by charging a senior WEC representative with overall responsibility for safeguards management during the construction phase. The potential for institutional strengthening and capacity building of WEC has been identified. Currently WEC is understaffed. WEC operating at proposed sanctioned strength would be adequately resourced to deliver the commitments set out in this EMP and SRMP.

The EU will consist of three sub-units (Environment; Ecology; and Occupational Health and Safety - OHS) with the following staff:

- Director - EU
- Deputy Director - Environment
- Assistant Director - Environment (with two site engineers)
- Assistant Director - Ecology (with one fish expert and one plantation expert)
- Assistant Director - OHS (with one support specialist)
- The Director EU with the assistance of Deputy Director-Environment will endorse and support the implementation of the EMP and associated policies and documentation. The Director will be responsible to ensure appropriate resources are made available to implement the EMP and to support established systems, procedures and environmental objectives.

Figure 9.1: DHP Organization Chart for Safeguards Implementation



Some specific responsibilities of the Director EU will include:

- Liaising with the Construction Supervision Consultants (CSC), and ensuring that they perform their responsibilities effectively and adequately
- Liaising with the SRU and other relevant Project entities for effective safeguard management;
- Assist in resolving disputes which may arise in respect to environmental management
- Liaising with government agencies and relevant stakeholders regarding environmental matters; overseeing the implementation of EMP requirements;
- Coordinating appropriate responses to environmental related complaints, ensuring complaints are investigated for effective resolution;
- Coordinating the involvement of environmental specialists (from the broader project team) as the need arises throughout the construction phase.
- Liaising with WEC to update them on the EMP implementation, and seeking any technical backup
- Ensure commissioning of additional studies required/recommended in EMAP. Prepare necessary TORs for hiring of consultants and contractors
- Prepare monthly and quarterly reports on the status of implementation of the EMP
- Conduct monthly meetings with the environmental staff of consultants and contractors on the progress of EMP implementation, issues associated with implementation, non-compliance issues, and recommended course of action. Document the minutes of the meetings and present them in the monthly reports
- Ensure review of EMP every six months, and ensure its updation it if required
- Ensure implementation of Traffic Management Plan.
- The Assistant Director – Environment will be mainly responsible for liaising with CSC on the field level for the implementation of EMP and preparing weekly compliance reports.
- The Assistant Director – Ecologist will be responsible for coordinating with district Forest and Fisheries departments (and other relevant agencies) for development of nurseries for plantation in the project area, supervision of aquatic ecology studies and monitoring, participating in landscaping plans for the quarry and spoil disposal areas, identifying needs for environmental enhancement measures in Kaigah Community Conservation Area (CCA), and conducting additional studies recommended in the terrestrial and aquatic ecology reports.
- The Assistant Director – OHS will be responsible for liaising with CSC for the implementation and supervision of occupational health and safety issues at the work areas.

Construction Supervision Consultants

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

CSC will have the following environmental staff:

- Team Leader (international environmental specialist)
- Environmental Specialists (one international and two national specialists)
- Ecologists (one international and one national)
- Occupational Health and Safety Specialist (one national)
- Environmental Surveyors (four national)

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

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

Contractor

Each contractor will be required to appoint adequate number of dedicated Environment/Social Officers at the site for the implementation of EMP 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. Appropriate numbers of the following personnel are required in the contractor's environmental team:

- Environmental Specialists
- Occupational Health and Safety Specialists

- Environmental Technicians (both for lab and field investigations)

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

9.4.2. O&M Phase

The O&M establishment at the DHP will be responsible for management of the environmental and social aspects of the Project including implementing the EMP during the operation and maintenance of the facility and dedicated staff will be appointed for this purpose at the site, with top supervision and technical backstopping to be provided by WEC.

9.5. Environmental and Social Management

The following plans will be prepared to manage and mitigate/reverse potential adverse environmental and social impacts (also see **Table 10.1**):

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. Tree species to be selected would be natural or semi-natural, adapted to the local (micro) climate and predominant soil conditions in the area. Establishment of a nursery will be considered as part of the Forestry Rejuvenation Plan for upland forest resources.

Borrow Area Restoration Plan for restoration of borrow areas would be prepared by the Contractor. This Plan would aim at 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. The Plan would be approved by the Construction Supervision Consultants (CSC) and a landscape architect assigned by WAPDA.

Disposal Area Restoration Plan for restoration of disposal areas would be prepared by the Contractor. This Plan would aim at restoring as much as possible the original natural situation of these sites by various measures (landscaping, leveling or smoothening) and removing all non-natural artifacts such as equipment parts, and sheds. The Plan will include measures to avoid land/soil erosion and landslides. The Plan would be approved by the CSC and a landscape architect assigned by WAPDA.

Pollution Prevention Plan will be prepared and implemented by the Contractor on the basis of the Environmental Code of Practices (ECP) and IFC/WBG EHS Guidelines (1997) which will be part of the bidding documents. The Plan will be submitted to the CSC for their review and approval before contractor mobilization.

Waste Disposal and Effluent Management Plan will be prepared and implemented by the Contractor on the basis of the EMP, ECP, and IFC/WBG EHS Guidelines (1997), which will be part of the bidding documents. The Plan will be submitted to the CSC for their 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 the EMP and ECP, which is part of the bidding documents.

The Plan will be submitted to the CSC for their review and approval before contractor mobilization.

A Traffic Management Plan will be prepared by the Contractor 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.

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

Public Health and Safety: A Public Health and Safety Plan will be prepared by the contractor 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. Also the increased safety risk for workers and public during construction has to be considered. The objective of the Plan is to minimize the risks and possible harmful effects on health due to construction activities. The Plan is scheduled for 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 health risks from living together in compounds. The workforce would have easy access to clinical care in order to minimize adverse effects and health risks. A medical facility will be set up for the construction workers. The facilities must also have the capacity to treat emergency cases. The Plan will be submitted to CSC/WEC for their review and approval.

An **Afforestation and Forest Rejuvenation Plan:** The forest areas above 1,500 m are already being exploited in an unsustainable manner: harvesting only. It can be expected that this type of exploitation will increase since it is one of the few potential sources of income for the increasing population, whereas the project-induced move up mountain will result in additional stress on forest resources as well as on wildlife. 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 would also create a relatively large number of jobs for forestry activities proper (including a nursery) and for enforcement of regulations. The Plan needs to be finalized before the end of 2014; it would include sustainable logging systems, rejuvenation schedules, nursery, manpower implications (forestry staff, guards) and a sound financial system to make the Plan self-sufficient.

A **Fisheries Development Program.** The Dasu reservoir, measuring about 2,400 ha, could produce a minimum of 500 ton of good quality fish with a value of some PKR 150 million (US$ 1.5 million), provided that a thought-through fisheries management program is introduced, together with its required infrastructure (hatchery, landing facilities, ice factory, craft and gear, laboratory, training facilities). Suitable commercial fisheries could provide at least 1,250 long term livelihood opportunities (based upon an average monthly income of PKR 10,000) and it will improve the nutritional level of the local communities. The Project, in cooperation with the Fishery Department will have to engage a reservoir fisheries specialist to prepare the program, preferably before the end of 2014.

Resettlement Action Plan (RAP): The Project will require acquire about 4,643 ha of land, affect a total of 767 households as a result of the construction 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 Resettlement Action Plan (RAP) has been prepared.

Income and Livelihood Restoration Program: The income and livelihood restoration program (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 programs 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 lacking development status of women, analyzed the challenging environment and explored potential entry points for gender interventions under the project. .A Gender Action Plan has been developed on the basis of this assessment. The action 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 putting to implementation.

Communication and Information: A Communication and Information Plan will be developed by WAPDA, based on the development of 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.

Management Plan for in-migrants: This plan outlines the approach to in-migration management and defines the steps to be taken by the project during construction and operation periods. The objective of the plan is to avoid and mitigate potential adverse impacts of influx of construction workers and other in-migrants on the local communities and the 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 of the project.

Table 9.1: Management Plans

	Plan	Responsibility		
		Plan Preparation	**Plan Approval**	**Implementation**
1.	Landscaping and Plantation Plan	Contractors (main works; colony works; resettlement sites)	CSC and PMU	Respective contractors
2.	Traffic Management Plan	Contractors (Main works and KKH)	CSC and PMU	Respective contractors
3.	Ecological Conservation Plan (Forestry and wildlife management study)	Consultant to be hired to conduct the ecological study	CSC and PMU	WAPDA (the study to provide the details)
4.	Aquatic and terrestrial baseline study	Consultant to be hired to conduct the aquatic study	CSC and PMU	WAPDA
5.	Pollution Prevention Plans (related to air, noise, soil, water resources)	All contractors	CSC and PMU	All contractors
6.	Fuels and hazardous substances management plan	All contractors	CSC and PMU	All contractors
7.	Oil and Chemical Spill Response Plan	All contractors	CSC and PMU	All contractors
8.	Waste Management/Disposal and Effluent Management Plan	All contractors	CSC and PMU	All contractors
9.	Spoil disposal and Area Restoration Plan	Main contractor and KKH contractor	CSC and PMU	Main contractor and KKH contractor
10.	Excavated Material management plan	All contractors	CSC and PMU	All contractors
11.	Quarry Area Management and Restoration Plan	Main contractor and KKH contractor	CSC and PMU	Main contractor and KKH contractor
12.	Emergency Preparedness Plan and Early Warning System	All contractors	CSC and PMU	All contractors
13.	Construction Camp Management Plan	All contractors	CSC and PMU	All contractors
14.	Drinking Water Supply and Sanitation Plan	All contractors	CSC and PMU	All contractors

	Plan	Responsibility		
		Plan Preparation	Plan Approval	Implementation
15.	Resettlement Action Plan (Plan already prepared)	WAPDA	WAPDA/WB	WAPDA
16.	Income and livelihood restoration program (ILRP) (Plan already prepared)	WAPDA	WAPDA/WB	WAPDA
17.	Gender Action Plan (Plan already prepared)	WAPDA	WAPDA/WB	WAPDA
18.	Fisheries Development management plan	WAPDA	WAPDA/WB	WAPDA
19.	Communication and Information Plan (Plan already prepared)	WAPDA	WAPDA/WB	WAPDA
20.	In-Migration Management Plan (Plan already prepared)	WAPDA	WAPDA/WB	WAPDA
21.	Grievance mechanism (plan already prepared)	WAPDA	WAPDA/WB	PMU/CSC
22.	Public Health Plan	WAPDA	WAPDA/WB	PMU/WAPDA
23.	Occupational Health and Safety (OHS) Plan	All contractors	CSC and PMU	All contractors
24.	Archaeological survey	CSC	PMU	Archaeologists to be engaged by WAPDA
25.	"Operation Environmental Action Plan"	WAPDA	WAPDA	PMU
26.	Sediment monitoring and management program	WAPDA	WAPDA	WAPDA
27.	Early Flood Warning and Climate Monitoring Program	WAPDA	WAPDA/WB	WAPDA

9.6. Mitigation Plans

The mitigation plans are the key components of the EMP and are structured around the following components: Project activities; Impacts – identified in the environmental assessment; Actions - measures to mitigate and manage impacts; Responsibility – the organization(s) responsible for executing the mitigation and monitoring performance indicators; and Target completion date / periodicity – the timing of when mitigations or monitoring would be implemented.

Should any changes to the Project design or methods of construction and operation take place post this assessment stage, the impacts and monitoring/mitigation measures discussed may need to be revised to reflect such changes to allow the environmental and social implications of these changes to be addressed. Separate mitigation plans have been prepared for the construction and O&M phases of the Project. These plans are presented in **Tables 9.2** and **9.3**.

Table 9.2: Mitigation Plan for Construction Stage

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
1. Activity: Design / pre-construction considerations						
1.1 Changes in land use, loss of properties, cultivated land and grazing land, relocation of settlements and amenities	– The RAP will be implemented for permanent land acquisition and loss of assets/livelihood and other similar impacts	WAPDA PMU	SRU	– Documentary evidence of RAP implementation – Establishment of resettlement sites – Payment of compensation amounts – People resettling in new villages – Income levels of displaced households – Number of public grievances re resettlement and compensation	Before construction	Project Component E1
	– Contractors will lease the land for construction facilities on temporary basis. Proper documentation will be carried out for this leasing.	Contractor	SRU	– Documentary evidence of land leasing for temporary facilities – Absence of grievances regarding temporary facilities	Before contractor mobilization	Included in contractors' costs (Components A, B, and C)
1.2 Slope Instability	– Excavated Material Disposal Plan to include siting and detailed assessment of the suitability of the proposed excavated materials disposal site – Identification of areas prone to land sliding. – Preparation of emergency response plan.	Design Consultants	WEC/ Environment Unit (EU)	– Identification of Disposal Area and availability of Disposal Area Management Plan – Availability of maps showing land slide prone areas. – Availability of contingency plan	Before construction: during detailed designing of the Project.	F1
1.3 Geology and seismology	– Foundations for infrastructure would comply with relevant design standards for structures in areas at risk of seismic activity. – Foundation design of the towers, powerhouse, and other structures to consider	Design Consultants	WEC/EU	– Compliance to the design to be ensured – Emergency Preparedness Plan in place prior to commencement of	Before construction	F1

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	the probability of earthquake at the earliest design stage. – Emergency Preparedness Plan to address the response to a disaster occurring during each phase of the Project lifecycle.			construction.		
1.4 Disposal of excavated material	– Identification of re-use of excavated material on site, to reduce off site effects – Maximization of use excavated material in construction.	Design Consultants	WEC/EU	– Availability of plan to dispose excavated material.	Before construction	F1
1.5 Surface Water quality	– Select access roads to avoid run-off to river. – Design cross- and side drainage	Design Consultants	WEC/EU	Inclusion of cross and side drainage system in the design	Before construction	F1
1.6 Groundwater quality	– Drainage system will be designed so that all spills will be drained and collected in a sump for further appropriate disposal; and – Oil and chemical storage and vehicle wash and oil change facilities will be on an impermeable surface to avoid percolation	Design Consultants	WEC/EU	- Monitoring in accordance with Ground Water Monitoring Program. - No breaches of Material Safety Data Sheet (MSDS) for hazardous substances.	Before construction	F1
1.7 Traffic Management	A Traffic Management Plan (TMP) will be prepared in accordance with ECP 15	Contractor	CSC	Approved TMP	Before mobilization of contractor	A, B, and C
1.8 Construction camp (and other temporary facilities) site selection	– Site for construction camp will be selected with approval from the Construction Supervision Consultants (CSC). – Areas having thick/dense vegetation will be avoided as far as possible.	Contractor	CSC	Approval from ESMU/ESM	Before mobilization of contractor	A, B, and C
1.9 Construction camp management	Construction Camp Management Plan will be prepared per ECP 16 and approval obtained from CSC.	Contractor	CSC	Approved Plan	Before mobilization of contractor	A, B, and C
1.10 Waste management	A Waste Management Plan will be prepared per ECP 1 and approval obtained from CSC.	Contractor	CSC	Approved Plan	Before mobilization of contractor	A, B, and C

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
1.11 Excavated material management	An Excavated Material Management Plan will be prepared and approval obtained from CSC.	Contractor	CSC	Approved Plan	Before commencing construction activities.	A, B, and C
1.12 Fuels and hazardous substances management	A fuels and hazardous substances management plan will be prepared per ECP 2 and approval obtained from CSC.	Contractor	CSC	Approved Plan	Before mobilization of contractor	A, B, and C
1.13 Water resource management	A water resource management plan will be prepared per ECP 3 and approval obtained from CSC.	Contractor	CSC	Approved Plan	Before mobilization of contractor	A, B, and C
1.14 Occupational Health and Safety (OHS) management	An OHS management plan will be prepared per ECP 18 and EHS Guidelines, and approval obtained from ESMU/ESM.	Contractor	CSC	Approved Plan	Before mobilization of contractor	A, B, and C
1.15 Drying of Riverbed Section	A detailed fishery study on the significance of migration will be carried out by a qualified fishery expert.	WAPDA	WEC	Presence of Study report		E2
2. Activity: Construction of 132 kV Power supply line from Dubair Khwar to Dasu						
2.1 Final design alignment of transmission line	- Alignment should avoid residential areas - Alignment should avoid agricultural and dense vegetated and forested areas as much as possible - Avoidance of areas prone to landslides	Contractor	CSC	Approval from ESMU/PESCO	2014	C
2.2 Land acquisition for owners of land and ROW	- Acquisition of land for erecting towers - Agreements for operation and maintenance of ROW corridor	WAPDA / Contractor	CSC	• Number of owners compensated • Number of agreements signed • Number of grievances regarding resettlement	2014-2015	C and E1
2.3 Protection of nullahs and other vulnerable habitats	- Avoid sensitive habitats and hotspots - Maintain fish access in nullahs - ensure no debris or wastes are released in the nullahs	Contractor	CSC/WEC	Number of non-compliances	During construction	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	- Minimize clearing and disruption of riparian vegetation					
2.4 Public Health and Safety of communities	- Measures to protect health and safety of community and workers - - Raising awareness and information of public on safety measures and pre-cautions. - Warning signs where appropriate - Ensure that community's drinking water source is not contaminated.	Contractor	CSC	• Number of complaints received • Number of incidents reported • Number of awareness raising events arranged	During construction and afterwards	C and E2
2.5 Occupational Health and Safety for workers	-Only allow trained and certified workers to install, maintain or repair electrical equipment -conduct regular trainings - availability and regular usage of PPEs - Strict safety measures to avoid contacts with life power lines and from working with electric and magnetic fields - Strict safety measures for working at great height on poles and structures - Adhere strictly to EHS guidelines and international standards for installation of electric equipment and devices	Contractor	CSC	• Monitoring of compliance with Health & Safety standards (including monthly reporting of accidents). • Availability and usage of PPEs • Number of accidents and near-miss reported • Number of trainings provided	During construction	C and E2
2.6 Natural habitats and forests	- Maintenance of vegetation of ROW based on ecological principles in order to prevent damage to the infrastructure from trees and the outbreak of fires - Minimize tree cutting and vegetation clearance	Contractor	CSC/ESMU	• Seasonal monitoring of vegetation in the ROW • Number of trees felled	During construction and afterwards	C and E2
2.7 Noise and dust prevention	- Noise prevention near residential areas - Regular watering of access roads and tracks - Liaison with the local community	Contractor	CSC/ESMU	• Monitoring of noise • Number of grievances regarding noise	During construction and afterwards	C and E2
3. Activity: Contractor Mobilization and Demobilization						
3.1 Traffic	– The approved TMP will be followed.	Contractor	CSC	– Number of any non-	During mobilization and	A, B, C, and

