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ABBREVIATIONS

ADB	Asian Development Bank
AKRSP	Agha Khan Rural Support Programme
BCM	Billion Cubic Meters
DAAM	Department of Archaeology and Museums, GoP
DBC	Diamer Basha Consultants
DBDP	Diamer Basha Dam Project
DDA	Diamer Development Authority
DRC	Dispute Resolution Committee
EIA	Environmental Impact Assessment
EMMC	Environmental Monitoring and Management Cell of WAPDA
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
FRL	Full Reservoir Level
HASH	Heidelberg Academy of Science and Humanities
IBIS	Indus Basin Irrigation System
IEE	Initial Environmental Examination
IPCC	International Panel for Carbon Control
IPoE	International Panel of Experts
IUCN	International Union for Conservation of Nature
IRSA	Indus River System Authority
kV	kilo Volt
masl	Meter above sea level
MOL	Minimum Operating Level
MW	Mega Watt
N(GB)A	Northern (Gilgit-Baltistan) Areas
NAPWD	Northern (Gilgit-Baltistan) Areas Public Works Department
NHA	National Highway Authority
NEAC	NESPAK – ACE Joint Venture Consultants
NWFP	North-West Frontier Province (Khyber Pakhtunkhwa)
NTDC	National Transmission and Despatch Company
PAPs	Project Affected Peoples
PEPA	Pakistan Environmental Protection Agency
PRO	Project Resettlement Organization, WAPDA
RAP	Resettlement Action Plan
RP	Resettlement Plan (the companion document of Land Acquisition, Resettlement and Development Plan)
RCC	Roller Compacted Concrete (dam)
Rs.	Pakistani Rupees
SCO	Special Communication Organization
SWHP	Surface Water Hydrology Project, WAPDA

ToR	Terms of Reference
WAA	Water Apportionment Accord
WAPDA	Water and Power Development Authority
WB	World Bank
WCD	World Commission on Dams
WWF	World Wildlife Fund for Nature

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- Mr. M. Saleem, Senior Sociologist (socio-economy, tribal affairs, etc.)
- Mr. Israr Ali Shah, Senior Engineer (hydrology and water quality), Water flow and quality
- Mrs. Syeda Zahra, Junior Research Officer (health and gender)
- Mr. Waheed-uz-Zaman, Resettlement Expert (resettlement, environment, etc.)
- Mr. Fakhr-e-Alam, Senior Research Officer (Environment), consultations of PAPs and field data collection
- Miss Naseema Bibi, Social Organizer (Field), health and gender including surveys

Besides members of DBC's Environmental Team the following specialists participated in the field works and also contributed to drafting of some specific sections reports (refer Volume III) for this EIA Report.

Special Report	Volume 3 of Report	Contributor
Vegetation Composition	C	Dr. Muhammad Arshad, Institute of Desert Studies, Bahawalpur University, Bahawalpur, Cholistan
Study of Insects in Project Area	D	Mr. Muhammad Abbas, Pakistan Museum of Natural History, Islamabad
Study of Amphibians and Reptiles in Project Area	E	i. Dr. Khalid Baig (deceased), Pakistan Museum of Natural History, Islamabad ii. Mr. Rafaqat Masroor, Pakistan Museum of Natural History, Islamabad
Study of Birds in Project Area	F	Dr. Aleem Chaudhry, Lahore
A Study of Fish and Fishery Aspects of Project Area	G	Prof. Dr. William George, F. C. College University, Lahore
General Characteristics of Agriculture in Project Area and Prospect for Improvements	B	Dr. Fateh Chaudhry, Lahore

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A EXECUTIVE SUMMARY

A.1 Introduction

This Environmental Impact Assessment (EIA) Report also includes the Environmental Management Plan (EMP) of Diamer Basha Dam Project (DBDP). It particularly embodies the environmental assessments made during the Engineering Design stage conducted over 2005-08. For this purpose, WAPDA engaged in August 2005 Diamer Basha Consultants (DBC), a joint venture of Pakistani consultancy firms of NDC, Barqaab, and PES under lead of Lahmeyer International GmbH (Germany). After conclusion of the basic assignment in June 2008, the services of DBC were extended by WAPDA till June 2010, for providing standing technical advice / assistance on project related matters including environment and resettlement and project appraisal by ADB initiated in March / April 20009.

The Environmental assessment was initially started by DBC in autumn 2005, based upon the following approach:

- Review of previous environmental studies on the project particularly as part of Feasibility Report (2004) completed by NEAC, a consortium of Pakistani firms, in August 2004.
- Scoping of overall environmental works, based upon the Terms of Reference (ToR) of DBC to confirm / establish the basic directions of assessment
- Conducting during 2006 to 2008, the baseline field works on physical environment including geology, land use, soils, water flow of nullahs and continuation of quarterly water quality measurements at eight sampling locations initiated by NEAC during 2002
- Conducting during 2006 to 2009, baseline field research of biological environment including plants, insects, amphibians, reptiles, birds, aquatic life and natural fish stocks
- Based on their field work, preparation of specialist reports on: plants, insects, amphibians, reptiles, birds, aquatic life and natural fish stocks by each specialist
- Conducting during 2006 to 2009, head-counting socio-economic baseline field works analysing population, tribal affairs, housing infrastructure, economy including agriculture, animal husbandry, forestry, fishery, water supply, occupations in other economic sectors, and social structures such as indigenous people, gender and community issues.
- Initiation of work for preparation of environmental related sector plans

This particular EIA Report is based on the format prescribed in the document of Asian Development Bank (ADB) dated June 2009 and titled ‘Safeguard Policy Statement’. It, inter-alia: describes the project; informs about the legal framework including requirements of international financing agencies (IFIs); outlines the results of the detailed baseline investigations; addresses the anticipated impacts; and develops potential alternatives for mitigation / management evolved through a process of information disclosure consultation and public participation. Important output is the ‘Impact Matrix Synopsis’ for construction and operation stages of the project (refer Annex E-1 to E-2).

Environmental Management Plan (EMP) as part of this EIA Report addresses various environmental measures in physical and biological terms and proposes their monitoring based on matrices (refer Annexes J-1 to J-4).

This EIA Report encompasses socio-economic baseline analyses, impact assessment, mitigation, compensation and monitoring measures related to the project. Resettlement Plan, as a separate companion document focuses on: land acquisition; compensation; resettlement of PAPs; and restoration of livelihood including development(s) of the area through sectoral plans as part of the policy to share project benefits with PAPs.

A.2 Policy, Legal and Administrative Framework

Basic legal and national regulatory framework is enshrined in the Environmental Protection Act (1997) of Pakistan. Accordingly, Diamer Basha Dam Project is classified as Category A, requiring a full Environmental Impact Assessment.

This environmental assessment is basically guided by ADB's 'Safeguard Policy Statement' of June 2009. Another relevant guideline is 'Strategic Environmental Priorities' recommended by the World Commission on Dams (2000) and relevant international environmental agreements, conventions and protocols for which partisan is a party.

Furthermore, it is guided by the application of national laws relating to major water storage projects and customary laws in Northern (Gilgit-Baltistan) Areas and North-West Frontier Province (Khyber Pakhtunkhwa) regarding traditional use of land and water.

A.3 Description of the Project

A.3.1 Salient Technical Features

The proposed dam site is going to be located approximately 40 km downstream of Chilas, the headquarter of Diamer district in Northern (Gilgit-Baltistan) Areas. Following project components are relevant in the context of environmental impacts during construction:

- About 272 m high roller compacted concrete (RCC) dam with upstream / downstream appurtenant structures covering a working area of about 730 ha
- Temporarily erected cofferdams (both upstream and downstream with crest elevations of 977.5 and 973 masl, respectively) for river diversion to construct the main dam
- Two underground powerhouses (one on each bank of Indus River) with installed capacity of 2,250 MW each and a switchyard on the left bank
- Incidental facilities for supply of electricity, drinking water, water sanitation, solid waste disposal
- Quarries for excavation of supplemental borrow material in addition to about 27 million m^3 excavation of rock and other borrow materials from the dam site area (quarries to be later submerged by the reservoir)
- An area (61 ha) designated for dumping of rock and other materials from dam excavation or quarries.
- Contractor's construction workshops and camps including labourers (on an area of about 108 ha) spread over five locations, all on the left bank between the dam and the downstream village of Shatial.
- WAPDA's Colony in Thor Valley (61 ha) including the consultants' staff during construction and its own staff during operation.
- Overall project will be completed in about 10 years.
- Filling of reservoir will be achieved in five stages extending over a period of 7 years.

Though reservoir length at FRL will be about 94 km, project area during construction period will be quite small and quite distant from the habitated areas.

During operational phase, the following environmentally relevant technical features will be relevant:-

- Seasonal reservoir operation to provide supplemental irrigation water including downstream ecological needs and electricity for the national needs
- Warming up of reservoir water especially during storage periods of summer
- Annual 100 m fluctuation of reservoir water level between Minimum Operation Level (MOL) of 1,060 masl and Full Reservoir Level (FRL) of 1,160 masl

- Initial river channel erosion / degradation immediately downstream of the dam
- Rock and landslides might be triggered due to the reservoir abrasion around the reservoir periphery
- Reservoir sedimentation and management commencing after 15-25 years of commissioning.

A.3.2 Main Benefits of the Project

Main direct benefits of the project will comprise:

- Enhanced water storage capability for the Indus Basin Irrigation System (IBIS) through addition of about 7.9 BCM of live storage at a time when the on-line storages would have lost over one-third of original capacity of about 18.5 BCM (almost equal to existing low Mangla Dam)
- Providing about 18,100 GWh of energy per annum from its installed capacity of 4,500 MW as well as enabling about 1100 GWh of additional generation at Tarbela due to conjunctive operation of the two reservoirs.
- Increased useful life of the downstream Tarbela reservoir by about 35 years through trapping large amount of sediment
- Alleviation of flood damage of the Indus River, particularly in the reach Kalabagh to Gudu

Besides the above national benefits, a major 'trickle-down effect' of the project will be significant improvement in socio-economic conditions in the backward Northern (Gilgit-Baltistan) Areas of Pakistan.

A.4 Socio-economic Environment Baseline

A.4.1 Physical and Biological Environment

Physical and biological environment of the Indus River valley section, potentially affected by the construction works and the following impoundment, is dominated by the following overall natural conditions, which are:

- Mountainous character of the valley, where rock and rock debris is covering large areas and soft soil is scarce.
- Lack of dense vegetation caused by the arid climate (annual precipitation < 200 mm), active land and rock sliding and severe overgrazing.
- Winter coldness combined with absence of monsoonal weather conditions with long and extremely hot summer season (July-August mean air temperature > 30° C and mean maximum temperature >43° C).

The state of soils, land use, plant communities and wildlife is adapted to above extreme conditions. With regard to biological elements the isolation of the upper Indus River valley furthermore affects the ecosystems. Plants and animals from southern parts of Pakistan are non-existent. The lower valley up to about 1,600 masl belongs to a dry Artemisia steppe ecosystem.

Due to the extreme dry climate in the Northern (Gilgit-Baltistan) Areas, the diversity of ecosystems is relatively low. This natural environmental condition has been influenced additionally by severe degradation mostly by overgrazing, firewood cutting and excavation of gravels, sand or other construction material for local purposes. Sensitive, but worldwide distributed, *Artemisia* steppe plant communities also have minimal coverage of soils surface due to natural climatic reasons.

Hunting during the past decades has damaged the wildlife to such an extent that these are now non-existent. Mostly reptiles and water fowl species (some migratory) birds are relevant but in the project area do not have high value from the nature conservation point of view. They have been driven back to higher areas away from the Indus River and the project area.

Beyond narrow gorges like the dam site mostly the lower valley morphology is determined by active sedimentation and deflation. Another dominant factor is the high annual river water level fluctuation in the range of 12 m. Thus, the ecosystems stretching along the river banks are extremely vulnerable and frequently changing. This results in lack of typical riverine zone with dense semi-aquatic vegetation cover and amphibians and rich water fowl. This is also the reason that the Indus River water is not used for any irrigation in the project area and the reliance of the local population is on nullah water only.

Above this river terrain the rock dominates. On plain or gently sloping areas the rock sometimes is covered with glacial (moraines), fluvial (alluvial fans, river terraces) deposits, which are the only areas with some soil cover. Here greyish xeromorphic soils carry Artemisia steppe plant community (estimated about 30% of the available land). Rocky outcrops and boulders are often interrupting this rangeland belt along the alluvial river bed. This is the preferred habitat for reptiles, the most important species. The rock agama, waran and gecko populations are relevant.

The close-by foothills exhibit rock debris where vegetation is mostly absent. Forests, including shrubs do not grow in the ranges below 1800 masl.

Indus River including its tributaries, named here as "*nullah*" or "*gah*", are torrential and extremely turbulent streams especially during high flow season from May to September. While the mean annual flow at the dam site is under 2,000 m^3/s, [over 62 billion cubic meters (BCM)] the river discharge fluctuates between 500 m^3/s in winter and >6,000 m^3/s during summer months. The river is inhabited by the north-Pakistan coldwater fish population, bound by the fish-zoological Palaearctic region between 1,200 and 2,000 m elevation. Due to the low biological mass, high turbulence and very limited spawning areas, the fish stocks are limited only to the small tributaries. None of them is rare and endangered. Some of the 14 species recorded by DBC during investigations of 2006 were introduced from outside.

Presently, the bird population is not dominated by migratory water fowl. Mammals are totally missing and thus separate biological investigations for their recording were conducted by DBC during 2006 and 2007. Presumably, most of mammals have disappeared due to hunting.

Most important habitat areas and animal species are:

- Nullah areas, where a wider range of climatic, water and soil condition determines a special pattern of plants and animals such as amphibians, reptiles, birds.
- Cultivated land, offering various conditions (perennial water) for insects, amphibians, reptiles and birds.
- Artemisia steppe areas with rock outcrops and boulders away from the villages, where particularly reptiles and some birds are settling.

However, from the natural conservation point of view there is very little to be highlighted.

The significance of rock carvings from the heritage point of view is high due to their large number of over 5200 objects (stones, cliffs) carrying over 31000 single carving or inscription. Cultural heritage of these objects is further enhanced by the fact that such a high and dense number of scenes from various millenniums are present in the area between Shing and Khanbari Nullah. Buddhism, Brahmanism and cultures from Central Asia have been recorded in the valley in many different scenes depicting the respective previous living conditions. It seems that the Indus River Valley, imbibed with the unique set-up of rock carvings was a basic medium of cultural exchange between Central and South Asia.

A.4.2 Socio-economic Environment

According to 1998 Census, the total population of Diamer district was 207,110 and comprised 52 % males and 48 % females. There is a distinct tribal structure in the project area. According to recent (2008) assessment, the population directly affected by the project was 28650. Out of this, the main

local tribal clans of Sheen, Yashkun and Kameen constituted about 55 % (15757 people). Remaining 45 % are so-called 'non-locals'. Out of these non-locals the largest tribe with about 30 % population (8595) is Soniwal. Some other non-local tribes are: Gujar (1,146 or 4 %); and Swatis (573 or 2 %). The remaining non-local or settler tribes with 8% (2292) population comprise: Kohistani; Pattan; Woolmaker; Jalkoti; Lohar; and Kashmiri.

Besides Chilas, some larger settlements such as Bunar Das and Gonar Farm have developed since completion of the Karakorum Highway in 1977. Upstream from the proposed dam site, there are 19 villages on the left bank and 12 are on right bank. Thus, there are 31 settlements subject to direct inundation from the project.

In addition, there are 149 left bank settlements located in the upper side valleys of nullahs. Most of these have access through link roads with existing Karakorum Highway. Similarly, 77 villages are located in the side valleys of right bank nullahs, which except Kiner Nullah are accessible only from the Indus River via suspension bridges. Though, there are 226 indirectly affected settlements in the wider project area, the project impact will be essentially related to the access from existing KKH. Under the post-project conditions, this facility will get vastly improved through construction of: relocated KKH on the left bank; and Right Bank Periphery Road.

Investigations by DBC on size of landholdings revealed an average cultivated farm per household of around 2,600 m² (5.12 kanal, the local area units equal to 501.6 m²) including built-up land with the small residential 'Kacha' houses and cattle pens.

Over 56 % of this land is owned by the local tribes of Sheen, Yashkun and the remainder 44 % by the non-local tribes. Currently, the owner-cultivators occupy 92.9% and non-owner (tenants) 7.1 % of the farm land. Major portion of the non-locals consist of Soniwals. Only a few villages are jointly inhabited by local and non-local tribes. Though in Chilas Sheen, Yashkun and Soniwals live as neighbours, in the surrounding villages the population is composed of either local or non-local tribes. Following three kinds of tenancy occupation are being practiced:

- Owner-cultivators
- Permanent tenants who normally pay to the landowner one third (in some cases 50 %) of the harvest in kind
- Short-term tenants (usually the share is 1:1 and only in some cases 2:1, while production costs such as seed, machinery, fertiliser, etc. are provided by the landowner)
- Lease *(Kalong)* tenancy system covering leasing for several years and the tenant paying in cash after the annual harvest.

Main winter crop of wheat is grown between November and April-May. Immediately after wheat harvest, the summer crops are sown. Around 80 % of the cultivated land in summer is covered by maize, which is also used for flour production including fodder stock for the domestic animals in winter. Some other crops are barley and potatoes. Besides home consumption, the farmers with sufficient land also sell potatoes in the market for export to the down country locations of Abbottabad, Mansehra and Islamabad. Different types of beans such as 'soya', 'mung' and 'mash' are sometimes grown in maize as intercrops.

Although there are no regular orchards in the project area, many fruit trees are grown. Approximately 525,000 trees (54 % fruit trees and 46% non-fruit varieties) are grown. Fruit trees consist of walnut, almond, fig, apricot, pomegranate, grapes, peaches, apple and others. Fruit trees are grown on the private land in and around the villages but outside of the settlements they are non-existent. Non-fruit trees are generally for providing shade in the settlements.

Diamer district is famous for some medicinal plants. Apart from black cumin (*kala zeera*), which is mostly used as spices, some medicinal plants are also collected for trade. One relevant species is a mushroom locally called "*Ghuchi*", having great medicinal value. Other species are *Ephedra* and *Artemisia*, which are found in abundance in the area. After collection, these are dried and sold in

the market for Rs. 4,000 to 5,000 per kg. A person, who is in this business on full time basis, can earn an average of Rs. 10,000 per month.

More than 94% of the households in the Project Area are having land for growing crops and fruits as well as feeding the livestock. Most of the daily consumer goods such as wheat, maize, potatoes, vegetables, fruits, milk, butter, eggs and meat are being produced for self consumption.

Although a limited part of traditional self-sustaining farming on small landholdings, livestock breeding and animal husbandry make a significant contribution to the family income. Each household has at least one buffalo and one or even more cows for milk production, butter and meat. Bullocks and buffalos are generally used for ploughing. The household donkey, sometimes a horse, is used for transportation in the valleys. Average population of livestock per household according to the Cadastral Survey conducted during 2007-08 jointly by Diamer District Administration / WAPDA / DBC was about 16. Due to limited fodder availability, the cattle barely supply the household needs of dairy products or meat. The average of 2 litres milk per day for buffalo and 3 for cow of milk reflects the small and emaciated size of animal husbandry.

Fishery, though performed on commercial basis in the project area, is limited due to very low fish population. According to Fishery Department Chilas, there are 46 full time and 53 part time fishermen, performing the activity for commercial purpose. In a year, they work for 200 days on the average with daily catch of about 5.6 kg.

The communities are still self-governed by the *Jirga,* an assembly of eldermen, which deals with all aspects of social life of the entire community including conflicts about land, water, family and religion etc. In addition, at Tehsil level in the tribal areas, a council of elders is appointed. It comprises one or two notables from every village in the area. Each member of this council is called Jastero. The number of Jasteros from each village depends on the size and population. This council convenes as and when necessary. A parallel counterpart is the Tehsil Council, which is the body of elected public representatives.

Private shop-keeping is occupation of many peoples and there are 453 shops in the project area, which mostly deal with supplying products for the daily consumption in the form of grocery. Shopkeepers in the project area are relatively affluent people due to the regular source of income. Their earnings vary between Rs. 10,000-15,000 per month depending on type and location of the shop. Along Karakorum Highway (KKH) some facilities of vehicle repairing, fuel filling and service stations have also developed.

Due to lack of access, there are extreme distortions in business and job opportunities on the right and left bank locations. Only along KKH on the left bank, aside from driver hotels in Thor Das, lower Gini Village, Bunar Das and Gonar Farm, there are some quality hotels in Chilas.

Project area villages in most cases have only primary schools, which due to the tradition in this area, are only for boys. Girls are almost excluded from any education. Most of the parents, particularly men in the project area, are not convinced about sending their daughters to the school. Therefore, the illiteracy rate is high. Census Data of 1998 reported that the overall illiteracy rate was around 64 % with women illiteracy at 91 %. The status of education facilities varies between villages, with a significantly better position in Ges Bala, Ges Pain and Chilas.

Families are run by typical patriarchal traditions. The elder male of the family controls the household affairs. Family structure is a mix of nucleus (husband, wife and their children) and extended joint family systems (husband, wife, their children and grand father, grandmother, brothers, sisters, and other immediate kins). Male members continue to dominate the decision-making in most family relationships. Women are almost excluded from these decisions. Traditionally, the people are marrying early. The total number of household members including parents and their children and grand parents is between 8 and 20. A number of families are still polygamous as permitted by the 'Islamic Shariah'.

There are very few job opportunities for females mostly offered by the Departments of Education, Health, Social Welfare, active NGOs like NADP and some vocational centres. Only a few females are working as doctors and nurses in the hospital or teachers with no occupation in business concerns. On the other hand, the females are mostly working in domestic agriculture, often doing the hardest jobs on land and livestock breeding, all round the year. Many women and girls of the Soniwal tribe are also engaged in extracting gold from sand of the Indus River.

Health status of women is the poorest of all groups of local population. They are exposed especially to poor nutrition, air pollution from internal cooking arrangements, early marriage, and frequent childbirths. Women in the Northern (Gilgit-Baltistan) Areas are generally afflicted by nutritional deficiency diseases. The most prevalent symptoms in the project area are protein-energy malnutrition, iron deficiency anaemia, iodine deficiency disorders, and vitamin A deficiency.

Pregnancy related problems and complications are quite common. The basic causes are high fertility rate, lack of midwives in the remote villages, lack of female doctors in the only hospital in Chilas, non-availability of drugs for any complications, and extreme unhygienic conditions. Consequently, 81 % of deliveries in the Diamer district are carried out at home by untrained formal birth attendants (*Dais*).

Some children, of the age 10 years and above are working part time at various automobile workshops, wood factories, construction works, newspaper stands, shops and hotels. The reasons for this compulsion are: high level of poverty forcing the parents to send the children to work; and lack of educational opportunities in the villages after primary school.

Under the prevailing socio-economic conditions in the project area, income of an average household is predominantly from cultivation on the small cultivated land plots with some domestic animals. This non-cash income is derived from self production of wheat, maize, vegetables, fruits, milk, butter, meat and eggs for the daily consumption. Estimated (2007) mean family income per household was between Rs. 7,000 and 10,000 per month. However, there were cases with family income less than Rs. 2000 per month. It has been estimated that ratio between cash and non-cash income in the households is 30:70. Cash income in the households of local tribes may be somewhat higher who, besides land, have supplemental sources of monthly salary or net profits from their business.

In most of the households, meagre income allows expenditures only for the daily consumables necessary for survival. Payments for expenditures on such items as salt, sugar, tea, spices are often not affordable. Around 60 % of the household expenditure is on food, which comes mainly from the self-sustaining agriculture. Out of this, about 42 % of the expenditure is for daily meals, which rarely contain meat.

Population of the Diamer district is almost entirely Muslim and constitutes 99.6 %. Most of the people belong to Hanfi Sunni Sect. In addition, there are very few Christians, Hindus Qadianis and Ahmadis, who constitute 0.4 % of the total population and are living in urban areas.

According to ADB guidelines “indigenous people are those with a social or cultural identity distinct from the dominant or mainstream society, which makes them vulnerable to being disadvantaged in the processes of development”. None of the tribes among PAPs fulfil this criteria. However, keeping in view the social and inter-tribal relations in the project area between the locals and non-locals, the criteria of ethnic minorities as mentioned in ADB’ guidelines seems relevant to Soniwals and non-local minority tribes. Notwithstanding apparent affluence among majority of Soniwals, they and other non-local tribal people feel deeply under-privileged leading to occasional ethnic tensions. This is evident from the fact that only a few villages are jointly inhabited by local and non-local tribes. Though in Chilas the Sheen, Yashkun and Soniwals live as neighbours, in the surrounding villages the population is composed of either local or non-local tribes.

Usually, three family members (often children) of Soniwals are involved in the gold washing process. During a working season of about six months the family can extract gold corresponding to a monthly income of over Rs. 10,000, which allows survival under the local conditions.

Landless people are considered as the most vulnerable part of the project area population constituting around 100 families, or 2.4 % of non-local population. All landless people are non-local tribes.

DBC field staff carried out a survey to identify the disabled, comprising physically disabled (mainly polio mellitus) or mentally retarded persons. Data were collected from the village elders and key informants from each of 31 potentially affected villages. The results of the survey showed that there were totally 83 disabled people (0.29 % of the 28,650 people living in the project area).