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
management	– Establishment of traffic management committee with the relevant stakeholders (traffic agencies, local governments along KKH, contractor). – Hold a one day workshop with the stakeholders to devise a plan for traffic management along KKH during construction period. – A traffic unit at Dasu is proposed to control the construction related traffic inflow and outflow with sub offices along KKH at Hassanabdal, Haripur, Abbotabad, Chatter Plain, Thakot, Besham, Pattan, Komilla, dam site, quarry site Kaigah. These offices will be connected with telephone, fax, mobile phone and internet. – The movement of traffic carrying cement or steel to be register at Hassanabdal (junction of KKH and GT road). These will travel in small lots of 10 trucks. Hassanabdal sub-office will inform the next stations by phone, fax or internet. – The weather conditions must be known before the start of the journey from Met office and drivers must be briefed before the start of the journey so that cargo may be protected from rain damage and driver may plan the journey accordingly. – The receiving stores must be notified, who must prepare for offloading the goods. This preparation includes the location of offloading, labor for offloading together with crane or low lift fork lifters. – Traffic facilities, such as speed limits and signal lights, are to be strengthened from Hassanabdal to Dasu			compliance reports – Number of complaints / grievances. – Number of traffic accidents/incidents involving project vehicles and lorries bringing materials and supply to project	demobilization	E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Support to be provided to the local traffic authorities to engage traffic police at the busy junctions – Implement the mitigation measures proposed in ECP 15.					
3.2 Soil Erosion and Contamination	– Vehicular traffic on unpaved roads will be avoided as far as possible. Operation of vehicles and machinery close to the water channels, water reservoir will be minimized. – Vehicles and equipment will not be repaired in the field. If unavoidable, impervious sheathing will be used to avoid soil and water contamination. – NEQS compliance will be ensured. – ECP 1, ECP 5, ECP 6, and ECP 7 will be implemented.	Contractor	CSC	Number of any non-compliance reports	Throughout contractor mobilization and demobilization	A, B, C, and E2
3.3 Air Quality	– Construction machinery and vehicles will be kept in good working condition and properly tuned, in order to minimize the exhaust emissions, and in compliance with the NEQS. – Fugitive dust emissions will be minimized by appropriate methods, such as spraying water on soil, where required and appropriate. – Project vehicles will avoid passing through the communities as far as possible. If unavoidable, speed will be reduced to 15 km/h to avoid excessive dust emissions. – Air quality will be properly monitored, especially near the population centers and WAPDA colonies. Appropriate actions will be undertaken in case ambient air quality at the population centers deteriorates beyond NEQS limits. – ECP 10 for air quality management will be	Contractor	CSC	– Number of non-compliance reports. – Number of community complaints. – Ambient air quality found beyond the national standards (NEQS)	Throughout contractor mobilization and demobilization	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	implemented.					
3.4 Noise	– Vehicles will have exhaust mufflers (silencers) to minimize noise generation. – Nighttime traffic will be avoided near the communities. Local population will be taken in confidence if such work is unavoidable. – Vehicular traffic through the communities will be avoided as far as possible. Vehicle speeds will be kept low, and horns will not be used while passing through or near the communities. – Compliance with NEQS and WBG'EHS Guidelines will be ensured. – ECP-11 will be enforced. – Continued consultations with the affected communities will be carried out.	Contractor	CSC	- Number of non-compliance reports; - Noise measurement data - Number of community complaints.	Throughout contractor mobilization and demobilization	A, B, C, and E2
3.5 Public Safety	– Occupational health and safety procedures will be enforced at site. – A Traffic Management Plan will be implemented that will aim at ensuring access to residential areas, and preventing of unsafe situations, especially near schools, housing areas, construction areas, camps and offices. – – Special attention should be focused on safety training for workers to prevent and restrict accidents and on the knowledge how to deal with emergencies. – Road signage will be fixed at appropriate locations to reduce safety hazard associated with project-related vehicular traffic. – Liaison with traffic police will be maintained – Project drivers will be trained on defensive driving. – Vehicle speeds near / within the communities	Contractor	CSC	– Numner of any non-compliance reports; – Number of any related public complaints – Number of accidents, incidents and near-misses.	Throughout contractor mobilization and demobilization	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	will be kept low, to avoid safety hazards. – ECP-15 and ECP-18 will be implemented.					
3.6 Damage to Infrastructure	All damaged infrastructure will be restored to original or better condition.	Contractor	CSC	– Number of any non-compliance reports; – Number of any public complaints.	Throughout contractor mobilization and demobilization	A, B, C, and E2
4. Activity: Construction workers camp establishment and operation						
4.1 Soil erosion; soil and water contamination	– location of camp will be selected after obtaining CSC's approval and in consultation with local community – Photographs will be taken to record the site conditions prior to the establishment of the camp. – Land clearing, leveling and grading will be minimized, and carried out in a manner to minimize soil erosion. – Camp will have rainwater drainage arrangements – Camps will have protection arrangements against soil erosion and land sliding – Vehicular traffic on unpaved roads will be avoided as far as possible. Operation of vehicles close to the water channels, water reservoirs will be minimized. – Contractors will prepare and implement a Waste Management Plan. – For the domestic sewage, appropriate treatment and disposal system (e.g., septic tank and soaking pits) will be constructed having adequate capacity – Waste oils will be collected in drums and sold to the recycling contractors. – The inert recyclable waste from the site (such as cardboard, drums, and broken/used parts) will be sold to recycling contractors. The	Contractor	CSC	– Compliance to the Camp Management Plan, Waste Management Plan – Number of any non-compliance reports – Results of soil and water quality analysis – Number of related complaints	Before and throughout the construction phase	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	hazardous waste will be kept separate and handled according to the nature of the waste. – Domestic sold waste from the camp site will be disposed off in a manner that does not cause soil contamination. – 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. – The camp site area will be completely restored after completion of construction works. All temporary structures will be demolished, – NEQS compliance will be ensured. – ECP-1, ECP-2, ECP-3, ECP 4, ECP 5, ECP 6, ECP 7, ECP 8, ECP 16, and ECP-18 will be implemented.					
4.2 Air Quality	– Generators and vehicles will be kept in good working condition and properly tuned, in order to minimize the exhaust emissions. – Fugitive dust emissions will be minimized by appropriate methods, such as spraying water on soil, where required and appropriate. – Air quality will be properly monitored, especially near the population centers and WAPDA colonies – NEQS compliance will be ensured. – ECP-10 will be implemented.	Contractor	CSC	– Number of any non-compliance reports – Air quality monitoring data – Number of related grievances	Throughout the construction phase	A, B, C, and E2
4.3 Vegetation loss; threat to wildlife	– Clearing natural vegetation will be avoided as far as possible. – The camp will be established in a natural clearing, outside forested areas. – Complete record will be maintained for any tree cutting.	Contractor	CSC	– Number of any non-compliance reports – Number of tree felled – Number of sighting of key wild species	Before and throughout the construction phase	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– The camp staff will not indulge in any animal shooting, trapping, catching, or killing activities. – The construction crew will be provided with liquefied petroleum gas (LPG) as cooking (and heating, if required) fuel. Use of fuel wood will be avoided. – Include information on wildlife protection in all tool-box orientation briefings for camp staff – ECP-12, ECP-13, and ECP-14 will be implemented.					
4.4 Noise	– Generators and vehicles will have exhaust mufflers (silencers) to minimize noise generation. – Liaison with the communities will be maintained. – Noise monitoring will be carried out. – NEQS compliance will be ensured. – ECP-11 will be implemented.	Contractor	CSC	– Number of any non-compliance reports – Noise monitoring data – Number of grievances regarding noise	Throughout the construction phase	A, B, C, and E2
4.5 Health and Safety	– OHS plan will be prepared and implemented – Protective fencing to be installed around the Camp to avoid any accidents. – Contain all fuel tanks in a fully bunded area with a storage capacity of at least 110 percent of the potential storage volume. – Spill control arrangements to be made for hazardous substances (e.g., fuels) – Firefighting equipment will be made available at the camps. – The camp staff will be provided OHS training. – All safety precautions will be taken to transport, handle and store hazardous	Contractor	CSC	– Number of any non-compliance reports – Number of trainings conducted – Number of accidents, incidents, and near misses.	Before and throughout the construction phase	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	substances, such as fuel. – Construction camps will have first aid kits – Camp crew will be provided with awareness for transmissible diseases (HIV, hepatitis B and C). – ECP-2 and ECP-18 will be implemented.					
4.6 Social and Gender Issues	– Local norms and customs will be respected – Camp crew will avoid entering the villages – No child labor will be employed in the camps. – Liaison with the community will be maintained. – ECP 17 will be implemented	Contractor	CSC	Number of non-compliance reports; Number of related complaints	Throughout the construction phase	A, B, C, and E2
4.7 Damage to PCRs	In case any artifact or site of archeological, cultural, historical, or religious significance are discovered during construction activities, the works will be stopped, and the Archeological Department will be informed.	Contractor	CSC	– Number of non-compliance reports – Number of reports of any PCR discovery	Throughout the construction phase	A, B, C, and E2
4.8 Increased Load on Local Services and Supplies	– the contractors to procure their supplies in a manner not significantly affecting the availability of essential commodities in the area for the residents. – Grievance redress mechanism will be established to address community complaints and grievances.	Contractor	CSC	Number of related public grievances	Construction phase	A, B, C, and E2
5. Activity: Transportation of Equipment and Construction Material						
5.1 Traffic management	– The approved TMP will be followed. – Establishment of traffic management committee with the relevant stakeholders (traffic agencies, local governments along KKH, contractor). – Hold a one day workshop with the stakeholders to devise a plan for traffic management along KKH during construction	Contractor	CSC	– Number of any non-compliance reports – Number of complaints / grievances. – Number of traffic accidents/incidents involving project vehicles and lorries bringing	Throughout the construction phase	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	period. – A traffic unit at Dasu is proposed to control the construction related traffic inflow and outflow with sub offices along KKH at Hassanabdal, Haripur, Abbotabad, Chatter Plain, Thakot, Besham, Pattan, Komilla, dam site, quarry site Kaigah. These offices will be connected with telephone, fax, mobile phone and internet. – The movement of traffic carrying cement or steel to be register at Hassanabdal (junction of KKH and GT road). These will travel in small lots of 10 trucks. Hassanabdal sub-office will inform the next stations by phone, fax or internet. – The weather conditions must be known before the start of the journey from Met office and drivers must be briefed before the start of the journey so that cargo may be protected from rain damage and driver may plan the journey accordingly. – The receiving stores must be notified, who must prepare for offloading the goods. This preparation includes the location of offloading, labor for offloading together with crane or low lift fork lifters. – Traffic facilities, such as speed limits and signal lights, are to be strengthened from Hassanabdal to Dasu – Support to be provided to the local traffic authorities to engage traffic police at the busy junctions – Implement the mitigation measures proposed in ECP 15.			materials and supply to project		
5.2 Soil Erosion and Contamination	– Vehicular traffic on unpaved roads will be avoided as far as possible. Operation of	Contractor	CSC	Number of any non-compliance reports	Before and during	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	vehicles and machinery close to the water channels, water reservoir will be minimized. – Vehicles and equipment will not be repaired in the field. If unavoidable, impervious sheathing will be used to avoid soil and water contamination. – NEQS compliance will be ensured. – ECP 1, ECP 5, ECP 6, and ECP 7 will be implemented.				construction	
5.3 Air Quality	– Construction machinery and vehicles will be kept in good working condition and properly tuned, in order to minimize the exhaust emissions, and in compliance with the NEQS. – Fugitive dust emissions will be minimized by appropriate methods, such as spraying water on soil, where required and appropriate. – Project vehicles will avoid passing through the communities as far as possible. If unavoidable, speed will be reduced to 15 km/h to avoid excessive dust emissions. – Trucks and conveyor belts carrying construction material and excavated soil will be covered if required to avoid air quality deterioration. – Air quality will be properly monitored, especially near the population centers and WAPDA colonies – ECP 10 for air quality management will be implemented.	Contractor	CSC	– Number of any non-compliance reports – Air quality monitoring data – Number of related grievances	Before and during construction	A, B, C, and E2
5.4 Noise	– Vehicles will have exhaust mufflers (silencers) to minimize noise generation. – Nighttime traffic will be avoided near the communities. Local population will be taken in confidence if such work is unavoidable.	Contractor	CSC	– Number of any non-compliance reports – Number of related public complaints – Noise monitoring data	Before and during construction	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Vehicular traffic through the communities will be avoided as far as possible. Vehicle speeds will be kept low, and horns will not be used while passing through or near the communities. – Liaison with the communities will be maintained. – Noise monitoring will be carried out – Compliance with NEQS and WBG'EHS Guidelines will be ensured. – ECP-11 will be enforced.					
5.5 Public Safety	– Road signage will be fixed at appropriate locations to reduce safety hazard associated with project-related vehicular traffic. – Liaison with traffic police and communities will be maintained – Project drivers will be trained on defensive driving. – Vehicle speeds near / within the communities will be kept low, to avoid safety hazards. – ECP-15 and ECP-18 will be implemented.	Contractor	CSC	– Number of any non-compliance reports – Number of accidents, incidents and near misses – Number of related public complaints – Number of trainings provided	Before and during construction	A, B, C, and E2
5.6 Damage to Infrastructure	All damaged infrastructure will be restored to original or better condition.	Contractors	CSC	Number of any non-compliance reports	Before and during construction	A, B, and C
6. Activity: Construction of Dam, Powerhouse, and other related structures						
6.1 Changes to topography	– Changes to the topography will only occur in designated areas to accommodate defined project features. – Excavation of material will be kept to a minimum. – Excavated material will be managed in accordance with the Excavated Material Disposal Plan. – Preparation and implementation of	Contractor	CSC	– Volume of spoil extracted (monitor against predictions). – All excavated materials to be disposed of in designated sites. – Number of non-compliances observed/reported – Presence of landscaping plan	Throughout the construction phase	A, B, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	landscaping plan at the key locations (project area between dam and end of tailrace and for the WAPDA Colony and Offices area) – Implement ECP 8.			– Evidence of implementation of the above plan.		
6.2 Landslide	– Method Statements and Risk Assessments prepared prior to any excavation activity – Any blasting activities in these areas will be controlled and contained within defined limits. – Pro-active measures will be implemented to stabilize and protect slopes and to protect workers safety. Early warning systems will be introduced that will indicate when cracks appear and allow any widening to be monitored. Access would be restricted during the periods that slope stability is not yet entirely secured and guaranteed by proper safety measures such as rock bolts, anchors, safety nets and gabion structures. – Permanent monitoring by the contractor will be required. – Slope protection measures, such as rock bolts, rock anchors, safety nets and other protection measures will have to be applied including proper terracing to reduce the risk of slope failures. – Stabilize landslide prone areas which may be impacted by construction activities or reservoir formation – Monitor stability of landslide prone areas at identified locations during construction and operational phases – During excavations the concerned slopes will be stabilized and excavation started exacted from the top then gradually working down	Contractor	CSC	– Number of blasting events. – Method Statements and Risk Assessments produced for construction of each item of infrastructure. – All excavated materials to be disposed of in designated sites. – Monitoring of early warning systems. – Number of landslides reported in the project area	Throughout the construction phase	A, B, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	the slope. After blasting a riser, it will be stabilized by pre-designed support systems such as shotcrete, mesh and rock bolts prior to drilling the next riser for excavation. Where there are confinement issues, cushion blasting will be the method applied. Extreme care will be taken in designing the blasting pattern and blasting will be controlled so as to avoid disturbance of nearby slopes where stability is in a critical condition. – Emergency Preparedness Plan and Early Warning System will set out response actions in the event of a landslide – Other methods to be considered as alternatives to blasting					
6.3 Soil erosion	– Areas not used during operation will be re-vegetated, particularly slopes – Borrow pits/areas to be restored to the extent possible/ necessary – Areas exposed during construction and not used for operation will be re-vegetated ('greened') immediately – Adopt measures set out in the Landscaping and Plantation Plan – Road edge buffers will be re-planted – Replanting to occur prior to the commencement of operation, using fast-growing native species; and grasses to assist slope and soil stability. – ECP-6 will be implemented.	Contractor	CSC	– Number of incidences of borrow pits not being covered. – Compliance with the Landscaping and Plantation Plan. – All replanting to be commenced prior to operation.	Throughout the construction phase and prior to operation	A, B, and E2
6.4 Soil and water contamination	– The contractor will prepare and implement a Pollution Prevention Plan prior to the start of the work. Proper baseline data will be collected. – Construction materials will be stored, used	Contractor	CSC	– Monthly auditing of management of hazardous materials against Material Safety Data Sheet – Soil and water quality	Throughout the construction phase	A, B, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	and handled appropriately. – Excavated Material Disposal Plan to include measures to reduce risk of environmental pollution. – Reduce risk of a pollution event through adoption of measures set out in Solid Waste Management Plan and Wastewater Treatment Plan – Hazardous and toxic materials stored separately – 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. – Oil and Chemical Spill Response Plan will be prepared. – Design drainage for the batching plant area to direct runoff into a sump/basin for inspection for pollutants prior to discharge – Design settling basins for the discharges from tunnel construction areas – Establish a laboratory at Dasu with all necessary facilities at the site for chemical analysis of water for key parameters (dissolved oxygen, turbidity, total suspended solids, total dissolved solids, petroleum products); along with potable conductivity, pH and turbidity meters to assess pollution from construction activities. – Any discharges to the river or streams should have turbidity of less than 2 mg/l to meet the NEQS 2000 – Regular waste water streams are to be passed through settling basins.			monitoring data – Number of any non compliance – Number of related complaints		

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Undertake pH monitoring of site runoff to ensure alkaline runoff is not leaving the site. – Construct a designated, signposted concrete wash down bay that is fully contained and bunded for all excess concrete and concrete wash down, e.g. plastic lined. – Regularly maintain the concrete washout bay, treating any water prior to release to natural systems. – NEQS compliance will be ensured. – ECP-1, ECP-2, ECP-4, ECP-5, and ECP-7 will be implemented.					
6.5 Risk of Water Pollution from Storage Tanks	The potential sources of pollution will be identified and removed during the construction period and prior to the first filling of the reservoir.	Contractor	CSC	Documentary evidence of removal of storage tanks Number of non-compliances	construction phase	A, B, and E2
6.6 Air Quality	– Air quality in the tunnels should be maintained in accordance with technical specifications – The quantity of fresh air pumping from outside to inside the tunnel must be boosted such that a wind velocity of 1 m/s is maintained as the minimum. – Construction materials will be stored in designated areas away from sensitive receptors and covered to minimize dust on site from site construction works – Construction vehicles will be sprayed with water when entering and leaving the site, covered if transporting materials, adhere to speed limits, and engines will be turned off when idling. – Water spraying will be carried out to suppress dust emissions where needed – Batching plants, asphalt plants, and crushers	Contractor	CSC	– Number of dust-related complaints. – Number of air quality-related complaints, – Air quality monitoring data –	Throughout construction phase	A, B, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	will have appropriate dust and emission abatement systems (e.g., wet scrubber) as appropriate. – Target zero dust related complaints – Target zero air quality related complaints. – NEQS compliance will be ensured. – Monitoring of ambient air quality near settlements and colonies. Appropriate actions to be undertaken in case ambient air quality deteriorates beyond NEQS limits. – ECP-10 will be implemented.					
6.7 Health and Safety	– Compliance with Occupational Health & Safety standards and OHS Plan – Use of personal protective equipment (PPE) – Construction sites to be cordoned off to stop unauthorized access – Develop controls and standard operating procedures for the use of fuels and other hazardous substances to prevent spills, accidents, and pilferage – Handle explosives strictly according to the protocols – Train and designate personnel for various OHS aspects such as spill control procedures, fire fighting – Establish fire fighting system and fire safety (fire extinguishers) at the construction sites where fire is an hazard – Spill kits and trained personnel are to be made available at the workshops. – Contain all fuel tanks in a fully bunded area with a storage capacity of at least 110 percent of the potential storage volume. – Use auto shut down valves for fuel transfer pipes	Contractor	CSC	– Number of respiratory protective devices and other PPEs issues to workers. – Monitoring of compliance with Health & Safety standards (including monthly reporting of accidents). – Number of accidents, incidents and near misses. – Number of trainings provided.	Throughout construction phase	A, B, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Transport of hazardous goods and fuel to be done in closed containers and ISO certified tanks – Provision of respiratory protective devices for workers where needed – Designate agreed routes for traffic (set out in the Traffic Management Plan) – Provision of insurance-backed compensation scheme for major injury or loss of life reflecting settlement sums that are consistent with national/international benchmarks. – Contractor to engage a doctor at the site/camp – Construction sites to have first aid boxes – Site to have ambulance to transfer injured/sick workers to nearest hospital – WBG's EHS Guidelines to be implemented – Regular OHS trainings to be provided to workers – ECP 2 and ECP-18 will be implemented.					
6.8 Noise and Vibration	– Perform test blasting with various charges and monitor resultant noise and vibration levels at various distances and to define the sensitive areas that will be affected during the future blasting activities – Blasting activity will be restricted to fixed times; – Communities will be informed in advance of planned blasting; – Construction plant producing sound in excess of 85dB will be fitted with mufflers; – Noise barriers will be provided in areas where significant noise is expected (e.g. during blasting).	Contractor	CSC	– Number of blasting events recorded. – Evidence of providing advance warning of blasting to communities. – Record of equipment used on site capable of producing over 85dB and whether equipment has been fitted with mufflers – Number of related community complaints – Noise monitoring data – Number of non-compliances	Throughout construction phase	A, B, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Noise monitoring will be conducted – NEQS compliance will be ensured. – ECP-11 will be implemented.					
6.9 Landscape and Visual Intrusion	– Preparation of a Landscape Plan – Adoption of Landscaping and Plantation Plan – New planting and landscape restoration as soon as practicable at the end of construction phase – Replanting of flora/vegetation alongside new access roads – Enhance flora environment by planting fruit trees and ornamental shrubs. – ECP 8 to be implemented	Contractor	CSC	Compliance with Landscaping and Plantation Plan	Before the completion of the construction phase	A, B, and E2
6.10 Vegetation loss	– A nursery will be established with the native species with a capacity to produce about 300,000 saplings with an objective to develop 100,000 trees (5 saplings for each proposed tree). – At higher altitudes (> 1500 m) a number of forest plantations will established where forest could be rejuvenated. This will be done at selected places on both sides (left and right bank) 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 (a.o Swat Kohistan). – Plantation to be developed in the buffer areas (at suitable sites) of the reservoir on the right bank, in DHPs office and colony, and at the resettlement with a target to develop about 5 trees for each tree cut. – Maintain each sapling for a period of minimum 2 years with the support of local community. Community will be paid for	Contractor	CSC	– Number of trees felled – Number of saplings planted – Survival rate of saplings after one year	Throughout construction phase	A, B, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	watering and raising the plantation. – A public education program should be designed and implemented to discourage cutting of trees by the construction workers – The Project will support the local government to establish a market for the supply of non-wood fuels such as LPG for cooking and heating to reduce the pressure on firewood. Contractors also shall provide non wood fuels such as LPG to the construction staff for cooking and heating purposes. – Avoid dumping material in vegetated areas. – Avoid unnecessary loss of vegetation – ECP-12 will be implemented.					
6.11 Fauna / Wildlife	– Kaigah community will be compensated for loss of income from wildlife management; – The community will be consulted and involved in the selection of alternative options to strengthen ecological conservation measures; – Studies will be undertaken to identify alternative wildlife conservation to be implemented elsewhere in the sub-catchments from DHP, possible also at the right bank of the reservoir – Establish vantage stations to monitor the presence and movement of Tragopan and migratory birds, breeding birds, small mammals, ungulates and otters. – Include information on wildlife protection in all construction related tool-box orientation briefings for new construction staff – A public education program will be designed and implemented to discourage poaching of	Contractor	CSC	– Number of instances of spoil being deposited in non-designated areas. – Number of reported incidences of hunting or poaching on the Project site / in land ownership. – Number of reports of sighting of key wild species	Throughout construction phase	A, B, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	wildlife – Avoid positioning spoil in areas used by fauna – No hunting or poaching – Provide corridors for animal movement. – ECP-13 and ECP 14will be implemented.					
6.12 Mortality of Fish	Inlets will be screened to prevent inflow of unwanted materials; the screening will have to be fine enough to prevent fish passage.	Contractor	CSC	Number of any non-compliance reports	construction phase	A, B, and E2
6.13 Impact on Ecological Connectivity and Migration of Fish	– Studies will be commissioned on fish resources in the area, their migration, and their food/economic value – Fisheries development and management plan will be prepared and implemented for the Dasu reservoir. – WAPDA will develop fish hatchery through which tributaries and reservoir will be restocked	WAPDA	WEC	– Presence of study report and management plan – Evidence of implementation of management plans	construction phase	E2
6.14 Damage to infrastructure	Any damaged infrastructure such as roads, bridges and culverts will be repaired	Contractor	CSC	Number of any non-compliance reports	construction phase	A and B
6.15 Damage to PCRs	– The mosque at Seer Gayal will be disassembled and reassembled at a new location. – The graves will be protected by stone-pitching so that no floating and washing away of the bodies or skeletal remains occur. – – In case any artifact or site of archeological, cultural, historical, or religious significance are discovered during construction activities, the works will be stopped, and the Archeological Department will be informed.	Contractor	CSC	– Number of any non-compliance reports – Number of reports of any new PCR discovered/reported	construction phase	A, B, and E2
	– DHP will support KP Archaeological Department to (i) procure 25 acres of land for	WAPDA	WEC	– Evidence of commencement of works	construction phase	E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	acquisition of land, in which rock carvings are located, (ii) fence the area, (iii) provide fiberglass sheds; (iv) develop tourist facilities and (v) documenting the importance of rock carvings and their translations. – DHP will commission an archeological study to survey in reservoir area to identify any PCRs			– Report of the archeological survey		
6.16 Loss of Access to Villages	– A new suspension bridge near Kandia will be constructed – A total of 35 km of new access roads will be built, all at a higher level of the right bank of the Indus. – A new jeepable track of 18 km will provide access to the villages in Kandia valley. – All new settlement sites will be provided with good access roads. – Other existing facilities for pedestrians to cross the river, such as foot bridges and cable cars will be replaced by appropriate alternatives. Different options for pedestrians for crossing the 73 km long reservoir will be considered since these connections are important assets and a lifeline for the remote communities at the right bank with the rest of the world.	Contractor	CSC	– Presence of new bridges and access paths – Number of related community complaints	construction phase	A, B, and C
6.17 Disturbance of Visual Landscape and Natural Habitats	– 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. – Landscape plans for the residential areas and the offices will be developed to create a good living and working environment. – Tree planting will be well organized and	Contractor	CSC	Number of any non-compliance reports	construction phase	A, B, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	where possible vegetation and natural habitats will have to be restored or newly created. – For the disposal and borrow areas a Restoration Plans will be prepared to restore original landscape and vegetation.					
6.18 Social conflict due to the Influx of Workers and In-migrants	Implementation of the In-Migration Management Plan. In accordance with this Plan procedures and rules will be worked out by the PMU in close cooperation with the contractors and local authorities.	PMU	WEC	Number of public grievances relating to in-migrants	Construction phase	E1
6.19 Respect of Local Cultural Norms and Values by Work Force	– Implementation of awareness campaign – The contractors would be aware of the possibility and risks of miscommunications between local residents and workers, a situation which easily could lead to social unrest. This would be prevented by raising awareness and implementation of a Code of Conduct for the workers. – Complaints from the local community will be addressed by the Grievance Mechanism that will be developed.	PMU and contractor	CSC	Number of related public grievances	Construction phase	A, B, and E2
6.20 Adverse Effects on Health Situation	– 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 spreading of sexually transmitted diseases such as HIV/AIDS. – The medical health facilities in the project area will be facilitated to deal with such incidences. – Measures to this end are included in a Public Health and Safety Plan that will be implemented.	PMU and contractor	CSC	Number of patients being treated in the local hospitals	Construction phase	A, B, and E1

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
6.21 Increased Load on Local Services and Supplies	– the contractors to procure their supplies in a manner not significantly affecting the availability of essential commodities in the area for the residents. – Grievance redress mechanism will be established to address community complaints and grievances.	Contractor	CSC	Number of related public grievances	Construction phase	A, B, and E2
7. Activity: KKH Construction and other related structures						
7.1 Changes to topography	– Changes to the topography will only occur in designated areas to accommodate defined project features. – Excavation of material will be kept to a minimum. – Excavated material will be managed in accordance with the Excavated Material Disposal Plan. – Preparation and implementation of landscaping plan at the key locations (project area between dam and end of tailrace and for the WAPDA Colony and Offices area) – Implement ECP 8.	Contractor	CSC	– Volume of spoil extracted (monitor against predictions). – All excavated materials to be disposed of in designated sites. – Number of non-compliances observed/reported	Throughout the construction phase	C and E2
7.2 Landslide	– Method Statements and Risk Assessments prepared prior to any excavation activity – Any blasting activities in these areas will be controlled and contained within defined limits. – Measures will be taken to ensure that the landslides do not affect the existing KKH and its traffic. Road clearing machinery will be deployed along the KKH where necessary. Warning signs will also be placed along the existing KKH. – Pro-active measures will be implemented to stabilize and protect slopes and to protect workers safety. Early warning systems will	Contractor	CSC	– Number of blasting events. – Method Statements and Risk Assessments produced for construction of each item of infrastructure. – All excavated materials to be disposed of in designated sites. – Monitoring of early warning systems. – Number of Landslides affecting traffic on existing KKH	Throughout the construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	be introduced that will indicate when cracks appear and allow any widening to be monitored. Access would be restricted during the periods that slope stability is not yet entirely secured and guaranteed by proper safety measures such as rock bolts, anchors, safety nets and gabion structures. – Permanent monitoring by the contractor will be required. – Slope protection measures, such as rock bolts, rock anchors, safety nets and other protection measures will have to be applied including proper terracing to reduce the risk of slope failures. – Stabilize landslide prone areas which may be impacted by construction activities or reservoir formation – Monitor stability of landslide prone areas at identified locations during construction and operational phases – During excavations the concerned slopes will be stabilized and excavation started exacted from the top then gradually working down the slope. After blasting a riser, it will be stabilized by pre-designed support systems such as shotcrete, mesh and rock bolts prior to drilling the next riser for excavation. Where there are confinement issues, cushion blasting will be the method applied. Extreme care will be taken in designing the blasting pattern and blasting will be controlled so as to avoid disturbance of nearby slopes where stability is in a critical condition. – Emergency Preparedness Plan and Early Warning System will set out response actions in the event of a landslide					