Though a number of non-governmental organizations (NGOs) are registered in the area, most of them are dormant. The most active NGO is Northern Area Development Project (NADP). It is working since nine years in Diamer district with the main office in Chilas. The core areas of its activity are Chilas, Darel and Tangir sub divisions of Diamer district, with coverage in terms of community and infrastructure development. NADP, co-financed by International Fund for Agriculture Development and the Government of Pakistan, have focused on irrigated agriculture and live-stock sectors. Reportedly, NADP is now in the process of being phased out due to lack of international funding support.

Another most important and outstanding NGO of Northern (Gilgit-Baltistan) Areas is Agha Khan Rural Support Programme (AKRSP) with head-quarter at Gilgit. However, due to some religio-political reasons, AKRSP is not active in Diamer district. Other relevant NGOs are International Union for Conservation of Nature (IUCN) and World Wildlife Fund (WWF) with their regional headquarters in Gilgit. Local NGOs are recognized only after registration with the Department of Social Welfare of Northern (Gilgit-Baltistan) Areas. Reportedly, 71 NGO's are registered with this Department in Chilas, out of which only 36 are involved in some activities.

In the context of construction and resettlement activities of the project, some NGO activity was observed in the past. In early 2006, a so-called 'Anti-Dam-Committee' was founded in Chilas. As a reaction, a 'Pro-Dam-Committee' was also formed and still working (mostly through induction into the officially constituted 'Land Acquisition and Resettlement Issue Resolution Committee').

A.5 Anticipated Environmental Impacts and Mitigation Measures

A.5.1 Overall Impact Assessment

During the construction period, some of the potential impacts environmental could be: on air quality in the surroundings of the dam construction site and the downstream segment KKH; some loss of amphibians, reptiles, and birds; and some pressure on the traditional communities. However, due to the distant location of the dam construction site in relation to the habitations mainly in the upper part around Chilas, and habitats of important animal species, these threats will be of minor significance.

During operation, especially due to the first inundation of about 115 km² area, physical, biological and socio-economic environment in the lower parts of the valley up to 1,160 masl would be severely impacted. Similarly during subsequent operation there will be some other environmental impacts. Most severe environmental impacts due to reservoir operation are shown in Box A-1.

Box A-1: Most Severe Environmental Impacts Due to Reservoir Operation

About 29,000 affected people
31 settlements totally or partially submerged
>3,100 traditional stone and mud houses submerged
Endemic reptiles endangered
Cold water Indus River regime modified
Over 31,000 unique rock carvings submerged

Source: DBC, 2010

Designed mitigation measures have been directed mainly towards reduction of these impacts. In cases, where reduction is not feasible, measures for compensation and restoration of human livelihood and wildlife habitats will have to be implemented. Basic instruments for addressing appropriate mitigation, compensation and restoration measures will be through: Environmental Management Plan (EMP) as part of this report; and the companion Resettlement Plan. 'Synopsis of Impact Matrices for the construction and operation stages have been also developed to support these measures (refer Annex J-1 and J-4 respectively).

A.5.2 Impacts During Construction

One of the most significant impacts during construction will be through the transport. It will be in the form of: high risk of accidents of settlers along the KKH and constructions roads; permanent noise during the three working shifts over a period of about 10 years; deterioration of the local transport due to blockages and accidents; and emission of exhaust gases. Various manifestations of this impact, will not only be confined to the project area between Shatial, dam site and Chilas, but may encompass the transport of goods and persons from Islamabad and Havelian onward on KKH. Air properties and human health would be impacted over 10 year construction period by the exhaust gases, dust, vibration, noise and accidents Due to substantially increased frequency of transport.

Another risk for workers and local people will be the use of explosive materials in the dam area and the proposed quarries. Fortunately, due to the remote locations this risk will not be significantly provided the contractor(s) follow the prescribed security measures.

Permanent withdrawal of land for excavation and placing of dam facilities and temporary withdrawal for labourer camps, batching plants, stock piling and roads, though significant, will not reduce the rangeland as most of this area is rocky. Thus the harm to steppe area and animal grazing, if any, will be nominal. Wildlife, which is already nominal and mainly comprises reptiles and birds, would be potentially affected. High risk will be posed by the occupation of new land for construction, in the case of reptiles especially during hibernation. Birds, especially those nesting on the earth, could be endangered when the land occupation occurs during nesting period.

Diversion of the Indus River for construction will not significantly alter the river flow. Two right bank diversion tunnels and canal will only re-route the flow during construction. Thus, the insignificant fish stocks, mainly comprising introduced species, will not be threatened.

Water quality of Indus River is presently very good due to lack of any environmental pollution. Risks from discharges at certain points, or in diffused pattern, could be significant due to machinery using fuel and lubricants, usage of huge amounts of cement, and sewerage effluent from labour construction camps. The limited water amount in some nullahs, and being used by the local population, will have to be protected through appropriate restriction upon its use by contractor(s).

Social impacts may also emerge from the presence of construction workers over a longer period, in the form of negative affects on health and cultural norms. These, if not properly managed, could cause social disturbances affecting traditional life, religious relations and may also risk introduction of HIV and other sexually transmitted diseases (STDs).

Unique rock carvings concentrated in the Indus River segment from Darel to Shing might be damaged during construction activities around the dam site and quarry areas. This could be caused by excavation, in particular blasting, as well as heavy machinery or other construction works in the project area.

In general, the prominent adverse impacts during construction are:

- Air pollution by road traffic along existing Karakorum Highway from down country to the dam site
- Damage to amphibian and reptile wildlife

- Threats to birds by killing and damaging nests, and expelling due to noise and vibration, and
- Restrictions on local transportation facilities through traffic interruptions and accidents etc.

Some other adverse impacts, avoidable through sound design and construction solutions, would be:

- Geologic deterioration triggered by landslides and seismicity
- Contamination of soils due to solid waste disposal
- Overuse of Indus River and nullah water
- Pollution of nullahs/Indus River
- Some increase of Indus River and nullah sediment load
- Disruption of forestry activities in rafting of logs
- Deterioration of social structure, including community and gender
- Damage to cultural heritage and rock carvings.

However, there are some technical impacts, which will even improve the environmental conditions as indicated below:

- Substantial improvement of transportation facilities (permanent access bridge downstream of the dam site, right bank road and upgradation of KKH)
- Improvement of education and vocational training facilities (in Chilas)
- Improvement of labour market and demand on vocational training
- Improvement of business including development of support services.

A.5.3 Impacts During Operation

Most significant adverse impact during reservoir operation will be caused by the submergence of the large reservoir area. This inundation will irreversibly change the overall nature and socio-economic setting of the area.

Most serious effect would be upon 31 settlements located in the reservoir submergence area, along with: loss of cultivated land developed over generations by the farmers; loss of rangeland for the animals; and dislocation of a population of about 29,000 people. The entire economic base of their livelihood would be upset through: loss of fertile land; and denial of subsistence agriculture for self supply.

From physical, as well as biological point of view the change of the Indus River into about 95 km long and 1-2 km wide lake due to construction of 272 m high dam, will be another significant impact. The water to be stored for initial filling the reservoir up to Minimum Operation Level (MOL) of 1060 masl will be in three stages over a period of about four years. Though withdrawn from the overall water balance of Indus River its impact will be insignificant. In addition, the hydrological character of the river would be completely transformed from a fluvial to a lacustrine water body. Presently, the water regime is determined by up to 12 m high annual water level fluctuations, which would go upto 100 m seasonal drawdown. Thus, the downstream releases would be regulated and inundations of semi-aquatic ecosystems in the section up to Tarbela reservoir reduced. However, these changes will not be of much significance due to the character of Indus River determined by seasonally changing river bed conditions with sedimentation, erosion and deflation. Another important contribution of the reservoir drawdown will be to facilitate stipulated releases of 142 m^3/s throughout the year for downstream ecological requirements of Indus Delta.

Severe impact could be caused if the river blocked any migration of natural fish stocks. In addition, fish could be annihilated during passage through the power turbines at the dam site. However, the impacts on water quality due to potential eutrophication of fish and blockage of fish passage will be of minor relevance due to the situation that the reservoir will not have distinct stagnation periods

due to perennial downstream water releases. In the extreme hot season only quite short periods would appear with a clear water temperature decline from the epilimnion to the hypolimnion in the depth. Thus, the risk for oxygen decline in the lower water layers and the eutrophication will be also small.

In this regime cold water fish species are confined to elevations between 1,200 up to 2,000 masl. Migrating fish species, much likely, are those adapted to various water temperature regimes such as the introduced trout (*salmo trutta*). Thus, the cold water fish species, with proposed FRL of 1160 masl for the dam, would not be impacted regarding migration.

Land ecosystems dominated by rock, despite withdrawal of approximately 12,765 ha land acquisition zone for the reservoir, would not be affected significantly because of the very low level of environmental values. This area is not only distant from any settlements, but from the natural conditions of land and soils which have any significant ecological relevance.

Due to impoundment of the reservoir, plant communities and wildlife would not suffer because they are not relevant due to the ecological conditions. Reservoir filling in accordance with the hydrological regime (May-September) would not affect adversely the reptiles. They would migrate to upper areas under the condition that new habitats around the reservoir are available. However, reptiles during their hibernation period October until March could be lost if the submergence was caused due to any unseasonal impounding.

Water fowl, some of them migrating from Siberia towards South Asia, are resting, nesting and feeding in the area presently. The submergence caused by the reservoir would even improve the conditions. Thus it is very likely that the number of water fowl species and individuals will be reasonably increased due to creation of the reservoir. Presently, there is the suspicion that due to the water conditions (temperature, low biomass) and the continuously changing water level a riverine zone does not develop. Once this is created through a reservoir, the ecological conditions for a big water bird population would improve significantly.

Severe loss of heritage would be caused by the inundation of rock carvings permanently up to 1,160 masl. A significant number of rock carving objects would be also lost temporarily due to seasonal reservoir fluctuation between 1,060 and 1,160 masl. These objects would become exposed during winter period and provide a tourist attraction through boat trips. However, it will have to be monitored whether these carvings after some years could be damaged irreversibly by the weathering of water (carbon, i.e., acid).

In general, the most significant adverse impacts during operation will be:

- Loss of about 128 km² land under reservoir related land acquisition zone
- Degradation of fish spawning areas in lower nullahs due to reservoir impoundment (to be compensated through Reservoir Fisheries Management Plan as part of the Resettlement Plan)
- Damage to fish while negotiating through dam facilities (expected to reduce over time due to fish awareness for keeping away from the hazard)
- Reduction in livestock due to reduction in grazing area (to be enhanced as part of Rangeland Management Plan)
- Degradation of fishery activities in nullahs (to be improved through the Reservoir Fisheries Management Plan as part of RP)
- Degradation of water supply (if not properly monitored / mitigated)
- Damage to existing local electricity generation and supply facilities (to be enhanced through proposed general electrification of the area)
- Damage to river-crossing transportation service (to be augmented through permanent river crossing facilities)

- Deterioration of labour market and business activities after construction (to be compensated through proposed livelihood restoration measures and 'trickle down' effect of massive investment)
- Damage to Cultural Heritage and Rock Carvings due to submergence (to be addressed through the Cultural Heritage Management Plan)

There are other adverse impacts, which might be avoided through developing sound operation modes such as:

- Downstream water reduction during initial reservoir filling (to be insignificant due to five stage filling over a period of seven years)
- Change of water quality during operation (to be continuously monitored)
- Loss of amphibians and reptiles due to submergence during seasonal impounding
- Loss of birds due to submergence of their habitats during seasonal impounding
- Degradation of ecosystem and wildlife downstream of Tarbela Dam (not relevant due to stabilization of this impact of progressive diversions starting in 1932 with construction of Sukkur Barrage on Indus and completion of Indus Basin Project in 1977)
- Degradation of health situation especially acceleration of malaria (to be monitored through a focussed programme)

However, there are some technical impacts, which might even improve the environmental conditions during operation such as:

- Carbon dioxide credits due to avoidance of substantial greenhouse gas emissions through substitution of thermal power generation
- Extended useful lifetime of Tarbela reservoir by about 35 years due to reduced sedimentation
- Improvement of natural conditions for migrating birds
- Enhancing fish habitat conditions and improved fishery activities through creation of a large reservoir and implementation of Reservoir Fisheries Management Plan
- Improvement of living environment in new settlements of Mode Villages
- Enhancement of cultivation by recession agriculture on the land vacated during the reservoir drawdown through coordinate public / private sector efforts
- Vast improvement in electricity supply through the energy provided at the dam
- Substantial improvement of cross / along river transportation system through alternate arrangements.

A.6 Analysis of Alternatives

This item, which represents an important part of any Environmental Impact Assessment, focused on following options:

- No-Project Alternative
- Changes of Location Upstream and Downstream
- Location of Hydropower Plant in Another Valley
- Reduction of Dam Height
- Changed Locations of Dam Elements
- Enhanced Water Release

All these options had been analysed but none of them offered a viable alternative. Even the 'No-Project Alternative' of scrapping Diamer Basha Dam was not found preferable because of denial of the Northern (Gilgit-Baltistan) Areas and particularly population of the impacted area, the large benefits from construction and operation of the dam.

As mentioned above, the overall project benefits to the region and the impacted area would be:

- Extended useful lifetime of Tarbela reservoir by about 35 years due to reduced sedimentation with the ensuing large economic and social benefits
- Sizeable avoidance of greenhouse gas emissions (carbon credits) due to substitution of otherwise necessary fossil fuel based energy generation
- Extension of natural conditions for migrating birds and diversifying fish habitat conditions, thus boosting fishery activities in reservoir
- Vast improvement in transportation facilities through: construction of permanent access bridge downstream of dam site; availability of dam crest for traffic; Right Bank Periphery Road; and upgradation / relocation of KKH
- Vast improvement in labour market conditions of Northern (Gilgit-Baltistan) Areas during construction with lasting positive effects on education, vocational training facilities and enhanced employment prospects for the younger generation
- Improvement of overall livelihood in the new settlements (Model Villages) with modern infrastructure such as water supply, electricity, communication, and education, and
- Boost to the overall local regional economy through: irrigation / recession agriculture; enhanced tourism and recreational facilities; and implementation of sectoral plans

Admittedly, the project will have serious adverse impacts on the natural and socio-economic environment, especially the relocation of almost 29,000 peoples but it seems manageable through appropriate mitigation measures. On the other hand, there is no real alternative as compared to Diamer Basha Dam, which could bring to this remote Pakistani region an opportunity of large scale socio-economic development.

A.7 Information Disclosure, Consultation and Participation

DBC, from beginning of investigations in 2006, gave special consideration to the aspect of information sharing with Project Affected Peoples (PAPs) including creation of awareness.

This activity was initiated by DBC during April 2006 through meetings in 26 out of 31 affected villages. Remaining 5 villages could not be covered due to unavailability of the concerned Jirga members. In this process, 233 PAPs were consulted. This brought about the realization that among PAPs, there was much unawareness, disapproval and even opposition against the project in general and the resettlement in particular. Consequently, during the initial scoping activities of 2006, many PAPs refused any support for the project as well as displayed an attitude of detachment. They, at that time, indicated their preference to leave the area and go wherever they liked after receipt of fair cash compensation. Mostly, they showed intention to go to ‘downstream’ locations, around Mansehra, Abbottabad, and even Islamabad. This initial reaction of PAPs was, probably caused by:

- Lack of trust in functionaries of the government.
- Continuous deprivation and discrimination of the non-locals by local tribes.
- Unclear perception about the consequences of relocation and resettlement.
- Disapproval of suburban living conditions, though with cleaner environment and better civic amenities, without having access to land and self-produced products for sustainability of livelihood.
- Lack of proper information about the price to be charged for cultivable land being provided under the proposed Model Village concept for resettlement of the dislocated population.

Second round of investigation, during 2006-07, completed scoping in all of 31 potentially inundated settlements. In addition, special meetings were held with businessmen, healthcare related personnel and Diamer District Administration. In most of the scoping sessions, written memoranda were presented by DBC and openly discussed. These discussions provided DBC, WAPDA and

Diamer District Administration with very useful overview of the conditions and views / expectations of PAPs particularly with regard to compensation and resettlement. Serious consideration was given to their genuine concerns and demands / proposals for development of the resettlement concept such as:

- Relocation to the proposed Model Villages was only accepted by Sheen and Yashkun (the main local tribes) from Lower Chilas (basically due to their proposed resettlement on their owned lands in Harpin Das).
- Sheen and Yashkun of Thalpan village preferred relocation in downstream developed areas such as Mansehra, Abbottabad and Islamabad.
- Non-local tribes, in particular Soniwals, totally refused to be relocated to any model village and wanted cash compensation.
- Majority of population did not want to be relocated anywhere by the government and instead demanded fair cash compensation to exercise their choice of voluntary resettlement.

To reassess, the number and locations of proposed Model Villages, a special Questionnaire Survey was carried out by DBC. Its specific aim was to elicit options of the affectees for exercising their choice to resettle in Model Villages or places of their own choice. Result of this special survey brought out that only about 37 % of affected households had opted for resettlement in the Model Villages. Therefore, the overall concept of resettlement through nine Model Villages needed review. Consequently, to start with, only two proposed locations of Composite Model Villages in vicinity of Chilas are being taken up for planning and development to accommodate 37 % of the willing households of PAPs.

Notwithstanding the efforts so far put in for public participation, this activity will have to be pursued through the forthcoming implementation phases of the Resettlement Plan. In particular, the focus will be on the improvement and modification of the proposed relocation concept based on the: construction of Model Villages in the vicinity of reservoir; and identification of suitable land in the upper Nullahs close to the present settlements, where most of the local people already own land for summer meadows.

A.8 Grievance Redress Mechanisms

Grievance redress mechanisms are prescribed both in the Land Acquisition Act (1894) and the draft Resettlement Ordinance (2002). The Grievance Redress mechanisms to be established in the Diamer Basha Project will have to conform to the ADB's Safeguard Policy. It requires establishment of an independent grievance redress structure to encourage PAPs not satisfied with any aspect of the resettlement procedure including entitlement, compensation of land, houses and other assets, for filing a petition in the appropriate regional / federal Court of Law.

The basic approach of grievance redress mechanisms of PAPs is to facilitate speedy and satisfactory resolution of disputes and grievances. The most appropriate vehicle of this purpose is work through representative committees of PAPs.

Another important function of grievance redress structure will be to ensure an effective mechanism for participation of PAPs in all the relevant activities of: land acquisition; compensation; resettlement; livelihood restoration and sustainability; and area development plans.

This process was initiated in April 2009 through constitution of ‘Resettlement Issues and Coordination Committee’ comprising representatives of Northern (Gilgit-Baltistan) Areas Administration; WAPDA; and PAPs. Basic responsibility of this committee is to facilitate resolution of issues pertaining to: land compensation matters; Resettlement Plan; establishment of Model Villages; and provision of jobs to local peoples. During August 2009, this Committee conducted negotiations with the Administration to negotiate compensation rates for the private land to be acquired for the project. This Committee again made useful contribution during February 2010 through negotiations on the demanded land compensation rates by PAPs. These discussions were held with a High Powered Ministerial Sub-committee established by GoP for priority resolution of

the issue, which unfortunately had triggered violent demonstrations at Chilas on 10 February, 2010. During these negotiations, besides addressing the core issue of land compensation rates, it was agreed to establish a 'Dispute Resolution Committee (DRC) with representation from N(GB)A (Gilgit-Baltistan) Administration, WAPDA and PAPs. DRC will be headed by Deputy Commissioner Diamer and include a member each from WAPDA and Resettlement Issues and Coordination Committee. It will basically redress the grievances of PAPs through its terms of reference (ToR) comprising: focus on day to day removal of irritants, specially where grievances are not covered by the Land Acquisition Act (1984); resolution of disputes for engagement of locals on non-specialised jobs; resolution of disputes regarding compensation about built-up structures, houses etc; and act as a forum of liaison among stakeholders.

For the purpose of systematic working of 'Grievance Redress Mechanism', WAPDA's Project Resettlement Organization (PRO) at Chilas will act as the focal point. Project Information Centre of PRO, on behalf of DRC, will:

- Provide advice / assistance to PAPs for filling and registering complaints
- Receive all complaints relating to grievance redressal
- Conduct initial processing to assess genuineness and authenticity of the complaints and disputes
- Put up the genuine cases to DRC by requesting the Chairman (Deputy Commissioner Diamer) for convening on periodic or case to case basis
- Maintain a register of complaints, disputes and grievances of PAPs and keep a track of the decision and their status of implementation including periodic appraising of DRC
- Record deliberations of DRC and follow-up the decisions with relevant quarters

In case PAPs are not satisfied with the decisions of DRC, they could appeal to the competent Court of Law in Northern (Gilgit-Baltistan) Areas. If they are still not satisfied, the PAPs will have right to appeal to the Federal Court in Islamabad.

A.9 Environmental Management Plan

A.9.1 Basic Focus

Environmental Management Plan (EMP) based upon thorough baseline study and impact analyses addresses the most important measures to be taken for avoidance of any environmental damage. These measures will focus on equivalent environmental measures for establishing mitigation and compensation through:

- Appropriate provisions in the Bidding Documents of contractor(s)
- Adequately monitoring and supervision of construction activities
- Adoption of appropriate operation measures during post-construction period of the project.

A.9.2 Implementation of EMP

This will be implemented basically through plans for the key areas as indicated in the following.

A.9.2.1 Integrated Land Management and Monitoring Plan

Main objectives of the 'Integrated Land Management and Monitoring Plan' will be:

- Avoiding any additional use of land (beyond the areas allocated for the project)
- Restoring degraded range and bush land by planting, wherever possible in the project vicinity
- Fencing of newly replanted zones for protecting against any threat (animals, humans)
- Avoiding any degradation of vegetation (reduced rangeland) thus inducing soil erosion

- Planting of shrubs in the risk prone area around reservoir to stabilise slopes
- Improving the ecological state of the remaining range and bush land
- Financially compensating the loss of income from livestock breeding (under certain conditions)
- Supporting effective rangeland management methods including transhumance and alternative feeding arrangements.

Contractor(s) and WAPDA with cooperation / participation of Diamer District Forest Department and any Nature Conservation Organisations will implement the degraded rangeland restoration programme, where feasible in the margins of reservoir as per following.

The starting point will be: mapping the re-cultivable areas (temporarily used land), especially of 10 m buffer zone around the reservoir (between 1,160 and 1,170 masl); identification and mapping of sliding risk area beyond the 10 m buffer zone; and determination of the areas suitable for re-cultivation. Implementation of re-cultivation and rangeland development will include measures such as:

- Quantification of the land for the various measures including ascertainment of its physical availability
- Selection of suitable grass and shrub species
- Quantification of seed and seedling requirements
- Preparation of seed and seedlings in local nurseries for the area to be recultivated
- Seeding and planting measures on all the lands designated for re-cultivation and protection
- Stabilising afforesting and protecting the 10 m buffer between 1160 and 1170 masl
- Protection measures (fencing) against any destruction for the first five years
- Substitution of animal fodder by other sources (if required)
- Training on sustainable rangeland management (for shepherds and other concerned peoples)
- Handing over of rehabilitated rangeland to local communities such as Model Villages

Any land acquired temporarily for construction purposes will have to be rehabilitated after proper restoration including the following measures:

- Cleaning from any remains from the construction
- Levelling
- Planting/seeding of grass species adapted to the area
- Planting of shrubs
- Fencing of the areas for certain period to allow recoupment.

After impoundment of the reservoir, the enhanced risk of land sliding in some areas will be also relevant. In order to mitigate this action, following measures might have to be undertaken:

- Potential sliding areas already indicated on the basis of available information might have to be excluded from planning of Model Villages
- Slope stability analyses of most sensitive areas identified after impoundment
- Evolving / implementing appropriate measures for stabilisation of slopes likely to slide such as wire nets or planting of shrubs

Protection of local population in the new locations (Model Villages) and villages above 1,170 masl might also need attention. Any areas identified as endangered will have to be marked at site and forbidden for trespassing or any erection of structures.

Further activities under the Integrated Land Development Plan could cover:

- Mitigation measures to avoid land and soil contamination by solid waste

- Investigating introduction of improved agricultural practices, including drip irrigation, in the Model Villages after initial conversion of land to agriculture
- Management / facilitation of recession agriculture on lands vacated during winter and early summer season due to reservoir drawdown of 100 m (between 1,160 and 1,060 masl including reactivation of 'Dases' for growing short duration fodder
- Development of transhumance system (using existing pastures at higher elevations)

A.9.3 Climate and Air Management and Monitoring Plan

'Climate and Air Management Plan' could be an instrument for mitigating any threats to these two very important elements of the environment. The plan should include concrete mitigation measures to sustain the current excellent state of climate and air. Most important emissions during construction and having potential influence on climate and air will be:-:

- Exhaust gases such as CO_2, N_2O, particulate material (soot) from vehicles, batching plants and cement mixers
- Exhaust gases and particular material along the temporary roads
- Dust from quarries site excavations and around stock piling areas
- Avoiding additional emissions after initial water impoundment by cleaning of the reservoir floor from any bio-degradable material before hand

Most important relevant factors during operation stage would be:-

- Change of land coverage
- Formation of large lake-like water body with different energy properties
- Mitigation of fog, if at all experienced, along the reservoir with appropriate prophylactic measures

A.9.4 Integrated Water Resources Management Plan

During construction stage, integrated Water Resources Management Plan will basically aim to protect the local water supply and avoidance of any degradation and pollution of water bodies, especially Indus River and nullahs. This would include following protection measures:

- Indus River and nullahs against pollution of:
  - Dumping of earthen material
  - Releasing oil and other chemicals from machinery
  - Avoiding release of sewage water from labourer camps and construction sites through preferred transport to the treatment plant
  - Dumping cement and/or concrete
- Local water supply from the nullahs (water quantity and quality)
- Springs being used for local water supply

Important part will be the treatment of sewage from construction or residential labourer camps. Only dry toilets will operate and faecal remains transported to the treatment plant for cleaning.