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Other methods to be considered as alternatives to blasting					
7.3 Soil erosion	– Areas not used during operation will be re-vegetated, particularly slopes – Borrow pits/areas to be restored to the extent possible/ necessary – Areas exposed during construction and not used for operation will be re-vegetated ('greened') immediately – Adopt measures set out in the Landscaping and Plantation Plan – Road edge buffers will be re-planted – Replanting to occur prior to the commencement of operation, using fast-growing native species; and grasses to assist slope and soil stability. – ECP-6 will be implemented.	Contractor	CSC	Number of incidences of borrow pits not being covered. Compliance with the Landscaping and Plantation Plan. All replanting to be commenced prior to operation.	Throughout the construction phase and prior to operation	C and E2
7.4 Soil and water contamination	– The contractor will prepare and implement a Pollution Prevention Plan prior to the start of the work. Proper baseline data will be collected. – Construction materials will be stored, used and handled appropriately. – Excavated Material Disposal Plan to include measures to reduce risk of environmental pollution. – Reduce risk of a pollution event through adoption of measures set out in Solid Waste Management Plan and Wastewater Treatment Plan – Hazardous and toxic materials stored separately – The contractor will identify suitable sites for disposal of hazardous and non- hazardous waste. The selection will be done in	Contractor	CSC	– Monthly auditing of management of hazardous materials against Material Safety Data Sheet – Soil and water quality monitoring data – Number of reports if any non compliance – Number of related complaints	Throughout the construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	consultation with the PMU and the local municipal authorities. – Oil and Chemical Spill Response Plan will be prepared. – Design drainage for the batching plant area to direct runoff into a sump/basin for inspection for pollutants prior to discharge – Design settling basins for the discharges from tunnel construction areas – Any discharges to the river or streams should have turbidity of less than 2 mg/l to meet the NEQS 2000 – Regular waste water streams are to be passed through settling basins. – Undertake pH monitoring of site runoff to ensure alkaline runoff is not leaving the site. – Construct a designated, signposted concrete wash down bay that is fully contained and bunded for all excess concrete and concrete wash down, e.g. plastic lined. – Regularly maintain the concrete washout bay, treating any water prior to release to natural systems. – NEQS compliance will be ensured. – ECP-1, ECP-2, ECP-4, ECP-5, and ECP-7 will be implemented.					
7.5 Air Quality	– Construction materials will be stored in designated areas away from sensitive receptors and covered to minimize dust on site from site construction works – Construction vehicles will be sprayed with water when entering and leaving the site, covered if transporting materials, adhere to speed limits, and engines will be turned off when idling.	Contractor	CSC	– Number of dust-related complaints. – Number of air quality-related complaints, – Compliance with Traffic Management Plan. – Air quality monitoring data	Throughout construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Water spraying will be carried out to suppress dust emissions where needed – Batching plants, asphalt plants, and crushers will have appropriate dust and emission abatement systems (e.g., wet scrubber) as appropriate. – Target zero dust related complaints – Target zero air quality related complaints. – NEQS compliance will be ensured. – Monitoring of ambient air quality near settlements and colonies. Appropriate actions to be undertaken in case ambient air quality deteriorates beyond NEQS limits. – ECP-10 will be implemented.					
7.6 Health and Safety	– Compliance with Occupational Health & Safety standards and HSE Plan – Use of personal protective equipment (PPE) – Construction sites to be cordoned off to stop unauthorized access – Develop controls and standard operating procedures for the use of fuels and other hazardous substances to prevent spills, accidents, and pilferage – Handle explosives strictly according to the protocols – Train and designate personnel for various HSE aspects such as spill control procedures, fire fighting – Establish fire fighting system and fire safety (fire extinguishers) at the construction sites where fire is an hazard – Spill kits and trained personnel are to be made available at the workshops. – Contain all fuel tanks in a fully bunded area with a storage capacity of at least 110 percent	Contractor	CSC	– Number of respiratory protective devices and other PPEs issues to workers. – Monitoring of compliance with Health & Safety standards (including monthly reporting of accidents). – Number of accidents, incidents and near misses. – Number of trainings provided.	Throughout construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	of the potential storage volume. – Use auto shut down valves for fuel transfer pipes – Transport of hazardous goods and fuel to be done in closed containers and ISO certified tanks – Provision of respiratory protective devices for workers where needed – Designate agreed routes for traffic (set out in the Traffic Management Plan) – Provision of insurance-backed compensation scheme for major injury or loss of life reflecting settlement sums that are consistent with national/international benchmarks. – Contractor to engage a doctor at the site/camp – Construction sites to have first aid boxes – Site to have ambulance to transfer injured/sick workers to nearest hospital – WBG's EHS Guidelines to be implemented – ECP 2 and ECP-18 will be implemented.					
7.7 Noise and Vibration	– Perform test blasting with various charges and monitor resultant noise and vibration levels at various distances and to define the sensitive areas that will be affected during the future blasting activities – Blasting activity will be restricted to fixed times; – Communities will be informed in advance of planned blasting; – Construction plant producing sound in excess of 85dB will be fitted with mufflers; – Noise barriers will be provided in areas where significant noise is expected (e.g. during blasting).	Contractor	CSC	– Number of blasting events recorded. – Evidence of providing advance warning of blasting to communities. – Record of equipment used on site capable of producing over 85dB and whether equipment has been fitted with mufflers – Number of related community complaints – Noise monitoring data	Throughout construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– NEQS compliance will be ensured. – ECP-11 will be implemented.			– Number of non compliances		
7.8 Landscape and Visual Intrusion	– Preparation of a Landscape Plan – Adoption of Landscaping and Plantation Plan – New planting and landscape restoration as soon as practicable at the end of construction phase – Replanting of flora/vegetation alongside new access roads – Enhance flora environment by planting fruit trees and ornamental shrubs. – ECP 8 to be implemented	Contractor	CSC	Compliance with Landscaping and Plantation Plan	Before the completion of the construction phase	C and E2
7.9 Vegetation loss	– A nursery will be established with the native species with a capacity to produce about 300,000 saplings with an objective to develop 100,000 trees (3 saplings for each proposed tree). – At higher altitudes (> 1500 m) a number of forest plantations will established where forest could be rejuvenated. This will be done at selected places on both sides (left and right bank) 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 (a.o Swat Kohistan). – Plantation to be developed in the buffer areas (at suitable sites) of the reservoir on the right bank, in DHPs office and colony, and at the resettlement with a target to develop about 5 trees for each tree cut. – Maintain each sapling for a period of minimum 2 years with the support of local community. Community will be paid for watering and raising the plantation.	Contractor	CSC	– Number of trees felled – Number of saplings planted Survival rate of saplings after one year	Throughout construction phase	E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– A public education program should be designed and implemented to discourage cutting of trees by the construction workers – The Project will support the local government to establish a market for the supply of non-wood fuels such as LPG for cooking and heating to reduce the pressure on firewood. Contractors also shall promote the usage of non wood fuels such as LPG to the construction staff for cooking and heating purposes. – Avoid dumping material in vegetated areas. – Avoid unnecessary loss of vegetation – ECP-12 will be implemented.					
7.10 Fauna / Wildlife	– Monitor wildlife in the reserve in cooperation with wildlife and forest officials; – Monitor noise levels during utilization of the quarry; – Reduction of duration, timing and strength of blasting operations and vibrations according to internationally recognized standards (e.g. Australian standards); – Use the Kaigah quarry only for borrowing material for dam construction and construction of the new KKH section (limited period); – Control of access to the project area for workers and public in cooperation with the community; – Awareness raising of workers, employees and general public; – Kaigah community will be compensated for loss of income from wildlife management; – The community will be consulted and involved in the selection of alternative	Contractor	CSC	– Number of instances of spoil being deposited in non-designated areas. – Number of reported incidences of hunting or poaching on the Project site / in land ownership. – Number of reports of sighting of key wild species	Throughout construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	options to strengthen ecological conservation measures; – Studies will be undertaken to identify alternative wildlife conservation to be implemented elsewhere in the sub-catchments from DHP, possible also at the right bank of the reservoir – Establish vantage stations to monitor the presence and movement of Tragopan and migratory birds, breeding birds, small mammals, ungulates and otters. – Revise, if required, this EMPs sub-plan or mitigation measures proposed in ECP 12 on Protection of Flora and ECP 13 on Protection of Fauna. – Include information on wildlife protection in all construction related tool-box orientation briefings for new construction staff – A public education program will be designed and implemented to discourage poaching of wildlife – Avoid positioning spoil in areas used by fauna – No hunting or poaching – Provide corridors for animal movement. – ECP-13 and ECP 14will be implemented.					
7.11 Mortality of Fish	No untreated effluents will be released in water bodies. Care will be observed to minimize sliding of soil and spoil in water bodies.	Contractor	CSC	Number of any non-compliance reports	construction phase	C and E2
7.12 Damage to infrastructure	Any damaged infrastructure such as roads, bridges and culverts will be repaired	Contractor	CSC	Number of any non-compliance reports	construction phase	C and E2
7.13 Damage to PCRs	– DHP will support KP Archaeological Department to (i) procure 25 acres of land for acquisition of land, in which rock carvings	Contractor	CSC	– Number of any non-compliance reports – Number of reports of any	construction phase	E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	are located, (ii) fence the area, (iii) provide fiberglass sheds; (iv) develop tourist facilities and (v) documenting the importance of rock carvings and their translations. – In case any artifact or site of archeological, cultural, historical, or religious significance are discovered during construction activities, the works will be stopped, and the Archeological Department will be informed.			new PCR discovered/reported		
7.14 Disturbance of Visual Landscape and Natural Habitats	– 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. – Landscape plans for the residential areas and the offices will be developed to create a good living and working environment. – Tree planting will be well organized and where possible vegetation and natural habitats will have to be restored or newly created. – For the disposal and borrow areas a Restoration Plans will be prepared to restore original landscape and vegetation.	Contractor	CSC	Number of any non-compliance reports	construction phase	C and E2
7.15 Social conflict due to the Influx of Workers and In-migrants	Implementation of the In-Migration Management Plan. In accordance with this Plan procedures and rules will be worked out by the PMU in close cooperation with the contractors and local authorities.	PMU	WEC	Number of public grievances relating to in-migrants	Construction phase	E1
7.16 Respect of Local Cultural Norms and Values by Work Force	– Implementation of awareness campaign – The contractors would be aware of the possibility and risks of miscommunications between local residents and workers, a situation which easily could lead to social unrest. This would be prevented by raising	PMU and contractor	CSC	Number of related public grievances	Construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	awareness and implementation of a Code of Conduct for the workers. – Complaints from the local community will be addressed by the Grievance Mechanism that will be developed.					
7.17 Adverse Effects on Health Situation	– 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 spreading of sexually transmitted diseases such as HIV/AIDS. – The medical health facilities in the project area will be facilitated to deal with such incidences. – Measures to this end are included in a Public Health and Safety Plan that will be implemented.	PMU and contractor	CSC	Number of patients being treated in the local hospitals	Construction phase	C and E1
7.18 Increased Load on Local Services and Supplies	– the contractors to procure their supplies in a manner not significantly affecting the availability of essential commodities in the area for the residents. – Grievance redress mechanism will be established to address community complaints and grievances.	Contractor	CSC	Number of related public grievances	Construction phase	C and E2
8. Activity: Quarry Operation						
8.1 Changes to topography	– Excavation of quarry areas for Kaigah to start from southern end and to proceed towards northern side. – The excavation should be done in a way that there will be natural berms towards sensitive receptors for noise control. – Implement ECP 7, ECP 8, and ECP 9.	Contractor	CSC	Number of any non-compliance reports	Construction phase	A, B, C, and E2
8.2 Landslide	– Method Statements and Risk Assessments to be prepared prior to any excavation activity	Contractor	CSC	– Number of blasting events.	construction phase	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Slope protection measures, will be applied including proper terracing to reduce the risk of slope failures. – Stabilize landslide prone areas which may be impacted by quarrying activities – During excavations the concerned slopes will be stabilized and excavation started exacted from the top then gradually working down the slope. After blasting a riser, it will be stabilized by pre-designed support systems such as shotcrete, mesh and rock bolts prior to drilling the next riser for excavation. Where there are confinement issues, cushion blasting will be the method applied. Extreme care will be taken in designing the blasting pattern and blasting will be controlled so as to avoid disturbance of nearby slopes where stability is in a critical condition. – Emergency Preparedness Plan and Early Warning System will set out response actions in the event of a landslide – ECP 6 will be implemented			– Method Statements and Risk Assessments produced for construction of each item of infrastructure. – All excavated materials to be disposed of in designated sites. – Monitoring of early warning systems. – Number of landslides reported		
8.3 Soil erosion	– Borrow pits/areas to be restored to the extent possible/ necessary – Road edge buffers will be re-planted – Replanting to be carried out after completing the quarrying, using fast-growing native species; and grasses to assist slope and soil stability. – ECP-6 will be implemented.	Contractor	CSC	Number of any non-compliance reports	construction phase	A, B, C, and E2
8.4 Soil and water contamination	– Any discharges to the river or streams should have turbidity of less than 2 mg/l to meet the NEQS 2000 – Regular waste water streams are to be passed through settling basins.	Contractor	CSC	– Monthly auditing of management of hazardous materials against Material Safety Data Sheet – Soil and water quality	construction phase	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Undertake pH monitoring of site runoff to ensure alkaline runoff is not leaving the site. – NEQS compliance will be ensured. – ECP-1, ECP-2, ECP-4, ECP-5, and ECP-7 will be implemented.			monitoring data – Number of reports if any non compliance – Number of related complaints		
8.5 Air Quality	– Exhaust from construction vehicles and equipment will comply with NEQS – Construction materials will be stored in designated areas away from sensitive receptors and covered to minimize dust on site from site construction works – Water spraying will be carried out to suppress dust emissions where needed – Wet scrubbers to be used where necessary to minimize dust emissions – Construction vehicles will be sprayed with water when entering and leaving the site, covered if transporting materials, adhere to speed limits, and engines will be turned off when idling. – Target zero dust related complaints – Target zero air quality related complaints. – ECP-10 will be implemented.	Contractor	CSC	– Number of dust-related complaints. – Number of air quality-related complaints, – Air quality monitoring data – Compliance with Traffic Management Plan.	construction phase	A, B, C, and E2
8.6 Health and Safety	– Compliance with Occupational Health & Safety standards and HSE Plan – Quarry sites to be cordoned off to stop unauthorized access – Develop controls and standard operating procedures for the use of fuels and other hazardous substances to prevent spills, accidents – Handle explosives strictly according to the protocols	Contractor	CSC	– Number of respiratory protective devices and other PPEs issues to workers. – Monitoring of compliance with Health & Safety standards (including monthly reporting of accidents). – Number of accidents, incidents and near misses. – Number of trainings	construction phase	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Train and designate personnel for various HSE aspects such as spill control procedures, fire fighting – Establish fire fighting system and fire safety (fire extinguishers) at the construction sites where fire is an hazard – Transport of hazardous goods and fuel to be done in closed containers and ISO certified tanks – Provision of respiratory protective devices for workers where needed – Designate agreed routes for traffic (set out in the Traffic Management Plan) – Quarry sites to have first aid boxes – WBG's EHS Guidelines to be implemented – ECP 2 and ECP-18 will be implemented.			provided.		
8.7 Noise and Vibration	– Perform test blasting with various charges and monitor resultant noise and vibration levels at various distances and to define the sensitive areas that will be affected during the future blasting activities – Blasting activity will be restricted to fixed times; – Communities will be informed in advance of planned blasting; – Construction plant producing sound in excess of 85dB will be fitted with mufflers; – Noise barriers will be provided in areas where significant noise is expected (e.g. during blasting). – NEQS compliance will be ensured. – ECP-11 will be implemented.	Contractor	CSC	– Number of blasting events recorded. – Evidence of providing advance warning of blasting to communities. – Number of record of equipment used on site capable of producing over 85dB and whether equipment has been fitted with mufflers – Number of related community complaints – Noise monitoring data	construction phase	A, B, C, and E2
8.8 Landscape and Visual Intrusion	– Preparation of a Landscape Plan – Adoption of Landscaping and Plantation Plan	Contractor	CSC	Number of any non-compliance reports	construction phase	E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– New planting and landscape restoration as soon as practicable at the end of construction phase – Replanting of flora/vegetation alongside new access roads – Enhance flora environment by planting fruit trees and ornamental shrubs. – ECP 8 to be implemented					
8.9 Vegetation loss	– Determine the need of re-vegetation and tree plantation after completing the quarrying operation – Prepare the Landscaping and Plantation Plan – Implement the above plans	CSC CSC Contractor	EU EU CSC	Number of any non-compliance reports	construction phase	E2
8.10 Fauna / Wildlife	– Kaigah community will be compensated for loss of income from wildlife management; – The community will be consulted and involved in the selection of alternative options to strengthen ecological conservation measures; – Studies will be undertaken to identify alternative wildlife conservation to be implemented elsewhere in the sub-catchments from DHP, possible also at the right bank of the reservoir – Establish vantage stations to monitor the presence and movement of Tragopan and migratory birds, breeding birds, small mammals, ungulates and otters. – Revise, if required, this EMPs sub-plan or mitigation measures proposed in ECP 12 on Protection of Flora and ECP 13 on Protection of Fauna. – Include information on wildlife protection in all construction related tool-box orientation briefings for new construction staff	WAPDA / Contractor	CSC	– Number of reported incidences of hunting or poaching on the Project site / in land ownership. – Number of reports of sighting of key wild species	construction phase	E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– A public education program will be designed and implemented to discourage poaching of wildlife – Avoid positioning spoil in areas used by fauna – No hunting or poaching – Provide corridors for animal movement. – ECP-13 and ECP 14will be implemented.					
8.11 Damage to infrastructure	Any damaged infrastructure such as roads, bridges and culverts will be repaired	Contractor	CSC	Number of any non-compliance reports	construction phase	A, B, and C
8.12 Damage to PCRs	In case any artifact or site of archeological, cultural, historical, or religious significance are discovered during construction activities, the works will be stopped, and the Archeological Department will be informed.	Contractor	CSC	– Number of any non-compliance reports – Number of reports of any new PCR discovered/reported	Throughout the construction phase	A, B, C, and E2
9. Activity: Spoil disposal area management						
9.1 Changes to topography	– Spoil disposal plan will be prepared and implemented – Area will be re-contoured to minimize changes in topography – Dispose excess rock material in the designated disposal site in an orderly manner (different spots to different size rocks)	Contractor	CSC	Number of any non-compliance reports	construction phase	A, B, C, and E2
9.2 Landslide	– Slope protection measures, will be applied including proper terracing to reduce the risk of slope failures. – Measures will be implemented to avoid slipping of the spoil in the river – Emergency Preparedness Plan and Early Warning System will set out response actions in the event of a landslide – ECP 6 will be implemented	Contractor	CSC	– Number of any non-compliance reports – Number of landslides reported in the disposal area	construction phase	A, B, C, and E2
9.3 Soil erosion	– Disposal areas to be restored to the extent possible/ necessary	Contractor	CSC	– Number of any non-compliance reports	construction phase	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Replanting to be carried out after completing the spoil disposal, using fast-growing native species; and grasses to assist slope and soil stability. – ECP-6 will be implemented.			– Number of saplings planted – Survival rate of saplings after one year		
9.4 Air Quality	– Water spraying and compaction will be carried out to suppress dust emissions where needed – ECP-10 will be implemented.	Contractor	CSC	– Number of dust-related complaints. – Number of air quality-related complaints, – Air quality monitoring data	construction phase	A, B, C, and E2
9.5 Landscape and Visual Intrusion	– Prepare and implement a Landscape Plan – Adoption of Landscaping and Plantation Plan – New planting and landscape restoration as soon as practicable at the end of construction phase – Enhance flora environment by planting fruit trees and ornamental shrubs. – ECP 8 to be implemented	WAPDA / Contractor	CSC	Number of any non-compliance reports	construction phase	E2
9.6 Vegetation loss	– Determine the need of re-vegetation and tree plantation after completing the spoil disposal – Prepare the Landscaping and Plantation Plan – Implement the above plans	CSC CSC Contractor	EU EU CSC	Number of any non-compliance reports	construction phase	E2
10. Activity: Construction of Colony						
10.1 Change in topography	– Changes to the topography will only occur in designated areas to accommodate defined project features. – Excavation of material will be kept to a minimum. – Excavated material will be managed in accordance with the Excavated Material Disposal Plan – Implement ECP 8	Contractor	CSC	– Volume of spoil extracted (monitor against predictions). – All excavated materials to be disposed of in designated sites. – Any non-compliances observed/reported	Throughout the construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
10.2 Landslide	– Method Statements and Risk Assessments prepared prior to any excavation activity – Slope protection measures, will have to be applied including proper terracing to reduce the risk of slope failures. – Stabilize landslide prone areas which may be impacted by construction activities or reservoir formation – During excavations the concerned slopes will be stabilized and excavation started exacted from the top then gradually working down the slope. – Emergency Preparedness Plan and Early Warning System will set out response actions in the event of a landslide	Contractor,	CSC	– Method Statements and Risk Assessments produced for construction of each item of infrastructure. – All excavated materials to be disposed of in designated sites. – Monitoring of early warning systems. – Number of landslides reported in the area	Throughout the construction phase	C and E2
10.3 Soil erosion	– Areas not used during operation will be re-vegetated, particularly slopes – Areas exposed during construction and not used for operation will be re-vegetated ('greened') immediately – Adopt measures set out in the Landscaping and Plantation Plan – Road edge buffers will be re-planted – Replanting to occur prior to the commencement of operation, using fast-growing native species; and grasses to assist slope and soil stability. – ECP-6 will be implemented.	Contractor	CSC	Number of incidences of borrow pits not being covered. Compliance with the Landscaping and Plantation Plan. All replanting to be commenced prior to operation.	Throughout the construction phase and prior to operation	C and E2
10.4 Soil and water contamination	– Construction materials will be stored, used and handled appropriately. – Excavated Material Disposal Plan to include measures to reduce risk of environmental pollution. – Reduce risk of a pollution event through adoption of measures set out in Solid Waste	Contractor	CSC	– Monthly auditing of management of hazardous materials against Material Safety Data Sheet – Soil and water quality monitoring data – Number of non compliance	Throughout the construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	Management Plan and Wastewater Treatment Plan – Hazardous and toxic materials stored separately – Oil and Chemical Spill Response Plan. – Design drainage for the batching plant area to direct runoff into a sump/basin for inspection for pollutants prior to discharge – Design settling basins for the discharges from tunnel construction areas – Any discharges to the river or streams should have turbidity of less than 2 mg/l to meet the NEQS 2000 – Regular waste water streams are to be passed through settling basins. – 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. – Undertake pH monitoring of site runoff to ensure alkaline runoff is not leaving the site. – Construct a designated, signposted concrete wash down bay that is fully contained and bunded for all excess concrete and concrete wash down, e.g. plastic lined. – Regularly maintain the concrete washout bay, treating any water prior to release to natural systems. – NEQS compliance will be ensured. – ECP-1, ECP-2, ECP-4, ECP-5, and ECP-7 will be implemented.			– Number of related complaints		
10.5 Air Quality	– Construction materials will be stored in designated areas away from sensitive receptors and covered to minimize dust on	Contractor	CSC	– Number of dust-related complaints. – Number of air quality-	Throughout construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	site from site construction works – Construction vehicles will be sprayed with water when entering and leaving the site, covered if transporting materials, adhere to speed limits, and engines will be turned off when idling. – Water spraying will be carried out to suppress dust emissions where needed – Batching plants and asphalt plants will have dust and emissions abatement systems. – Monitor ambient air quality near communities. – Target zero dust related complaints – Target zero air quality related complaints. – NEQS compliance will be ensured. – ECP-10 will be implemented.			related complaints, – Compliance with Traffic Management Plan. – Air quality monitoring data		
10.6 Health and Safety	– Compliance with Occupational Health & Safety standards and HSE Plan – Construction sites to be cordoned off to stop unauthorized access – Develop controls and standard operating procedures for the use of fuels and other hazardous substances to prevent spills, accidents – Train and designate personnel for various HSE aspects such as spill control procedures, fire fighting – Establish fire fighting system and fire safety (fire extinguishers) at the construction sites where fire is an hazard – Spill kits and trained personnel are to be made available at the workshops. – Transport of hazardous goods and fuel to be done in closed containers and ISO certified tanks	Contractor	CSC	– Number of respiratory protective devices and other PPEs issues to workers. – Monitoring of compliance with Health & Safety standards (including monthly reporting of accidents). – Number of accidents, incidents and near misses. – Number of trainings provided.	Throughout construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Provision of respiratory protective devices for workers where needed – Designate agreed routes for traffic (set out in the Traffic Management Plan) – Provision of insurance-backed compensation scheme for major injury or loss of life reflecting settlement sums that are consistent with national/international benchmarks. – Construction sites to have first aid boxes – Site to have ambulance to transfer injured/sick workers to nearest hospital – WBG's EHS Guidelines to be implemented – ECP 2 and ECP-18 will be implemented.					
10.7 Noise and Vibration	– Construction plant producing sound in excess of 85dB will be fitted with mufflers; – Noise barriers will be provided in areas where significant noise is expected (e.g. during blasting). – NEQS compliance will be ensured. – Community liaison will be maintained. – ECP-11 will be implemented.	Contractor	CSC	– Record of equipment used on site capable of producing over 85dB and whether equipment has been fitted with mufflers – Number of related community complaints – Noise monitoring data – Number of non-compliances	Throughout construction phase	C and E2
10.8 Landscape and Visual Intrusion	– Preparation of a Landscape Plan – Adoption of Landscaping and Plantation Plan – New planting and landscape restoration as soon as practicable at the end of construction phase – Replanting of flora/vegetation alongside new access roads – Enhance flora environment by planting fruit trees and ornamental shrubs. – ECP 8 to be implemented	WAPDA / Contractor	CSC	Compliance with Landscaping and Plantation Plan	Before the completion of the construction phase	E2
10.9 Vegetation loss	– Plantation to be developed in the buffer areas (at suitable sites) with a target to develop	Contractor	CSC	– Number of trees felled – Number of saplings planted	Throughout construction	E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	about 5 trees for each tree cut. – Maintain each sapling for a period of minimum 2 years with the support of local community. Community will be paid for watering and raising the plantation. – A public education program should be designed and implemented to discourage cutting of trees by the construction workers – Avoid dumping material in vegetated areas. – Avoid unnecessary loss of vegetation – ECP-12 will be implemented.			– Survival rate of saplings after one year	phase	
10.10 Fauna / Wildlife	– Include information on wildlife protection in all construction related tool-box orientation briefings for new construction staff – A public education program will be designed and implemented to discourage poaching of wildlife – Avoid positioning spoil in areas used by fauna – No hunting or poaching – Provide corridors for animal movement. – ECP-13 and ECP 14will be implemented.	Contractor	CSC	– Number of instances of spoil being deposited in non-designated areas. – Number of reported incidences of hunting or poaching on the Project site / in land ownership. – Number of reports of sighting of key wild species	Throughout construction phase	C and E2
10.11 Damage to infrastructure	Any damaged infrastructure such as roads, bridges and culverts will be repaired	Contractor	CSC	Number of any non-compliance reports	construction phase	C
10.12 Damage to PCRs	In case any artifact or site of archeological, cultural, historical, or religious significance are discovered during construction activities, the works will be stopped, and the Archeological Department will be informed.	Contractor	CSC	– Number of any non-compliance reports – Reports of any new PCR discovered/reported	Throughout the construction phase	C and E2
10.13 Access	The Colony will be provided with access road connecting it with the KKH	Contractor	CSC	Presence of access road Number of related complaints	construction phase	C
11. Activity: Construction of Resettlement Sites						
11.1 Change in topography	– Changes to the topography will only occur in designated areas to accommodate defined	Contractor	CSC	– Volume of spoil extracted (monitor against	Throughout the construction	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	project features. – Excavation of material will be kept to a minimum. – Excavated material will be managed in accordance with the Excavated Material Disposal Plan – Implement ECP 8			predictions). – All excavated materials to be disposed of in designated sites. – Any non-compliances observed/reported	phase	
11.2 Landslide	– Method Statements and Risk Assessments prepared prior to any excavation activity – Slope protection measures, will have to be applied including proper terracing to reduce the risk of slope failures. – Stabilize landslide prone areas which may be impacted by construction activities or reservoir formation – During excavations the concerned slopes will be stabilized and excavation started exacted from the top then gradually working down the slope. – Emergency Preparedness Plan and Early Warning System will set out response actions in the event of a landslide	Contractor,	CSC	– Method Statements and Risk Assessments produced for construction of each item of infrastructure. – All excavated materials to be disposed of in designated sites. – Monitoring of early warning systems. – Number of landslides reported in the area	Throughout the construction phase	C and E2
11.3 Soil erosion	– Areas not used during operation will be re-vegetated, particularly slopes – Areas exposed during construction and not used for operation will be re-vegetated ('greened') immediately – Adopt measures set out in the Landscaping and Plantation Plan – Road edge buffers will be re-planted – Replanting to occur prior to the commencement of operation, using fast-growing native species; and grasses to assist slope and soil stability. – ECP-6 will be implemented.	Contractor	CSC	– Number of incidences of borrow pits not being covered. – Compliance with the Landscaping and Plantation Plan. – All replanting to be commenced prior to operation.	Throughout the construction phase and prior to operation	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
11.4 Soil and water contamination	– Construction materials will be stored, used and handled appropriately. – Excavated Material Disposal Plan to include measures to reduce risk of environmental pollution. – Reduce risk of a pollution event through adoption of measures set out in Solid Waste Management Plan and Wastewater Treatment Plan – Hazardous and toxic materials stored separately – Oil and Chemical Spill Response Plan. – Design drainage for the batching plant area to direct runoff into a sump/basin for inspection for pollutants prior to discharge – Design settling basins for the discharges from tunnel construction areas – Any discharges to the river or streams should have turbidity of less than 2 mg/l to meet the NEQS 2000 – Regular waste water streams are to be passed through settling basins. – 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. – Undertake pH monitoring of site runoff to ensure alkaline runoff is not leaving the site. – Construct a designated, signposted concrete wash down bay that is fully contained and bunded for all excess concrete and concrete wash down, e.g. plastic lined. – Regularly maintain the concrete washout bay, treating any water prior to release to	Contractor	CSC	– Monthly auditing of management of hazardous materials against Material Safety Data Sheet – Soil and water quality monitoring data – Number of non compliance – Number of related complaints	Throughout the construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	natural systems. – NEQS compliance will be ensured. – ECP-1, ECP-2, ECP-4, ECP-5, and ECP-7 will be implemented.					
11.5 Air Quality	– Construction materials will be stored in designated areas away from sensitive receptors and covered to minimize dust on site from site construction works – Construction vehicles will be sprayed with water when entering and leaving the site, covered if transporting materials, adhere to speed limits, and engines will be turned off when idling. – Water spraying will be carried out to suppress dust emissions where needed – Batching plants and asphalt plants will have dust and emissions abatement systems. – Monitor ambient air quality near communities. – Target zero dust related complaints – Target zero air quality related complaints. – NEQS compliance will be ensured. – ECP-10 will be implemented.	Contractor	CSC	– Number of dust-related complaints. – Number of air quality-related complaints, – Air quality monitoring data – Number of non compliances –	Throughout construction phase	C and E2
11.6 Health and Safety	– Compliance with Occupational Health & Safety standards and HSE Plan – Construction sites to be cordoned off to stop unauthorized access – Develop controls and standard operating procedures for the use of fuels and other hazardous substances to prevent spills, accidents – Train and designate personnel for various HSE aspects such as spill control procedures, fire fighting	Contractor	CSC	– Number of respiratory protective devices and other PPEs issues to workers. – Monitoring of compliance with Health & Safety standards (including monthly reporting of accidents). – Number of accidents, incidents and near misses. – Number of trainings	Throughout construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Establish fire fighting system and fire safety (fire extinguishers) at the construction sites where fire is an hazard – Spill kits and trained personnel are to be made available at the workshops. – Transport of hazardous goods and fuel to be done in closed containers and ISO certified tanks – Provision of respiratory protective devices for workers where needed – Designate agreed routes for traffic (set out in the Traffic Management Plan) – Provision of insurance-backed compensation scheme for major injury or loss of life reflecting settlement sums that are consistent with national/international benchmarks. – Construction sites to have first aid boxes – Site to have ambulance to transfer injured/sick workers to nearest hospital – WBG's EHS Guidelines to be implemented – ECP 2 and ECP-18 will be implemented.			provided. – Number of non compliances		
11.7 Noise and Vibration	– Construction plant producing sound in excess of 85dB will be fitted with mufflers; – Noise barriers will be provided in areas where significant noise is expected (e.g. during blasting). – Maintain liaison with the communities – NEQS compliance will be ensured. – ECP-11 will be implemented.	Contractor	CSC	– Record of equipment used on site capable of producing over 85dB and whether equipment has been fitted with mufflers – Number of related community complaints – Noise monitoring data	Throughout construction phase	C and E2
11.8 Landscape and Visual Intrusion	– Preparation of a Landscape Plan – Adoption of Landscaping and Plantation Plan – New planting and landscape restoration as soon as practicable at the end of construction phase	Contractor	CSC	Compliance with Landscaping and Plantation Plan	Before the completion of the construction phase	E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	– Replanting of flora/vegetation alongside new access roads – Enhance flora environment by planting fruit trees and ornamental shrubs. – ECP 8 to be implemented					
11.9 Vegetation loss	– Plantation to be developed in the buffer areas (at suitable sites) with a target to develop about 5 trees for each tree cut. – Maintain each sapling for a period of minimum 2 years with the support of local community. Community will be paid for watering and raising the plantation. – A public education program should be designed and implemented to discourage cutting of trees by the construction workers – Avoid dumping material in vegetated areas. – Avoid unnecessary loss of vegetation – ECP-12 will be implemented.	Contractor	CSC	– Number of trees felled – Number of saplings planted – Survival rate of saplings after one year	Throughout construction phase	E2
11.10 Fauna / Wildlife	– Include information on wildlife protection in all construction related tool-box orientation briefings for new construction staff – A public education program will be designed and implemented to discourage poaching of wildlife – Avoid positioning spoil in areas used by fauna – No hunting or poaching – Provide corridors for animal movement. – ECP-13 and ECP 14will be implemented.	Contractor	CSC	– Number of instances of spoil being deposited in non-designated areas. – Number of reported incidences of hunting or poaching on the Project site / in land ownership. – Number of reports of sighting of key wild species	Throughout construction phase	C and E2
11.11 Damage to infrastructure	Any damaged infrastructure such as roads, bridges and culverts will be repaired	Contractor	CSC	Number of any non-compliance reports	construction phase	C
11.12 Damage to PCRs	In case any artifact or site of archeological, cultural, historical, or religious significance are discovered during construction activities, the	Contractor	CSC	– Number of any non-compliance reports – Reports of any new PCR	Throughout the construction phase	C and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	works will be stopped, and the Archeological Department will be informed.			discovered/reported		
11.13 Access	The Resettlement Sites will be provided with access roads connecting it with the KKH	Contractor	CSC	– Presence of access roads – Number of related community complaints	construction phase	C
12. Activity: Waste management						
12.1 Soil and water contamination	– Contractors will prepare and implement a Waste Management Plan. – Appropriate hazardous, industrial and domestic waste disposal facilities must be established – For the domestic sewage, appropriate treatment and disposal system (e.g., septic tanks and soaking pits) will be constructed having adequate capacity – Waste oils will be collected in drums and sold to the recycling contractors. – The inert recyclable waste from the site (such as cardboard, drums, and broken/used parts) will be sold to recycling contractors. – The hazardous waste will be kept separate and handled according to the nature of the waste. – Domestic solid waste will be disposed off in a manner that does not cause soil contamination. – Awareness raising for minimizing use of non-biodegradable substances – Regular maintenance of waste management facilities will be undertaken – Implement ECP 1	Contractor	CSC	– Monthly auditing of management of hazardous materials against Material Safety Data Sheet – Soil and water quality monitoring data – Reports if any non compliance – Number of related complaints	construction phase	A, B, C, and E2
12.2 Odor	– Waste disposal sites will be located away from the communities – Regular maintenance of waste management	Contractor	CSC	Number of related complaints	construction phase	A, B, C, and E2

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
	facilities will be undertaken					
13. Activity: De-commissioning						
13.1 Soil erosion	As part of decommissioning, all disturbed areas would be contoured and re-vegetated	Contractor	CSC	Audit areas of site that were disturbed and remain without vegetation.	During decommissioning	-
13.2 Surface Water Quality; air contamination; noise; and other environmental impacts.	– Disturbed areas will be contoured and re-vegetated to minimize the potential for soil erosion and water quality related impacts. – ECP-1, ECP-2, ECP-3, ECP-4, ECP-5, ECP 6, ECP 7, ECP-8, ECP-10, ECP-11, ECP-12, ECP-13, ECP-14, ECP-15, and ECP-16, ECP 17, and ECP 18 will be implemented.	Contractor	CSC	– – Monitoring data for air quality, water and other environmental parameters – Number of related community complaints	Upon completion of decommissioning	-

Table 9.3: Mitigation Plan for O&M Phase

	Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing
			Execution	Monitoring		
1	General	- An ‘Operation Environmental Action Plan’ (OEAP) needs to be prepared demonstrating the manner in which the Contractor/Operator will comply with the requirements of management plans proposed in EMAP. - The following strategies and procedures will be developed prior to the commencement of Project operations: - Dam specific security and public access control strategy; - Dam specific greenhouse gases (GHG) abatement strategy; - Dam specific waste management strategy; - Dam specific air and noise control strategy; - Dam specific traffic control strategy; - Reservoir specific sediment and erosion, and landslides control strategy; - Recycling strategy; - Environmental releases strategy;	EU/WEC	WEC	Presence of Plan and associated strategies	Before O&M phase

	Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing
			Execution	Monitoring		
2	Inundation or terrestrial habitat	Planting of native trees in reservoir buffer areas Promotion of conservation of natural habitat in Kaigha and other suitable areas (Kandia, Laachi, Sazin kot) Further studies on terrestrial baseline during pre-construction/construction and design of additional offset measures if required Implementation of monitoring programs	WAPDA	WEC	- Number of trees planted - Survival rate of trees after one year - Presence of study report	
3	Loss of aquatic habitat	Maintenance of spawning areas and developing fish hatchery for production of native snow carps (snow carp hatcheries are already established in India and Nepal) and stocking of fish in the tributaries and reservoirs is recommended to compensate the loss of habitat and reservoir fishery production. Further studies will be carried out during construction and operation stage to establish detailed baseline data on aquatic ecology to develop additional offset measures and research on hatchery development	WAPDA	WEC	- Presence of study report - Presence of fish hatcheries - Amount of restocking in a year	
4	First filling of reservoir	The water level rise during filling to be around 1-2 m per day Public awareness campaign will be implemented to inform the communities about the reservoir filling and associated risk of accidents	Contractor/PMU		Number of public awareness actions	Before/during first filling of reservoir
5	Fish migration	The aquatic study described in Section 7.6.2 will also include fish migration; - WAPDA will develop fish hatchery through which tributaries and reservoir will be restocked.	WAPDA	WEC	Presence of study report	
6	Land slides	- Monitor stability of landslide prone areas during operational phases. - Monitor stability of landslide prone areas at 18 identified locations - First filling of reservoir should be done at a slow pace of 1 m/day	EU	WEC	Number of landslides in the area	Operation
7	Impact of Reduced Water Flows between Dam and Tailrace	Release a minimum of 20 m3/s of environmental flow from dam and 222 m3/s from tail race WAPDA will conduct downstream monitoring and adjustment of flows if required.	WAPDA	WEC	–	

	Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing
			Execution	Monitoring		
8	Fisheries and other aquatic fauna	– Start a reservoir fishery management program and monitor reservoir fishery production – Maintain environmental flows downstream of the dam	EU	WEC	– Evidence of initiation of fishery management program – Evidence of maintaining environmental flow through the dam	Operation
5	Loss of active dam storage due to sediment deposition in the reservoirs	Integrated watershed management of UIB is critical for control of sedimentation in to the Indus. Detailed studies are recommended for planning, design and implementation of integrated watershed management for control of erosion and sedimentation in the UIB	Dam Control Office	WEC	Initiation of water shed management program	Operation
6	Dam safety due to earth quakes	- Monitoring of seismicity in the project area - Installation of dams safety monitoring equipment	Dam Control Office		Presence of instrumentation	Operation
7	Changes in Natural river flows of the downstream	- Operate the dam as a true run of river by allowing the whatever flow received will be returned in the Stage 1 (pre-Basha) - Maintain a minimum environmental flow of 20 m^3/s during low flow season - Always run one turbine during Stage 2 (post-Basha) if the dam is operated as peaking plant.	Dam Control Office	WEC	Initiation of regular monitoring of water flow, water quality and fish in river downstream of dam	Operation
8	Degradation of downstream erosion and ecosystems	Implement a sediment monitoring and management program in the reservoir systems to minimize sedimentation.	Dam Control Office	WEC	Initiation of sediment monitoring program	Operation
9	Changes in downstream water quality due to thermal stratification and changes in sediment load and dissolved oxygen in the reservoir	Vertical monitoring of DO and temperature in the reservoir Operational protocol to release simultaneous release of waters from LLOs and spillways for missing of surface and deep waters in the reservoir	Dam Control Office	WEC	Initiation of regular monitoring of water flow, water quality and fish in river downstream of dam	Operation
10	Impacts on migratory birds	Manage reservoirs and surrounding areas to improve the quality of aquatic habitats for water birds Monitor the migratory birds migration to the reservoir	Consultants (e.g. WWF)	EU	Initiation of monitoring program	Operation

	Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing
			Execution	Monitoring		
11	Potential for reservoir fish development	Native fish species (snow carp) are recommended for reservoir fisheries development. However further following studies are required to assess the potential for reservoir fisheries development: A small R&D hatchery is recommended to undertake applied research on snow carp focusing on need to increase biological knowledge related to wild fish and fish habitat management and culture. Fish, fish habitat and fisheries in Tarbela Reservoir;	Consultants/ KP Fisheries	EU	Initiation of fisheries development program	Operation
12	Reservoir sedimentation	To prolong the life of the reservoir (at least to 40 years) it is estimated that annual flushing should start after 15 years.	Dam Control Office	WEC	Initiation of monitoring program	Operation
13	Impact of Flushing of Reservoir on Fish Production during Base Load Operation of Plant	Implement Fisheries Development and Management Program WAPDA to carry out flushing during high flow season (not in low flow/winter) WAPADA to develop ramp down criteria (5-10 cm/hr) WAPDA will conduct monitoring of dissolved oxygen and temperature in reservoir and de-stratification or simultaneous release of water from low level outlets and spillways if required. WAPDA will carry out downstream monitoring of fish, habitats and sediments.	Dam Control Office	WEC	Initiation of monitoring program	Operation
14	Safety hazards along KKH	Road signage to be placed at appropriate locations Community awareness programs will be implemented	NHA/	-	– Number of awareness campaigns conducted – Number of traffic accidents in the area	O&M

9.7. Monitoring Plan

The monitoring program has a dual purpose. It is designed (i) to monitor the contractor's work during project implementation in order to check contractual compliance with specified mitigation measures, and subsequently (ii) 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 and carried out by a local organization or consultant with sufficient experience in environmental, ecological and social monitoring. The total cost of monitoring has been estimated at US$ 0.50 m. Monitoring indicators and frequency are shown in **Table 9.4**.

Table 9.4: Effects Monitoring Plan

<table>
<tr><th rowspan="2">Parameter</th><th rowspan="2">Means of Monitoring</th><th rowspan="2">Frequency</th><th colspan="2">Responsible Agency</th></tr>
<tr><th>Implementation</th><th>Supervision</th></tr>
<tr><td colspan="5">During Construction</td></tr>
<tr><td>Landslides</td><td>Visual Inspection on stability of landslide areas</td><td>Monthly</td><td>Contractor</td><td>CSC, DHP</td></tr>
<tr><td>Top Soil</td><td>Visual inspection on stripping, storage and reuse of top soil</td><td>Monthly</td><td>Contractor</td><td>EU-CSC, EU-DHP</td></tr>
<tr><td>Erosion</td><td>Visual inspection of erosion prevention measures and occurrence of erosion</td><td>Monthly</td><td>Contractor</td><td>EU-CSC, EU-DHP</td></tr>
<tr><td>Operation of quarry sites</td><td>Visual inspection of quarry sites</td><td>Monthly</td><td>Contractor</td><td>EU-CSC, EU-DHP</td></tr>
<tr><td rowspan="3">Surface water quality</td><td rowspan="2">Sampling and analysis of river water quality and waste water discharges for the parameters given in NEQS</td><td>Quarterly</td><td>Contractor</td><td>EU-CSC, EU-DHP</td></tr>
<tr><td>Annually</td><td>External Monitor (DHP through a nationally recognized Laboratory)</td><td>EU-CSC, EU-DHP</td></tr>
<tr><td>Spot measurements of pH, conductivity, turbidity. Visual inspection on presence of petroleum products.</td><td>Monthly</td><td>EU-CSC</td><td>EU-CSC, EU-DHP</td></tr>
<tr><td>Air Quality (dust, smoke)</td><td>Visual inspection to ensure good standard equipment is in use and dust suppression measures</td><td>Weekly</td><td>Contractor</td><td>EU-CSC, EU-DHP</td></tr>
</table>

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
	(spraying of waters) are in place.			
	Visual inspection to ensure dust suppression work plan is being implemented	Weekly	Contractor	EU EU-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	Quarterly	Contractor	EU-CSC, EU-DHP
		Annually	External Monitor (DHP through a nationally recognized laboratory)	EU-CSC, EU-DHP
Emissions from plant and equipment	Visual Inspection	Monthly	Contractor	EU-CSC, EU-DHP
Noise and vibration	24 hour noise monitoring	Quarterly	Contractor	EU-CSC, EU-DHP
	24 hour noise monitoring	Annually	External Monitor (DHP through a nationally recognized laboratory)	EU-CSC, EU-DHP
	Spot measurements	Monthly	CSC	EU-DHP
Waste Management	Visual inspection on spoil disposal	Monthly	Contractor	EU-CSC, EU-DHP
	Visual inspection that solid waste is disposed at designated sites	Monthly	Contractor	EU-CSC, EU-DHP
Spills from hydrocarbon and chemical storage	Visual Inspection for leaks and spills	Monthly	Contractor	EU-CSC, EU-DHP
Wild life (including migratory bird)	Surveys for wildlife and migratory birds	Half yearly	DHP through nationally recognized institute	EU-CSC, EU-DHP
	Ensure the adherence of the migratory measures proposed in the EMP	Monthly	DHP through nationally recognized institute	EU-CSC, EU-DHP

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
Fish	Surveys for	Half yearly	DHP through nationally recognized institute	EU-CSC, EU-DHP, External Monitor
Traffic Safety	Visual inspection to see whether Traffic Management Plan is implemented	Monthly	Contractor	EU-CSC, EU-DHP,
Local Roads	Visual inspection to ensure local roads are not damaged	Monthly	Contractor	EU-CSC, EU-DHP,
Cultural and archeological Sites	Visual observation for Physical Cultural Resources	Monthly	Contractor	EU-CSC, EU-DHP,, External Monitor
Drinking water and sanitation	Ensure the construction workers are provided with safe water and sanitation facilities in the site	Weekly	Contractor	EU-CSC, EU-DHP,
Safety of workers	Usage of Personal Protective equipment	Monthly	Contractor	EU-CSC, EU-DHP,
Reinstatement of Work Sites	Visual Inspection	After completion of all works	Contractor	EU-CSC, EU-DHP,
Plantation	Visual inspection to ensure plantations are growing well.	Monthly	District Forest Office with support of civil society	EU-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
Downstream river flows	Measurements of discharges to the downstream	Monthly	DHP	External Monitor
Migratory birds	Surveys for migratory	Half Yearly	DHP through nationally recognized institute	EU-DHP, External Monitor

Parameter	Means of Monitoring	Frequency	Responsible Agency	
			Implementation	Supervision
Fish	Surveys for fish	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

The role of WAPDA is to select consultants and organizations needed for implementing the EMP and the SRMP They will supervise progress and quality of EMP and SRMP and take over regular monitoring activities during O&M phase. Result of monitoring of impacts will have to be reviewed and evaluated from time to time by the M&E consultants. Findings might be used to revise the operational rules of the project.