During operation stage the Plan would focus on managing the following aspects:

- Safe water supply arrangements for the new Model Villages
- Formation of reservoir stagnation with potential changes of water quality (eutrophication)
- Mitigation of water pollution caused by organic residues at reservoir bed
- Reservoir and impoundment related issues (including downstream degradation)
- Water sanitation in Model Villages (along with sewage treatment) including Chilas

- Degradation of local water supply from nullahs and springs
- Avoiding pollution of water during operation
- Regulation of reservoir releases for optimal water / power benefits consistent with instructions of IRSA including ecological requirement downstream of Kotri

Special attention will have to be given to proper treatment of sewage from various sources and other relevant measures such as:

- Enforced protection against any release of pollution into the nullahs and the river / reservoir
- Pilot scale field testing of natural / biological sewage treatment (including use of reeds)
- Improved solid waste disposal, particularly from the Model Villages

A.9.5 Health Protection and Safety Management Plan

Health Protection and Safety Management Plan will play a crucial role both during the stages of project construction and operation. During construction, the contractor(s) will be obliged to take care of safety of workers and local population, mostly linked to: transport of goods and bulk material by heavy vehicles on public roads between Shatial and dam site and dam site and quarries; construction activities at dam site; blasting at dam site and quarries; and dumping of materials for stockpiling or slope stability.

Special protective measure will have to be adopted by the contractor(s) and permanently monitored by WAPDA and independently by the regional health and labour protection institutions. These will include:

- Security guidelines
- Permanent training of personnel on security and safety measures
- Deploying best available equipment and material
- Fencing of special areas such as quarries
- Guarding of special areas such as quarries, storage places of explosive or any other volatile materials
- Insurance coverage

Health Protection and Safety Management Plan will have to be focused on following activities during construction:

- Avoiding accidents from use of explosive materials taking into account:
  - Transport from downstream areas to the dam site (along the highly frequented highway)
  - Storage of explosive material
  - Blasting and security for workers, local population, and traffic along KKH
- Safety of construction workers, local population and their livestock especially including protection and mitigation measures such as:
  - Accidents caused by vehicles to local population on the public roads / KKH
  - Accidents with goat and sheep herds
  - Accidents with local vehicles and passengers
  - Damage to houses and cultivated land caused by vehicles
  - Accidents to local people often children at the quarries (including use of explosive material).
- Avoiding disturbance of local life by noise through establishing special blasting conditions such as:
  - Limiting to the only day time (06:00 to 22:00 hours)
  - Prohibiting within 200 m of habitations

During operation, the potential impacts will have to be assessed from the point of view of changing the local climate and hydrology with increased risk for any diseases. Particularly, all waterborne diseases should be monitored indicating the potential sources in respect of hepatitis, typhus and other ailments. Additionally, increased risk of malaria in the reservoir area (through development of mosquito habitats along the reservoir shoreline) would need monitoring for timely introduction of any protective measures by the local Health Department.

A.9.6 Wildlife Management and Monitoring Plan

Nature conservation status in the project area is very low. This is mostly caused by the severe degradation of plant communities and animals in the *Artemisia* dry steppe. Except reptiles and birds (including migratory waterfowl) no other biological objects have similar relevance from the point of view of biodiversity and wildlife.

During construction, there will be potential threats to birds and reptiles, due to acquisition of land for excavation (dam and quarries) and dumping of the materials. Rock areas, in particular those more distant to settlements are habitats for lizzards such as agamas and geckos. Increased transportation, not only on Karakorum Highway but side and temporary construction roads will have a negative impact on reptiles while crossing roads during hot season. Already, quite a few killed reptiles including agama, geckos and snakes are found on the road.

After creation of reservoir large dry steppe areas would be lost totally. Habitats of reptiles and birds will be lost and these animals will have to move for recovering new areas for breeding und feeding, if available.

Based upon the inventory of the above named species, with assistance and close cooperation from the national and international organisations for nature conservation, appropriate measures such as protection, relocation, breeding and introduction will have to be determined, if considered necessary later on. Obviously endemic mammals are not presently available in the project area.

During construction, there may be need for training and awareness building of the personnel of contractor(s). However, the most important stakeholders will be the local people, particularly those concerned with the rangeland, including shepherds, foresters and farmers.

Wildlife Management and Monitoring Plan will have to be focused on the following objectives and tasks:

- Avoiding damage of animal habitats during excavation and dumping of construction materials avoiding following areas:
  - Lowest parts of nullahs (the most important habitat areas)
  - Locations around springs
  - Settlements and cultivated land (with irrigation canals)
  - Rangeland with relevant vegetation cover
- Protection of animals including birds most sensitive to noise and vibrations by following measures:
  - Avoiding construction works close to sleeping and nesting places of birds during night time
  - Machinery and vehicles conforming to acceptable noise and vibration parameters
  - Avoiding any traffic (for both construction and leisure needs) through bird habitats
  - Fencing, lighting measures for clearing the construction site, but not during breeding period
  - Careful execution of construction works.
- Preservation of reptiles and their habitats through:
  - Investigating the areas to be used for construction (by Herpetologists)
  - Fencing, lighting measures for clearing the construction site, but not during breeding period

  - Avoiding any construction in reptile areas during the hibernation period
  - Relocation of important individuals and species (especially the endangered endemic species).
- Avoiding any harm to these species during reservoir filling / drawdown through:
  - Non-filing during winter (November-March), which is normally unlikely
  - Limiting reservoir filling to < 1 m/day, during the active summer (June – September)
- Prohibition of hunting

Further degradation of downstream riverine forests and wetlands should be avoided during operation stage of the project. In the context of wildlife, though relatively insignificant in the context of this particular project, a related requirement will be to maintain certain ecological releases on Indus River, particularly when aquatic and semi-aquatic life up to section downstream of Kotri Barrage are active. With the implementation of the proposed recommendation of 2005 studies on 'Water Escapages Downstream of Kotri Barrage', it is envisaged that conditions in this regard could be alleviated. With introduction of Diamer Basha Reservoir, the federal regulating agency of Indus River System Authority (IRSA) will be able to better manage river supplies for fulfilling the requirements of ecology, as far as possible.

A.9.7 Fish Stocks Management Plan

Major impact on fish stocks will occur with the reservoir impounding. Hydrograph and hydrological conditions of Indus River and lower nullah reaches will be significantly changed. Particularly, the spawning areas in Khanbari, Buto, Thak and other nullahs will be changed with adverse impacts on fish stocks. In addition, some fish will be lost when passing through the dam outlets and turbines. Main activities and measures of Fish Stocks Management Plan will be:

- Enabling migration of fish stocks across dam site during construction by measures such as:
  - Appropriate diversions works (canal and tunnel)
  - Avoiding dumping of earth material in Indus River and nullahs
  - Prohibiting blasting at locations with direct impact on water bodies
- Avoiding damage of fish stocks due to water pollution, including:
  - Sewage water treatment flowing out of all labourer camps and lavatories
  - Locating tanks of fuel, oil and other liquids quite distant from any water body
  - Prohibiting washing of vehicles or other machinery in Indus River or nullahs
  - Allowing change of oil for engines and other machinery only in certified workshops
  - Proper maintenance of all vehicles and machinery in order to avoid any leakages
- Prohibition of fish poaching by labourer and construction workers
- Avoiding damage of fish stocks at the dam outlets during operation

From environmental stand point, fish stocks in the Indus River are not of much nature conservation relevance due to location of the dam at the boundary of cold and warm water zone. Thus dam will not block any upstream and also downstream migration of natural fish stock. However, the fish stocks will have to be monitored carefully during the operation phase in order to assess the loss of fish, particularly any newly introduced species in the reservoir.

A.9.8 Reservoir Fishery Management Plan

With the experience at Mangla, Chashma and Tarbela, WAPDA could develop Diamer Basha reservoir as a sizeable fishery resource. Fishery would also become a very relevant factor of employment, which presently is not the case. In addition, the fish would significantly improve food basis of this distant area of Pakistan, where the nutritional level for most of the people is very poor.

This is proposed to be achieved through implementation of a 'Reservoir Fisheries Management Plan' (refer Appendix F, Volume III of Resettlement Plan). Main components of this Plan are:- The overall concept will be to develop the following components to create a sustainable fishery in Diamer Basha reservoir:

- Re-activation of the two almost non-functional existing hatcheries for production of fingerlings in advance:
  - Nima (Khanbari Nullah)
  - Chilas (Buto Nullah)
- Reestablishment of Nima hatchery after submergence at higher location near Narar
- Establishment of at least one big hatchery through enlargement / relocation of the existing one near Chilas
- Adequate production of fingerlings for release into the reservoir
- Research on most suitable fish species for future introduction in the reservoir
- Improving the lot of fishermen through creation of a cooperative

Big hatchery would be completed in the year before first full reservoir filling (possibly 2020), to enable release into reservoir the fingerlings in required number. This hatchery would work initially for a period of about 5 years under control of WAPDA, and later on transferred to the Fishery Department, Diamer district.

A.9.9 Rock Carving Mitigation and Monitoring Plan

Rock carvings in Northern (Gilgit-Baltistan) Areas belong to the national cultural heritage. Indus River valley during past millenniums was the travelling route for many people from different cultures and regions. In the area to be submerged by the reservoir, more than 31,000 rock carvings have been inventoried, distributed on over 5200 stones often comprising several carvings and inscriptions. Maximum concentration of rock carvings is the immediate river valley between Thalpan and Chilas.

Scientific investigations of German Archaeologists from Heidelberg Academy of Science and Humanities (HASH) in cooperation with the Dept. of Archaeology and Museums of Pakistan have been continuing since mid 1980s. The results of this research are contained in the annual published reports available in the above named Department.

A 'Cultural Heritage Management Plan' (refer Appendix C, Volume III of Resettlement Plan) will be implemented with the main plank of rock carvings mitigation. This Plan is based on the inventory carried out by HASH with the following objectives:

- Protection of any damage to rock carvings at the dam site and in the quarry areas during construction
- Identification of most important rock carvings (on the basis of assessment by HASH in consultation with the Department of Archaeology and Museums)
- Physical relocation of most important rock carving objects, where feasible
- Documentation of all important rock carving objects
- Production of computer based 3-D scanned replicas of the most important rock carvings
- Construction of Rock Carvings Exhibition Centre at Chilas
- Promotion of further related scientific activities such as expeditions, publication of rock carving inventory in Urdu language, launching a professorial chair for Archaeology in Karakoram University at Gilgit, awarding of five annual scholarships to students from project area for a period of 5 years and support to a scientific journal on archaeology (over the initial five years).

A.10 Monitoring

Environmental monitoring is an obligatory part of every EIA and EMP. It is required to observe and monitor the state of various environmental components, which are going to be affected potentially.

Basic objective is to monitor all sensitive parameters in order to avoid adverse changes. If there are adverse changes a follow-up by the contractor (during construction) and WAPDA (during operation) will ensure prompt actions to ameliorate those conditions. This will require a schedule of observations and monitoring to match the related requirements. The related monitoring, on synoptic format, has been described through the following Annexes:-

- Annex J-1: Monitoring of construction related impacts on physical environment
- Annex J-2: Monitoring of construction related impacts on biological environment, including health and safety, and rock carvings
- Annex J-3: Monitoring of operation related impacts on physical environment, and
- Annex J-4: Monitoring of operation related impacts on biological environment, including health and safety and rock carvings.

This monitoring will have to be done independently by WAPDA. However, special support will have to be mustered in the areas of: biology; fishery; malaria and health issues; and rock carvings

Monitoring of all mitigation and compensation measures related to the affected population and socio-economic assets will be dealt with separately under the Resettlement Plan.

A.11 Research

There are many aspects for which the current knowledge is not sufficient and will require some further investigations. Especially, the response of environment to the formation of reservoir needs to be investigated for proper environmental management.

The following research topics should be carried out preferably by scientific institutions from Northern (Gilgit-Baltistan) Areas and NWFP (Khyber Pakhtunkhwa). Developing science and education will be a contribution to the region for sharing the benefits from dam construction.

To pursue the research agenda during project operation phase, the following topics will be relevant:-

- River Channel Erosion Immediately Downstream of Reservoir
- Sliding of Slopes and Rock Erosion Along Reservoir Periphery After Impoundment
- Eutrophication and Aquatic Life of Reservoir
- Impact on Springs on Reservoir Periphery Including Water Quality
- Pilot Testing of Sewage Treatment Through Natural Wetland Process
- Introduction of Commercial Fish in Reservoir Area
- Alternate Processes of Gold Extraction From Sand Including Marketing
- Development of Reservoir Related Tourism and Sports
- Malaria and Other Waterborne Infections in Reservoir Area

A.12 Administrative Structure

A.12.1 WAPDA's Organization

For the purpose of overall project implementation, WAPDA will set-up an exclusive organization with formations at headquarter and field (refer Figure L-1). At the field level Diamer Basha Dam Organization will be established under a General Manager to oversee implementation related activities of:

- Preliminary works

- Core project construction through engagement of construction supervision consultants
- Environmental Management and Monitoring through an exclusive cell
- Resettlement and relocation issues of PAPs through a separately created Project Resettlement Organization

Environmental Management and Monitoring Cell (EMMC) under the General Manager at site will be responsible to monitor implementation and mitigation tasks outlined in this EIA Report, including EMP and RP.

While the tasks related to core construction will be overlooked by the supervision consultants, EMMC will need augmentation for:

- Physical and biological environment issues
- Health and safety
- Rock carvings / cultural heritage
- Monitoring of physical and biological environment features

Resettlement management and monitoring, though independently overlooked by EMMC, will be basic responsibility of Project Resettlement Organization (PRO). The related activities of PRO will cover:

- Resettlement
- Compensation
- Awareness and public participation
- Progress of Resettlement process

Project Information Centre of PRO will have to play an important role in creation of awareness among PAPs and mutual confidence building with WAPDA before and after the period of project construction.

Task of the environmental management will also be initiated at the start of construction but not end with impoundment of reservoir. In fact, EMMC will be part of regular set-up of WAPDA during operation stage of the project.

A.12.2 Obligations of Construction Contractors

Contractors, particularly those involved in core project construction, will have to follow 'Sound Environmental Practices' in accordance with the specifications laid down in the respective Bidding Documents. This will, inter-alia, require compliance with following environmental obligations:

- Saving any piece of nature on land, rock material, soils, vegetation
- Preserving local exclusive rights of natural resources use (in particular on water and land)
- Deploying equipment and machinery conforming to environmental parameters (noise, emissions)
- Establishing high standard maintenance system for vehicles and machinery
- Enforcing high standards of skills and responsibility upon the assigned staff
- Managing a highly safe construction system
- Organising appropriate environmental management and safety control system

A.12.3 Environmental Costing

Environmental related cost of the project will have to cater for:

- Planning and implementation of various related management and mitigation plans and monitoring activities (land management, climate and air management, water resources management, health protection and safety, wildlife management, fishery management and cultural heritage (rock carvings) management)
- Monitoring of various activities during construction and operation

During construction, Environmental Management and Monitoring Cell (EMMC) under the General Manager will act as the focal point. This set-up will also form an integral component of WAPDA's permanent set-up for project operation.

Cost of the above mentioned environmental related activities during construction will be charged to the PC-I of 'Land Acquisition and Resettlement' (refer Annex L-1). During operation, this liability will be passed on to the permanent set-up of WAPDA in this regard.

A.13 Conclusions and Recommendations

It is recognized that the project implementation will have serious adverse impacts on the environment in the project area. Out of these adverse impacts, the most prominent would be to relocate a number of PAPs. Submerging their homes, severing economic activities mainly dealing with cultivation and animal husbandry and deteriorating the social structure of traditional villages and neighbourhoods will be a major fallout of this intervention by the public sector.

On the other hand, there will huge positive impacts on the economy of entire Pakistan. These will comprise: supplemental irrigation for highly stressed system; about 35 years increased useful life of Tarbela Dam; supplying relatively cheap electricity from a renewable source for the economic growth of millions of people in the Pakistan; and avoiding further aggravation of global warming. This leads to recommendation for construction of the project based on thorough investigations over last 30 years and state of the art design.

Construction of project will introduce new economic dimensions not only to the particular area but the whole region through:

- Boosting labour and education
- Developing modern infrastructure
- Establishing advanced livelihood through the Model Villages
- Changing and preserving traditional life as much as needed for a modern Pakistani society
- Benefit sharing for further consolidation of the 'trickle down' impact through massive investment

Benefit sharing would mean establishing new livelihoods for the affected people through settlements and homes, supporting cultivation in new areas and general electrification. Benefit sharing, as the basic concept, would also provide a jumping board for developing the entire economic and social life in Northern (Gilgit-Baltistan) Areas, particularly through improved means of communication and general electrification.

B LEGISLATION AND REGULATORY FRAMEWORK

B.1 National Legislation on Environmental Impact Assessment

B.1.1 Pakistan Environmental Protection Act (1997)

Legal requirements for the Environmental Impact Assessment of the Diamer Basha Dam Project are based on the following national legislations:

- Pakistan Environmental Protection Act, 1997
- Review of IEE and EIA Regulations, 2000.

Pakistan Environmental Protection Act [1, p 1-36] formulates basic requirements for the Initial Environmental Examination and Environmental Impact Assessment. It points out: "*No proponent of a project shall commence construction or operation unless he has filed with the Government Agency designated by Federal Environmental Protection Agency or Provincial Environmental Protection Agencies, as the case may be, or, where the project is likely to cause an adverse environmental effect an environmental impact assessment, and has obtained from the Government Agency approval in respect thereof*".

The Government of Pakistan furthermore adopted in year 2000 the *Review of IEE and EIA Regulations.* These contain procedures for the Environmental Protection Agency to: assess compliance with environmental quality requirements; categorise the project including need for preparation of environmental assessment study (either IEE or EIA), and to review the submitted study. Furthermore, it defines the role of Environmental Protection Agency (EPA) as approving governmental agency.

The Pakistan Environmental Protection Act, 1997, and also the Review of IEE and EIA Regulations, 2000 do not require preparation of an Environmental Management Plan – often called Environmental Action Plan. Accordingly, the sponsor after getting the formal approval of the IEE or EIA, may commence construction.

B.1.2 Pakistan Environmental Assessment Procedures (1997)

In 1997, Federal Environmental Protection Agency developed *'Environmental Assessment Procedures'*. These addressed '*comprehensive procedures and guidelines for environmental assessment in Pakistan*'. This document was evolved on the basis of:

- Pakistan Environmental Protection Act, 1997
- Policy and Procedures for the filing, review and approval of environmental assessments
- Guidelines for the preparation and review of Environmental Reports
- Guidelines for public consultation
- Guidelines for sensitive and critical areas
- Pakistan Environmental Legislation and the National Environmental Quality Standards
- Sector guidelines for major thermal power stations, major chemical and manufacturing plants, water supply projects, industrial estates, new township development, major roads, sewerage schemes, oil and gas exploration.

In addition, the document listed some other sectors for which procedures had yet to be drafted. These sectors were: Irrigation and drainage; dams; forestry; and municipal waste disposal. So far sector guidelines for dams have not been prepared by Pakistan Environmental Protection Agency (PEPA).

B.1.3 Guidelines for the Preparation and Review of Environmental Reports (1997)

'Guidelines for the Preparation and Review of Environmental Reports'(1997), prepared by PEPA cover the aspects of commencing construction and required environmental assessment. These describe that there are different ways of achieving mitigations such as: investigation of project alternatives; changes in planning and design; improved monitoring and management practices; compensation in cash; replacement; relocation; and rehabilitation.

As special option on page 22 of the guidelines, it is required *"…to ensure that the commitments in the Environmental Report, subsequent review reports, and Environmental Approval conditions are fully implemented".* Consequently, the need for preparation of an Environmental Management Plan (EMP) is underscored.

Regarding the timing in the project cycle, PEPA ranks the EMP as "a comprehensive technical document which is usually finalised during or following detailed design of the proposal, after Environmental Approval of the development application" (p 22). As most important purpose of the EMP, PEPA emphasises that *"All contractors will be required to observe the mitigation measures stipulated in the Environment Approval"*.

Diamer Basha Consultants (DBC), on behalf of Water and Power Development Authority (WAPDA) have followed "Good Practice of Environmental Assessment" in preparing this Environmental Impact Assessment (EIA) Report.

B.2 International Regulations and Requirements on Environmental Assessments

B.2.1 ADB Requirements for Preparation of Environmental Assessments of Projects

Asian Development Bank in its Safeguard Policy Statement (June 2009) affirms that "environmental and social sustainability is a cornerstone of economic growth and poverty reduction in Asia and the Pacific" (p 14). Furthermore the document underlines the ADB's Strategy 2020, promoting the "sustainability of project outcomes by protecting the environment and people from project's potential adverse impacts".

The Environmental Impact Assessment in hand is fully committed to the requirements determined in the "ADB Safeguard Policy Statement". The environmental works carried out by DBC on behalf of WAPDA have been essentially guided by these rules as enunciated in the "Outline of an Environmental Impact Assessment Report" (Annex to Attachment 1 of this document).

In the light of significance attached by ADB to various environmental impacts, Diamer Basha Dam Project (DBDP) is to be assigned Category A due the following reasons:

- Unprecedented work in Northern (Gilgit-Baltistan) Areas of Pakistan:
  - 4,500 MW hydropower generation capacity
  - About 110 km long reservoir altering the life of local population
- Irreversible infrastructure:
  - About 1 km long and 272 m high dam obstructing the Karakorum Valley
  - Establishment of underground structures like tunnels and caverns
- Diverse impacts:
  - Changing the livelihood of > 28,000 directly affected local population
  - Changing the hydrological and aquatic regime upstream and downstream.

Thus, a full Environmental Impact Assessment of the project was started in 2005 and concluded in 2010 through the following documents:-

- Environmental Impact Assessment report including an EMP (this document)

- Resettlement Plan for involuntarily relocation of the impacted villages and communities (companion document)
- Indigenous Peoples Plan, (if needed).

B.2.2 Compliance With Other International Requirements

Furthermore, DBC during the entire process of preparation of documents followed the various international procedures defined by documents such as:

- IFC Operational Policy 4.01 Environmental Assessment (1998)
- IFC Annex C – Environmental Action Plan OP 4.01 (1998)
- WCD (World Commission on Dams): Environmental Indicators and Strategic Priorities
- Relevant international environmental agreements, conventions and protocols to which Pakistan is a party

B.3 National Water Rights

B.3.1.1.1 Indian Irrigation Commission (1901-1903)

British Indian Government appointed the Indian Irrigation Commission at the turn of the 19th century to lay down the policy so that irrigation schemes in the sub-continent could be completed without detriment to the right of upper and lower riparians. The policy was reaffirmed by the Government of India Act 1919, which required that all irrigation projects concerning more than one province be referred to the Governor General for his decision.

B.3.1.1.2 Anderson Committee (1935)

This was appointed by the Government of India to apportion the water rights of various co-shares of the Indus Basin.

B.3.1.1.3 Draft Sindh-Punjab Agreement (1945)

As a sequel to the Sindh-Punjab water dispute in early 1940s, the Government of India appointed Indus (Rao) Commission. On the basis of ruling by this Commission, Government of Sindh and Punjab negotiated this agreement. Accordingly, a draft was prepared but it could not be signed due to independence of the sub-continent in 1947.

B.3.1.1.4 Indus Waters Treaty (1960)

In 1948, India unilaterally cut off supplies to Pakistan canals originating from the headworks, located on the eastern rivers thereby asserting its right on the waters of the three eastern rivers (Ravi, Beas and Sutlej). After protracted negotiations, the water dispute between India and Pakistan was finally resolved through the good offices of World Bank and culminated in the signing of the Indus Waters Treaty on 19 September 1960.

Under the Indus Waters Treaty, India was entitled to exclusive use of the water of eastern rivers namely, Ravi, Beas and Sutlej. The supplies of the western rivers (Indus, Jhelum and Chenab) except for insignificant local use in Indian Occupied Kashmir were allocated to Pakistan.

To implement the provisions of Indus Waters Treaty, Indus Basin Project (IBP) was implemented in Pakistan over the period of 1960-77. Besides network of inter-river link canals, IBP included two major storage reservoirs on Jhelum (Mangla) and Indus (Tarbela) to mitigate the effect of diverting three-eastern rivers by India. As part of the implementation schedule of IBP, Mangla Dam Project was completed in 1967, followed by Tarbela Dam in 1977. A small re-regulatory storage as part of Chashma-Jhelum Link was also created at Chashma Barrage in 1971.