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

9.8. 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 environmental/social unit 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, but selected project staff involved in construction and operation of the project would also be trained. The contractor will also be required to impart environmental and social trainings to its staff, to ensure effective implementation of the EMP 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 partake in the environmental and social management of the WAPDA projects, particularly towards the effective ESMP implementation of the DHP, as well as the ESA studies and EMP and SRMP implementation of the forthcoming hydropower projects such as the Basha dam. Additional funds of US$ 0.3 million have been allocated to build capacity in WAPDA to effectively implement the project, O&M of the structures it manages and fully carrying out its mandated functions. This would include: (i) enhancing WAPDA’s capacity in planning and programming, engineering and O&M of the project facilities, financial management, procurement, and management of the environment and social issues; (ii) technical assistance and training in such areas as engineering designs, river training works, hydraulics, detailed designs of structures, contract administration and construction supervision, procurement, operations and management planning, asset management plans, financial management, and legal issues; and (iii) an independent panel of experts for design and construction quality and safety enhancement or any other issues that may have to be addressed during project implementation.

9.9. Panel of Experts

WAPDA has engaged an independent panel of environment and social experts to advise the design team during the detailed design phase. This panel will be retained during the construction phase also to advise ESMU and other project entities on all environmental and social matters including effective implementation of EMP and SRMP, particularly on unanticipated situations, impacts, and their mitigation. The Panel will review on a regular basis the various reports and documents produced by EMU, Supervision Consultants and contractors; periodically visit the site to have first-hand information on the environmental and social impacts and EMP/SRMP implementation; and provide 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.

9.10. Audits

Internal Environmental Audits will be held once during construction phase and once at the end of the construction activities. The objective of the audits is to review the effectiveness of environmental management. It is proposed that WEC would carry out these audits on six-monthly basis. External audits on the implementation of the EMP and SRMP will be made by an independent environmental management specialist on a six monthly basis. These audits would be used to re-examine the continued appropriateness of the EMP and SRMP and to provide advice on any up-dates required.

9.11. Reporting and Grievances

Reporting. Proper arrangements are necessary for recording, disseminating and responding to information which emerges from the various environmental monitoring and management programs. They are also necessary for rendering the environmental management system “auditable”. However, the primary focus must remain on the pragmatic control of impacts, not the creation of complex bureaucratic procedures.

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. Grievances recorded will be reviewed and investigated by Project staff and outside authorities as appropriate. The investigations will aim to identify whether the incident leading to the grievance is a singular occurrence or likely to reoccur. Possible remedial measures or actions will be identified and implemented when justified. The responsibility for addressing grievances will rest with a committee including Project Manager, the Contractor’s Site Manager and a person designated to be responsible for stakeholder liaison.

9.12. Cost of EMP/SRMP

The cost estimate of the implementation of the Environmental Management Plan (EMP) is presented in **Table 9.5**. The total cost of the Social Resettlement Management Plan (SRMP) is presented in **Table 9.6**.

Table 9.5: Cost Estimate of Implementation of EMP

		Description	Estimated Cost (m USD)	Sub Total (m USD)
E2. Environmental Management Plan				
1	Contractor's budget for implementation of EMP, establishing laboratory and equipment for monitoring (air, noise and water quality)			**19.30**
	1.1	Contractors implementation of EMP & Environmental Staff of Contractors	18.32	
	1.2	Water Quality Laboratory	0.54	
	1.3	Air, Noise, Vibration and Potable Water Quality Equipment	0.44	
2	Aquatic ecology management plans			**4.31**
	2.1	Fish and habitat monitoring during pre – construction, construction and operation stages of the Project	0.97	
	2.2	Alternate fish passages, if fish passage is concluded necessary	0.70	
	2.3	Installation of screens to avoid injury to fish at various outlets.	0.40	
	2.4	Fish Hatchery and R&D facility	2.04	
	2.5	Fish habitat improvement of the tributaries	0.10	
	2.6	Capacity building of local Fisheries Departments	0.10	
3	Terrestrial ecology management plans			**5.75**
	3.1	Tree Plantation	1.63	
		Enhancement of Community Protected Area in Kaigah and studies for developing new conservation areas	1.00	
	3.3	Afforestation/ Forest Regeneration	3.12	
4	Physical cultural resources management plan			**1.65**
	4.1	Protection of Shatial Rock Carvings	1.52	
	4.2	Relocation of historical mosque at Seer Gayal	0.03	
	4.3	Protection of Graveyards that will be submerged in reservoir	0.01	
	4.4	Enhancement of Seo Mosque	0.03	
	4.5	Chance finds	0.06	
5	Traffic management		1.54	1.54
6	Weather Station at Dasu Colony		0.15	0.15
7	Environmental management and enhancement of		2.10	2.10

		Description	Estimated Cost (m USD)	Sub Total (m USD)
	resettlement villages			
8	Baseline studies on terrestrial & aquatic ecology in UIB Basin (Bunji to Tarbela), and monitoring (by IUCN & WWF)		10.00	10.00
		Subtotal E2	**44.80**	**44.80**
E 3. Glacier, Watershed Monitoring				
9	Glacier Monitoring Program		4.00	4.00
10	Flood warning and climate monitoring (Telemetry Network)		2.50	2.50
11	Integrated Watershed Development of Upper Indus Basin (Tarbela Catchment)		4.00	4.00
		Subtotal E3	**10.50**	**10.50**
F1. Construction Supervision Consulting Services				
12	Environment staff in CSC		4.33	4.33
		Subtotal F1	**4.33**	**4.33**
G. PMU Support				
13	Environment staff in PMU (including equipment, vehicles, maintenance)		2.18	2.18
14	Internal auditing		0.20	0.20
15	External monitoring		0.50	0.50
16	Panel of Experts		0.43	0.43
17	Capacity building			0.90
	17.1	Capacity Building of environmental staff of DHP and WAPDA Environmental Cell (WEC)	0.60	
	17.2	Establishment of GIS/MIS	0.10	
	17.3	Institutional strengthening of WEC	0.20	
		Subtotal G	**4.21**	**4.21**
		Grand Total	**63.84**	**63.84**

Table 9.6: Cost Estimate SRMP

	COST ITEM	Total (m PKR)	Total (m US$)
1	Public Consultation and Participation Plan	50	0.5
2	Resettlement Action Plan	28,269	297.6
3	Public Health Action Plan	1425	15.0
4	Grievance Redress Plan	190	2.0
5	Communications Plan	81	0.8
7	Downstream Fishing Communities: baseline & impact assessment	475	5.0
	Total Estimated Cost	30,490	320.9

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 (FGD). Given the cultural context, key issues were largely addressed by community elders at *jirga* meetings. In some sense, standard participatory tools such as PRA and FGD and small group meetings are 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. Objectives of the consultation process are:

- Analyze household and community level issues and draw early attention for mitigations and/or resolution of the same issues
- Promote participation of the local people, local level government stakeholders, elected representatives and other community representatives to create opportunity to play a role and express their views
- Acquire suggestions of the community for mitigating any anticipated adverse environmental and social impacts and expected benefits of the Project;
- Obtain the views of various categories of vulnerable groups, discuss project impacts and benefits on these groups, and ascertain their expectations regarding project benefits
- Develop strategies to minimize potential social and environmental adverse impacts in conjunction with government stakeholders
- Promote pro-people and community-based resettlement and development strategies
- Socially prepare the community with confidence and capacity to deal with displacement, environmental and resettlement management.

During the consultations with the communities, salient features of the project, potential social and environmental impacts of the project, and proposed scope of ESA study were explained to the participants. Similarly, during the consultation workshops, booklets were distributed to the participants containing information on the project, scoping of impacts, mitigation frameworks, and ToRs of the ESA study.

A total of 2,392 persons were involved in various consultation meetings at the project sites and consultation workshops (**Table 10.1**) between April 2012 and October 2012.

Table 10.1: Number of Participants 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

Community consultations were held during the feasibility study in 2007. A summary of consultations undertaken during feasibility study is given in **Table 10.2**.

Table 10.2: Summary of consultations undertaken during Feasibility Study

	Date	Objectives	Person/agency consulted	No. of participants
Social survey conducted in the reservoir area only				
1	2007	Social economic survey	602 households	602
2	2007	Business survey	25 business activities	25
Group discussions at scoping sessions				
2	Apr. 29, 2007	To share the perceptions and develop a better understanding and contribution towards preparation of the Feasibility Study Report	Representatives, Village Seo	11
3	Jun. 24, 2007		Representatives, Village Segal	15
4	Nov. 3, 2007		Representatives, Village Seglo and Commercial Activities	22
5	Nov. 3, 2007		Representatives, Village Seo	25
6	Nov. 4, 2007		Representatives, Village Khashai and Choochang	21
7	Nov. 4, 2007		Representatives, Village Kaigah	14
8	Nov. 6, 2007		Representatives, Village Sazin	10
9	Nov. 6, 2007		Representatives, Village Shatial	15
10	Nov. 6, 2007		Representatives, Village Darel Bridge	10
11	Nov. 6, 2007		Representatives, Village Samar Nullah	18
Total				**788**

Source: Feasibility Study EIA, 2009

During detailed design phase, consultation meetings were conducted in 34 villages in the month of June 2012. Details of the consultations are given in **Table 10.3**.

Table 10.3: Consultations with Community Representatives

	Date	Side of the River	Name of Village	No. of Participants
1	27-06-2012	Right Bank	Kass	9
2	24-06-2012	Right Bank	Rango	10
3	24-06-2012	Right Bank	Seo	13
4	11-06-2012	Right Bank	Siglo	6
5	02-06-2012	Right Bank	Melar	12
6	03-06-2012	Right Bank	Kuz Kai	2
7	03-06-2012	Right Bank	Kai Dogha	4
8	04-06-2012	Right Bank	Seer Gayal	8
9	05-06-2012	Right Bank	Kot Gal	11
10	06-06-2012	Right Bank	Not Bail	13
11	06-06-2012	Right Bank	Sluch	12
12	10-06-2012	Right Bank	Thuti	16
13	08-06-2012	Right Bank	Warisabad	8
14	25-06-2012	Right Bank	Doonder	12
15	17-06-2012	Right Bank	Gummo	9
16	09-07-2012	Right Bank	Cheer Chial	12
17	12-06-2012	Right Bank	Khaliqabad	7
18	26-06-2012	Left Bank	Chuchang	12
19	24-06-2012	Left Bank	Khoshi	25
20	23-06-2012	Left Bank	Logro	27
21	10-06-2012	Left Bank	Uchar Nallah	6
22	09-06-2012	Left Bank	Barseen	10
23	10-06-2012	Left Bank	Largani	10
24	08-06-2012	Left Bank	GulBagh/Maidan	12
25	06-06-2012	Left Bank	Kaigah	15
26	12-06-2012	Left Bank	Pani Bagh	12
27	09-06-2012	Left Bank	Gadeer	2
28	29-06-2012	Left Bank	Chalash	9
29	21-06-2012	Left Bank	Looter	14
30	19-06-2012	Left Bank	Shori Nallah	14
31	15-06-2012	Left Bank	Summar Nallah	15
32	18-06-2012	Left Bank	Lachi Nallah	7
33	14-06-2012	Left Bank	Sazeen Camp	5
34	20-06-2012	Left Bank	Shatial	26

	Date	Side of the River	Name of Village	No. of Participants
			Total	**385**

In addition to the consultation meetings, one on one consultation was held with 1,487 people during environmental and social surveys. Details of these consultations are given in **Table 10.4**.

Table 10.4: Summary of the Consultations undertaken during Detailed Design

	Date	Objectives	Person/agency consulted
1	May-July, 2012	Social economic survey	319 households
2		Resettlement Inventory survey	763 households
3		Environmental baseline survey	63 households
4	Aug. 2012	Gender survey	250 women respondents interviewed at Basic Health Unit (BHU) and Rural Health Center (RHC),
5	July.-Sep. 2012	Ecological Survey	Focus group discussions on fish and wildlife. With 40 persons
6	Aug-Sep. 2012	Consultation on availability of relocation sites	26 over 35 sub-tribes consulted (52 village leaders participated)
Total			**1,487**

Jirga Meetings

The Jirga is like a local "workshop", in which the tribal elders deliberate on important political, legal and development issues. As an important political instrument and political process, the Jirga system plays a vital role in the social, economic and political spheres. Local jirgas in a tribal setup is called by an elder of a tribe for settling local affairs within the family, clan, sub-tribe and tribe. The jirga exercises both judicial and executive roles to settle all disputes pertaining to the distribution of land, properties, blood feuds, blood money and other important inter-tribal affairs on the basis of tribal conventions, traditions and principles of justice. Often grand jirgas are convened to resolve issues of regional and national interests.

Prior to starting of detailed design, a grand Jirga meeting was held on 28th July 2011, in which a list of demands (Charter of Demands) were submitted to the Project Director, DHP on behalf of the affected people of the Project. The list was signed by Abdul Sattar Khan, Member of Province Assembly, KP.

Three Jirga meetings were conducted during detailed design to inform the community leaders about the project, its details and potential impacts, and seek their participation in social and environmental assessment. Details of Jirga meetings are given in **Table 10.5**. In the first Jirga meeting held in March 2012, a committee of 'List of Notables' was formed by the Jirga to assist in environmental assessment. A new committee of 'Affectees of Dasu' was formed during the Jirga meeting in September 2012.

Table 10.5: Details of Jirga Meetings

	Date	Details of Participants
1	28 Jul. 2011	Members of Grand Jirga (35 members) Abdul Sattar Khan, Member of Province Assembly, KP;
2	2 Mar. 2012	Total participants: 114 persons 1. Project affected tribes/sub-tribes; 2. Jirga members 3. Relevant governmental agencies
3	8 June, 2012	20 participants (*Jirga* members)
4	27 September 2012	112 participants (*Jirga* members and community)

Issues Discussed

The main issues discussed with affected persons and communities are listed in **Table 10.6** and how these issues are addressed and incorporated is also shown in this table.

Table 10.6: 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 APs and WAPDA. The local demands have been for the rate applied in the case of Basha Diamer Dam upstream. LA notification has not been set yet by Dasu DRO. In view of the absence of cadastral surveys/maps, it is important to prepare the maps and records first with community and jirgas 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 by WAPDA.
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 costs. 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 sites design.
Job and Employment	The affected communities/sub-tribes demand full employment in the project during construction and in post-construction periods.	WAPDA has also taken initiatives to conduct pilot training for candidates

Issues	Description	Action Point
	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. Accordingly, In addition, some outside employment or overseas employment opportunities are also expected by local APs.	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 the limited scope of APs, namely, youth with at least completed primary education.	A long term livelihood restoration plan is developed.
Environmental and Social Issues	Despite community-based preferred relocation, it will bring some disruptions- for example schooling, access to market and health clinic. Two suggestions were made at meetings: (i) reforestation as an alternative livelihood after relocation, and (ii) the agro-ecosystem of the affected area and need for new irrigation support.	A long term livelihood restoration plan is developed.
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 on their limited and fragile social infrastructure.	ESA includes issues relating to traffic management, community health as well as safety
In-migrants and Outsiders	This has been flagged in the community level meeting as a very big concern by the affected communities. 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 plan on In-Migrant Management is prepared.

10.3. Consultation Workshops

A summary of comments and suggestions received in the consultation workshops is given in **Table 10.7**.

Table 10.7: 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.
Physical cultural resources in the area are to be properly documented.	ESA addresses issues relating to PCR and proposes mitigation as well as enhancement measures.
The people in Kohistan have unique social culture, which may be affected by resettlement.	The social structure of the affected people will not be disturbed and will remain same. Relocation of the affected people will be still within their winter migration range.
It is apprehended that existing health facilities will not be enough to meet local and inward migrant workers' need. How the Project will address these health 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 have been be designed for the Project.
KKH is life line of northern areas as it is only highway connecting northern areas with reset of the Pakistan. Impact of construction traffic on KKH 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 EIA	Contractors' demobilization is considered in the EMP and ECPs.
WAPDA shall have an Environmental Monitoring Unit at Project Site for supervision of EMP implementation.	An Environmental Unit is recommended for both DHP (WAPDA) and supervision consultants.
Initial filling of reservoir may affect the downstream release of water to Rabi crops	The first water filling of reservoir will be carried out slowly at the rate of 2 m/day. The rest of the river water will be allowed to flow downstream of the dam through LLO. No impact on Rabi crop will be expected.
Low flow season operation of the dam and its impact on aquatic life to be considered.	The reservoir will be operated as full runoff river (base load plant). Whatever water comes to the reservoir, the same will be released through the power house. Further, environmental flows will be released to maintain the downstream habitat.
Project design shall consider geohazards (landslides and earth quakes) in the area.	The Project is designed complying with guidelines of International Commission on Large Dams (ICOLD) to deal with geological and geomorphological hazards. State of art engineering modeling was carried out for design of dam.
Floods from GLOFs will be a serious risk to the Project. Early warning system for flood	Design flood (Probable Maximum Flood) of the Project considered extreme flood events from GLOFs and

Comments and suggestions	Action Point/Response
forecasting is necessary for the safe operation of the Project.	extreme rainfall events. A flood telemetry network will be established in the 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 one of the SRMP volume on 'Hydropower Development, Conflict and Security Issues: A Perspective'
Historical and archeological sites are to be protected. DHP should support the Archeology Department of Peshawar for protection of Shatial rock carvings, a designated archeological site.	The EMP considers 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 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 Markhor is protected by private arrangement and an annual hunting license is auctioned for about $20,000 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 Basha and Bunji projects start along with Dasu.	Currently there is no confirmed schedule available on construction of Bash and Bunji. This issue is further studied as part of the ESA.
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 is prepared to address these issues.
Indus valley is a flyway for migratory birds from Siberia to Sub Continent. Impact of transmission line on birds' migration to be assessed.	Bird collision and electrocution are potential threats on migratory birds. These issues will be addressed in the Transmission line EIA
Electromagnetic waves from transmission lines and their impact on human health to be assessed.	These issues will be addressed in the Transmission line EIA
Cumulative impacts of hydropower development on Upper Indus Basin on Lower Indus Basin should be monitored.	The present assessment limits its scope of Upper Indus Basin (Tarbela Catchment). A detailed study is in pipeline from WCAP on 'Strategic/Sectoral Environmental and Social Assessment of Indus Basin'
Impact on migratory birds and important bird areas (IBA) to be assessed.	DHP will have a positive impact on the migratory 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.
The Project design should consider geological hazards (seismic activity and faults) in the Project area.	The Project is designed complying with guidelines of International Commission on Large Dams (ICOLD) to deal with seismicity and faults. State of art engineering modeling was carried out for design of dam.

Comments and suggestions	Action Point/Response
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 EA.
Habitat management plan for endangered species is to be proposed.	A community conservation area is proposed for protection of important fauna in the project area such Markhor, musk deer, monal pheasant and Tragopan peasant.
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.
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 be given proper guidance.	Recommended in RAP.
Capacity of WAPDA in term of human resources needs to be increased to address social and environmental issues.	Field level social and environmental units will be established in DHP.
Potential livelihood and income generation activities to start	Short term and long term livelihood restoration plans are recommended in RAP
Education sector is very important in this area. Focus on Education & Health sector.	Education and heath will be considered in the social development plan and benefit sharing of the Project
Involvement of women is very important. Design livelihood livestock related activities for women.	A Gender Action Plan is prepared.
Mobilization of women for capacity building related to income generation activities need to be more focused	A Gender Action Plan is prepared.
Invertebrate fauna/aquatic flora should be addressed	These are part of aquatic ecology assessment
Establishment of fish hatchery	Fish hatchery will be established, initially for R&D, and then later for full scale development if the farming of snow trout is feasible in the reservoir.
Motivate local people for terrace farming.	Recommended in RAP
Livestock farming through providing quality animals breeds	Recommended in RAP

10.4. Disclosure

The updated EIA will be submitted to KP- EPA on 16 December 2013. A Public Hearing is scheduled to be held in Dasu during February 2014, which is about 30 days after the submission of the EIA which is in accordance with the ESA review and approval process in the Country. Organized by the KP-EPA, the Hearing will be attended by WAPDA officials, media, local representatives, and most importantly, local community members. The ESA summary has been translated in Urdu. Both the Urdu and the English version will be distributed to local authorities and relevant stakeholders. The Summary and the ESA document have been published on the website of WAPDA.

Annex A: Terms of Reference for Studies

FORESTRY AND WILDLIFE MANAGEMENT STUDY

1 Objective
Purposes of this study are:
- to determine forestry status and trends in areas between 1,000 and 2,500 m in the Indus District of Kohistan, Pakistan,
- to develop a general ecological management plan for sub-catchment areas of DHP, and
- to develop detailed community-led ecological management plans for at least two sub-catchment areas, focusing on sustainable forest management and conservation management of wildlife.

The realization of this study should preferably be synchronized with a comparable study proposed for the Basha area (WWF-Pakistan).

2 Justification
The forest cover of North Pakistan is estimated at 29%, but is reported to decrease by 2% annually. A reversion of this deforestation trend is highly needed, since both the unique mountain fauna and human settlements are highly dependent on forestry resources. The mountain fauna includes a number of rare and endangered species, some of them restricted to the mountain range concerned and protected under Pakistani law. The human population around the valleys of the Indus River and its tributaries is dependent on forestry resources for their livelihood. Fire wood is an essential commodity, not only for home cooking and heating, but also for trading; no clear alternatives are available as yet. The construction of hydrological structures in the Indus River will force river-dwelling populations to resettle at higher altitudes, which will increase the negative pressure on forest resources and wildlife. Development of a forestry and wildlife management system, therefore, is meant to counteract or reverse these negative trends.

3 Study components
3.1 Forestry survey
The present forestry situation will be determined through a GIS on medium resolution satellite data. In comparison with earlier data, the GIS will provide a baseline to select high degradation areas (catchments of small rivers and nullahs) for development of forestry management and it will provide a baseline for monitoring future negative and positive changes in the region.
The GIS will be accompanied by field truthing, during which common distinctions will be used to characterize forest stands. Characterization will be assessed on the basis of commonness of species (indicative of biodiversity value and sensitivity for disturbance) and usefulness for humans or animals (wood and non-wood forest products).

3.2 Identification of forestry management opportunities
On the basis of common forestry practice and experiences in comparable areas elsewhere (including e.g. Nepal) opportunities will be identified of relatively undisturbed sub-catchments, and for restoration of already degraded areas, all at higher altitudes (1,000 – 2,500 m).
For conservation management sufficient tools are available within Pakistani laws and regulations; a main additional requirement is the provision of information and training to potential human users of these areas on sustainable forestry activities and alternative livelihoods.
As far as degraded sub-catchments are concerned, tools include afforestation, rejuvenation, and plantation forestry, combined with agroforestry and horticultural activities. Also here information and training of local communities will be required.

3.3 Preparation of detailed plans
Within the framework of the Ecological Conservation Plan for DHP four sub-catchments will be selected on the basis of the GIS survey: two with relative healthy forestry stands and two with already high human pressure on forestry resources. The identified management opportunities will

be worked out in detail for these areas, keeping up with needs shown in livelihood analyses for these areas. In each sub-catchment pilot schemes will be organized, showing technologies and socio-economic possibilities. Once established, the pilot schemes will also be used as information and training venue for forestry management activities in other sub-catchments.

3.4 Mountainous wildlife management

Healthy forests are essential for healthy wildlife populations. For some of the rare or endangered species, however, the available biotopes have already become scarce, whereas hunters add pressure on the remaining populations.

One of the species that is endangered is the protected Markhor (*Capra falconeri*); the remaining wild population is extremely low, especially caused by increased trophy hunting. The KP Wildlife Department decided to involve local communities in the protection of Markhor (and other associated wildlife species) through the establishment of "Community Game Reserves". Here trophy hunters are allowed to shoot a predetermined number of Markhors for a rather high fee, of which some 75% flows back to the communities that protect the area. The Community Game Reserves have shown to be doing well for both the communities and the wildlife.

One of the Reserves is the Kaigah Community Game Reserve, within the impact zone of DHP. Translocation of the KKH, as well as quarrying activities are expected to chase the Markhors further into the mountains and will therefore severely decrease revenues of the community involved.

In the framework of the detailed planning of forestry activities in sub-catchments, identification of a compensation area for the Kaigah Community Game Reserve will be included, as well as assistance in its registration, development and management. Moreover, an additional Community Game Reserve area will be identified to be managed by one of the other communities resettled in DHP.

3.5 Community Conservation Fund

The study will be financed under the Environmental Management Plan of DHP. In this plan it is foreseen that funds for environmental activities will remain available after the Dasu hydrological structure is in place and functioning, e.g. through a small percentage of the electricity proceeds. Partly these proceeds could be made available through a "Community Conservation Fund", from which community conservation activities like forestry and wildlife management will be funded. Establishment of this fund (organization, responsibilities, conditions for disbursements, etc.) will be part and parcel of the present study.

The Fund will assure continuation of the forestry and wildlife management activities commenced during the present study. A solid system for monitoring and evaluation of progress will be prepared.

4 Time frame and budget

The following time frame is foreseen for the study:

First year:	• Site office established and core study team in place; • Survey team deployed for GIS based forest cover assessment; • Survey team deployed for analysis of forestry management opportunities and livelihood dependency on natural resources; • GIS produced, including forest cover, change analysis and location of critical (sub)catchments; • Four (sub)catchments selected and forestry management activities planned; • (At least two) community game reserve areas selected and wildlife management activities planned.
Second year:	• Field team in place for education and information activities and execution of pilot schemes; • Community-based resources management organizations mobilized; • Training and guidance in forestry and wildlife management techniques; • Pilot schemes operational; • Compensation area for Kaigah Community Game Reserve operational and

	registration carried out; • Community Conservation Fund established; • Future field activities planned; • Detailed monitoring and evaluation scheme prepared, including impacts on forestry, wildlife and socio-economics of communities concerned.

Costs of the study are estimated at a maximum of 2 million US$.

5 Manpower for proposed study

The study requires GIS specialists, forestry experts and community workers. Organizations with relevant experience should be requested to prepare a detailed proposal. A suitable organization is WWF-Pakistan, of which the main office is not too far away (Lahore) and where both GIS facilities and technical know-how are available. WWF prepared already a comparable proposal for the Diamer Basha area.

Aquatic and Terrestrial Baseline and Management Study

1 Objective

During the DHP environmental impact assessment the lack of readily available and reliable baseline data on flora and fauna was seriously felt. The purpose of the study is to develop a sound ecological baseline for the Indus Corridor between Basha and Tarbela (from Raikot bridge towards Tarbela dam), in order to better interpret and mitigate actual impacts of DHP and to be able to prepare a more advanced management plans for future activities in the area, including construction of the Diamer-Basha dam.

2 Justification

The mountain areas of Pakistan are home to exceptional wildlife and wilderness areas with high biodiversity: 232 species of plants, 199 species of avifauna, 31 mammals and 18 species of reptiles and amphibians species are recorded in (often rather old) literature. The area contains the full extent of the Western Himalayas Endemic Bird Area (BirdLife International, 2013).

The Indus valley bottom is largely covered with scrub vegetation with a typical low biodiversity, but the river and its tributaries are reported to contain rather unique aquatic fauna, including some 180 species of fish. From the animal species a number are rare and threatened.

Protection of species is limited, both in effort and in surface area. The Kaigah tributary (nullah) is a forested 5,000 ha Community Conservation Area for Markhor, but will also provide protection to other mammal and bird species. Other conservation areas are the Tangir Game Reserve (Diamer district; notified in 1975 but not managed) and the Palas Valley (Kohistan district), identified as a Biosphere Reserve by WWF, but it not yet ratified by the government. Outside these conservation a number of critical biotopes for Markhor, Musk deer, Black bear, Tragopan, Monal pheasant as well as other rare species are identified, such as Laachi nullah and Sazin kot on the Indus left bank and Kandia Valley (between the villages Thooti and Aliel) and the area opposite to Shori nullah on the right bank. In all these areas high biodiversity is reported to be under heavy stress from deforestation, firewood collection, overgrazing, over-hunting, over-harvesting of medicinal plants, over-fishing, soil erosion, use of pesticides, weak law enforcement, and combinations of these factors. However: firm recent data are absent.

In order to be able to improve conservation and protection activities in the Indus valley and its watersheds, and in order to be able to accurately assess impacts of development projects in the widest sense, establishment of an ecological baseline is highly required, covering flora and fauna species and associations, biotopes and hotspots of threatened species, and seasonal effects.

3 Study components

3.1 Consolidation of existing data

Existing information will be collected and consolidated through completion of a full literature and internet review. The review should not be limited to the Indus region, but should include relevant data from comparable areas and resource centers in Pakistan, India and Nepal. The resulting list of species and list of conservation activities will be annotated as much as possible (number, location, year, season, other relevant remarks). When available, physico-chemical data will be added. Subsequently, this quantitative information will be turned more qualified by comparison of data over time. This exercise is expected to show the relative value of data and, especially, gaps in information.

3.2 Preparation of survey plan

Realistically, it will not be possible to implement a full survey of all biota and ecosystems in this both horizontally and vertically divers area. For a practical plan of field surveys choices (species, areas) will have to be made, using the (at least) the following criteria:

- The above analysis of existing and missing data. This will show what information needs updating, what species or ecosystems might be used as indicators of change, and what biological phenomena will require additional attention (reproduction success, food chains, migration of fish and birds);
- A division of the large area in ecologically different sections, e.g.:
    - Section 1 - Raikot bridge to Diamer Basha dam (the future BHP storage reservoir); information from this section will provide basic information for the Diamer-Basha EIA and especially for the future of aquatic fauna in the complete river valley;
    - Section 2 - Diamer Basha dam to Dasu dam: this is the future DHP reservoir (73 km); information from this section will provide basic information for environmental activities under DHP;
    - Section 3 - Dasu dam to Besham: natural river section with potential impacts on hydrology, sedimentation, and aquatic ecology from BHP and/or DHP; major tributaries flowing into Indus in this section, a.o Palas en Dubair river;
    - Section 4 - Besham - upper end Tarbela reservoir, few or no impacts likely on this natural river section - low gradient; and
    - Section 5 - Tarbela reservoir (c100 km); information from this section will provide information to better predict ecological changes behind the Dasu and Diamer-Basha dams.

  Section 3 might have to be subdivided further, e.g. in an Indus river sub-sections and a nullah sub-section. All sections will have a riverine and a mountainous component.
- Availability of experienced staff and suitable equipment for field sampling at different stations in different seasons.

3.3 Actual field surveys

Collection of information on presence, seasonal behavior and biotope characteristics of selected species at selected locations. Depending on the above analysis, a group of experts will be required. In order to obtain fully comparable data, the same survey team should do sampling in all selected locations. There could be different survey teams for the riverine and the mountainous areas; as far as observations are done in both areas (e.g. birds) they should use the same sampling protocols.

Surveys of terrestrial fauna (including invertebrates) might include direct observations (survey team) and indirect observations, carried out by instructed community members. Aquatic macro- and micro-fauna will require expert sampling techniques, including mark and recapture for fish species.

Surveys of macro- and micro-flora should be carried out following commonly used survey techniques, that reveal both qualitative (species composition) and quantitative (spread, density) data.

As far as collection of physico-chemical data in river and nullahs is concerned: care should be taken that only those data are collected that might lead to interpretation of ecological phenomena and that they are collected in a way that allows conclusions. Too often parameters like O2, pH, BOD and temperature of water bodies are collected once a season, whereas these parameters might change substantially over time in one day. At the same time, ecologically relevant data like riverbed status, sediment load, hiding places, presence of food sources are often not noted.

Since ecological data on riverine fish are urgently needed to be able to mitigate environmental impacts of dam projects, sampling should result in knowledge on migration behavior and reproduction needs (physiological data (stomachs, ovaries); locations for overwintering pools; locations for spawning and nursing).

3.3 Reporting

All collected information should be worked up in reports immediately, so that further sampling may be adapted to results obtained so far.

4 Time frame and budget

The following time frame is foreseen for the study:

First year:	• Site office established and core study team in place; • Literature/internet review completed; • Ecological survey teams deployed for aquatic and terrestrial biota assessment; • Selection of five-six ecologically representative valley areas between Basha and Tarbela; • Selection of survey techniques (indicator species, sampling/observation techniques); • Survey activities commenced (one season).
Second year:	• Survey activities continued (other seasons); • Analyses of findings; • Reporting; • Ecological conservation plans for critical areas (including evaluation schemes); • Fisheries management plan; • Identification of detailed studies required.

Costs of the study are estimated at a maximum of 1.5 million US$.

5 Manpower for proposed study

The study requires specialists in floristic and faunistic surveys and community workers. Organizations with relevant experience should be requested to prepare a detailed proposal. Suitable organizations are WWF-Pakistan and IUCN-Pakistan, where essential technical know-how is available. Cooperation with universities (provision of specialists) will be required.

Annex B: Baseline Data of Biological Environment

Fish species of Northern Pakistan

Family / Species			**Local Name**
A – Indigenous species			
1.	Family – Cyprinidae		
	Sub family – Schizothoracinae		
	1.	Schizothorax plagiostomus	Gahi, Cheemo
	2.	Schizothorax labiatus	Chochan
	3.	Schizothorax esocinus	Chakhat
	4.	Schizothorax skarduensis	Khaduk
	5.	Schizothorax intermedius	Khaduk
	6.	Schizothorax longipinnis	Khaduk
	7.	Schizopygopsis stoliczkai	-
	8.	Schizocypris curviforms	-
	9.	Ptychobarbus conirostris	-
	10.	Diptychus maculatus	-
	11.	Racoma labiata	Snowcarp
2.	Family – Sisoridae		
	12.	Glyptosternum reticulatum	-
3.	Family – Noemacheilidae		
	13.	Triplophysa stoliczkai	-
	14.	Triplophysa gracilius	-
	15.	Triplophysa yaseenis	-
	16.	Triplophysa trawovasea	-
	17.	Triplophysa tenuicauda	-
	18.	Triplophysa microps	-
B – Exotic species			
4.	Family – Salmonidae		
	19.	Salmo trutta faria	Brown Trout
	20.	Oncorhynchus Mysis	Rainbow Trout
5.	Family – Cyprinidae		
	21.	Cyprinus carpio	Chinese carp / Gulfam

Source: *M. Rafique (2000) Pak. Museum of National History, Islamabad.*

Phytoplankton Identification of Project Area

Algae Groups	**River Mainstem**		**Tributaries**	
	Upstream	**Down-stream**	**Left hand streams**	**Right hand streams**
Cyanophyceae				
- Anabanea spp	+	+	+	+
- Oscillatoria spp	+	+	+	+
- Phormidium spp	-	+	+	+
- Spirulina spp	-	-	+	+
- Johanneslaptista spp	-	-	+	-
- Cylindrospernum spp	-	-	+	+

Algae Groups	River Mainstem		Tributaries	
	Upstream	Down-stream	Left hand streams	Right hand streams
Chlorophyceae				
- Closteriopsis sp	+	+	-	+
- Oedogonium spp	+	+	+	+
- Ulothorix spp	-	-	+	+
- Cladophora spp	-	-	+	+
- Nitzschia spp	-	-	+	-
- Fragilario spp	-	-	+	+
- Synedra spp	-	-	+	-
- Tabellari spp	-	-	+	+
Chrysophyceae				
- Navicula spp	+	+	-	+
- Pinnularia spp	+	+	+	+
- Cymbella spp	+	+	-	-
- Diatoma spp	-	-	+	+
Xanthophyceae				
- Tribonema spp	-	-	+	+

Source: Sampling during August / September 2012 Trip at Project site.

Zooplankton Identification of Project Area

Groups	River Mainstem		Tributaries	
	Upstream	Down-stream	Left hand streams	Right hand streams
Protozoa				
- Paramecium spp	+	+	+	+
Rotifera				
- Karetella sp	-	-	+	+
- Euchlanus spp	+	-	-	-
- Branchionus spp	+	+	+	+
- Tansignus spp	-	-	+	+
Cladocera				
- Bosmina spp	-	+	+	+
- Daphnia spp	-	-	+	+
- Ceriodaphnia spp	-	-	+	+
Decapods				
- Cyclops spp	+	-	+	+
- Diaptomus spp	-	-	+	+
Insecta				
- Damsel Nymph spp	+	+	+	-
- Caddish fly Larva	-	-	+	+
Mollusca				
- Limnaea spp	-	-	+	-
- Valvata spp	-	-	+	+

Source: Sampling during August / September 2012 Trip at Project site.

Floral Biodiversity Recorded In Dasu Project Area (None of the species are included in the Red List)

No.	Plant Species	Family	Habit	Life span	Life form	Local name
1	*Abelmoschus esculentus* (L.) Moench.	Malvaceae	Herb	Annual	Therophyte	Bhindi
2	*Abies pindrow* Royle.	Pinaceae	Tree	Perennial	Phanerophyte	Chur
3	*Achyranthes aspera* L.	Amaranthaceae	Herb	Annual	Chamaephyte	Malkuni
4	*Adiantum capillus-veneris* L.	Adiantaceae	Herb	Perennial	Chamaephyte	
5	*Adiantum venustum* D. Don	Adiantaceae	Herb	Perennial	Chamaephyte	Jathoori
6	*Ailanthus altissima* (Mill.) Swingle	Simarubaceae	Tree	Perennial	Phanerophyte	Darawa
7	*Ajuga bracteosa* Wall. ex Bth.	Lamiaceae	Herb	Annual	Therophyte	
8	*Ajuga parviflora* Bth.	Lamiaceae	Herb	Annual	Therophyte	
9	*Alnus nitida* Endl.	Betulaceae	Shrub	Perennial	Phanerophyte	
10	*Alternanthera pachyacantha*	Aizoaceae	Herb	Perennial	Hemicryptophyte	
11	*Alternanthera pungens* Kunth.	Amaranthaceae	Herb	Annual	Chamaephyte	
12	*Amaranthus caudatus* L.	Amaranthaceae	Herb	Annual	Therophyte	Ghanar
13	*Amaranthus graecizense* L.	Amaranthaceae	Herb	Annual	Therophyte	
14	*Amaranthus oleraceus* L.	Amaranthaceae	Herb	Annual	Therophyte	Kas ghanar
15	*Amaranthus viridis* L.	Amaranthaceae	Herb	Annual	Therophyte	Ghanar
16	*Anagallis arvensis* L.	Primulaceae	Herb	Annual	Therophyte	
17	*Arabidopsis himalaica* (Edgew.) O.E.S.	Brassicaceae	Herb	Annual	Therophyte	
18	*Aristida cyanatha* Nees ex Steud.	Poaceae	Grass	Perennial	Hemicryptophyte	
19	*Artemesia maritima* L.	Asteraceae	Herb	Annual	Therophyte	Daroon
20	*Asparagus filicinus* Buch.-Ham. ex D. Don	Asparagaceae	Shrub	Perennial	Hemicryptophyte	Zao
21	*Aster aitchisonii* Boiss.	Asteraceae	Herb	Annual	Therophyte	
22	*Astragalus candolleanus* Royle ex Benth.	Fabaceae	Shrub	Perennial	Phanerophyte	Chioo
23	*Atriplex lasiantha* Boiss.	Chenopodiaceae	Herb	Annual	Therophyte	Kiklohukbursa
24	*Barleria acanthoides* Vahl.	Acanthaceae	Subshrub	Perennial	Chamaephyte	
25	*Barleria cristata* L.	Acanthaceae	Herbs	Perennial	Chamaephyte	
26	*Bauhinia variegata* L.	Caesalpiniaceae	Tree	Perennial	Phanerophyte	
27	*Bergenia ciliata* (Haw.) Sternb.	Saxifragaceae	Herb	Annual	Hemicryptophyte	Korat
28	*Bidens biternata* (Lour.) Merr. & Sherff.	Asteraceae	Herb	Annual	Therophyte	Surbul
29	*Boerhavia procumbens* Banks ex Roxb.	Nyctaginaceae	Herb	Perennial	Cryptophyte	
30	*Bothriochloa bladhii* (Retz.) S.T Blake	Poaceae	Grass	Perennial	Hemicryptophyte	Lhash
31	*Bothriochloa ischaemum* (L.) Keng	Poaceae	Grass	Perennial	Hemicryptophyte	Lhash
32	*Brachiaria distachya* (L.) Stapf	Poaceae	Grass	Annual	Therophyte	
33	*Brachiaria reptans* (L.) Gard. & C.E. Hubb.	Poaceae	Grass	Annual	Therophyte	

No.	Plant Species	Family	Habit	Life span	Life form	Local name
34	*Brousonetia papyrifera* (L.) Vent.	Moraceae	Tree	Perennial	Phanerophyte	Jangal murt
35	*Calamintha umbrosa* (M. Bieb.) Fisch. & Mey.	Lamiaceae	Herb	Annual	Therophyte	Bheroo rang
36	*Calotropis procera* (Willd.) R. Br.	Asclepiadaceae	Shrub	Perennial	Phanerophyte	
37	*Cannabis sativa* L.	Cannabinaceae	Herb	Annual	Therophyte	
38	*Capparis spinosa* L.	Capparidaceae	Shrub	Perennial	Hemicryptophyte	Kurr
39	*Capsella bursa-pastoris* (L.) Medik	Brassicaceae	Herb	Annual	Therophyte	
40	*Carex chitralensis* Nelmes Mag.	Cyperaceae	Sedge	Annual	Hemicryptophyte	Zatch
41	*Carum carvi* L.	Apiaceae	Herb	Annual	Therophyte	Zeera
42	*Cedrus deodara* (Roxb. Ex Lamb.) G. Don	Pinaceae	tree	Perennial	Phanerophyte	Beesh
43	*Celtis australis* L.	Ulmaceae	Shrub	Perennial	Phanerophyte	Makosh
44	*Centella asiatica* (L.) Urban	Apiaceae	Herb	Annual	Cryptophyte	Tikroo
45	*Cheilanthus farinosa* (Forssk.) Kaulf.	Pteridaceae	Herb	Annual	Therophyte	
46	*Chenopodium album* L.	Chenopodiaceae	Herb	Annual	Therophyte	Kanwan
47	*Chenopodium ambrosioides* L.	Chenopodiaceae	Subshrub	Biennial	Hemicryptophyte	Tahoo
48	*Chenopodium botrys* L.	Chenopodiaceae	Herb	Annual	Therophyte	Kunwan
49	*Chenopodium* cf. *opulifolium* Schrad. ex Koch & Ziz.	Chenopodiaceae	Herb	Annual	Therophyte	
50	*Chrozophora tinctoria* (L.)Juss.	Euphorbiaceae	Herb	Annual	Therophyte	
51	*Chrysopogon aucheri* (Boiss.) Stapf	Poaceae	Grass	Perennial	Hemicryptophyte	
52	*Cirsium falconerii* (Hk.f.) Petrak	Asteraceae	Herb	Annual	Therophyte	Jocho
53	*Citrullus colocynthis* (L.) Schrad.	Cucurbitaceae	Subshrub	Perennial	Hemicryptophyte	
54	*Clematis montana* Buch.	Ranunculaceae	Climber	Perennial	Phanerophyte	
55	*Clematis nepalensis* Royle	Ranunculaceae	Climber	Perennial	Phanerophyte	
56	*Cleome viscosa* L.	Capparidaceae	Herb	Annual	Therophyte	
57	*Commelina paludosa* Bl. Enum.	Commelineace	Herb	Annual	therophyte	
58	*Convolvulus arvensis* L.	Convolvulaceae	Climber	Perennial	Hemicryptophyte	Halor
59	*Conyza aegyptica* Ait.	Asteraceae	Herb	Annual	Therophyte	
60	*Conyza bonariensis* L.	Asteraceae	Herb	Annual	Therophyte	Phuljoo
61	*Conyza canadensis* L.	Asteraceae	Herb	Annual	Therophyte	Panar tahoor
62	*Coronopus didymus* (L.) Sm.	Brassicaceae	Herb	Annual	Cryptophyte	Marchaki
63	*Cotinus coggygria* Scop.	Anacardiaceae	Tree	Perennial	Phanerophyte	Khakoh/Shini
64	*Cotoneaster affinins* var. *bacillaris* (Lindl.) Schneider	Rosaceae	Shrub	Perennial	Phanerophyte	Luni
65	*Cotoneaster microphylla* Wall. ex Lindl.	Rosaceae	Shrub	Perennial	Phanerophyte	Kiur
66	*Cotoneaster nummularia*	Rosaceae	Shrub	Perennial	Phanerophyte	Dudul/Mago

No.	Plant Species	Family	Habit	Life span	Life form	Local name
	Fisher & Meyer					sh
67	*Cousinia thomsonii* Clarke	Asteraceae	Herb	Annual	Therophyte	
68	*Cucumis melo* var. *agrestis* Naud.	Cucurbitaceae	Herb	Annual	Cryptophyte	
69	*Cucurbita maxima* Duch. ex Lam.	Cucurbitaceae	Climber	Annual	Cryptophyte	
70	*Cuscuta reflexa* Roxb.	Cuscutaceae	Parasite	Annual	Therophyte	Zhoo
71	*Cymbopogon distans* (Nees) W. Wats.	Poaceae	Grass	Perennial	Hemicryptophyte	Kattal
72	*Cynodon dactylon* (L.) Pers.	Poaceae	Grass	Perennial	Hemicryptophyte	Kabal
73	*Cynoglossum lanceolatum* Forssk.	Boraginaceae	Herb	Annual	Therophyte	Chiroo
74	*Cyperus niveus* Retz.	Cyperaceae	Sedge	Perennial	Hemicryptophyte	
75	*Cyperus rotundus* L.	Cyperaceae	Sedge	Perennial	Hemicryptophyte	
76	*Dactyloctenium aegyptium* L.	Poaceae	Grass	Annual	Hemicryptophyte	Sarkhoo gha
77	*Dalbergia sissoo* Roxb.	Fabaceae	Tree	Perennial	Phanerophyte	
78	*Datura innoxia* Mill.	Solanaceae	Shrub	Perennial	Chamaephyte	
79	*Datura stramonium* L.	Solanaceae	Shrub	Perennial	Phanerophyte	
80	*Debregeasia salicifolia* (D. Don) Rendle	Urticaceae	Shrub	Perennial	Phanerophyte	Chiroo
81	*Dianthus crinitus* Sm.	Caryophyllaceae	Herb	Annual	Therophyte	
82	*Dichanthium annulatum* (Forssk.) Stapf	Poaceae	Grass	Perennial	Hemicryptophyte	
83	*Dicliptera roxburghiana* Nees	Acanthaceae	Herb	Annual	Cryptophyte	
84	*Digera muricata* (L.) Mart.	Amaranthaceae	Herb	Annual	Therophyte	
85	*Digitaria sanguinalis* (L.) Scop.	Poaceae	Grass	Annual	Hemicryptophyte	
86	*Diospyros lotus* L.	Ebenaceae	Tree	Perennial	Phanerophyte	Amlok
87	*Dodonaea viscosa* (L.) Jacq.	Sapindaceae	Shrub	Perennial	Phanerophyte	Shounth/Bajj
88	*Duchesnea indica* (Andr.) Focke	Rosaceae	Herb	Annual	Cryptophyte	
89	*Echinochloa colona* (L.) Link	Poaceae	Grass	Annual	Therophyte	
90	*Echinops cornigerus* DC.	Asteraceae	Herb	Annual	Therophyte	Kuro/Ziach
91	*Eclipta prostrata* (L.) L.	Asteraceae	Herb	Annual	Therophyte	
92	*Ephedra ciliata* Fisch. & Mey. ex C.A. Mey.	Ephederaceae	Shrub		Hemicryptophyte	Ragaal
93	*Ephedra intermedia* Schrenk	Ephederaceae	Shrub	Perennial	Phanerophyte	Suo
94	*Eragrostis aterovirens* (Desf.) Trin. ex Nees	Poaceae	Herb	Annual	Therophyte	
95	*Eragrostis cilianensis* (All.) Vig.	Poaceae	Herb	Annual	Therophyte	
96	*Eragrostis minor* Host.	Poaceae	Herb	Annual	Therophyte	
97	*Eucalyptus lanceolatus*	Myrtaceae	Tree	Perennial	Phanerophyte	
98	*Euonymus pendulus* Wall.	Celastraceae	Shrub	Perennial	Phanerophyte	
99	*Euphorbia granulata* Forssk.	Euphorbiaceae	Herb	Annual	Therophyte	