B.3.1.1.5 Water Apportionment Accord (1991)

In 1991, the Water Apportionment Accord was signed between the representatives of all the four provinces to allocate supplies to the existing projects and future developments of the Indus River System. The need for storage wherever feasible on the Indus and other rivers was also recognised for planning future agricultural developments. The Water Apportionment Accord also included the following provision for Indus Delta:

> "*The need for certain minimum water escape to the sea below Kotri Barrage to check sea intrusion was recognized. An optimum level of 10 MAF was discussed. It was decided that further studies would be undertaken to establish the minimal escapage needs downstream of Kotri Barrage."*

An Indus River System Authority was to be established to implement the Water Apportionment Accord with representation from all four provinces and the Federal Government. The system-wise allocations would also be worked out on a 10-day basis with actual average system uses for the post-Tarbela period 1977-82 providing guidelines for developing future regulation pattern.

B.3.1.1.6 Indus River System Authority (IRSA)

In April 1993, the Indus River System Authority *(IRSA)* was established under an Act of the Parliament to oversee as well as regulate water distribution of Indus River System among provinces according to Water Apportionment Accord.

B.4 Customary Laws Governing Natural Resource Management in Northern (Gilgit-Baltistan) Areas

Natural resources in Northern (Gilgit-Baltistan) Areas are managed under unwritten customary laws passed down through oral tradition, which have now been adopted by community. Presently, two different types of traditional laws operate in the Northern (Gilgit-Baltistan) Areas with reference to rights of users and management of natural resources. These are:

- Rawaj (Customary Law): A set of rules are practiced, preserved and passed down through oral traditions and have become the model for accepted behaviour for members of a community.
- Shariah (Islamic law): Laid down in the Holy Quran covering almost all aspects of a Muslim's life.

Either or both systems may be used in resolving a dispute over the use and management of natural resources i.e. forests, pastures, wildlife and water. Respondents to questionnaire survey (2006-07) by DBC reported that: 'it was agreed when Northern (Gilgit-Baltistan) Areas became a part of Pakistan in the early 1950s that the communities would retain rights over their forest, pastures, and nullahs. Therefore, all matters pertaining to natural resources should be decided in accordance with customary law'.

There are 17 nullahs on left side and 12 on right side of River Indus in the project impacted area from Raikot Bridge to dam site. Usually, communities have a traditional right to utilize water source from nullahs that flows through their village boundaries. Water from such a source is considered common property. A neighbouring village is not allowed to use the same source of water without the consent of the owners. There are two types of ownerships of nullahs in the Northern (Gilgit-Baltistan) Areas: those owned by individual villages; and those owned by several villages.

In the past, traditional water rights were established for irrigation water. Currently, it is also an important issue in relation to piped water supply schemes. In villages where water is abundant throughout the year and where it is only used for irrigation, water rights are not strongly enforced. In villages with a seasonal shortage, water rights can become a more serious issue as they affect the allocation of water. A relevant example is shown in Box B-1.

Box B-1: Water Rights – An Example from Bargin Nullah

Water Rights decision by two Jirgas:

Bargin nullah has insufficient water to supply all agricultural land in Draing Hit and Draing Das Village. Both communities have water rights for the agricultural lands. However, they do not have equal rights because the village Draing Das had been developed as new settler village. Finally they jointly developed the following system to overcome water shortage:

The inhabitants of Draing Hit will use the water of Bargin Nullah for two days (means 20 days per month). Then water will be given to the inhabitants of Draing Das for one day. Thus, they only have half the water rights although both villagers belong to the local tribes of Sheen and Yashkun.

In final analysis, the inhabitants of Draing Das, despite having more cultivable land than Draing Hit, are entitled only to half water use rights. Thus, some land in Draing Das remains uncultivated while in Draing Hit there is more water available for lesser cultivated land.

Water use rights entitle specific people to utilize a particular water source. In most villages, communities have also developed systems to determine the quantity of water to be used by a single household. A single household's allocation is determined by the size of its landholding. In villages where water is short, communities have developed indigenous systems for water distribution to overcome shortages. The *Maliks*, who are local tribes of Yashkun, Sheen and Kameen exercise the community ownership in using natural resources including nullah.

The *Wai Sigalo*, appointed by the people, is supplying water for irrigation and other purposes from the nullah through the water channels to the farmers. He supplies in the morning water to the fields and makes sure that no excess water comes into the fields. He closes the supply in the evening. Local tribes Yashkun, Sheen and Kameen do not pay for use of the water. However, tenants such as Soniwal, Gujar, Kohistan, Pattan and other non-local tribes get water only after paying *Kalang* to the Jirga of community. Depending on the Jirga, the fine for non-payment can be in the form of an animal, ghee or cash. The *Wai Sigalo* is paid for his service by all households with 15 kg maize per year. Maintenance and repair of the waterways under the supervision of the Jirga head ("*Jastero*") is collective responsibility of males in the village.

C DESCRIPTION OF THE PROJECT

C.1 Pakistan's Vision 2025 Programme

Construction of Diamer Basha Dam Project (DBDP) will form an important plank of WAPDA's Vision 2025 Programme, approved by the Government of Pakistan in 2001. Its basic objective will be to augment the water and power resources of Pakistan for boosting irrigated agriculture and electricity generation. These two inputs are essential for sustaining the national economy and particularly food and fibre needs of burgeoning population of Pakistan, currently (2010) estimated around 175 million and growing at the compound annual rate of over 2 %.

Agriculture sector of Pakistan is under huge stress as a result of reducing irrigation supplies due to progressive siltation of the three on-line storage reservoirs at Mangla, Tarbela and Chashma. In addition, some new irrigation projects with aggregate water allocations of about 4.2 billion cubic meters (BCM) are nearing completion as part of Vision 2025 Programme. Despite significant industrial development, Pakistan's economy continues to be agro-based with as much as 65 % foreign exchange earnings from agriculture. Concrete measures are thus necessary not only to sustain but enhance supplies for irrigated agricultural production. This could be best accomplished through construction of large water storage projects like Diamer Basha Dam.

Availability of scarce fossil fuel resources of oil and natural gas for power generation and large imports of former are adversely affecting the national balance of payments. As much as 85 % of oil and allied products are imported and during the year 2007-2008 this bill stood at US$ 1.25 billion. Progressively increasing shortage of natural gas has necessitated increased use of furnace oil, prices of which are also tied with the oil prices in international market.

C.2 Current Energy Situation and Future Potential

Large deposits of Thar coal in Pakistan still remain un-utilized for power generation. This is basically due to lignitic nature and excessive moisture in Thar coal, exploitation and mining of which will require huge foreign investment and long gestation period. On the other hand, energy requirements in the country have been recently growing between 3-4 times of the annual rate of population growth of over 2 %. Previously, there used to be some load-shedding only during the winter months due to shortage of natural gas for thermal generation. However, now it has assumed menacing proportions due to the snow balling impact of: under-utilized capacity of existing thermal power plants due to one reason or another, significantly higher rate of demand growth against projections, and almost complete moratorium on construction of a major multi-purpose storage project after commissioning of Tarbela in 1977. Consequently, the country is now facing one of the worst power storages of its history. This persisting power deficit has decelerated, in particular, the industrial and agricultural sectors with stunted growth of national economy.

Viewed in the current energy crunch scenario, very high priority should be accorded to exploitation of the available hydropower potential through multi-purpose projects of the size of Diamer Basha. Fortunately, Pakistan is endowed with a very large renewable energy resource in the form of hydropower with a conservatively estimated potential of around 46,000 MW. Out of this, only about 6,600 MW has been exploited to date. During the past few decades, due to non-construction of any multi-purpose storage project, the share of hydropower generation in the National Power Grid has gone down from about 70 % to 30 %. This trend, besides serious economic consequences, needs to be reversed to keep the power tariff within affordability of the consumers.

C.3 Project Goals and National Benefits

WAPDA, on behalf of the Government of Pakistan and other international donors, to be supported by the Asian Development Bank (ADB), is proposing to construct Diamer Basha Dam Project (DBDP) on the upper Indus River located nearly 40 km downstream of Chilas town (refer to Map 1).

Primary objectives of DBDP are to improve significantly the storage capacity in the stressed Indus River System and to inject a big chunk of relatively cheap and clean (due to the renewable nature)

energy to the electricity starved 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 45 years through trapping large amount of sediment
- 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.

Besides the above national benefits, a major 'trickle-down effect' of the project will be significant improvement in socio-economic conditions in the backward Northern (Gilgit-Baltistan) Areas of Pakistan.

C.4 Salient Features of the Diamer Basha Dam

Salient features of Diamer Basha Dam Project are shown in Box C-1 while details are contained in Annex C-1.

Box C-1: Salient Features of Diamer Basha Dam Project

Element	Details / feature	Description
Catchment	Area	153,200 km²
	Mean Annual Inflow	62 BCM
	Probable Maximum Flood (PMF)	49,4170 m^3/s
Dam and Reservoir	Location	40 km downstream of Chilas
	Type	roller compacted concrete (RCC)
	Crest Level	1,170 masl
	Maximum Height	272 m
	Full Reservoir Level (FRL)	1,160 masl
	Minimum Operation Level (MOL)	1,060 masl
	Live Storage Capacity	7.9 BCM
	Length of Reservoir	102 km
	Surface Area	115.2 km²
	Storage Capacity	13 % of Inflow
Power Facilities	Number of Power Houses (Left and Right Bank)	2
	Turbines (units)	12
	Total Installed Capacity	4500 MW

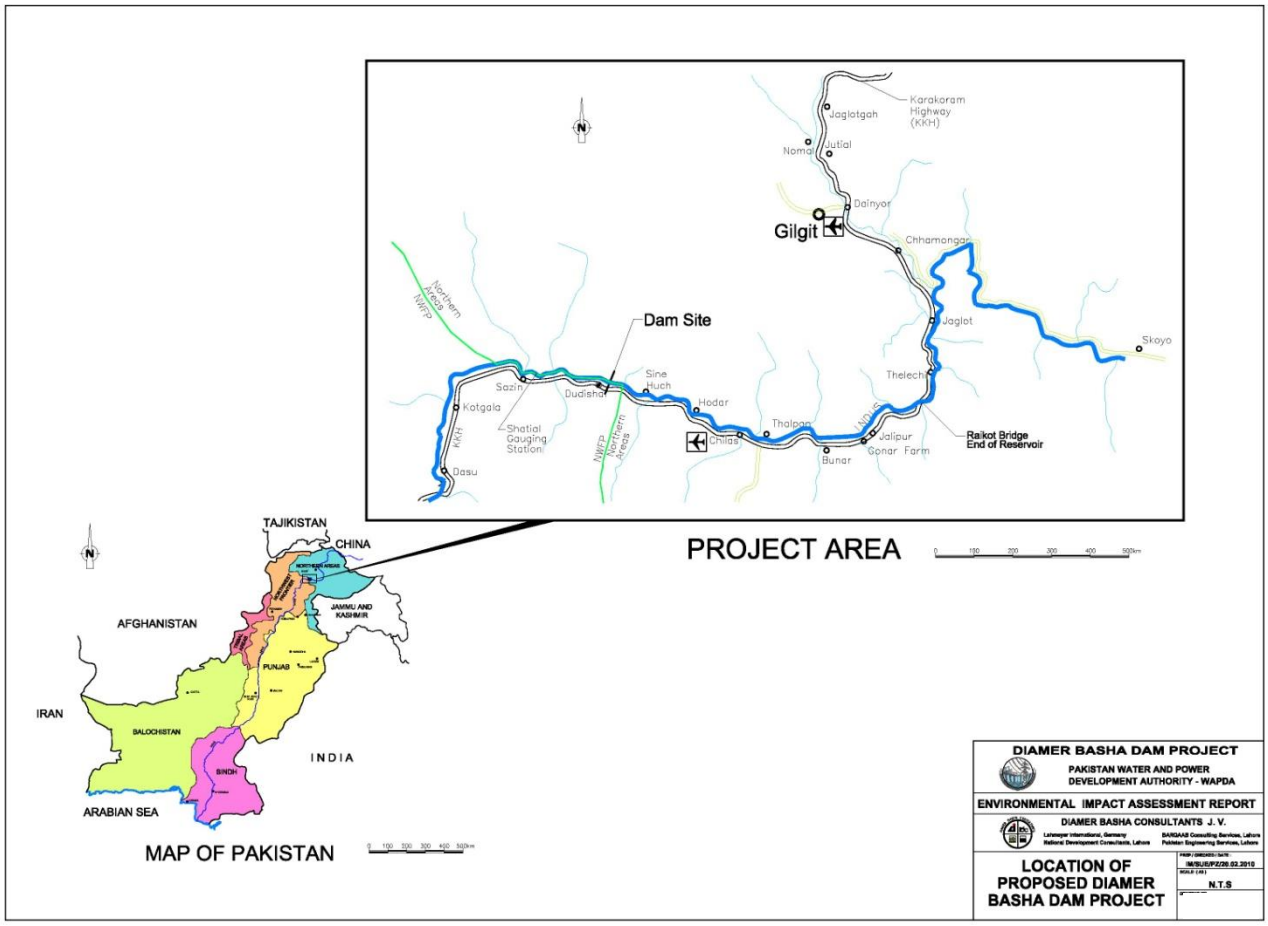
Source: DBC, 2009

C.5 Location, Footprint and Catchment Area

C.5.1 Location

Diamer Basha Dam will be located about 40 km downstream of Chilas, the district headquarter of Diamer in N(GB)A (refer Figure C-1 and Map 1). This location has been selected on the basis of evaluation through Feasibility Studies of MONENCO (1984) and NEAC (2004) and investigations by DBC (2006-08) during the phase of detailed engineering design.

Figure C-1: Location of Proposed Diamer Basha Dam Project



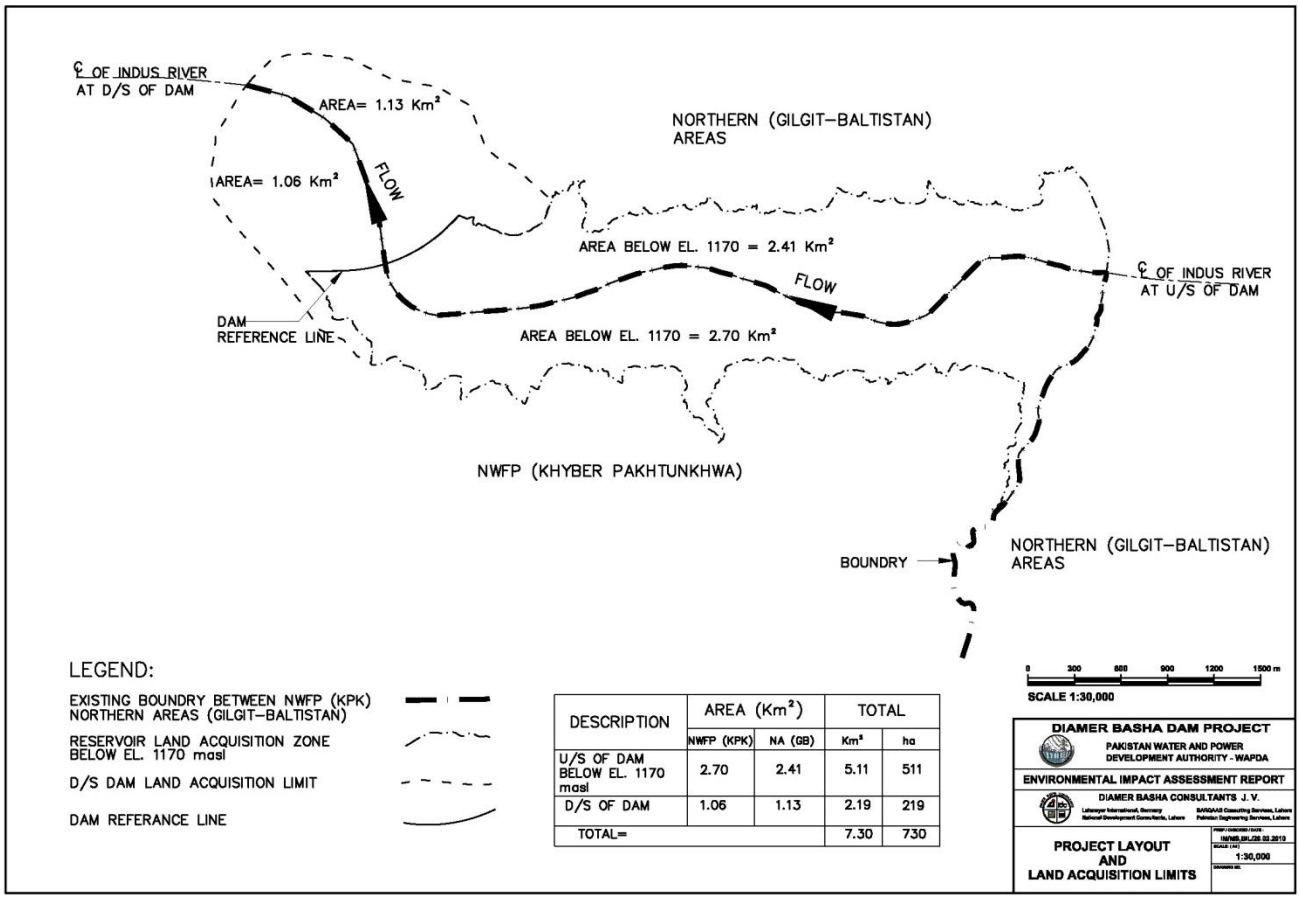
C.5.2 Footprint

The dam will be slightly curved gravity structure of roller compacted concrete (RCC) with a crest level of 1,170 meters above sea level (masl) and crest length of over 1,000 m. The maximum height will be 272 m above the firm rock foundation. Full reservoir level (FRL) will be 1,160 masl with minimum operating level (MOL) of 1,060 masl having a live storage capacity of 7.9 BCM. A spillway will be located over the dam with two low level outlets and five reservoir flushing outlets underneath embedded in the dam body. The spillway will be used for releasing excess supplies during high flows as well as controlling the reservoir water level in the event of floods. The low level outlets will be operated to replenish the downstream supplies in case of any shortfall through the power outflows. The reservoir flushing outlets have been designed for the purpose of eroding and flushing sediment deposited in the reservoir when necessitated by the advancing delta.

Two underground powerhouses will be constructed, one on each bank, with total installed capacity of 4,500 MW (2,250 MW each). The power house on the left bank will be located in NWFP (Khyber Pakhtunkhwa) while that on the right bank in the Northern (Gilgit-Baltistan) Areas (refer Figure C-

2). Total number of turbo-generator units will be 12, each of 375 MW. Each power complex will consist of two headrace tunnels, two surge tanks, six penstocks, six power units and two tailrace tunnels. The design discharge for each unit will be 247 m³/s.

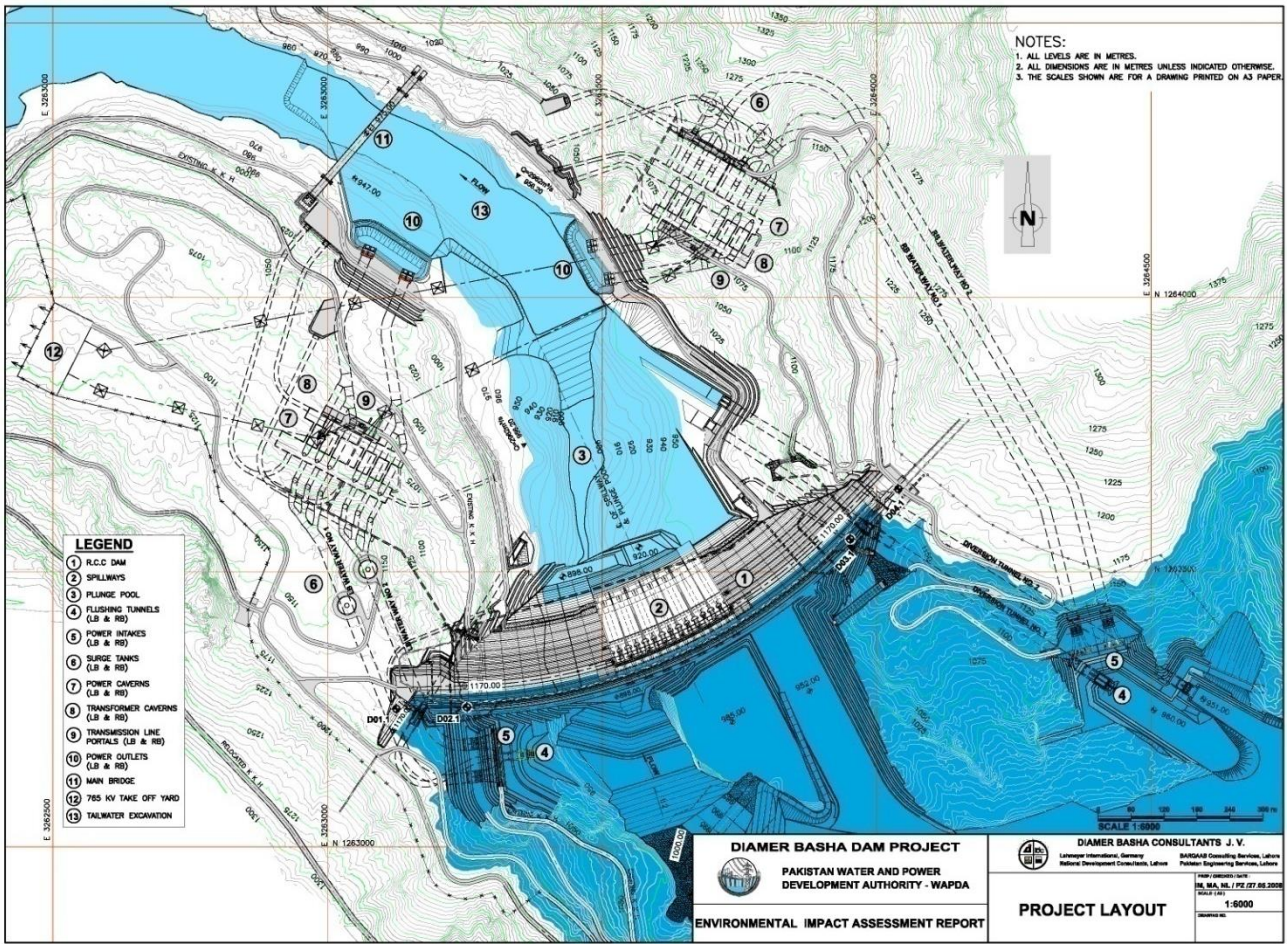
Figure C-2: Project Layout and Land Acquisition Limits



DESCRIPTION	AREA (Km²)		TOTAL	
	NWFP (KPK)	NA (GB)	Km²	ha
U/S OF DAM BELOW EL. 1170 masl	2.70	2.41	5.11	511
D/S OF DAM	1.06	1.13	2.19	219
TOTAL=			7.30	730

An area of about 730 ha will be occupied by the dam and appurtenant structures, including two power houses (refer Figure C-3). This area comprises the riverbed itself, steep rock slopes on the left, a huge rock outcrop on the right bank and some flood banks. No residential or cultivated land is going to be occupied by the project.

Figure C-3: Project Footprint and Regional Boundary



Besides the area for the permanent facilities of dam, some additional areas will be needed mostly for temporary use. About 183 ha at six locations are foreseen as: construction camps including labour; storage of cement, fuel, steel, timber and other materials; and quarry sites outside the land acquisition zone of 1,170 masl. Most of these areas are located along the Karakorum Highway (KKH) between Shatial (19 km downstream), the dam site and identified quarry sites upstream. Further area is required for stock piling of sand and aggregates, which will be submerged in the future reservoir.

Environmentally relevant dam construction activities are (also refer MAP-2):

- Excavation and permanent coverage of 730 ha large area of dam including powerhouses and switchyard, mostly composed of riverbed and rocks
- Excavation of rock and temporary coverage by diversion through upstream and downstream cofferdams
- Blocking of Indus River (up to water level of 977.5 masl) through upstream cofferdam
- Diversion of the Indus River through canal and two tunnels for downstream release of water
- Dumping of 18 million m³ excavated material on 61 ha area at suitable locations
- Batching plant area(s) at suitable locations
- Heavy vehicles transport along the site to Chilas and downstream from the dam site
- Workers at dam site(s) with peak requirement of over 10,000
- Working schedule: 24 hours, 7 days per week, 3 shifts, over 10 years

C.5.3 Catchment Area

The Indus River generally flows in a deep, narrow gorge and at a very steep gradient down to the selected dam site. The entire catchment area above the dam site is about 153,200 km^2 and drains Himalaya, Hindukush and Karakoram Ranges. The flow contribution is from both glaciers and snowmelt in the high mountain areas of Pakistan, India and China (Tibat).

C.6 Other Construction Works and Related Activities

C.6.1 Transmission Lines and Initial Environmental Examination

It is proposed that the electricity generated by the project be evacuated to the national load centres through 765 kV transmission system. Its feasibility including routing has been undertaken by National Transmission and Despatch Company (NTDC) of WAPDA as part of integrated study for evacuation of hydropower generation in the North (Diamer Basha, Dasu, Bunji projects etc) to the National Grid in the South. Design and construction of these extra high voltage transmission lines from the dam site will be also the responsibility of NTDC.

Electricity generated by the project, besides connection to the downstream National Grid, will also be transmitted to Chilas and further to Gilgit through a separate 132 kV double circuit transmission line. This transmission line will play a pivotal role in future development of the project area through general electrification.

For this transmission line to Gilgit, DBC have conducted an Initial Environmental Examination (IEE). Design and construction of this transmission line will be also the responsibility of NTDC (WAPDA).