No.	Plant Species	Family	Habit	Life span	Life form	Local name
100	*Euphorbia hirta* L.	Euphorbiaceae	Herb	Annual	Therophyte	
101	*Euphorbia indica* Lam.	Euphorbiaceae	Herb	Annual	Therophyte	Ispatre
102	*Euphorbia kanorica* Boiss.	Euphorbiaceae	herb	Perennial	Hemicryptophyte	
103	*Euphorbia prostrata (*L.) Ait	Euphorbiaceae	Herb	Perennial	Cryptophyte	
104	*Euphrasia himalayica* Wettst.	Scrophulariaceae	Herb	Annual	Therophyte	
105	*Ficus carica* L.	Moraceae	Tree	Perennial	Phanerophyte	Pha
106	*Fumaria indica* (Hausskn.) H.N. Pugsley	Fumariaceae	Herb	Annual	Therophyte	
107	*Gallium aparine* L.	Rubiaceae	Herb	Annual	Therophyte	
108	*Gentiana capitata* Ham. ex D. Don	Gentianaceae	Herb	Annual	Therophyte	Salaloo
109	*Geranium rotundifolium* L.	Geraniaceae	Herb	Annual	Therophyte	
110	*Geranium willichianum* D. Don	Geraniaceae	Herb	Annual	Therophyte	Ratajot
111	*Grewia optiva* Drum. ex Burret.	Tiliaceae	Tree	Perennial	Phanerophyte	
112	*Heliotropium europaeum* L.	Boraginaceae	Herb	Annual	Therophyte	
113	*Heliotropium* spp.	Boraginaceae	Herb	Annual	Therophyte	Dodosulo
114	*Heteropogon contortus* (L.) P. Beauv.	Poaceae	Grass	Perennial	Hemicryptophyte	
115	*Impatiens edgeworthii* Hook.f.	Scrophulariaceae	Herb	Annual	Cryptophyte	
116	*Indigofera heterantha* Wall. Ex Brand	Fabaceae	Shrub	Perennial	Phanerophyte	Kachhi
117	*Juglans regia* L.	Juglandaceae	Tree	Perennial	Phanerophyte	chhoe
118	*Juncus* spp.	Juncaceae	Herb	Perennial	Hemicryptophyte	
119	*Kickxia ramosissima* (Wall.) Janchen	Scrophulariaceae	Herb	Annual	Therophyte	
120	*Lactuca auriculata* (Wall. ex Dc.)	Asteraceae	Herb	Annual	Therophyte	
121	*Lactuca dissecta* D. Don.	Asteraceae	Herb	Annual	Therophyte	
122	*Lactuca serriola* L.	Asteraceae	Herb	Annual	Therophyte	Harool
123	*Lagenaria siceraria* (Molina) Standley	Cucurbitaceae	Climber	Annual	Cryptophyte	
124	*Launaea procumbens* (Roxb.) Ram. & Rajgo.	Asteraceae	Herb	Annual	Chamaephyte	
125	*Lepidium pinnitifidum* Ledeb.	Brassicaceae	Herb	Annual	Therophyte	Makoch
126	*Lespedeza elegans* Cambess.	Fabaceae	Herb	Annual	Cryptophyte	
127	*Leucaena leucocephala* (Lam.) de-Wit	Mimosaceae	Tree	Perennial	Phanerophyte	
128	*Luffa cylindrica* (L.) Roem.	Cucurbitaceae	Climber	Annual	Cryptophyte	
129	*Malva neglecta* Waller.	Malvaceae	Herb	Annual	Therophyte	Shani
130	*Malva parviflora* L.	Malvaceae	Herb	Annual	Therophyte	Zarooshal/Masha
131	*Malvastrum coromendelianum* L.	Malvaceae	Herb	Perennial	Cryptophyte	
132	*Maytenus royleanus* (Wall. ex Lawson)	Celastraceae	Shrub	Perennial	Phanerophyte	Phaikar

No.	Plant Species	Family	Habit	Life span	Life form	Local name
	Cufodontis					
133	*Medicago lupulina L.*	Fabaceae	Herb	Annual	Therophyte	
134	*Melia azedarach* L.	Meliaceae	Tree	Perennial	Phanerophyte	
135	*Mentha longifolia* (L.) Huds.	Lamiaceae	Herb	Perennial	Hemicryptophyte	Feeru
136	*Micromeria biflora* (Ham.) Bth.	Lamiaceae	Herb	Perennial	Hemicryptophyte	Kaldajar
137	*Morus alba* L.	Moraceae	Tree	Perennial	Phanerophyte	Marath
138	*Morus nigra* L.	Moraceae	Tree	Perennial	Phanerophyte	
139	*Myrtus communis* L.	Myrtaceae	Shrub	Perennial	Phanerophyte	Amboo/Lachi
140	*Nasturtium officinale* R. Br.	Brassicaceae	Herb	Biennial	Hemicryptophyte	Zalzaal
141	*Nerium oleander* L.	Apocynaceae	Shrub	Perennial	Phanerophyte	
142	*Olea ferruginea* Royle	Oleaceae	Tree	Perennial	Phanerophyte	
143	*Onopordum acanthium* L.	Asteraceae	Herb	Annual	Therophyte	Zehech
144	*Otostegia limbata* (Benth.) Boiss.	Lamiaceae	Shrub	Perennial	Phanerophyte	
145	*Oxalis corniculata* L.	Oxalidaceae	Herb	Perennial	Hemicryptophyte	Chukoo
146	*Parthenium hytserophorus* L.	Asteraceae	Herb	annual	Therophyte	
147	*Paspalidium flavidum* (Retz.) A. Camus	Poaceae	Grass	Perennial	Hemicryptophyte	
148	*Paspalum paspalodes* (Michx.) Scribner	Poaceae	Grass	Annual	Therophyte	
149	*Pennesitum orientale* L.	Poaceae	Grass	Perennial	Hemicryptophyte	
150	*Periploca aphylla* Decne.	Asclepiadaceae	Shrub	Perennial	Phanerophyte	Sui
151	*Persicaria barbata* (L.) Hara	Polygonaceae	Herb	Perennial	Cryptophyte	Danduni
152	*Phalaris minor* Retz.	Poaceae	Grass	Annual	Therophyte	
153	*Phragmites australis* (Cav.) Trin.ex Steud.	Poaceae	Shrub	Perennial	Hemicryptophyte	Nai
154	*Phyla nodiflora* (L.) Greene	Verbenaceae	Herb	Biennial	Phanerophyte	
155	*Physalis peruviana* L.	Solanaceae	Herb	Annual	Therophyte	Manakach
156	*Pinus gerardiana* Wall. non Lamb.	Pinaceae	Tree	Perennial	Phanerophyte	Thulesh
157	*Pinus roxburghii* Sargent	Pinaceae	Tree	Perennial	Phanerophyte	Chugi
158	*Pinus wallichiana* A.B. Jackson	Pinaceae	Tree	Perennial	Phanerophyte	Chhar
159	*Pistacia chinensis* Bunge	Anacardiaceae	Tree	Perennial	Phanerophyte	Kangar
160	*Plantago aitchisonii* Pilger	Plantginaceae	Herb	Annual	Therophyte	Shileet
161	*Plantago lanceolata* L.	Plantginaceae	Herb	Annual	Therophyte	Shileet
162	*Plantago ovata* Frossk.	Plantginaceae	Herb	Annual	Therophyte	Shileet
163	*Plectranthus rugosus* Wall. ex Bth.	Lamiaceae	Herb	Annual	Therophyte	Salal
164	*Poa annua* L.	Poaceae	Herb	Annual	Therophyte	
165	*Polygonum affine* D. Don	Polygonaceae	Herb	Annual	Hemicryptophyte	Banke
166	*Polygonum effusum* Meirsn.	Polygonaceae	Herb	Annual	Hemicryptophyte	Banke
167	*Bistorta capitata*	Polygonaceae	Herb	Annual	Hemicryptophyte	Mana kash
168	*Polypogon fugax* Nees ex	Poaceae	Herb	Annual	Therophyte	

No.	Plant Species	Family	Habit	Life span	Life form	Local name
	Steud.					
169	*Polypogon monspeliensis* (L.) Desf.	Poaceae	Herb	Annual	Therophyte	
170	*Populus deltoides* Bartram ex Marsh.	Salicaceae	Tree	Perennial	Phanerophyte	Sufaida
171	*Portulaca oleracea* L.	Portulacaceae	Herb	Annual	Therophyte	Pishil
172	*Prunus amygdalus* Batsch	Rosaceae	Tree	Perennial	Phanerophyte	
173	*Prunus armeniaca* L.	Rosaceae	Tree	Perennial	Phanerophyte	Ashae
174	*Prunus domestica* L.	Rosaceae	Tree	Perennial	Phanerophyte	Aroo
175	*Pteridium aquilinum* (L.) Kuhn.	Pteridaceae	Herb	Perennial	Hemicryptophyte	
176	*Pteris crerica* L.	Pteridaceae	Herb	Perennial	Hemicryptophyte	Kuenz
177	*Pteris vittata* L.	Pteridaceae	Herb	Perennial	Hemicryptophyte	Kuenz
178	*Punica granatum* L.	Punicaceae	Shrub	Perennial	Phanerophyte	Dangoo
179	*Pyrus communis* L.	Rosaceae	Tree	Perennial	Phanerophyte	Taango
180	*Pyrus mallus* L.	Rosaceae	Tree	Perennial	Phanerophyte	Bhaap
181	*Quercus baloot* Griffith	Fagaceae	Tree	Perennial	Phanerophyte	Bani/Jaand
182	*Quercus dilatata* Lindl. ex Royle	Fagaceae	Tree	Perennial	Phanerophyte	Kagani/Zharyun
183	*Rananculus scleratus* L.	Rananculaceae	Herb	Annual	Therophyte	
184	*Rhus mysurensis* Heyne ex Wight & Arn.	Anacardiaceae	Tree	Perennial	Phanerophyte	Kasudur
185	*Ribes alpestre* Dcne. ex Jacq.	Rosaceae	Shrub	Perennial	Phanerophyte	Shigay
186	*Ricinis communis* L.	Euphorbiaceae	Shrub	Perennial	Phanerophyte	
187	*Robinia pseudoacacia* L.	Fabaceae	Tree	Perennial	Phanerophyte	
188	*Rubus ellipticus* Smith	Rubiaceae	shrub	Perennial	Phanerophyte	Gorash
189	*Rumex dentatus* L.	Polygonaceae	Herb	Perennial	Chamaephyte	
190	*Rumex hastatus* D. Don	Polygonaceae	Subshrub	Perennial	Phanerophyte	
191	*Rumex nepalensis* Spreng	Polygonaceae	Herb	Perennial	Chamaephyte	Hababil
192	*Saccharum ravennae* (L.) Murray	Poaceae	Grass	Perennial	Hemicryptophyte	Swar phuroo
193	*Salix acmophylla* Boiss.	Salicaceae	Tree	Perennial	Phanerophyte	Chhubi
194	*Salvia moorcroftiana* Wall. ex Bth.	Lamiaceae	Herb	Annual	Cryptophyte	
195	*Saussurea albescens* (DC.) Schr. Bip.	Asteraceae	Herb	Annual	Therophyte	
196	*Saussurea atkinsonii* Clarke	Asteraceae	Herb	Annual	Therophyte	
197	*Saussurea heteromalla* DC.	Asteraceae	Herb	Annual	Therophyte	
198	*Scorzonera virgata* DC.	Asteraceae	Herb	Annual	Therophyte	
199	*Setaria glauca* (L.) P. Beauv	Poaceae	Grass	Annual	Therophyte	
200	*Setaria viridis* (L.). P. Beauv.	Poaceae	Grass	Annual	Therophyte	Pashtili
201	*Silene conoidea* L.	Caryophyllaceae	Herb	Annual	Therophyte	
202	*Solanum nigrum* L.	Solanaceae	Herb	annual	Therophyte	
203	*Solanum surattense* Burm.f.	Solanaceae	Herb	Perennial	Phanerophyte	Shuroo gae/mano gae
204	*Solanum villosum* (L.) Moench	Solanaceae	Herb	Annual	Therophyte	

No.	Plant Species	Family	Habit	Life span	Life form	Local name
205	*Sonchus arvensis* f. brachyotus (DC.) Kirp.	Asteraceae	Herb	Annual	Therophyte	
206	*Sonchus asper* (L.) Hill.	Asteraceae	Herb	Annual	Therophyte	
207	*Sonchus oleraceus* L.	Asteraceae	Herb	Annual	Therophyte	Chuloor
208	*Sorghum halepense* (L.) Bern.	Poaceae	Herb	Perennial	Therophyte	
209	*Stellaria media* (L.) Cyr.	Caryophyllaceae	Herb	Annual	Therophyte	
210	*Tagetes minuta* L.	Asteraceae	Herb	Annual	Therophyte	
211	*Tamarix aphylla* (L.) Karst.	Tamaricaceae	Tree	Perennial	Phanerophyte	
212	*Taraxacum officinale* Weber.	Asteraceae	Herb	Perennial	Chamaephyte	Palor
213	*Taraxcum wallichii* DC.	Asteraceae	Herb	Perennial	Chamaephyte	
214	*Themeda anathera* (Nees) Hack.	Poaceae	Herb	Perennial	Hemicryptophyte	Furun
215	*Thymus serphyllum*	Lamiaceae	Herb	Annual	Chamaephyte	Isperki
216	*Tragus biflorus* Schult.	Poaceae	Grass	Annual	Therophyte	
217	*Tribulus longipetalus* Viv.	Zygophyllaceae	Herb	Annual	Therophyte	Shiwo kuroo
218	*Tribulus terrestris* L.	Zygophyllaceae	Herb	Annual	Therophyte	Shiwo kuroo
219	*Trifolium repens* L.	Fabaceae	Herb	Perennial	Hemicryptophyte	
220	*Urtica dioica* L.	Urticaceae	Subshrub	Annual	Therophyte	Jomi
221	*Valeriana stracheyi*	Valerianaceae	Herb	Annual	Therophyte	Koindaru
222	*Valeriana wallichii* DC.	Valerianaceae	Herb	Annual	Therophyte	
223	*Verbascum thapsus* L.	Scrophulariaceae	Herb	Biennial	Therophyte	Khardak/Kheros
224	*Verbena officinalis* L.	Verbenaceae	Herb	Annual	Cryptophyte	Chiroo
225	*Veronica beccabunga* L.	Scrophulariaceae	Herb	Annual	Therophyte	
226	*Vitex negundo* L.	Verbenaceae	Shrub	Perennial	Phanerophyte	
227	Vitis himalyana	Vitaceae	Climber	Perennial	Phanerophyte	Kuchar jachh
228	*Vitis jaquemontii* Parker	Vitaceae	Climber	Perennial	Phanerophyte	Magrath
229	*Vitis vinifera* L.	Vitaceae	Climber	Perennial	Phanerophyte	Jach
230	*Withania coagulens* Dunal	Solanaceae	Subshrub	Perennial	Phanerophyte	
231	*Xanthium strumarium* L.	Asteraceae	Herb	Annual	Phanerophyte	Kundi
232	*Zizyphus sativa* Gaertn	Rhamnaceae	Shrub	Perennial	Phanerophyte	Sizin/Sigiun

The List of Important Mammals from Kohistan area

	Common Name	Scientific name	Family	Status	Remarks
1.	Asiatic jackal	*Canis aureus*	Canidae	NT	Pellet Laachi Nallah, Melar
2.	Indian wolf	*Canis lupus*	Canidae	EN	Reported by locals from Laachi nullah and Kandian Valley
3.	Hill or Kashmir fox	*Vulpes velpes griffithi*	Canidae	NT	Pellet near Melar Village, reported by locals from Kandian valley, Laachi Sazin kot area
4.	Common Leopard	*Panthera pardus*	Felidae	CR	Reported rarely by locals of Kandian, Laachi
5.	Leopard cat	*Prionilurus*	Felidae	DD	Preserved skin at house-Laachi Nallah

	Common Name	Scientific name	Family	Status	Remarks
		bengalensis			
6.	Caracal	*Felis caracal*	Felidae	CR	Crossed KKh near Kandian suspended bridge in evening time; also reported by locals of Kandian valley
7.	Asiatic Black bear	*Ursus thibetanus*	Ursidae	V	Reported from higher elevation of Laachi, Kandian, Sazin and Chochung area
8.	Himalayan musk deer	*Moschus chrysogaster*	Moschidae	EN	Youngone captured from Pallas by local of Dasu and sold for Pak Rs. 15000. Also reported from higher valleys of Kandian, Laachi and Palas valley
9.	Markhor	*Capra falconeri cashmiriensis*	Bovidae	EN	Stuffed specimens at Laachi nullah, Sazin kot, Kandian valley-Aliel village. Summara Nallah police check post-hunted one female; reported from Kaigah, Laachi, Sazin and Kandian Valley
10.	Rhesus macaque	*Macaca mulatta*	Cercopithei dae	NT	Reported by locals from Laachi nullah, Kandian, Sazin kot, Chochung, Jalkot areas at higher elevation

NT=Near threatened; EN=Endangered; CR=Critically Endangered; V=Vulnerable; DD=Data deficient (status described by IUCN-Pakistan, 2005)

Birds Reported From the Study Kohistan Area

Non-passerines Birds Recorded from Kohistan Area

S/No	Common Name	Scientific Name	Family	Status
1.	Great or Eurasian Cormorant **	*Phalacrocorax carbo sinensis*	Phalacrocoracidae	A
2.	Chukar *	*Alectoris chukar*	Phasianidae	C
3.	Grey Partridge/Francolin*	*Francolinus pondicerianus*	Phasianidae	C
4.	Himalayan Monal*	*Lophophorus impejanus*	Phasianidae	R
5.	Western Tragopan*	*Tragopan melanocephalus*	Phasianidae	V
6.	Marsh harrier**	*Circus aeruginosus*	Accipitridae	C
7.	Black kite*	*Milvus migrans*	Accipitridae	A
8.	Shikra *	*Accipiter badius*	Accipitridae	F
9.	Common Kestrel*	*Falco tinnunculus*	Falconidae	C
10.	Water rail**	*Rallus aquaticus*	Rallidae	F
11.	Red-wattled lapwing*	*Vanellus indicus*	Charadriidae	A
12.	Common sandpiper***	*Actitis hypoleucos*	Tringinae	C
13.	Blue rock pigeon*	*Columba livia*	Columbidae	A
14.	Indian ring dove*	*Streptopelia decaocto*	Columbidae	A
15.	Oriental turtle dove*	*Streptopelia orientalis*	Columbidae	C

S/No	Common Name	Scientific Name	Family	Status
16.	Little brown dove*	*Streptopelia senegalensis*	Columbidae	A
17.	Spotted dove***	*Streptopelia chinensis*	Columbidae	C
18.	Northern eagle owl*	*Bubo bubo*	Strigidae	F
19.	Common kingfisher*	*Alcedo atthis*	Apodidae	F
20.	Indian roller*	*Coracias benghalensis*	Meropidae	C
21.	Hoopoe*	*Upupa epops*	Upupidae	C
22.	Asian Koel***l	*Eudynamys scolopacea*	Cuculidae	C

*Resident; **Passage migrant; ***Summer breeder/wintering; A=Abundant; C=Common; F=Frequent; S=Scarce; V=Vulnerable; R=Rare (status described by Roberts, 1991, 1992)

Passerines Birds Recorded from Kohistan area

S/No	Common Name	Scientific name	Family	Status
1.	Crested lark*	*Galerida cristate*	Alaudidae	A
2.	Yellow wagtail**	*Motacilla flava*	Motacillidae	C
3.	Grey wagtail***	*Motacilla cinera*	Motacillidae	C
4.	White/pied wagtail***	*Motacilla alba*	Motacillidae	A
5.	Large wagtail*	*Motacilla maderaspatensis*	Motacillidae	C
6.	White-cheeked bulbul*	*Pycnonotus leucogenys*	Pycnonotidae	A
7.	Brown dipper*	*Cinclus pallasii*	Cinclidae	C
8.	Blue throat**/***	*Luscinia svecia*	Turdidae	F
9.	Indian blue robin**/***	*Luscinia brunnea*	Turdidae	C
10.	Blue-headed redstart***	*Phoenicurus caeruleocephalus*	Turdidae	C
11.	Black redstart***	*Phoenicurus ochruros*	Turdidae	C
12.	White-bellied Redstart*	*Hodgsonius phoenicuroides*	Turdidae	S
13.	Plumbeous water Redstart***	*Rhyacornis fuliginosus*	Turdidae	C
14.	Common Stonechat**/***	*Saxicola torquate*	Turdidae	C
15.	Pied Bushchat*	*Saxicola caprata*	Turdidae	C
16.	Rufous-tailed Rock Thrush**	*Monticola saxatilis*	Turdidae	R
17.	Blue whistling thrush***	*Myiophoneus cacruleus*	Turdidae	C
18.	Eurasian blackbird*	*Turdus merula*	Turdidae	F
19.	Grey-hooded flycatcher***	*Seicercus xanthoschistos*	Sylviidae	C
20.	White-cheeked nuthatch*	*Sitta leucopsis*	Sittidae	C
21.	Eurasian nuthatch***	*Sitta europaea*	Sittidae	F
22.	Isabelline shrike ***	*Lanius isbellinus*	Laniidae	F
23.	Bay-backed shrike*	*Lanius vittatus*	Laniidae	C
24.	Jungle crow*	*Corvus macrorhynchos*	Corvidae	C

S/No	Common Name	Scientific name	Family	Status
25.	House crow*	*Corvus splendens*	Corvidae	A
26.	Common Raven*	*Corvus corax*	Corvidae	F
27.	Lanceolated/Black-headed Jay*	*Garrulus lanceolatus*	Corvidae	F
28.	Yellow-billed Chough*	*Phyrhocorax phyrhocorax*	Corvidae	A
29.	Common myna*	*Acridotheres tristis*	Sturnidae	A
30.	Jungle myna*	*Acridotheres fuscus*	Sturnidae	F
31.	House sparrow *	*Passer domesticus*	Passeridae	A
32.	Red-fronted serin*	*Serinus pusillus*	Carduelinae	A
33.	Rock bunting ***	*Emberiza cia*	Emberizinae	C
34.	Grey necked bunting***	*Emberiza buchanani*	Emberizinae	S
35.	Black Drongo*	*Dicrurus macrocercus*	Dicruridae	A
36.	Great Tit*	*Parus major*	Paridae	C

*Resident; **Passage migrant; ***Summer breeder/wintering; A=Abundant; C=Common; F=Frequent; S=Scarce; V=Vulnerable; R=Rare (status described by Roberts, 1991, 1992)

Aquatic/ Wetland Birds in Kohistan Area[4]

Sr./No	Common Name	Scientific name	Family
1.	Great or Eurasian Cormorant	*Phalacrocorax carbo sinensis*	Phalacrocora-cidae
2.	Water rail	*Rallus aquaticus*	Rallidae
3.	Red-wattled lapwing	*Vanellus indicus*	Charadriidae
4.	Common sandpiper	*Actitis hypoleucos*	Tringinae
5.	Common kingfisher	*Alcedo atthis*	Alcedinidae
6.	White-breasted kingfisher	*Halcyon smyrnesis*	Alcedinidae
7.	Marsh harrier	*Circus aeruginosus*	Accipitridae
8.	Yellow wagtail	*Motacilla flava*	Motacillidae
9.	Grey wagtail	*Motacilla cinera*	Motacillidae
10.	White/pied wagtail	*Motacilla alba*	Motacillidae
11.	Large wagtail	*Motacilla maderaspatensis*	Motacillidae
12.	Brown dipper	*Cinclus pallasii*	Cinclidae
13.	Black redstart	*Phoenicurus ochruros*	Turdidae
14.	White-bellied Redstart	*Hodgsonius phoenicuroides*	Turdidae
15.	Plumbeous water Redstart	*Rhyacornis fuliginosus*	Turdidae
16.	Grey Heron	*Ardea Cinerea*	Ardeidae
17.	Grelag Goose	*Anser anser*	Anatidae

[4] Note:
1-Species listed from 1-15 were recorded during field surveys conducted in July-September 2012
2-Analysis is completed for other potential wetland birds that are already reported to visiting/ staging/ migrating in this area and or they will likely be attracted to the large water body after the construction of the reservoir.
3- It is anticipated that this list will continue to grow as information and data becomes available.