C.6.2 Transportation During Construction and Bridge Close to the Dam

The dam is located in a narrow gorge far from any settlement. The existing Karakorum Highway (KKH) on the left bank will be relocated along the foothills at elevations above 1,200 masl starting from downstream location of Shatial. This component is going to be constructed under a separate contract to be administered by National Highway Authority (NHA).

There will be very high demand on transportation during construction for purposes of goods and personnel over a period of about 10 years. Railway transport is only available up to Havelian and so the only transport artery is the KKH. Therefore this highway will be utilised in both directions

- Upstream: from Kashgar-Gilgit-Chilas to the dam site; and
- Downstream: from Havelian-Abbottabad–Mansehra-Thakot–Dasu up to the dam site.

The upgradation of five sections (about 324 km) of the Karakorum Highway from Havelian to the dam site is now under way through National Highway Authority. Similarly, relocation of KKH at the left bank along the foothills at higher elevations (1,200-1,250 masl) will be under separate contract to be administered by NHA.

Prerequisite for dam construction works is to link KKH with the right bank close to Dudishal village through a permanent access bridge. The bridge will be built as part of the Diamer Basha Dam Project, some 1100 m downstream of the dam site. Currently, a light traffic road is under construction by Northern (Gilgit-Baltistan) Areas Public Works Department (NAPWD) along the right bank starting from Dudishal. This road crosses proposed dam site at higher elevation and traverses upstream towards Khanbari Nullah. This road from Khanbari valley further on to the village Nima could later serve as alignment for the proposed right bank periphery road.

Various, mostly only jeep-able, roads start and end at KKH. They are the only access from the settlements in the side valleys and nullahs. In addition, other project related construction roads will also be required to be constructed by the contractors for accessing various locations such as dam

site, cofferdams, underground powerhouses, storage places, concrete batching plants, quarries and construction camps.

A right bank periphery road is proposed to be constructed starting from the permanent access bridge downstream of the dam site and extending up to the upper segment of relocated KKH after crossing over to the right bank of Indus River. This single item, besides providing uninterrupted access to all the affected settlements on the right bank, will go a long way towards socio-economic development of this isolated backward area.

Due to the lack of any plant in Northern (Gilgit-Baltistan) Areas approximately 2 million t of cement will have to be transported from large factories around Islamabad and Rawalpindi to the dam site continuously over a number of years. Currently a road to Chilas via Mansehra and Babusar Pass is under reconstruction but it may not provide a reliable all weather connection.

Environmentally relevant road/bridge construction elements are:

- Location including length and surface area of construction roads around dam, powerhouse, switchyard, etc.: 730 ha area.
- Labourer camps, batching plant, stock piling etc: 173 ha area

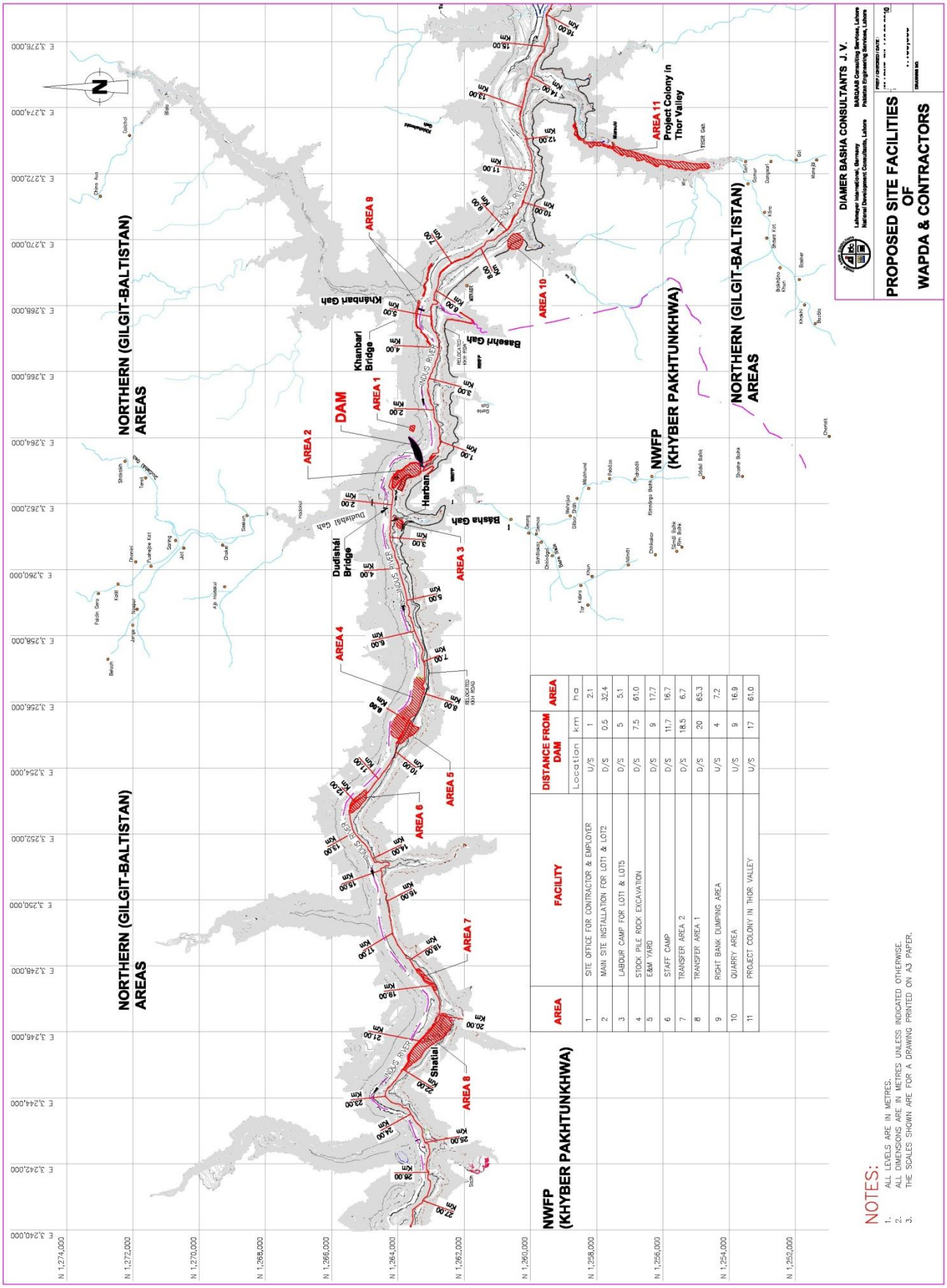
Environmentally relevant dam construction processes are:

- Average of daily transport for construction on the road Dudishal-Nima (Khanbari valley)
- Average of daily transport for construction and potential deterioration of regional transport on Karakorum Highway section Dudishal-Dam Site due to bridge construction.
- Working schedule: shifts.

C.6.3 Construction Camps and Storage Area

During construction about 173 ha additional area will be required for contractors' camps and storage. It will be located both upstream and downstream of the dam site as shown in Figure C-4, and comprise main site installations, labour camps, excavation stock piles, work yards, staff camps, transfer areas, dumping areas, quarry areas, and the Project Colony in Thor Valley.

Figure C-4: Proposed Facilities of WAPDA and Contractors



AREA	FACILITY	DISTANCE FROM DAM		AREA
		Location	km	ha
1	SITE OFFICE FOR CONTRACTOR & EMPLOYER	U/S	1	2.1
2	MAIN SITE INSTALLATION FOR LOT1 & LOT2	D/S	0.5	32.4
3	LABOUR CAMP FOR LOT1 & LOT5	D/S	5	5.1
4	STOCK PILE ROCK EXCAVATION	D/S	7.5	61.0
5	E&M YARD	D/S	9	17.7
6	STAFF CAMP	D/S	11.7	16.7
7	TRANSFER AREA 2	D/S	18.5	6.7
8	TRANSFER AREA 1	D/S	20	65.3
9	RIGHT BANK DUMPING AREA	U/S	4	7.2
10	QUARRY AREA	U/S	9	16.9
11	PROJECT COLONY IN THOR VALLEY	U/S	17	61.0

Most of the land under these facilities will lie outside the reservoir land acquisition zone of 1,170 masl. However, excepting the Project Colony in Thor Valley, the area to be acquired will comprise barren land in the river bed and margins. As shown in Figure C-4, this area will stretch up to about 14 km upstream and 22 km downstream of the dam site.

The main six areas will be located downstream on the left bank along KKH from dam site to Shatial (see Figure C-4). Administratively, this area lies in District Kohistan of NWFP (Khyber Pakhtunkhwa) with relevant particulars listed in Table C-1:

Table C-1: Additional Area for Construction Camps and Storages Outside the Dam Site

Sr. No.	Proposed Site	Area (ha)
1	Labour Camp(s) Lot 1 to 5	5
2	Stock Pile Rock Excavation	61
3	E&M Yard	18
4	Staff Camps	17
5 6	Equipment and Machinery Storage	72
Total		**173**

Source: DBC November 2007

Environmentally relevant labourer camp elements are:

- Labourer and staff camp(s) downstream of dam site on left bank: 22 ha.
- Peak occupational capacity of camps: estimated over 10,000 persons male
- Overall period is from 2011 to 2020 (about ten years).

Environmentally relevant processes are:

- Staff and workers to be accommodated: over 10,000 with about 99% locals.
- Gender and health issues
- Traditional, cultural peculiarities of the labourers.
- Alcohol, drugs, prostitution, communicable diseases.
- Labourer camps after completion of construction to be handed over to WAPDA; further transfer to interested governmental agencies or local communities could also be considered at nominal / salvage value.

To properly handle the lodging of this large work force, the contractor(s) will be obliged to prepare and implement 'Labour Development-Cum-Management Plan' including the camp followers (a preliminary version included as Appendix H in Volume III of RP).

C.6.4 Water Supply in Construction Facilities and Camps

Presently almost all water for drinking for an estimated population of about 82,000 people in the project area is taken from the nullahs. The additional need of water for the construction activities including camps (WAPDA/Contractors) will be supplied with drinking water, extracted either from the Indus River or perennial nullahs, subject to availability over and above the requirements of local population.

This water supply, particularly for the construction workers will have to conform to Pakistan Water Quality Standards.

C.6.5 Water Sanitation in Construction Facilities and Camps

The sewage effluent from construction facilities and camps will have to be treated at site using modern technologies. All such treated water will be released into Indus River or nullahs so as not to harm population and natural environment.

C.6.6 Solid Waste Disposal in Construction Facilities and Camps

Sewage water and solid waste materials from any construction activities including camps will have to be collected and, if possible, re-utilised as compost or to be treated and disposed off safely.

C.6.7 Supply and Handling of Electricity and Fuel

In the project area, there is a lack of electricity and consequently many settlements even along the Indus River presently do not have any electricity or water supply. The contractor(s) will have to establish facilities for generating electricity for all construction purposes.

Thus, liquids such as petrol, diesel, and lubricants will be used by the construction contractor(s) in large quantities. All these items will have to be transported to the site through special tanks and carefully stored and handled at appropriate places to avoid harmful spillage or even fires.

Environmentally relevant pollution processes are:

- Potential Indus River pollution: avoidance through release of treated water according to the Pakistan standards into the river.
- Potential exhaust gas emissions: from incineration plant(s) for solid waste as per Pakistan Standards.
- Explosive material: Secure handling and storage facilities in accordance with Pakistan Standards.

C.6.8 Handling of Liquids and Explosives During Construction

Much explosive material will be needed for excavations at the dam site (including powerhouse, diversion tunnels and cofferdams etc.) and the quarries. Locations will have to be established, as per prescribed regulations, for safe storage/handling of these explosives. Environmentally relevant excavation / quarrying processes are:

- Blasting: locations, frequency (15-20 numbers at maximum per day), and security measures (Pakistan Standard Register).
- Use of explosive material: ammonium nitrate (bulk) and slurry type explosive (cartridged) non-detonators shall be used, safe storage locations downstream of dam site for about 13,500 tons of explosives.

C.6.9 Excavation of Construction Materials at Quarries

Huge amount of surface rock and common excavation (estimated over 23 million m^3) will be done around the dam site. Fortunately, on the other hand, there will be very large requirement for aggregates to be consumed in the main roller compacted concrete (RCC) dam. Firstly, the excavated material will be processed for conversion to aggregates. Any shortfall will be made up from some of the quarries located upstream of the dam in the margin of the future reservoir. Reportedly, there are some lacustrine deposits in the project area, which could be used as additives and retarders for production of RCC. Sand and gravel for the concrete production could be manufactured either from the excavated materials or the quarry areas identified in the project vicinity. Most of these quarry areas will be flooded after reservoir impounding.

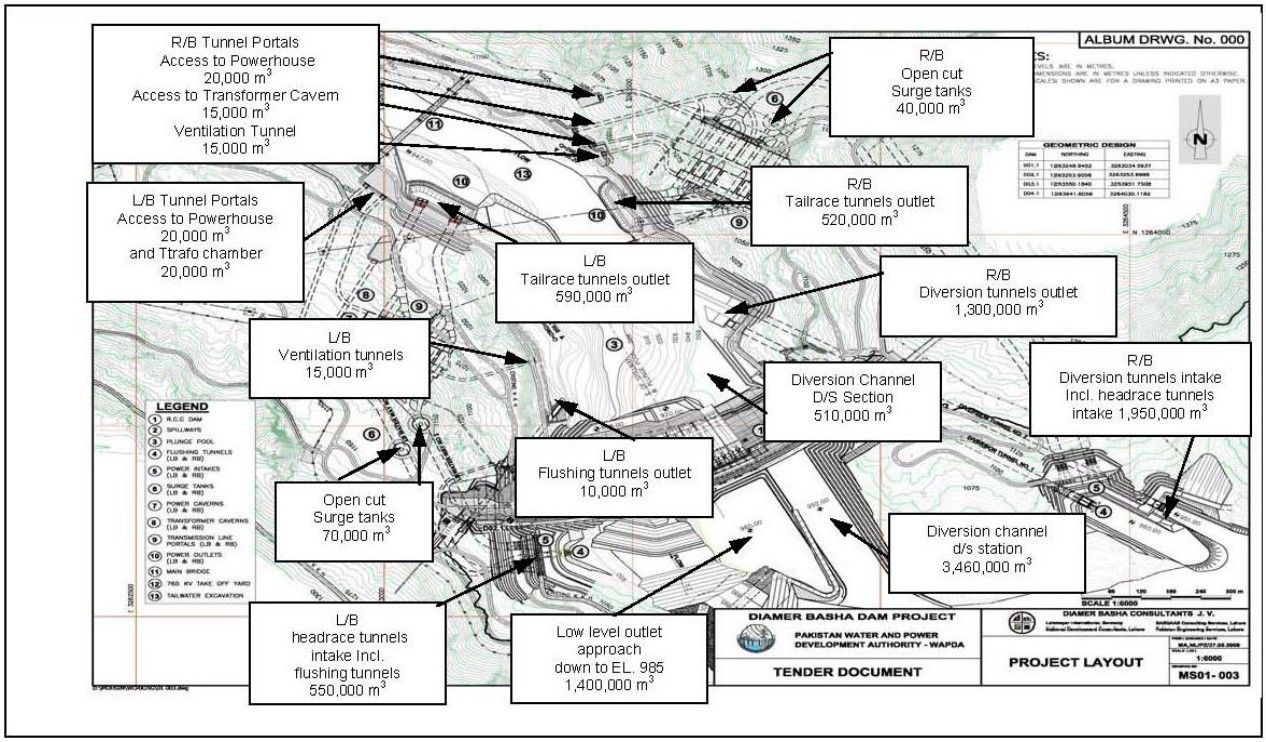
One major problem from construction as well environmental point of view will be spoiling of the materials for certain periods before using for the RCC dam construction.

Environmentally relevant excavation / quarrying processes are:

- Types and amount of construction materials required
- Locations of quarries and borrow areas: Khanbari, Baseri, Minar, Thor, and Gini
- Overall excavation amount: > 27 million m³ of rock, gravels and sand from dam site area
- Transport (for quarries only) road locations
- Excavation periods: surface excavation 4.5 years; underground excavation 5 years
- Average of daily transport on quarry roads (vehicles per 24 h) with principal haul units of 30 to 60 ton load capacity of rear dump trucks assuming:
  - Surface excavation > 750 movements per day maximum
  - Underground excavation >250 movements per day
- Workers and other personnel at quarry site(s): number of locals and expatriates.
- Working schedule: 2/day shifts, period, 8 years.
- Avoidance of damage of rock carvings in the quarry areas.
- Blasting operations for underground works estimated between 15-20 per day, and for surface rock excavation between 5-10 blasts per day.

Figure C-5 indicates the proposed 14 location of blasting operations / equally divided between left and right banks with corresponding estimated quantities of rock excavation.

Figure C-5: Proposed Locations of Blasting Operations



C.7 Reservoir Operation

C.7.1 Reservoir Filling

Normal reservoir filling will be during about 100 days from June through August. Conjunctive operation of Tarbela and Diamer Basha would have the impact of somewhat lowering the water level below Tarbela during this 100 day filling period. Starting in June with 0.01 m, this lowering of water level in the Indus River downstream of Tarbela could increase to 0.39 m in August.

Environmentally relevant operational items of the project area:

- Trash rack protection at the power intake gates: 140 mm openings.

Environmentally relevant filling and operation issues are:

- Hibernation period of reptiles from end April to end May.
- Initial staged filling period of four years:
  - First year of partial filling: (7^{th} construction year) 2017.
  - Second year of partial filling (8^{th} construction year) 2018.
  - Third year of partial filling (9^{th} construction year) 2019.
  - Fourth year of filling to FRL (10^{th} construction year) 2020
- Regular filling period: June to August.
- Minimum release through powerhouse / low level outlets at MOL of 1,060 masl: about 2,960 m^3/s from the two powerhouses and 1,040 m^3/s from two low level outlets.
- Spill-out: For a discharge of about 2,700 m distance upto Dudishal.
- Spill-out magnitude: During flood routing

Event	Outflow (m^3/s)	Reservoir Level (masl)	Downstream Water Level (masl)
1 in 10,000 year flood	18,860	1,160.36	969.0
Probable Maximum Flood (PMF)	35,690	1,167.71	979.33

- Spill-out after reservoir filling:

  Average annual spill = 1,726 m^3/s (1977 – 251 m^3/s)

  Average annual frequency = 50 days (August 11 to September 30).

C.7.2 Reservoir and Storage Capacity

Cross reservoir volume at FRL of 1,160 masl will be about 10 BCM with a live storage volume of about 7.9 BCM. The dam will impound about 13% of the mean annual river flow of the Indus at this site. The reservoir will have a length of 102.1 km and reach up to Raikot Bridge (refer MAP-4 Diamer Basha Reservoir). The total area of the reservoir at FRL of 1,160 m will be about 115.2 km^2. At the MOL of 1,060 m the reservoir will occupy an area of 47.6 km^2 extending to a length of 73.1 km. Initial reservoir filling in stages will take place over four years starting from 7^{th} construction year (2017). Its normal filling will be over the high runoff period from June to August while drawdown may be from September to May to supplement low flow period water supply.

It is estimated that above the FRL of 1,160 masl even with occurrence of critical event of "Glacier Lake Outburst Flood" (GLOF) corresponding to PMF, the reservoir level will not attain the level

beyond 1,167.71 masl. After providing for a further freeboard, the designed crest level of the dam has been kept as 1,170 masl.

During the drawdown season, an area of about 67.6 km^2 (>16,500 acres) will be vacated. It is expected that between elevations 1,060 and 1,160 masl the lowest portions of the reservoir will remain exposed for only 2-3 months. On the other hand, the higher parts of the reservoir may remain dry for a period of 5-6 months and thus become available for recession agriculture for short or full season crops.

C.7.3 Downstream Water Releases

Diamer Basha Dam together with Tarbela will substantially augment the capability to provide irrigation water at the appropriate time for crop requirements and generate electricity as a by-product.

Diamer Basha Dam will be mostly operated in diurnal peaking mode, with very large fluctuations in river outflows. This could induce about six (6) meters daily rise and fall of water level in the downstream narrow Indus River channel. Due to long and very narrow river channel up to Tarbela, these fluctuations may well be attenuated without adverse impact. In case Dasu Dam is also constructed downstream, these daily water level fluctuations would be effectively re-regulated through that reservoir.

C.7.4 Reservoir Sedimentation and Management

Assessment has been also completed by DBC of riverbed degradation likely to occur downstream after reservoir impounding. From an initial degradation of 4.5 m immediately downstream of dam site, it is expected to recoup over the time as higher sediment outflow from the reservoir starts by flowing through low-level outlets and flushing tunnels.

Reservoir sedimentation may require more attention in future. From environmental point of view, the flushing procedure would be relevant. The conclusions emerging from the above mentioned DBC study are summarised below:

- Within the commonly considered economic lifetime of a hydropower project of 50 years, reservoir sedimentation will reduce the gross storage of the project from about 10.0 to 3.5 BCM whereas the live storage will reduce from about 7.9 to 3.1 BCM. Without application of sediment management measures, the active lifetime of the reservoir is expected to be in the order of 50 to 55 years.
- In view of the magnitude of Diamer Basha Dam Project with high investment, it will be desirable to extend the reservoir life beyond 50-55 years. The study indicates that a life time exceeding 100 years is feasible with implementation of adequate reservoir sedimentation management measures. Development of another major storage in the upper Indus basin and reservoir flushing are considered to be the most effective measures.
- Sediment depositions in the vicinity of the power intakes may achieve a considerable thickness occasionally. So the flushing tunnels provided for each power intake should be operated frequently according to the requirements starting some 15-25 years after commissioning of the project.

i. Riverbed degradation is also likely to occur downstream after reservoir impounding. From an initial degradation of 4.5 m immediately downstream of dam site, it is expected to recoup over the time as higher sediment outflow from the reservoir starts by flowing through low level outlets and flushing tunnels.

Environmentally relevant sedimentation items are:

- Periodic sediment flushing procedure: left and right bank power intakes flushing tunnels; operative after 15-25 years
- Regular sediment flushing procedure: five reservoir flushing outlets, operation after 45-50 years
- Impacts of these flushing procedures will be:
  - The power intake flushing operation will cause formation of a crater above the flushing tunnel intake so that the power intakes remain clear of any sediment deposits. So, there will be a localised effect to keep the power intakes free from entry of coarser sediments.
  - The reservoir flushing may start after about 45 years when the delta is at a distance of about 10 km upstream of the dam. With annual flushing, the formation of the delta is expected to be retarded and life of the project prolonged.
  - On the downstream side, the sediment from reservoir flushing will be deposited in the degraded river bed and bring it up to approximately pre-dam level. The power intake flushing will be a process of short duration, and the quantity of the flushed sediment will be too small to cause any downstream changes.
- Magnitude of both flushing procedures will be:
  - For power intake flushing, the total capacity of two flushing tunnels at 1,060 masl will be 1,326 m^3/s and insignificant to cause any downstream damages.
  - For reservoir flushing, the capacity of outlets will be 2,633 m^3/s at 1,010 masl and 3,412 m^3/s at 1,020 masl, which will not cause any damage to downstream villages and land (as in Dudishal). The sediment laden water will also not cause erosion due to armoured river bed.

C.8 Project Implementation

C.8.1 Previous Environmental Assessments

This project will establish, in Diamer region of Northern (Gilgit-Baltistan) Areas, a mega dam on Indus River Montreal Engineering Company (MONENCO), a Canadian firm engaged by CIDA for hydropower studies in Pakistan, initially assessed the feasibility of construction of the dam at this location. One of the important outcome of this report was to highlight international significance of the rock carvings in the Karakorum Valley.

This location, during the next 20 years or so, was investigated in more detail by WAPDA focusing on geology and especially seismology. In 2002, WAPDA engaged a consortium of National Engineering Services of Pakistan and Associated Consulting Engineers, called NEAC. In 2004, NEAC completed a Feasibility Report, which investigated all hydropower construction issues covering design, hydrology and geology. This Report also prepared a first environmental check, which highlighted two main subjects of concern:

- Need to resettle a sizeable number of local population; and
- Serious adverse impact on cultural heritage in the form of rock carvings.

Overall approach was to gather the baseline data through secondary information regarding physical, biological and socio-economic aspects. Satellite information was utilized to assess potentially affected houses and other assets, such as trees. Socio-economic data was supplemented by scoping sessions and interviews with the local Heads of line departments. Following sample surveys, using a rapid appraisal approach, were also conducted:-

- Demography and household composition
- Woman situation
- Village structure
- Commercial activities

The basic purpose of preparing Environmental Impact Assessment Report (EIA) by NEAC (2004) was to complete initial information on:

- Project affected peoples (PAPs)
- Magnitude of adverse impacts
- Apprehensions of PAPs about the possible negative impacts of project
- Magnitude of the perceived losses to be incurred through project implementation
- Feedback from PAPs for developing proposal for compensation and resettlement.

As mentioned above, Feasibility Report (2004) proposed that the upstream areas from dam site to Tatta Pani and Raikot Bridge be acquired up to elevation of 1175 masl accounting for +5 m easement above the FRL of 1170 masl.

C.8.2 Project Components for Tender Design

In 2005, the Joint Venture of Diamer Basha Consultants (DBC) was engaged by WAPDA for upgradation of Feasibility Report, completion of tender design and preparation of bidding documents for project implementation. This assignment was completed by DBC in June 2008. Accordingly, the core project comprising the dam and appurtenant structures will be implemented through the five lots under international competitive bidding as shown in Table C-2.