Sr./No	**Common Name**	**Scientific name**	**Family**
18.	Ruddy shelduck	*Tadorna ferruginea*	Anatidae
19.	Wigeon	*Anas penelope*	Anatidae
20.	Gadwall	*Anas strepera*	Anatidae
21.	Common teal	*Anas crecca*	Anatidae
22.	Mallard	*Anas platyrynchos*	Anatidae
23.	Ferruginous duck	*Aythya nyroca*	Anatidae
24.	Pintail	*Anas acuta*	Anatidae
25.	Shoveler	*Anas clypeata*	Anatidae
26.	Common Pochard	*Aythya ferina*	Anatidae
27.	Tufted duck	*Aythya fuligula*	Anatidae
28.	Common crane	*Grus grus*	Gruidae
29.	Demoiselle crane	*Anthropoides virgo*	Gruidae
30.	Pheasant-tailed Jacana	*Hydrophasianus chirugus*	Jacanidae
31.	Curlew sandpiper	*Calidris ferruginea*	Scolopacidae
32.	Ruff	*Philomachus pugnax*	Scolopacidae
33.	Common snipe	*Gallinago gallinago*	Gallinagininae
34.	Red shank	*Tringa tetanus*	Tringinae
35.	Green shank	*Tringa nebularia*	Tringinae
36.	Marsh sandpiper	*Tringa stagnatilis*	Tringinae
37.	Common sandpiper	*Actitia hypoleucos*	Tringinae
38.	Caspian tern	*Sterna caspica*	Sternidae
39.	Water pipit	*Anthua spinoletta*	Motacillidae

Amphibian And Reptiles Reported From Kohistan Area

Sr. No.	Scientific Name	Common Name	Family	Status
1	*Bufo stomaticus*	Indus Toad	BUFONIDAE	LC
2	*Bufo viridis*	Green Toad	-do--	C
3	*Paa hazarensis/ Sternosignata*	Mountain Frog	RANIDAE	LC
4	*Agama tuberculata*	Kashmir Rock Agama	AGAMIDAE	NE
5	*Agama agrorensis*	Agrore Valley Agama	-do-	NE
6	*Hemidactylus flaviviridis*	Yellow-bellied House Gecko	Gekkonidae	NE
7	*Gymnodactylus stoliczkai*	Karakoram Rock Gecko	Gekkonidae	NE
8	*Ophisops jerdonii*	Punjab/Jerdon Snake-eyed Lizard	Lacertidae	NE
9	*Eumeces taeniolatus*	Yellow-bellied Mole Skink	SCINCIDAE	NE
10	*Liolopsima himalayanum*	Himalayan Ground Skink	-do-	NE
11	*Riopa punctata*	Dotted Garden Skink	-do-	NE
12	*Coluber rhodorachis*	Cliff Racer	COLUBRIDAE	NE

13	*Coluber ravergieri*	Mountain Racer	-do--	NE
14	*Naja oxiana*	Oxus Cobra	ELAPIDAE	NE
15	*Agkistrodon himalayanus*	Himalayan Pit Viper	VIPERIDAE	NE
16	*Sphalerosophis diademea*	Diadem Snake	Colubridae	NE
17	*Ptyas mucosus*	Dhaman	–do-	NE
18	*Eirenis persicus*	Dark-headed Dwarf Racer	–do-	NE

LC=Least concern; C=Common; NE=Not evaluated ; Source: Palas Conservation Project.

Annex C: Environmental Code of Practices

Introduction

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

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

- ECP 1: Waste Management
- ECP 2: Fuels and Hazardous Goods Management
- ECP 3: Water Resources Management
- ECP 4: Drainage Management
- ECP 5: Soil Quality Management
- ECP 6: Erosion and Sediment Control
- ECP 7: Top Soil Management
- ECP 8: Topography and Landscaping
- ECP 9: Quarry Areas Development & Operation
- ECP 10: Air Quality Management
- ECP 11: Noise and Vibration Management
- ECP 12: Protection of Flora
- ECP 13: Protection of Fauna
- ECP 14: Protection of Fisheries
- ECP 15: Road Transport and Road Traffic Management
- ECP 16: Construction Camp Management
- ECP 17: Cultural and Religious Issues
- ECP 18: Workers Health and Safety

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

ECP 1: Waste Management

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

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Store, transport and handle all chemicals avoiding potential environmental pollution. • Store all hazardous wastes appropriately in bunded areas away from water courses. • Make available Material Safety Data Sheets (MSDS) for hazardous materials on-site during construction. • Collect hydrocarbon wastes, including lube oils, for safe transport off-site for reuse, recycling, treatment or disposal at approved locations. • Construct concrete or other impermeable flooring to prevent seepage in case of spills.

ECP 2: Fuels and Hazardous Goods Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Fuels and hazardous goods.	Materials used in construction have a potential to be a source of contamination. Improper storage and handling of fuels, lubricants, chemicals and hazardous goods/materials on-site, and potential spills from these goods may harm the environment or health of construction workers.	The Contractor shall • Prepare spill control procedures and submit the plan for supervision consultant approval. • Train the relevant construction personnel in handling of fuels and spill control procedures. • Store dangerous goods in bunded areas on top of a sealed plastic sheet away from watercourses. • Refueling shall occur only within bunded areas. • Store and use fuels in accordance with material safety data sheets (MSDS). Make available MSDS for chemicals and dangerous goods on-site. • Transport waste of dangerous goods, which cannot be recycled, to a designated disposal site. • Provide absorbent and containment material (e.g., absorbent matting)

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		where hazardous material are used and stored; and ensure personnel trained in the correct use. • Provide protective clothing, safety boots, helmets, masks, gloves, goggles, to the construction personnel, appropriate to materials in use. • Make sure all containers, drums, and tanks that are used for storage are in good condition and are labeled with expiry date. Any container, drum, or tank that is dented, cracked, or rusted might eventually leak. Check for leakage regularly to identify potential problems before they occur. • Store and use fuels in accordance with material safety data sheets (MSDSs). • Store all liquid fuels in fully bunded storage containers, with appropriate volumes, a roof, a collection point and appropriate filling/decanting point. • Store hazardous materials above flood level considered for construction purposes • Put containers and drums in temporary storages in clearly marked areas, where they will not be run over by vehicles or heavy machinery. The area shall preferably slope or drain to a safe collection area in the event of a spill. • Take all precautionary measures when handling and storing fuels and lubricants, avoiding environmental pollution. • Avoid the use of material with greater potential for contamination by substituting them with more environmentally friendly materials.

ECP 3: Water Resources Management

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

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

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Drinking water	Untreated surface water is not suitable for drinking purposes due to presence of suspended solids and ecoli.	The Contractor Shall • Provide the drinking water that meets NEQS standards. Drinking water to be chlorinated at source, and ensure presence of residual chlorine 0.1 ~ 0.25 ppm as minimum after 30 minutes of chlorine contact time.

ECP 4: Drainage Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Excavation and earth works, and construction yards	Lack of proper drainage for rainwater/liquid waste or wastewater owing to the construction activities harms environment in terms of water and soil contamination, and mosquito growth.	The Contractor shall • Prepare a drainage management plan and submit the plan for supervision consultant approval. • Prepare a program to prevent/avoid standing waters, which supervision consultant will verify in advance and confirm during implementation. • Provide alternative drainage for rainwater if the construction works/earth-fillings cut the established drainage line. • Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there. • Rehabilitate road drainage structures immediately if damaged by contractors' road transports. • Build new drainage lines as appropriate and required for wastewater from construction yards connecting to the available nearby recipient water bodies. Ensure wastewater quality conforms to NEQS, before it is being discharged into the recipient water bodies.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Ensure that there will be no water stagnation at the construction sites and camps. • Provide appropriate silt collector and silt screen at the inlet and manholes and periodically clean the drainage system to avoid drainage congestion. • Protect natural slopes of drainage channels to ensure adequate storm water drains. • Regularly inspect and maintain all drainage channels to assess and alleviate any drainage congestion problem.
Ponding of water	Health hazards due to mosquito breeding	• Do not allow ponding of water especially near the waste storage areas and construction camps. • Discard all the storage containers that are capable of storing of water, after use or store them in inverted position.

ECP 5: Soil Quality Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Storage of hazardous and toxic chemicals	Spillage of hazardous and toxic chemicals will contaminate the soils	The Contractor shall • Strictly manage the wastes management plans proposed in ECP1 and storage of materials in ECP2. • Construct appropriate spill contaminant facilities for all fuel storage areas. • Establish and maintain a hazardous material register detailing the location and quantities of hazardous substances including the storage, and their disposals. • Train personnel and implement safe work practices for minimizing the risk of spillage. • Identify the cause of contamination, if it is reported, and contain the area of contamination. The impact may be contained by isolating the source or implementing controls around the affected site.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Remediate the contaminated land using the most appropriate available method.
Construction material stock piles	Erosion from construction material stockpiles may contaminate the soils	The Contractor shall • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds.

ECP 6: Erosion and Sediment Control

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

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

ECP 7: Top Soil Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Land clearing and earth works	Earthworks will impact the fertile top soils that are enriched with nutrients required for plant growth or agricultural development.	The Contractor shall • Strip the top soil to a depth of 15 cm and store in stock piles of height not exceeding 2m. • Remove unwanted materials from top soil like grass, roots of trees and similar others.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• The stockpiles will be done in slopes of 2:1 to reduce surface runoff and enhance percolation through the mass of stored soil. • Locate topsoil stockpiles in areas outside drainage lines and protect from erosion. • Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil. • Spread the topsoil to maintain the physico-chemical and biological activity of the soil. The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites. • Prior to the re-spreading of topsoil, the ground surface will be ripped to assist the bunding of the soil layers, water penetration and revegetation
Transport	Vehicular movement outside ROW or temporary access roads will affect the soil fertility of the agricultural lands	• Limit equipment and vehicular movements to within the approved construction zone. • Plan construction access to make use, if possible, of the final road alignment.

ECP 8: Topography and Landscaping

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Land clearing and earth works	Construction activities especially earthworks will change topography and disturb the natural rainwater/flood water drainage as well as will change the local landscape.	The Contractor shall • Prepare land scaping and restoration plan and submit the plan for supervision consultant approval. • Ensure the topography of the final surface of all raised lands (construction yards, approach roads and rails, access roads, etc.) are conducive to enhance natural draining of rainwater/flood water.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Keep the final or finished surface of all the raised lands free from any kind of depression that causes water logging. • Undertake mitigation measures for erosion control/prevention by grass-turfing and tree plantation, where there is a possibility of rain-cut that will change the shape of topography. • Cover immediately the uncovered open surface that has no use of construction activities with grass-cover and tree plantation to prevent soil erosion and bring improved landscaping. • Reinstate the natural landscape of the ancillary construction sites after completion of works.

ECP 9: Quarry Areas Development & Operation

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

ECP 10: Air Quality Management

Project Activity/ Impact Source	**Environmental Impacts**	**Mitigation Measures/ Management Guidelines**
Construction vehicular traffic	Air quality can be adversely affected by vehicle exhaust emissions and combustion of fuels.	The Contractor shall • Prepare air quality management plan and submit the plan for supervision consultant approval.

Project Activity/ Impact Source	**Environmental Impacts**	**Mitigation Measures/ Management Guidelines**
		• Fit vehicles with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition. • Operate the vehicles in a fuel efficient manner. • Cover hauls vehicles carrying dusty materials moving outside the construction site. • Impose speed limits on all vehicle movement at the worksite to reduce dust emissions. • Control the movement of construction traffic. • Water construction materials prior to loading and transport. • Service all vehicles regularly to minimize emissions. • Limit the idling time of vehicles not more than 2 minutes.
Construction machinery	Air quality can be adversely affected by emissions from machinery and combustion of fuels.	The Contractor shall • Fit machinery with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition in accordance with the specifications defined by their manufacturers to maximize combustion efficiency and minimize the contaminant emissions. Proof or maintenance register shall be required by the equipment suppliers and contractors/subcontractors. • Focus special attention on containing the emissions from generators. • Machinery causing excess pollution (e.g. visible smoke) will be banned from construction sites. • Service all equipment regularly to minimize emissions. • Provide filtering systems, duct collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all its stages, including unloading, collection, aggregate handling, cement dumping, circulation of trucks and machinery inside the installations.
Construction	Dust generation from	The Contractor shall

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
activities	construction sites, material stockpiles and access roads is a nuisance in the environment and can be a health hazard, and also can affect the local crops;	• Water the material stockpiles, access roads and bare soils on an as required basis to minimize the potential for environmental nuisance due to dust. Increase the watering frequency during periods of high risk (e.g. high winds). Stored materials such as gravel and sand shall be covered and confined to avoid their being wind-drifted. • Minimize the extent and period of exposure of the bare surfaces. • Restore disturbed areas as soon as practicable by vegetation/grass-turfing. • Store the cement in silos and minimize the emissions from silos by equipping them with filters. • Establish adequate locations for storage, mixing and loading of construction materials, in a way that dust dispersion is prevented because of such operations. • Not water as dust suppression on potentially contaminated areas so that a liquid waste stream will be generated. • Crushing of rocky and aggregate materials shall be wet-crushed, or performed with particle emission control systems. • Not permit the burning of solid waste.

ECP 11: Noise and Vibration Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Noise quality will be deteriorated due to vehicular traffic	The Contractor shall • Prepare a noise and vibration management plan and submit the plan for supervision consultant approval. • Maintain all vehicles in order to keep it in good working order in accordance with manufactures maintenance procedures. • Make sure all drivers will comply with the traffic codes concerning maximum speed limit, driving hours, etc. • Organize the loading and unloading of

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		trucks, and handling operations for the purpose of minimizing construction noise on the work site.
Construction machinery	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Appropriately site all noise generating activities to avoid noise pollution to local residents. • Use the quietest available plant and equipment. • Maintain all equipment in order to keep it in good working order in accordance with manufactures maintenance procedures. Equipment suppliers and contractors shall present proof of maintenance register of their equipment. • Install acoustic enclosures around generators to reduce noise levels. • Fit high efficiency mufflers to appropriate construction equipment. • Avoid the unnecessary use of alarms, horns and sirens.
Construction activity	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Notify adjacent landholders prior any typical noise events outside of daylight hours. • Educate the operators of construction equipment on potential noise problems and the techniques to minimize noise emissions. • Employ best available work practices on-site to minimize occupational noise levels. • Install temporary noise control barriers where appropriate. • Notify affected people if major noisy activities will be undertaken, e.g. blasting. • Plan activities on site and deliveries to and from site to minimize impact. • Monitor and analyze noise and vibration results and adjust construction practices as required. • Avoid undertaking the noisiest activities, where possible, when working at night near the residential areas.

ECP 12: Protection of Flora

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

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

ECP 13: Protection of Fauna

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities	The location of construction activities can result in the loss of wild life habitat and habitat quality,	The Contractor shall • Prepare a plan for ptotection of fauna and submit the plan for supervision consultant approval. • Limit the construction works within the designated sites allocated to the contractors. • check the site for animals trapped in, or in danger from site works and use a qualified person to relocate the animal.
	Impact on migratory birds, its habitat and its active nests	The Contractor shall • Not be permitted to destruct active nests or eggs of migratory birds. • Minimize the tree removal during the bird breeding season. If works must be continued during the bird breeding season, a nest survey will be conducted by a qualified biologist prior to commence of works to identify and locate active nests.

Project Activity/ Impact Source	**Environmental Impacts**	**Mitigation Measures/ Management Guidelines**
		• If bird nests are located/ detected within the ledges and roadside embankments then those areas should be avoided. • Petroleum products should not come in contact with the natural and sensitive ecosystems. Contractor must minimize the release of oil, oil wastes or any other substances harmful to migratory birds' habitats, to any waters, wetlands or any areas frequented by migratory birds.
Vegetation clearance	Clearance of vegetation may impact shelter, feeding and/or breeding and/or physical destruction and severing of habitat areas	The Contractor shall • Restrict the tree removal to the minimum numbers required. • Relocate hollows, where appropriate. • Fell the hollow bearing trees in a manner which reduces the potential for fauna mortality. Felled trees will be inspected after felling for fauna and if identified and readily accessible will be removed and relocated or rendered assistance if injured. After felling, hollow bearing trees will remain unmoved overnight to allow animals to move of their own volition.
Night time lighting	Lighting from construction sites and construction camps may affect the visibility of night time migratory birds that use the moon and stars for navigation during their migrations.	The Contractor shall • Use lower wattage flat lens fixtures that direct light down and reduce glare, thus reducing light pollution, • Avoid flood lights unless they are absolutely required. • Use motion sensitive lighting to minimize unneeded lighting. • Use, if possible, green lights that are considered as bird's friendly lighting instead of white or red colored lights. • Install light shades or plan the direction of lights to reduce light spilling outside the construction area.
Construction camps	Illegal poaching	The Contractor shall • Provide adequate knowledge to the workers regarding protection of flora and fauna, and relevant government regulations and punishments for illegal poaching.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Ensure that staff and Subcontractors are trained and empowered to identify, address and report potential environmental problems.

ECP 14: Protection of Fish

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities in River	The main potential impacts to fisheries are hydrocarbon spills and leaks from riverine transport and disposal of wastes into the river	The Contractor shall • Prepare a plan for ptotection of fish and submit the plan for supervision consultant approval. • Ensure the construction equipment used in the river are well maintained and do not have oil leakage to contaminate river water. • Contain oil immediately on river in case of accidental spillage from equipment; make an emergency oil spill containment plan to be supported with enough equipments, materials and human resources. • Do not dump wastes, be it hazardous or non-hazardous into the nearby water bodies or in the river.
Construction activities on the land	The main potential impacts to aquatic flora and fauna River are increased suspended solids from earthworks erosion, sanitary discharge from work camps, and hydrocarbon spills	The Contractor shall • follow mitigation measures proposed in ECP 3 : Water Resources Management and EC4: Drainage Management.

ECP 15: Road Transport and Road Traffic Management

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

ECP 16: Construction Camp Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines

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

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

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Fuel supplies for cooking purposes	Illegal sourcing of fuel wood by construction workers will impact the natural flora and fauna	The Contractor shall • Provide fuel to the construction camps for their domestic purpose, in order to discourage them to use fuel wood or other biomass. • Made available alternative fuels like natural gas or kerosene on ration to the workforce to prevent them using biomass for cooking. • Conduct awareness campaigns to educate workers on preserving the protecting the biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection.
Health and Hygiene	There will be a potential for diseases to be transmitted including malaria, exacerbated by inadequate health and safety practices. There will be an increased risk of work crews spreading sexually transmitted infections and HIV/AIDS.	The Contractor shall • Provide adequate health care facilities within construction sites. • Provide first aid facility round the clock. Maintain stock of medicines in the facility and appoint fulltime designated first aider or nurse. • Provide ambulance facility for the laborers during emergency to be transported to nearest hospitals. • Initial health screening of the laborers coming from outside areas. • Train all construction workers in basic

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		sanitation and health care issues and safety matters, and on the specific hazards of their work. • Provide HIV awareness programming, including STI (sexually transmitted infections) and HIV information, education and communication for all workers on regular basis. • Provide adequate drainage facilities throughout the camps to ensure that disease vectors such as stagnant water bodies and puddles do not form. Regular mosquito repellant sprays during rainy season in offices and construction camps and yards. • Not dispose food waste openly as that will attract rats and stray dogs. • Carryout short training sessions on best hygiene practices to be mandatorily participated by all workers. Place display boards at strategic locations within the camps containing messages on best hygienic practices.
Safety	In adequate safety facilities to the construction camps may create security problems and fire hazards	The Contractor shall • Provide appropriate security personnel (police or private security guards) and enclosures to prevent unauthorized entry in to the camp area. • Maintain register to keep a track on a head count of persons present in the camp at any given time. • Encourage use of flameproof material for the construction of labor housing / site office. Also, ensure that these houses/rooms are of sound construction and capable of withstanding wind storms/cyclones. • Provide appropriate type of fire fighting equipments suitable for the construction camps • Display emergency contact numbers clearly and prominently at strategic places in camps. • Communicate the roles and responsibilities of laborers in case of

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

ECP 17: Cultural and Religious Issues

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities near religious and cultural sites	Disturbance from construction works to the cultural and religious sites, and contractors lack of knowledge on cultural	The Contractor shall • Communicate to the public through community consultation regarding the scope and schedule of construction, as well as certain construction activities

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	issues cause social disturbances.	causing disruptions or access restriction. • Not block access to cultural and religious sites, wherever possible. • Restrict all construction activities within the foot prints of the construction sites. • Stop construction works that produce noise (particularly during prayer time) should there be any mosque/religious/educational institutions close to the construction sites and users make objections. • Take special care and use appropriate equipment when working next to a cultural/religious institution. • Stop work immediately and notify the site manager if, during construction, an archaeological or burial site is discovered. It is an offence to recommence work in the vicinity of the site until approval to continue is given. • Provide separate prayer facilities to the construction workers. • Show appropriate behavior with all construction workers especially women and elderly people. • Allow the workers to participate in praying during construction time. • Resolve cultural issues in consultation with local leaders and supervision consultants. • Establish a mechanism that allows local people to raise grievances arising from the construction process. • Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works so as to maintain effective surveillance over public health, social and security matters.

ECP 18: Worker Health and Safety

Project Activity/ Impact Source	**Environmental Impacts**	**Mitigation Measures/ Management Guidelines**
Best practices	Construction works may pose health and safety risks to the construction workers and site visitors leading to severe injuries and deaths. The population in the proximity of the construction site and the construction workers will be exposed to a number of (i) biophysical health risk factors, (e.g. noise, dust, chemicals, construction material, solid waste, waste water, vector transmitted diseases etc), (ii) risk factors resulting from human behavior (e.g. STD, HIV etc) and (iii) road accidents from construction traffic.	The Contractor shall • Prepare a Occupational Health and Safety plan and submit the plan for supervision consultant's approval. • Implement suitable safety standards for all workers and site visitors which should not be less than those laid down on the international standards (e.g. International Labor Office guideline on 'Safety and Health in Construction; World Bank Group's 'Environmental Health and Safety Guidelines') and contractor's own national standards or statutory regulations, in addition to complying with Pakistan standards. • Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas. • Provide personal protection equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full-face eye shields, and ear protection. Maintain the PPE properly by cleaning dirty ones and replacing them with the damaged ones. • Safety procedures include provision of information, training and protective clothing to workers involved in hazardous operations and proper performance of their job. • Appoint an environment, health and safety manager to look after the health and safety of the workers.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works and establishment of construction camps so as to maintain effective surveillance over public health, social and security matters.
	Child and pregnant labor	The Contractor shall • not hire children of less than 14 years of age and pregnant women or women who delivered a child within 8 preceding weeks.
Accidents	Lack of first aid facilities and health care facilities in the immediate vicinity will aggravate the health conditions of the victims	The Contractor shall • Ensure health care facilities and first aid facilities are readily available. Appropriately equipped first-aid stations should be easily accessible throughout the place of work. • Document and report occupational accidents, diseases, and incidents. • Prevent accidents, injury, and disease arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards, in a manner consistent with good international industry practice. • Identify potential hazards to workers, particularly those that may be life-threatening and provide necessary preventive and protective measures. • Provide awareness to the construction drivers to strictly follow the driving rules. • Provide adequate lighting in the construction area, inside the tunnels, inside the powerhouse cavern and along the roads.
Construction Camps	Lack of proper infrastructure facilities, such as housing, water	The Contractor shall provide the following facilities in the campsites to

Project Activity/ Impact Source	**Environmental Impacts**	**Mitigation Measures/ Management Guidelines**
	supply and sanitation facilities will increase pressure on the local services and generate substandard living standards and health hazards.	improve health and hygienic conditions as mentioned in ECP 16 Construction Camp Management • Adequate ventilation facilities • Safe and reliable water supply. • Hygienic sanitary facilities and sewerage system. • Treatment facilities for sewerage of toilet and domestic wastes • Storm water drainage facilities. • Recreational and social facilities • Safe storage facilities for petroleum and other chemicals in accordance with ECP 2 • Solid waste collection and disposal system in accordance with ECP1. • Arrangement for trainings • Paved internal roads. • Security fence at least 2 m height. • Sick bay and first aid facilities
Water and sanitation facilities at the construction sites	Lack of Water sanitation facilities at construction sites cause inconvenience to the construction workers and affect their personal hygiene.	The contractor shall • Provide portable toilets at the construction sites, if about 25 people are working the whole day for a month. Location of portable facilities should be at least 6 m away from storm drain system and surface waters. These portable toilets should be cleaned once a day and all the sewerage should be pumped from the collection tank once a day and should be brought to the common septic tank for further treatment. • Provide safe drinking water facilities to the construction workers at all the construction sites.
Other ECPs	Potential risks on health and hygiene of construction workers and general public	The Contractor shall follow the following ECPs to reduce health risks to the construction workers and nearby community

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• ECP 2: Fuels and Hazardous Goods Management • ECP 4: Drainage Management • ECP 10: Air Quality Management • ECP 11: Noise and Vibration Management • ECP 15: Road Transport and Road Traffic Management
Trainings	Lack of awareness and basic knowledge in health care among the construction workforce, make them susceptible to potential diseases.	The Contractor shall • Train all construction workers in basic sanitation and health care issues (e.g., how to avoid malaria and transmission of sexually transmitted infections (STI) HIV/AIDS. • Train all construction workers in general health and safety matters, and on the specific hazards of their work. Training should consist of basic hazard awareness, site specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate. • Implement malaria, HIV/AIDS and STI education campaign targeting all workers hired, international and national, female and male, skilled, semi- and unskilled occupations, at the time of recruitment and thereafter pursued throughout the construction phase on ongoing and regular basis. This should be complemented by easy access to condoms at the workplace as well as to voluntary counseling and testing.