Table C-2: Diamer Basha Dam Project – Proposed Implementation of Core Project

Lot No.	Contract
LOT 1	Concrete Dam and Related Structures Including Diversion Tunnels and Permanent Access Bridge
LOT 2	Underground Works and Related Structures (Left and Right Bank)
LOT 3	Hydro-mechanical Equipment and Hydraulic Steel Structures
LOT 4	Power Plant Generation Equipment (Left and Right Bank)
LOT 5	Electrical High Voltage Equipment and Power Plant Electrical Equipment (Left and Right Bank)

Source: DBC 2009

In addition to the above core project, some preparatory and preliminary works will have to construct and comprise:

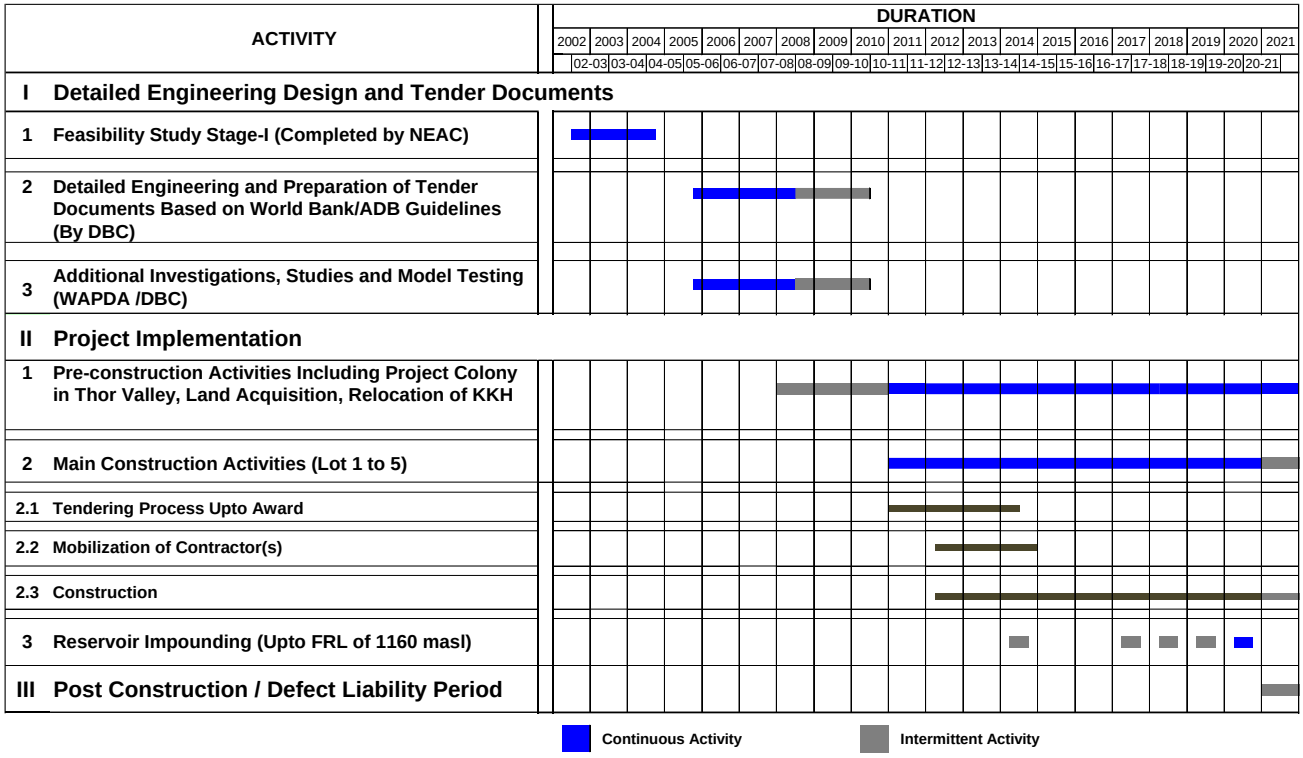
- Essential upgradation of about 324 km length of existing KKH from Havelian to dam site including New Thakot Bridge (through NHA).
- Relocation of about 141 km of Karakorum Highway from Shatial to Raikot Bridge (through NHA)
- Right Bank Periphery Road
- Project Colony in Thor Valley to accommodate WAPDA and Consultants' staff for construction supervision.

Land acquisition for the entire project including resettlement and relocation of displaced population of 28,650 people (2008 estimate) will be addressed through the companion Resettlement Plan.

C.8.3 Construction Schedule

It is expected that the project implementation related activities will start during 2010. Overall construction period may extend over 10 years through 2020. 'Proposed Timeframe for Overall Project Implementation Including Resettlement and Impoundment' is shown in Figure C-6.

Figure C-6: Tentative Timeframe for Implementation of Diamer Basha Dam Project



It will be noticed from Figure C-6 that reservoir filling will be achieved in five stages (also refer Table E-8 for details). Initial impounding to 975 masl is envisaged during 2014 with river diversion for construction. Further filling to FRL (1,160 masl) will be achieved through four stages up to 2020.

Pre-construction activities including land acquisition and resettlement processes initiated during 2009 are scheduled for completion by end 2018 to coincide with initial impounding above MOL of 1060 masl.

Environmentally relevant construction schedule milestone are:

- Start of land acquisition : 2010
- Start of construction by prime contractor : 2012
- Initiation of resettlement process : 2012
- Start of partial impounding above MOL : 2018
- Completion of project with impounding to FRL : 2020

C.8.4 Resettlement / Environmental Schedule

Corresponding to the overall project implementation schedule (refer Figure C-6), the proposed timeframe for implementation of RP as shown in Figure C-7.

Figure C-7: Proposed Implementation Timeframe of Resettlement / Environment

SR. NO.	ACTIVITY	FINANCIAL YEAR											
		2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
I	Land Acquisition, Resettlement and Development Plan												
1	Acquisition of Land												
2	Compensation of Assets												
3	Development of Model Villages Including Related Infrastructure												
4	Business and Livelihood Restoration												
5	Improved Communication (Right Bank Periphery Road & Ferry Boat Facilities)												
6	Improvement of Water and Sanitation Facilities at Chilas and Other Settlements												
7	Socio-Economic Development Through Sectoral Plans												
8	Environmental Monitoring and Research												
9	Project Resettlement Organization												
10	Project NGO												

D DESCRIPTION OF THE ENVIRONMENT (BASELINE DATA)

D.1 Physical Environment Baseline

D.1.1 Quality, Accuracy and Reliability of Environmental Data

A 17-member Environmental and Resettlement Team of was engaged by DBC to design, collect, analyse environmental and resettlement related data. This team composed of field staff and the lead specialists. These specialist designed surveys in their relevant areas of expertise and after collection and analysis of the data prepared their subject specialist reports. These specialists were responsible for the quality, accuracy and reliability of environmental and soci-economic data. The quality and accuracy aspects have been discussed in the relevant sections of main topics concerning: water quality; plants: fish; insects; amphibians and reptiles; and birds.

Besides the specialist topics, the data collection activities cover a range of spectrum of environmental and socio-economic topics ; census data, population, Diamer District administration, governmental institutions, non governmental organizations (NGOs), village-wise public rural appraisal, socio-economic analyses of the affected villages (2006), scoping sessions in the affected villages (autumn 2006), various meetings with other groups of affected persons or stakeholders (2006 and 2007),

Focussed analyses covered; female-based household analysis, analysis of indigenous people and ethnic minorities structure, analysis of tenancy structure, analysis of gender conditions, analysis of disabled persons structure, scoping sessions, head-counting socio-economic survey 2007-2008 ,.

Cadastral Survey conducted during 2007-08 jointly by WAPDA and Revenue Department of Diamer District with advice / assistance of DBC. It covered: land inventory; built-up properties including infrastructure (private and public); domestic animals; number of heads per type of livestock per household; trees both fruit, non- fruit and age per households. This information has been also utilized for establishment of computerised socio-economic database.

D.1.2 Geology

Karakorum Mountains belong to the alpidian folding system (which borders in the northeast with the Himalaya and Hindukush). The mountains are still under intensive vertical and horizontal movement and folding. The area belongs to one of the most intensive seismic zones, which was recently manifested as big earthquake on 08 October 2005 with the epicentre 150 km south of the impact area. Other indications for young tectonic processes are the hydrothermal waters at Tata Pani, which means "*hot water*" on Karakorum Highway short of Raikot Bridge. The most important geological formations are:

- Magmatic rocks, named as Chilas Complex, to which belong ultra-mafic rocks, gabbros, gabbro-norites, and diorites.
- Metamorphic rocks of the so-called Nanga Parbat group (which are of Pre-cambrian origin), to which belong meta-sediments and orthogneis, and from the cretaceous Kohistan Island Arc tectonic group, mostly amphibolites and metasediments.
- Moraine deposits covering upper terraces, consisting of clay, silt and sand, stones and boulders.
- Youngest fluvial terraces of recent river activities with big accumulation of cobbles, gravels, sand and partly silt.

The valley along river line is generally narrow and very steep, with slopes above 45° with sometimes even vertical cliffs. Here in very steep parts scree and debris fans are active. At places, the valley is wider and dominated by the seasonal fluctuating river, the adjacent riverbed with its

very active sand riverbanks and terraces at various levels. These upper terraces had been developed by cutting of the river into glacial deposits of the various ice ages.

Some of the terraces, in particular those upstream of Bunar Das up to Jalipur are covered by moraines (see Map-8 Geological Base Map – Reservoir Area). The area on both side of the Gandlo Nullah (named Kino Das) is a plain moraine terrace with a decent height above the river. Due to active morphological processes, the river formed a steep cliff of clay-sand deposits, mixed with boulders, cobbles, and gravels. This lower part of the valley is built by alluvial terraces of the river, and partially of the tributaries (nullahs). Photograph D-1 shows the Indus Valley close to Chilas, looking upstream.

Photograph D-1: Indus River Close to Chilas

Source DBC 2006

There are some areas along over 100 km project area between Basha Village and Raikot Bridge, where some rock or landslides appeared recently.

D.1.3 Land Use

Due to the geological structure and climatic conditions most of the land in the project area is barren, with no vegetation or only very little cover (see also Photograph D-1). In the lower valley, active geomorphologic processes caused by high annual water level fluctuations (12 m during 2005-2006), fine sand deflation and moving and sliding from the foothills determine short-term changes of surface of the land. This dictates certain use pattern, as shown in MAP-3 on 'Land Use - Reservoir Area'.

Distribution of land formations, resources and structure along with types relevant in the project area upto FRL of 1160 masl as determined from 1:50,000 scale mapping of Survey of Pakistan on 5 m contour interval is as shown in Table D-1 (also see Map-5).

Table D-1: Land Use Distribution

Type	Proportion (%)
Sand areas without use (except gold washing)	29.76
Rock areas almost without vegetation	15.58
Rock areas with sparse vegetation (vegetation cover < 10 %)	33.49
Rangeland (vegetation cover > 10%)	0.46
Forest and shrub areas	0.00

Type	Proportion (%)
Cultivated land (including partially built-up areas)	7.93
Built-up areas (no cultivated land)	0.06
Commercial areas	0.45
River Bed	12.27
Total	**100.00**

Source: DBC, December 2007

Table D-1 shows that dominating land (almost 79 %) use is rock area (including, moraines or terraces), which is often without any vegetation. Some of the land is covered by a sparse grass vegetation. The alluvial strip along the river, sometimes adjoining the aeolian sediments, mostly is devoid of any vegetation.

Forests only occur at higher locations above 2,000 masl (see Map 3 'Land Use Map – Project Area'). Cultivated land is located only where sufficient water is available. Thus, cultivated land is only to be found along the nullahs. There is almost no cultivated land close to the Indus River. In the locations such as Thurli Das, both Sine Huch villages (Thor and Hodar valley), Soniwal Hit, or Bunar Das, the cultivated land is never supplied by water from the Indus River. That is why a natural littoral (riverine) zone along the Indus River does not appear in the land use pattern.

The left bank of the Indus River, in general, due to the construction of KKH is more densely populated and has most of the commercial and business objects. Crossing is only possible at six locations between the dam site and Raikot Bridge through light traffic suspension bridges.

D.1.4 Soil Patterns

The soil pattern (see Map-5 'Soil Map – Project Area') is determined by the geology, the active morphological processes and the climatic conditions. In general, there are the following soil formations:

- Alluvial sand areas directly besides the Indus River, frequently flooded, without any soil formation.
- Alluvial sand areas on slightly upper terraces of Indus River, with some initial soil formation.
- Dry rock areas on various locations of the foothills, having some soil formation only at plateaus.
- Scarp slope areas of the foothills covered often by scree, talus and rock debris without any soil formation.
- Xeromorphic grey soils on glacio-fluvial sand material (river terraces with gravels and sand, sometimes alluvial fans) with 1-3 dm upper humus horizon.
- Xeromorphic grey soils on clay-silt material from glacial origin (mostly moraines, lacustrine deposits).
- Alluvial sediments, mostly sand, in the nullahs, with gleyic soil formation due to permanent or seasonal water-logging adjacent to the stream.
- Hortisols (soils under intensive cultivation) on irrigation fields comprising sand and clay deposits, mostly along the nullah or on Indus River sand terraces.
- Aeolian sand along the river and some higher locations, partially with some initial soil formation.

The soil pattern as shown in Map 5 follows predominantly the distribution of geological formations and materials. Most limiting factor for soil formation is the lack of water for growth of vegetation and induced breakdown of organic material. The formation of soils therefore is very rudimentary as it is

in desert and dry steppe areas. Some organic material is creating greyish colouring in the upper thin horizon of the top soil. In most locations, the organic matter in the soil is negligible and the soil fertility is very low. Low organic matter in the soil results in lowered water holding capacity, rendering it infertile. This is mostly the case on the upper moraines and fluvial terraces, where fine grained material such as silt and clay to some extent is available. Under watering, these soils will become productive fertile soils like in Bunar Das, Goner Farm, Ges Pain, Ges Bala, and Thalpan. These soils are man-made mostly based upon gleyic soils of the nullahs.

In summary, relevant soils in the project area are only located on areas of alluvial or glacial origin and developed on sand-clay deposits. However, these soils predominantly contain stones. The fertility is only reasonable when sufficiently irrigated. Presently, agriculture is being practiced on these soils. However, it is only possible with sufficient water from inundation or/and water logging from the nullah. Under natural conditions this is the case only along the nullahs. In contrast, no soil formation of this type can be found along the Indus River.

Construction of DBDP will require acquisition of 1138 ha (2811 acres) of agricultural land in various valleys upstream of the dam site located in Diamer district of Northern (Gilgit-Baltistan) Areas. This land provides basic means of livelihood to the majority of PAPs. This impact is proposed to be mitigated through 'land for land' by providing each affected household a 6 kanal plot of cultivable land with irrigation facilities in the Model Villages around reservoir periphery. Appendix B in Volume III on 'General Characteristics of Agriculture in Diamer Basha Dam Project Area and Prospects for Further Improvements' examines: existing agriculture; project impact on cultivated lands; and prospects for further improvements particularly in the Model Villages.

On the rocks areas due to the absence of fine material and active morphological processes, there is no soil cover. Only soils have been developed on the plateaus of the mountains, especially under coniferous forest, where the water is available.

D.1.5 Geomorphology

The geomorphology is divided into two major parts, the gorge of the Indus River with steep slopes partially up to > 2,000 masl, and the river bed with the river itself. Existing soil pattern and geomorphological structure is shown in Table D-2.

Table D-2: Existing Soil Patterns and Geomorphologic Structure

Geomorphologic Unit	Soil	Terrain	Land Use
Foothills and ranges along the Indus River from 1,400 up to 2,000 masl	Mostly rock (cliffs) without any soil formation, weathered rock debris falls down on the top of the ranges, soil formation (brown soil under forest)	Steep slopes >40°, partially natural coniferous trees and shrubs at the steepest locations	Extensive grazing, tree logging
Scree, debris and other material collecting in fans covering the foothills	No soil formation due to active sliding processes	Slopes 20-40°, alluvial fan with a size of cone, no vegetation	None

Geomorphologic Unit	Soil	Terrain	Land Use
Middle and upper terraces	Soil formation under high summer drought (xeromorphic conditions) resulting in thin grey upper soils horizon	Mostly <10°, plain area, some, mostly moraine material, partly fluvial material from river/nullahs, clay-silt with boulders cut by some erosion tunnels (dry nullahs), rangeland dominated by *Artemisia*	Grazing
Lower terraces	No soil formation	Plain, materials composed of alluvial deposits such as gravels and sand, partially covered by aeolian sand, little vegetation of *Artemisia* steppe	Grazing, some exploitation close to villages (timber storage places)
Bed of Indus River	No soil formation	Riverbed with actual gravel and sand banks, no vegetation	None (except gold washing)
Nullah sediments	Soil formation along the nullah (inundation and groundwater)	Narrow strips, only some meters/decametres wide, meadows, agricultural land	Agriculture, grazing, locations for settlements

Source: DBC, November 2007

D.1.6 Climate

D.1.6.1 Regional Climate of Northern Pakistan

The Indus River catchment is characterized by high mountains of Hindukush, bordering Afghanistan, Tajikistan and China, Karakoram and Himalaya Mountains in the middle and eastern part of the Indus basin. This large drainage basin is divided into two distinct areas, determined by two main climatic factors. The northern mountains of Pakistan from their climatic pattern belong to the Central Asian mountain belt composed of Tien Shan, Pamir, and Hindukush. This northern and western part of the mountains in Northern Pakistan is influenced by the atmospheric circulation driven by the strong westerly wind system. The major precipitation in the area occurs during winter, in particular January-February and April, which clearly indicates the influence of westerly cyclones. Initially, wet and mild air masses formed above the Atlantic Ocean crossing Europe and Russia, are recovering partially above the Black and Caspian Sea. Then they are bringing this precipitation finally to the north-western slopes of the mountains of Central Asia including Northern Pakistan.

Northern Pakistan area is mostly protected from penetrations of monsoons during summer due to the mountain belt south of the project area. The most northern penetration point of the monsoon is approximately up to Dasu, about 70 km downstream of the dam site. However, there are some climatic events, bringing even clouds and rain from the southern part of Pakistan.

The eastern catchment area with Karakoram and Himalaya ranges are less influenced by these western cyclones. The major factor determining temperature and primarily humidity is the summer monsoon, which dominates the lower Indus catchment. Due to the high mountains, where the land is above 5,000 m elevation precipitation mostly is falling as snow, supplying large snow pack areas

and glaciers. Basic runoff of the entire basin at the dam site comes from glaciers and snowmelt during summer season.

D.1.6.2 Climatic Elements

i. Precipitation

The precipitation in this area is of two types. Much of it falls as snow on higher mountains with small portion as rain at lower levels. The mountainous area mostly is above 2,500 up to 8,000 masl (Nanga Parbat). Here the main precipitation is much higher than the valley bottom (1,000-1,500 masl). Unfortunately, there is no high altitude climatic station in project area. Only Skardu (2,210 masl) is operating, where the mean precipitation is only 175.1 mm/a (due to its eastern location the westerly winds do not reach the area of Skardu to that extent). Table D-3 lists long term precipitation at some stations in the upper Indus catchment.

Table D-3: Precipitation at Skardu, Gilgit, Bunji, Chilas and Besham Qila

Month	Skardu (2,210 m)			Gilgit (1,460 m)			Bunji (1,372 m)			Chilas (1,251 m)			Besham Qila (612 m)		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
January	13.8	0.0	28.5	18.3	0.0	151.6	10.2	0.0	29.6	13.6	1.0	26.2	69.8	1.8	151.6
February	17.0	1.3	33.2	12.9	0.0	103.7	24.8	0.0	88.1	24.1	17.8	30.5	140.0	25.6	330.9
March	26.6	1.3	73.6	26.4	0.0	215.8	26.6	5.6	63.1	16.4	15.2	17.5	178.5	64.5	272.4
April	31.7	1.3	92.7	16.4	2.1	41.2	42.7	18.4	83.9	51.9	39.1	64.8	128.9	16.5	189.7
May	24.7	2.5	66.1	25.8	3.3	59.8	42.5	8.6	130.8	25.3	22.4	28.2	72.9	22.7	137.0
June	8.0	2.0	31.3	27.6	13.8	65.4	18.2	5.1	40.6	1.9	0.0	3.8	89.9	25.2	176.4
July	10.2	0.0	41.9	28.1	4.8	126.8	17.8	3.5	50.1	10.7	6.4	15.0	102.2	46.0	184.6
August	15.2	1.8	59.4	35.7	0.0	168.4	26.3	7.6	67.6	11.2	0.0	22.4	130.5	43.2	220.7
September	5.1	0.0	10.4	24.4	1.0	122.9	14.9	0.0	44.1	7.0	0.0	14.7	57.6	15.0	122.9
October	3.2	0.0	12.6	5.7	0.0	20.6	6.2	0.0	28.2	10.4	0.0	23.9	32.2	6.6	81.5
November	3.0	0.0	15.3	11.9	0.0	108.5	7.3	0.0	29.6	4.1	2.0	7.9	39.8	2.6	108.5
December	16.6	0.0	88.0	2.2	0.0	8.2	12.6	0.0	48.1	14.6	5.8	29.5	40.0	0.0	135.0
Total	**175.1**			**235.5**			**250.1**			**191.3**			**1082.1**		

Source: DBC, IM-HYG-003

Besham Qila represents the station in lower part of Indus River valley, where the influence of the monsoon in quite dominant. Being at relatively low elevation (612 m) the precipitation, here is only as rain averaging over 1,000 mm/a. And, the two monsoon months July and August offer much rainfall. Interestingly the seasons with the highest rainfall here are also winter and spring (March). The same climatic pattern can be noticed for other stations, which are all lying in the north from Gilgit and Skardu down to Bunji and Chilas. Here the wettest months are again March and April. The north-westerly winds bring clouds and rain during those months predominantly.

Chilas seems to be in the middle between the two dominant climatic areas. Both the North-western cyclones and the monsoons coming from the south-east, do not reach the Indus River valley around Chilas. However, the precipitation at higher elevation of project area might be assumed higher than Chilas as no observation station exists in high mountains. We can look only at Chilas data, which is located about 200 m above the Indus River. Here, the mean yearly precipitation is 191.3 mm, which is only rainfall. Very rarely in this lower valley bottom the precipitation occurs as snow. The maximum amount of rainfall, namely 70% is received during winter and spring season (from October to April).

Scanty little rainfall, in general, only causes winter cold dry-steppe and semi-desert ecosystems. Typical elements of this ecosystem are some plants, growing and flowering at spring time (April-May) only.

ii. Temperature

The temperature conditions are quite different between winter and summer. The seasonal fluctuation of mean monthly air temperature is different between the southern mountainous areas, determined by Besham Qila, where only 18.4 °C difference occurs. In Northern (Gilgit-Baltistan) Areas due to the higher elevation, winter season is more dominant. Thus, Chilas has 25.1° C difference between mean temperature of summer and winter months.

The hottest summer condition (under the observed locations) is recorded in Chilas. July mean temperature is 33.5 °C caused by high heat at daytime due to lack of any clouds. Here the mean maximum temperature is 43.3° C. This temperature regime lasts from June up to August, when the temperature also at night time is not dropping down 20° C, often 25° C.

The surface temperature for the four summer months, though never recorded, could be above 50° C on the dark rocks, which are widely distributed over outcrops, cliffs and boulders.

The winter, represented by January with 7.2° C is quite cold. However, also during the winter months there are periods with almost no clouds, when the irradiation is quite strong. Result is quite high noon temperatures during the day. Table D-4 lists temperature data of various stations in the upper Indus catchment.

Table D-4: Air Temperature Data of Skardu, Gilgit, Bunji, Chilas and Besham Qila

Month	Temperature (°C)				
	Skardu (2,210 m)	Gilgit (1,460 m)	Bunji (1,372 m)	Chilas (1,251 m)	Besham Qila (612 m)
January	-2.9	0.1	3.8	7.2	12.1
February	0.2	2.3	6.8	8.8	12.4
March	6.4	7.4	12.0	16.7	16.4
April	12.7	12.5	17.9	19.4	21.6
May	17.0	16.5	22.6	23.9	27.3
June	20.6	20.0	27.1	30.2	30.7
July	23.5	23.0	30.0	32.1	30.5
August	22.6	23.1	29.0	32.3	29.0
September	19.0	18.9	25.4	28.8	27.7
October	12.5	12.4	19.6	20.7	23.3
November	7.0	8.3	12.3	14.2	18.1
December	1.0	2.5	5.4	8.5	13.4
Difference (°C)	**26.4**	**23.0**	**26.2**	**25.1**	**18.4**

Source: DBC, IM-HYG-003

Quite informative are the differences between mean minimum and maximum temperatures. In general, the differences increase towards Northern Pakistan (refer Table D-5). The difference between maximum and minimum temperature is growing from Tarbela with 42° C, over Chilas 44.4° C, Gilgit 50.4° C, Bunji 51.1° C, to a maximum of 65.5° C at the mountainous station of Skardu.

Table D-5: Air Temperature Extremes of Skardu, Gilgit, Bunji, Chilas, Besham Qila and Tarbela

Station	Elevation (masl)	Air Temperature (in °C)	
		Mean Minimum	Mean Maximum
Skardu	2,120	-24.4	41.1
Gilgit	1,460	-11.1	39.4
Bunji	1,372	-6.7	44.4
Chilas	1,251	1.1	43.3

Station	Elevation (masl)	Air Temperature (in °C)	
		Mean Minimum	Mean Maximum
Besham Qila	612	-0.6	48.3
Tarbela	347	3.0	45.0

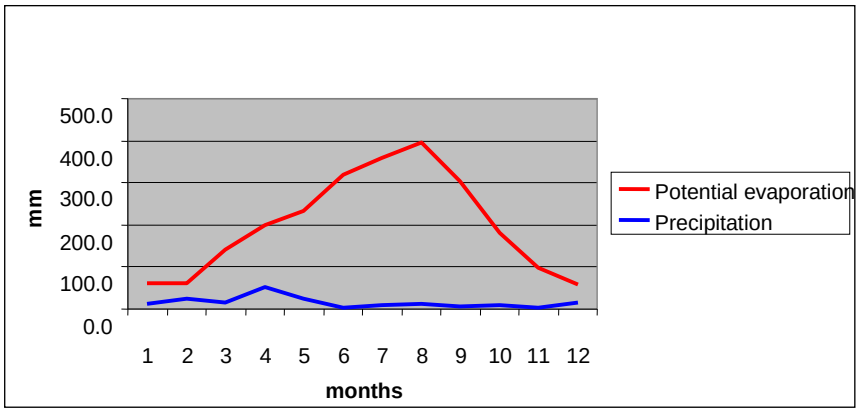
Source: DBC, IM-HYG-003

It may be worth noting from table D-5 that the mean minimum temperature at Chilas is still in positive range (1.1° C). Only a short distance upstream at Bunji, there is much lower winter (mean minimum) recorded temperature of -6.7° C.

iii. Potential Evaporation

Due to the climatic conditions, there is a very large gap between precipitation and potential for evaporation at Chilas as show in Figure D-1.

Figure D-1: Precipitation and Potential Evaporation at Chilas Climatic Station



Source: DBC IM-HYG-003

It can be seen that during all months the potential evaporation exceeds by far the available precipitation, causing aridity. The natural vegetation of Artemisia Steppe community is adapted to this very dry condition, where water is not available, except the short spring period.

In Chilas average air humidity during the summer months (between June and September), is below 40%, with even 32.5% in July. During winter months, the humidity rises slightly, but the average does not exceed 60%.

iv. Wind

Wind observations – direction and speed – are available for some climatic stations. However, the data should be interpreted carefully, because the wind measurements predominantly reflect the local wind systems. Bearing in mind that the Chilas station is located at the northern slope of the foothills it may be understood that the overall wind system of the project area cannot be represented. Much likely, the observations reflect the local valley wind system, which is following the morphology and therefore daily energy exchange between mountain ranges and valley bottom. The recorded wind data at various stations is listed in Table D-6.

Table D-6: Wind Direction and Speed at Climatic Stations

Station	Wind Direction (%)									Speed (km/h)
	CALM	N	NE	E	SE	S	SW	W	NW	
Skardu	80	0	2	2	0	8	5	3	0	5.3
Gilgit	74	0	1	4	8	1	1	9	2	3.7
Astore	50	17	1	0	0	30	1	0	1	5.6

Station	Wind Direction (%)									Speed (km/h)
	CALM	N	NE	E	SE	S	SW	W	NW	
Bunji	-	-	-	-	-	-	-	-	-	9.5
Chilas	68	0	0	1	2	1	6	20	2	5.8
Besham Qila	-	-	-	-	-	-	-	-	-	1.6

Source: DBC, IM-HYG-003

The above table shows that predominantly, in 68 % of the cases such as Chilas, there is no wind. However, for the remaining cases, 93 % are westerly winds, implying west-east movement stretching across Indus River valley. This upstream-downstream situation seems to be reflected clearly in Astore, where due to the morphology, 38% of the days northern and 62% southern winds are recorded.

v. Fog

There are no records on fog situations. This may be explained by the absence of this phenomenon. Bearing in mind the very low humidity (between 32.5 and 59.5%) the general physical conditions do not favour development of fog. However, the physical conditions, availability of water for evaporation (see above) and the harsh temperature differences between water and air above could allow some fog development. There is the assumption that some fog will appear in autumn, when the water is still warmer than the air above. The same will appear in spring, when the water is colder than the air. However, this phenomenon is only concentrated on the contact area between the river and the air. In addition, fog will appear only very shortly in the early morning and soon disappear with the fast warming.

D.1.6.3 Climate Change

i. Climate Change Phenomena of 20th Century

Climate and associated hydrological changes around the globe have been identified and future changes, in both qualitative and quantitative terms, have been predicted. Basic information and prediction is submitted regularly by the Intergovernmental Panel on Climate Change (IPCC). Many investigations made within the framework of IPCC in many countries revealed that the temperatures of lowest 8 km of atmosphere have risen during past four decades with following results:

- Global average surface temperature (average of near surface air temperature over land, and sea surface): increased over 20th century by about 0.6° C
- Most of warming occurred during 20th century in two periods: 1910-1945 and 1976-2000
- Warmest decade: 1990s
- Warmest year: 1998
- Increase of night-time daily minimum air temperatures over land of 0.2° C per decade
- Lengthening of freeze-free season in many mid- and high latitude regions
- Frequency of extreme low temperatures: reduction since 1950
- Frequency of extreme high temperatures: small increase since 1950
- Deglaciation: most observed glaciers are retreating
- Precipitation over mid- and high latitudes of the Northern Hemisphere: increase of 0.5-1%% per decade in the 20th century
- Rainfall over tropical land (10° N to 10° S): increase by 0.2 to 0.3% per decade
- Frequency of heavy precipitation events in mid and high latitudes of Northern Hemisphere: 2 to 4% increase over the later half of the 20th century
- Clouds cover over mid to high latitude land areas: increase of 2% during 20th century

- Emissions of greenhouse gases and aerosols: continuing increase due to human activities
- Carbon dioxide (CO_2) atmospheric concentration: increase by 31% since 1750 (3/4 are from fossil fuel burning during the past 20 years)
- Methane (CH_4): increased by 151% since 1750 and continues to increase; annual growth in the 1990s (compared with the 1980s) slowed and became more variable; > 50% of CH_4 emissions is anthropogenic (e.g. use of fossil fuels, cattle, rice agriculture and landfills)
- Nitrous oxide (NO_2): increased by 17% since 1750 and continues to increase; 1/3 of current NO_2 emissions are anthropogenic (e.g. agricultural soils, cattle feed lots and chemical industry)
- Global average sea level: risen since late 1950s.

'Worldwide Climate Modelling' in the framework of IPCC revealed many regional differences, not only because of the spatially different human factor but also due to the regional pattern changes in temperature and precipitation.

ii. IPCC Prediction of Potential Climate Changes

There are clear indications that most of the above outlined phenomena are manmade. This leads to the consequence that the present period and future decades would be determined by those factors as well, if the greenhouse gas emission cannot be reduced in the required amount. The November 2007 IPCC Meeting in Valencia (Spain) required reduction in CO_2 emission up to 2050 by 50%. Based upon the above-referred changes of climatic elements in the past century, IPCC predicted behaviour of the global climate based upon model simulations. Accordingly, globally averaged surface temperature will increase by 1.4 to 5.8° C over the period 1990 to 2100. This is lower than the preliminarily estimated temperature due to the lowering of sulphur dioxide emissions. This rate of warming would be larger than the observed changes during the 20th century. All land, particularly at northern high latitudes in the cold season will warm more rapidly than the global average. Northern regions of North America, Northern and Central Asia will exceed global warming of more than 40%. In contrast, the warming will be less than the global mean change in South and Southeast Asia in summer and in Southern South America in winter.

Precipitation, much likely by the second half of the 21st century will continue increasing over northern mid to high latitudes and Antarctica in winter. At low latitudes, there are both regional increases and decreases over land areas. Larger year-to-year variations in precipitation are very likely over most areas where an increase in mean precipitation is projected. Predicted main climate change phenomena, as addressed by IPCC (2001), are listed in Box D-1.

Box D-1: Overall Climate Change Phenomena Addressed by IPCC (2005)

- Higher maximum temperatures and more hot days over nearly all land areas
- Fewer cold days and frost days over nearly higher minimum temperatures
- Reduced diurnal temperature range over most land areas
- Increase of heat index over land areas
- More intense precipitation events
- Increased summer continental drying with associated risk of drought
- Increase in tropical cyclone peak wind
- Increase in tropical cyclone mean and peak precipitation intensities

iii. Potential Climate Change Phenomena for Indus River Catchment

The northern mountains of Pakistan from global climate point of view belong to Central Asian mountainous belt. This belt has its most northern ranges in the Tien-Shan, to the south followed by Pamir up to most southern, the Hindukush and Karakorum. These ranges are the source of some major rivers, including the Indus. IPCC estimates that the total water flowing from the Himalayas towards the Indian subcontinent is approximately 8.6 x 10^6 m^3 per year (IPCC Report 2001, Volume

Asia). Due to the high location mostly above 5,000 m elevation, the Indus River catchment is determined by large glaciers with dominant glacier-melt. Only 1,500 glaciers covering 33,000 km^2 are located in the Himalaya Mountains.

IPCC stated that around 2/3 of the glaciers in the Himalayan and Tien Shan mountain ranges have retreated in the past decade, which is due to the about 50–80 m higher mean equilibrium-line altitude (since first half of the 19th century) at which snow accumulation is equal to snow ablation. Available records suggest that Gangotri glacier is retreating by about 30 m/a.

Warming is likely to increase snow melting far more rapidly than in the past century. IPCC stated for Pakistan consistently rising trend since the beginning of 20th century of annual mean surface temperature. This is going to result in increased runoff for a few decades, to be followed by major, permanent reductions in runoff.

However, there is also information of expansion of the larger glaciers (see Hewitt, Bibliography at S. No. 5 of Reference) in the central Karakorum Mountains, which also contrasts to the Greater Himalaya. This relates to the trend during past 50 years in some northern Central Asian countries where an increase of precipitation has been recorded (except Kazakhstan where the annual precipitation over the period 1894-1997 has decreased). This process causes a partial extension of glaciers against the global trends.

For the Himalayan Mountain region, continued glacial melt is expected to increase, which would lead to higher summer flows for a few decades, followed by a reduction in flow as the glaciers disappear. Thus, IPCC studies forecast a decline of Indus River flow with 27 % by the year 2050 (Brahmaputra 14 %).

Even presently, there are already trends of reducing runoff since the early 1960s. A tributary to the Indus upstream of the project area, the Hunza River, joining Gilgit River close to Gilgit Town, is fed by Karakorum Mountain glaciers and the reduction in run-off is consistent with the expansion of glaciers.

The precipitation in spring, summer, and autumn, however, has shown slight increasing trends. In Pakistan, seven of 10 stations have shown a tendency toward increasing rainfall during monsoon season. Moreover, temporary variability is quite high: Occasionally, as much as 90% of the annual total is recorded in just 2 months of the year at a few places in the region. Towards North, the influence of monsoon is continuously decreasing.

For the same period is predicted an increase in runoff of Yangtze River (37 %), Huang He River (26 %), Yenisey River (15 %), Lena (27 %), Ob (12 %), and Amur (14 %).

Climate change is likely to substantially increase overall monsoonal rainfall in Pakistan, but this rainfall will not reach the northern Karakorum and Hindukush mountains in most cases.

The sea level rise caused by global warming for the Indian Sea coast of south Pakistan for the period until 2050 is forecasted with 0.20 m and could impact an area of 1,700 km^2.

D.1.6.4 Greenhouse Gas Emissions

Currently there is no input from any industry in Pakistan, which causes emissions of greenhouse gases such as CO_2 and CH_4. Neither mining nor processing industry contributes to the accelerated emission of those gases. The only manmade sources are cars, but in a very low figure compared to populated areas. Even rotting processes from much organic material or from any cattle carcasses are insignificant due to the arid conditions.

Relevant air element is the emission of dust, which is natural-born blowing out mostly from silt from the vegetation cover free area outside of the villages. Due to overgrazing, construction and excavation and along Karakorum Highway or other frequented roads there is some threat from dust emission.

D.1.7 Water

D.1.7.1 Indus River

i. Upper Indus Basin

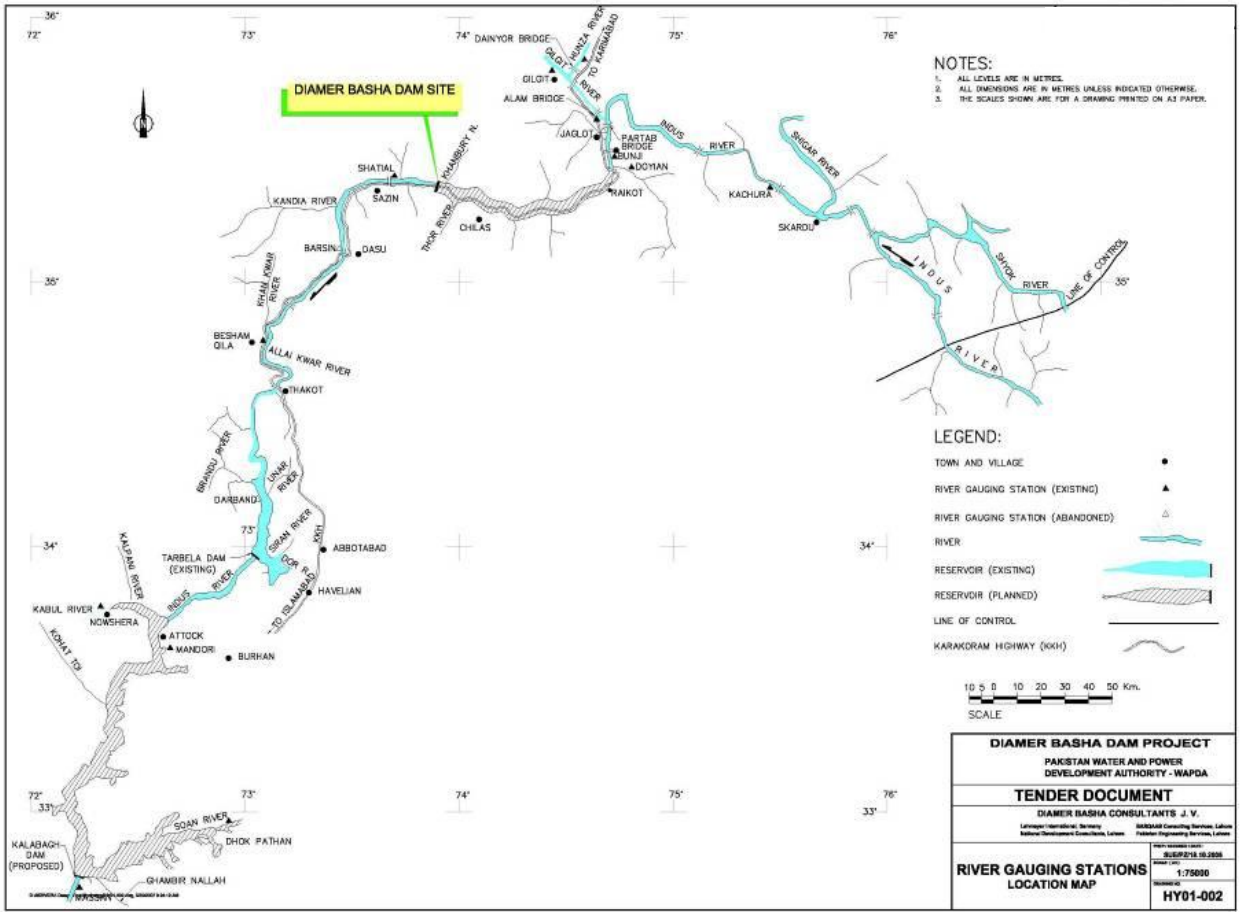
Indus River rises in the Tibetan plateau, at an elevation of about 5,500 m. The upper Indus River flows in general in westerly direction crossing the Himalayan and Karakorum Mountain area with a number of peaks above 8,500 masl. Even the southern ranges of the Himalayan Mountains are higher than 6,000 m. This means that snow can be experienced at all elevations in the basin in winter season. Most of the tributaries are sourced by glaciers, which interestingly are thickening and expanding (while the overall trend in many areas of the world due to climate change is otherwise).

The entire length of the Indus River is 2,900 km before it outfalls into the Arabian sea draining an area of about 963,480 km^2. At Diamer Basha dam site the catchment area of the Indus River is 153,200 km^2. In upper Northern (Gilgit-Baltistan) Areas the river flows in a deep narrow channel with a steep gradient. Major tributaries contributing to the Indus River flow above the dam site are Shyok River, Shigar River, and Gilgit River (including Hunza) and the left bank Astor River. The distance from the dam site downstream to Tarbela dam is 315 km (see Figure D-2).

Throughout most of its length down to the dam site the river valley widens out only at a few locations. The valley between Basha Village and Raikot Bridge has been selected to form Diamer Basha reservoir.

Section of Indus River, where the Diamer Basha Dam site is located, has bed elevation of about 945-950 masl. The river flow of this section is derived from the upstream gauging station at Partab Bridge (Bunji) and Shatial Bridge and 18 km downstream of Dam site (see Figure D-2). The most important peak season is summer (June-September) in which months the average exceeds a mean monthly average of 5,000 m^3/s. The total flow during the four months reaches almost four fifth (79.6 %). During winter period between December and April, the mean flow remains below 500 m^3/s.

Figure D-2: River Gauging Stations



Source: DBC, IM-HYD-005

ii. Indus River Flow

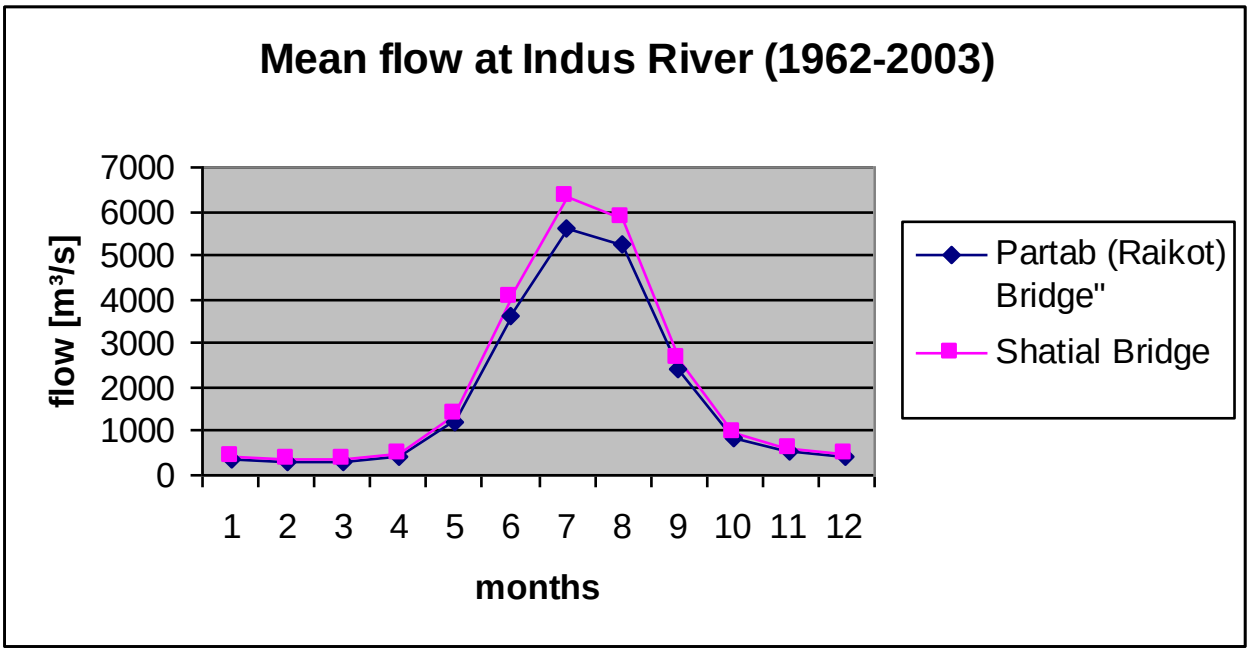
The annual mean flow at Partab Bridge/ Bunji and Shatial is 1782 m³/s and 2005 m³/s respectively. At the dam site the annual mean flow is 1977 m^3/s. Especially, in summer the river is very turbulent and experiences day to day fluctuation. The annual water level fluctuation at the Khanbari Gauging Station from 2005 to 2007 was 12 m. The river especially during those months is muddy due to heavy sediment and suspended load, which comes from the erosion of soils, but mostly from moraines and terraces in upper catchment areas.

D.1.7.2 Nullahs

i. Catchment

Along the potential reservoir, many nullahs fall into the Indus River sourced by glaciers (refer Figure D-3) and large snow pack areas in this mountainous area above 5,000 m. The nullahs often deliver clear blue-green water into the Indus River. In the extremely dry project area only some precipitation mostly as rain is available (less than 200 mm/a). Snow in the Chilas valley only rarely reaches the lower elevation of 1,000-1,300 m. Spring water is limited due to scarce groundwater accumulating sediments, which are only to be found in the terraces partially formed along the Indus River. Groundwater at certain springs is partially used by the local population. In summary, rainfall and springs (or groundwater) in their contribution to the overall water balance could be neglected (refer APPENDIX A in Volume III “Water Resources and Water Quality Report of Project Area”).

Figure D-3: Mean Monthly Flow of Indus River Between Shatial and Partab Bridge

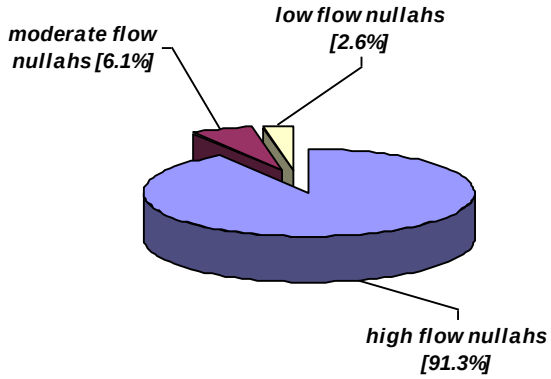


Source: DBC, 2006

ii. Flows

The water balance in the project area (at the downstream gauging station Shatial) is dominated by the Indus River water (94.5%). The 29 nullahs, 12 on the right and 17 on the left bank as shown in Figure D-4 (ignoring dry nullahs), are contributing 82.04 m³/s (4.0%) to the water balance at Shatial.

Figure D-4: Water Flow of Nullahs

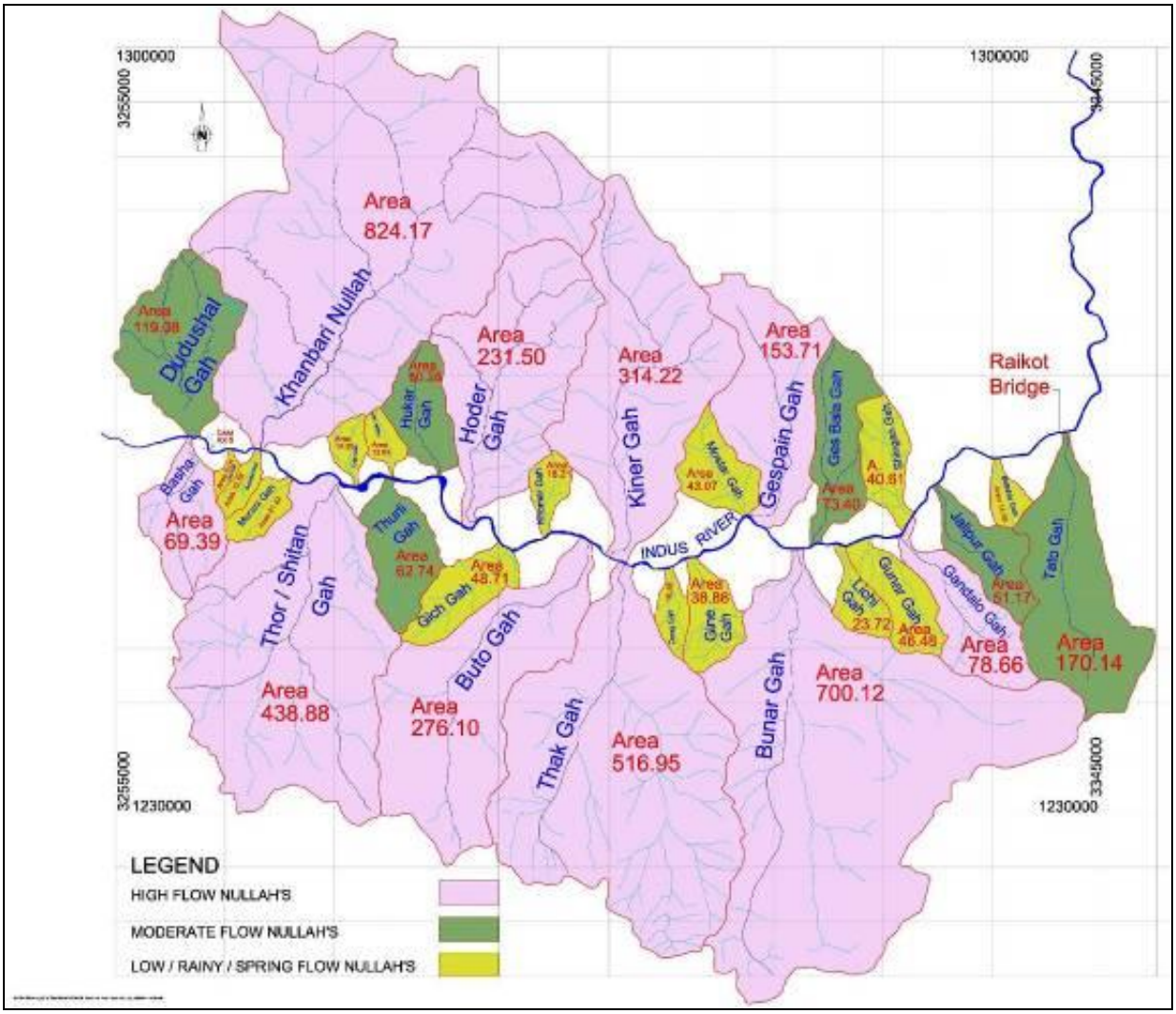


Source: DBC, 2007

The addition of 222.4 m³/s flow between Partab Bridge (1,782.4 m³/s) and Shatial (2,004.8 m³/s) is accounted for by upper tributaries such as Astor River, Shaitan Nullah, Bunji Nullah and Sai Nullah and the downstream tributary of Shatial Nullah.

Figure D-5 shows that 14 nullahs (almost half) categorised as high flow nullahs including the Khanbari, Bunar, Thak, and Thor are supplying about 91% of the flow to Indus River in the project area.

Figure D-5: Catchments of Nullahs

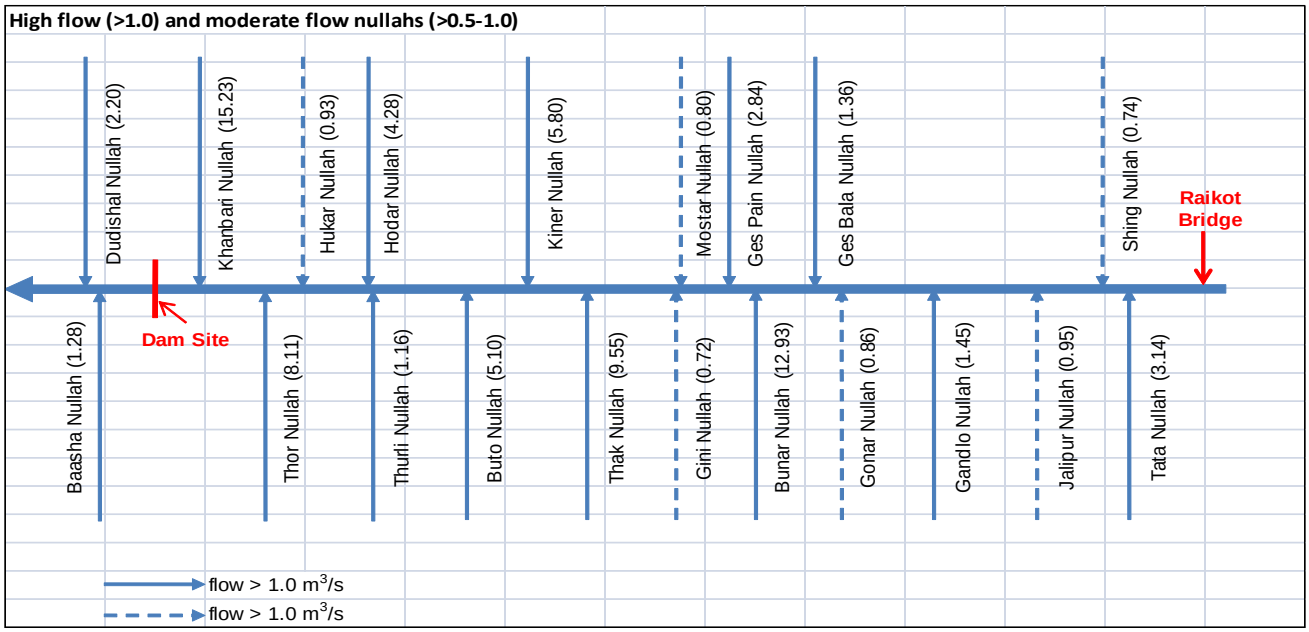


Source: DBC, 2006

There are some other nullahs, without any perennial flow and are therefore, not included in the investigation. These so-called dry nullahs are often wet during early spring, but later on become dry. No habitation has been established on these 'dry nullahs'.

High and moderate flow nullahs are also depicted in 'Nullah Flow Diagram' of Figure D-6.

Figure D-6: Nullah Flow Diagram



Source: DBC 2007

Considering only the project area the mean flow of 82.04 m^3/s is contributed by various nullahs (see Table D-7). The location of the nullahs is illustrated in the flow chart (Figure D-6).

Table D-7: Mean Flow Contribution of Nullahs Between Bunji and Shatial

Flow Category	Contribution (m^3/s)	Nullah	Mean Flow (m^3/s)	Total Mean Flow (m^3/s)
High	>1.0	Khanbari	15.23	
		Bunar	12.93	
		Thak	9.55	
		Thor	8.11	
		Kiner	5.80	
		Buto	5.10	
		Hodar	4.28	
		Tata	3.14	
		Ges Pain	2.84	
		Dudishal	2.20	
		Gandlo	1.45	
		Ges Bala	1.36	
		Basha	1.28	
		Thurli	1.16	74.43
Moderate	0.5-1.0	Jalipur	0.95	
		Hukar	0.93	
		Gonar	0.86	
		Mostar	0.80	
		Shingan	0.74	
		Gini	0.72	5.00
Low	<0.5	Lichi	0.44	
		Murani	0.39	
		Khomar	0.34	
		Dong	0.31	
		Batchlo	0.28	

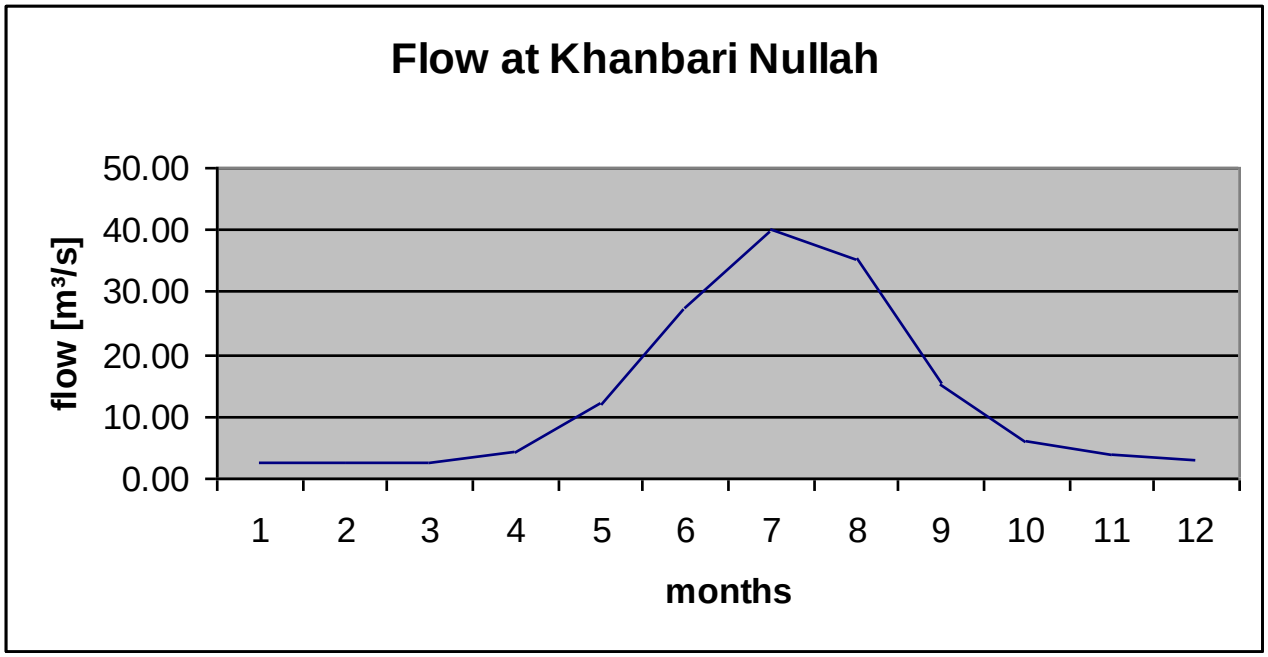
Flow Category	Contribution (m^3/s)	Nullah	Mean Flow (m^3/s)	Total Mean Flow (m^3/s)
		Tatlo Haller Basehri Ganlua	0.27 0.26 0.23 0.09	2.61
				82.04

Source: DBC, 2007

iii. Seasonal Variation of Nullah Flow

In accordance with climate and elevation of individual catchment, the snowmelt begins in March at lower elevations and continues until July, when also the glaciers melt attains peak (typical hydrograph of Khanbari Nullah in Figure D-7). Between 40% and 70 % of the total runoff of the upper Indus basin and its tributaries occurs in July and August. The low water months are December to March.

Figure D-7: Flow at Khanbari Nullah



Source: DBC, 2007

D.1.7.3 Groundwater and Spring Sources

During field investigations by DBC, more than fifty springs adjacent to some perennial nullahs were identified. It is estimated that about 40 % of these will get submerged in the reservoir. These springs are being frequently used by the local population for drinking purpose. In some cases, they also channel the spring water for irrigation. Some of the springs flow throughout the year while some dry out during the hot summer season. Usually, the spring water is cooler and due to the natural conditions not contaminated.

In general, however, groundwater and springs in the project area have very small discharge. The geological conditions are the primary factors. Basically, the rocks forming the core of Northern (Gilgit-Baltistan) Areas mountain range commonly have limited porosity and permeability, limiting groundwater occurrence to local fracture zones or pockets of alluvium (Hagen 1980). Groundwater is available only in the well-sorted alluvium layers of moraines and terraces, which are filling the Indus River valley. The climatic situation, only having 193 mm/a mean precipitation (mostly rain),

also does not favour at all the formation of groundwater. Any rainfall will be consumed by the vegetation (if there is any) or evaporated from the ground surface.

D.1.7.4 Water Quality

i. Methodology and Sampling Station

Some investigations on water quality were started by NEAC in 2003 at 8 stations. During 2006, DBC extended these to 12 locations in the project area (refer Table D-9). Main objective of these quarterly water quality investigations was to establish monitoring baseline for the Diamer Basha Dam Project. Before commencing construction it is important to determine the hydro-chemical character of the water of Indus River and main tributaries. The data are crucial also to the public and the Government to initiate appropriate actions and policies for preserving the present water quality during 10 years construction and after impoundment of the reservoir. Appendix A in Volume III on 'Water Resources and Water Quality Report of Project Area' contains the related information. Results of quarterly water quality sampling conducted during June-July 2006 are shown in Table D-8.

Table D-8: Water Quality Sampling Locations Including Data Gathered During June-July 2006 Investigations

Parameter	Unit	Khan-bari Nullah	Thor Nullah	Indus River, Thor Nullah	Indus River at Chilas	Buto Nullah	Kiner Gah	Thak Nullah	Bunar Gah	Indus River Raikot Bridge
Water colour		Bluish white	bluish	muddy	muddy	White	white	white	white	muddy
Transparency	m	1.1	0.8	0.15	0.15	0.8	0.9	0.6	0.8	0.15
pH		8.3	8.5	8.8	8.8	8.6	8.8	8.9	8.8	8.7
Conductivity	mg/l	30	20	50	48	40	20	38	50	50
Alkalinity	mg/l	93	45	186	160	75	63	69	30	75
Hardness	mg/l	68	60	96	86	66	42	68	21	75
Dissolved oxygen (O_2)	mg/l	5.3	5.2	6	6	5.9	4	6	5	5.8
CO_2	mg/l	18	5.5	15	16	12	5	7	4	7
HCO_3	mg/l	0.4	0.8	1.5	-	0.5	0.4	0.9	1.2	1.2
Cl	mg/l	0.1	0.2	0.2	-	0.2	0.1	0.2	1.2	0.2
SO_4	mg/l	0.05	0.3	0.2	-	0.1	0.05	0.2	1.2	0.3
NO_3	mg/l	-	-	-	-	-	-	-	1.2	-
Ca	mg/l	0.4	0.6	1.2	-	0.4	0.4	1.1	1.2	1
Mg	mg/l	0.1	0.4	0.5	-	0.3	0.1	0.3	1.2	0.7
Na	mg/l	0.04	0.1	0.18	-	0.08	0.04	0.13	1.2	0.13
K	mg/l	0.02	0.04	0.11	-	0.07	0.02	0.04	1.2	0.07

Source: DBC, 2006

Although Pakistan Water Quality Standard does not prescribe investigation of nutrients such as phosphorus and nitrogen, the oligotrophic character of the water bodies in the project area is determined by the overall geologic and environmental conditions. There is a distinct seasonal differentiation of the energy regime as indicated below:

- Summer season: high water flows, high velocity of water, temperature regime 12-14° C, (in shallow water areas of downstream nullahs up to 17-19° C), moderate conditions for

phytoplankton and zooplankton growth, and detritus of plants and organisms to be spilled away towards the Indus River.

- Winter season: low water, lower velocity of water, cold air, and temperature below 10° C, which does not favour any phytoplankton and zooplankton development.

Streams fed by glaciers (as the high water flow nullahs mostly are) even in summer do not allow temperature rise above 13° C (as Bunar Gah demonstrates). The Indus River temperature regime observed at Shatial Bridge has been depicted in Figure D-9. It can be seen that there are about six months in winter when the mean water temperature in the Indus River does not exceed 10 °C, which is a limit for biological activity. In addition, the water during December-February cools down to 5 °C. During summer season, starting in April, the water temperature quickly rises to 12° C. Almost for seven months the temperature is above, or close to 12° C, which allows photosynthesis.

Table D-9: Water Quality Sampling Stations

Sampling Station	Location	NEAC 2003	DBC 2006-07
Indus River at Raikot Bridge	Midpoint of Raikot Bridge	X	X
Jalipur Nullah	1 km upstream of the confluence of Jalipur nullah with Indus River. Potential source of water supply for the proposed Model Village of Kino Das		X
Gandlo Nullah	100 m upstream of the Bridge on Karakorum Highway		X
Thak Nullah	Approximately 1 km upstream of Karakorum Highway in Thak Valley	X	X
Indus River at Thak Nullah	Indus River, few meters downstream of Thak Nullah confluence	X	X
Kiner Nullah	Just short of confluence with Indus River	X	X
Buto Nullah	Shortly before confluence with Indus River in Chilas, potential source of water supply for the proposed Model Village of Thak Das		X
Indus River at Chilas	About 1 km downstream of Chilas	X	X
Sewage Drain in Chilas	Located in western lower Chilas and being used for irrigation	X	X
Hodar Nullah	Near Balokish Village at elevation of ±1,200 masl. Potential source of water supply for the proposed nearby Model Village		X
Indus River at Dam Site	Right bank about 100 m upstream of the proposed dam site at axis D (about 1 km upstream of the present axis C)	X	X
Indus River at Shatial Bridge	Upstream on the left bank side and close to Shatial bridge.	X	X

Source: DBC

As mentioned above, water quality investigations were started by NEAC in order to obtain physical, chemical and biological characteristics for the EIA Study. DBC, extended these investigations to new locations in nullahs, which would have some relevance for the Environmental Impact Assessment, and also for the EMP and RP. The selected nullahs represent those streams having relatively high discharge of water. The other nullahs either do not supply perennial water or have little flow during winter.

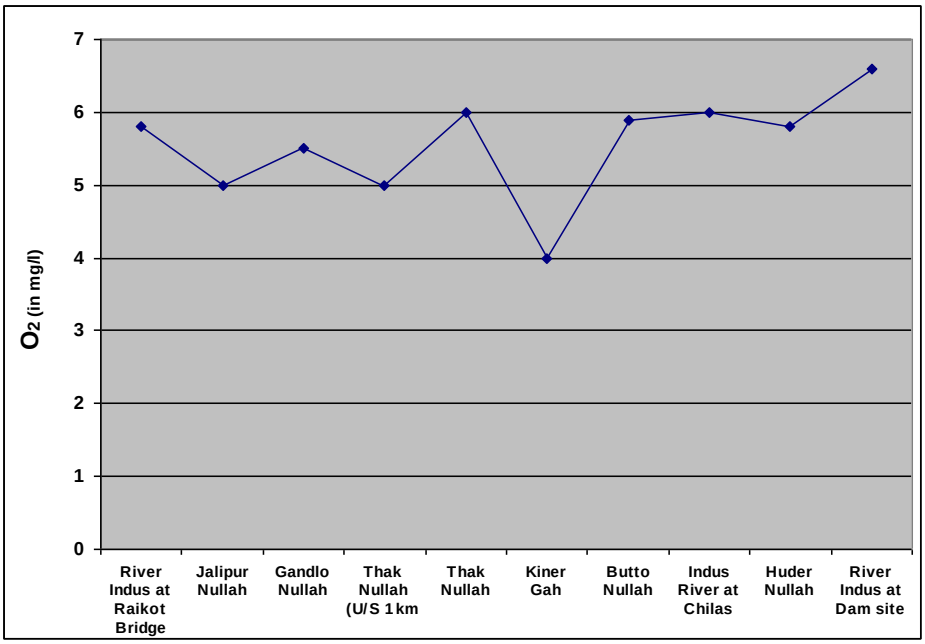
The quarterly investigations are also duly covering different flow regimes during winter and summer.

Most of the testing criteria were selected by NEAC to obtain classical water quality parameters. The same were followed since 2006 and investigations by DBC covered:

- Physiochemical data analysed by Quick Sampling Kit at the site: air and water temperature, pH, dissolved oxygen (O_2, CO_2 and HCO_3, transparency, hardness, conductivity, alkalinity, and chemicals such as Ca, Mg, K, and Na. A sample of such data after quick analysis at site is shown in Annex D-1.
- Hydro-chemical data analyses in Pakistan Council for Scientific and Industrial Research Laboratory in Lahore (3-5 days later due to travel conditions): Chemical Oxygen Demand, Total Suspended Solids, Total Dissolved, BOD_5, cat ions and anions such as Chlorides (Cl), Sulphates (SO_4), Fluoride, Cyanide, Sulphide, Ammonia (NH_3-N), Cadmium, Chromium, Copper, Lead, Mercury, Selenium, Nickel, Silver, Zinc, Arsenic, Barium, Iron, Manganese Boron.

Some of the project area information related to dissolved oxygen at the selected sampling stations, is illustrated in Figure D-8:

Figure D-8: Dissolved Oxygen Distribution in Indus River and Nullahs

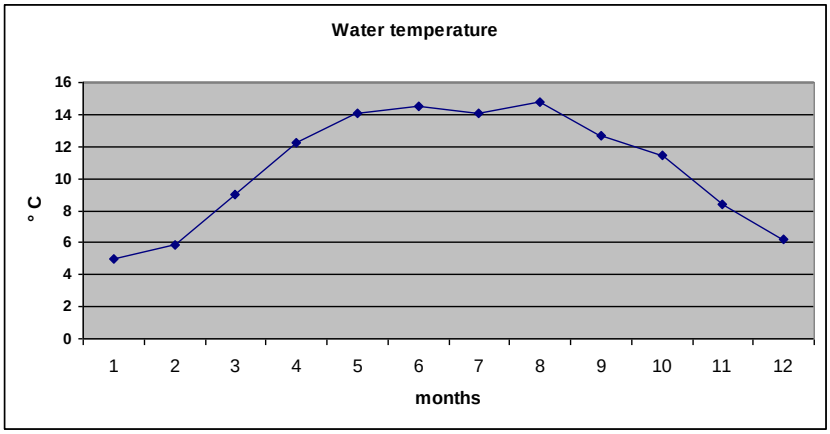


Source: DBC, 2009

ii. Water Temperature

Water temperature measurements are made at the gauging station of Shatial Bridge since 1983. The water temperature is observed at about 1 m depth but close to the bank of Indus River and not in midstream. Likely the summer temperature measured close to riverbanks will be slightly higher than the normal river water temperature. The seasonal temperature regime of the river at Shatial is shown in Figure D-9.

Figure D-9: Indus River Water Temperature at Shatial Bridge (1983-2002)



Source: DBC IM-HGY-003

It can be seen from the above Figure D-9, that from mid October until end of March, average water temperature does not exceed 10° C, which is unfavourable for the biological activity. During the winter period between December and February, the water further cools down to 5-6 °C.

iii. Water Quality State of Indus River and Nullahs

The physical and chemical water quality data for all sampled locations, except the sewage effluent from Chilas, depicts natural conditions. The prevailing conditions do not contribute to water pollution. Most of the nullahs are supplied by glaciers or snow melt directly. Both these water sources are very clean and normally there is not much pollution. Due to absence of any industry and vehicular exhaust gases, there is no hazard to the quality of clean air and water. The only pollution is from sewage and solid waste disposal of the local population. The cold water conditions in this high mountain area also do not support any significant biomass development. Due to the very low pollution and excessive amount of water, pollution is not relevant in the project area. Therefore, the chemical water quality in the Indus River as well as nullahs adequately meets national and international water standards (oxygen contents in the range of 4 to 6.5% are quite good).

As regards drinking water quality, sampling analysis from twenty seven (27) sites in the project area showed that a significant number of the samples did not meet national and international drinking water criteria. Hence, proper treatment, storage and distribution of all such drinking water sources proposed for the Model Villages, would have to be undertaken as per National Drinking Water Policy guidelines contained in Appendix-A in Volume III, 'Water Resources and Water Quality Report of Project Area'.

D.1.7.5 Sedimentation

The sediment load of the Indus River is generated by weathering and erosion processes in the upper catchment. Table D-10 shows the total load computations split up into bed load and suspended loads.

Table D-10: Sediment Load at Key Locations

Gauging Station	Catchment Area (km²)	Annual Flow (Billion m³)	Suspended Load (Million tons/year)	Bed Load (Million tons/year) [a)]	Total Load (Million tons/year)
Partab Bridge	142,700	56.7	148.2	14.9	163.1
Basha Dam Site	153,200	62.9	177.7	17.8	195.5
Besham Qila	162,400	76.5	203.5	20.3	223.8
Tarbela	169,400	78.9	212.0	21.0	233.0

a) Assumed as 10% of suspended load
Source: DBC 'Report on Reservoir Operation and Sediment Transport', November 2007

It can be seen from Table D-10 that proportion of suspended load, is about 90 % and quite high. Its average composition is: silt (44 %); clay (16 %); and sand (40 %). This causes high turbidity in river water due to high percentage (60 %) of the colloidal material comprising clay and silt.

As already mentioned this sediment load will reduce the original total storage volume of 10.008 BCM to about 3.455 BCM after 50 years. Correspondingly, the original live storage capacity will reduce from 7.889 to 3.144 BCM.

D.1.7.6 Downstream Hydrograph

i. Project Area to Tarbela Reservoir Section

Presently, the hydrograph in this section is principally represented by the flow at Shatial Bridge gauging station (see Figure D-3). From the environmental point of view, the present hydrological conditions may be characterised by following features:

- Very narrow gorge
- Turbulent river running (mean flow approximately 2,000 m^3/s)
- Meandering only in some wider parts
- High seasonal fluctuation in the range of about 12 m (2006-2007 observations).

Meandering process only appears where the alluvial zone is wider. This in particular is the case between Thor Nullah and Thalpan. Only here the width of the river bed including younger alluvial sediments on terraces is approximately 1 km. In the upper part of the project area also moraines dominate the valley as the Indus River had cut into these clay-silt terraces (Jalipur-Gandlo-Gonar Farm).

The river in the section downstream of the dam site up to Tarbela generally runs in a narrow gorge and, only at few places there are wider alluvial areas. Due to this morphological condition and high seasonal fluctuations the following factors should be recognised:

- Settlements on immediate river banks not established at all
- Riverine forests due to extreme level fluctuations not appearing
- Littoral zone almost totally missing
- Water for agricultural use not used.

Navigation on this river section does not play any role. Only some people with very small boats are crossing the Indus River for private purposes. In some cases, wooden logs are floated down the river for transport to storage areas along the Indus River.

Above Tarbela dam, some sections of reservoir are used for cross-bank navigation, particularly in wide basins. The reservoir in these basins is also rich in fish stock. The seasonally vacated bottom of the Tarbela reservoir is also used for recession agriculture through residual moisture and soil enriched by sediment deposition.

ii. Tarbela-Kotri-Arabian Sea Section

Indus River downstream of Tarbela after running through the Attock gorge debouches into plains above Jinnah Barrage. From this point on, the river runs through a long floodplain, down to Kotri Barrage and Arabian Sea through Indus Delta. Through deposition of sediments Indus River has formed flood plain, called Kacha, which at places is up to 14 km wide.

To harness the flows of River Indus for development of irrigated agriculture a series of barrages was constructed down to Kotri Barrage before completion of Tarbela reservoir in 1977. Under these conditions, the irrigation system on Indus River was essentially dependent on run-of-the-river. However, after induction of major Mangla and Tarbela storages a substantial re-regulatory capability was created in the Indus Basin Irrigation System (IBIS). Barrages on Indus River along with salient technical features are listed in Table D-11:

Table D-11: Barrages on Indus River

Barrage	Year of Construction	Distance to Next Barrage (km)	Designed Maximum Discharge (m^3/s)	Number of Bays	Maximum Flood level Above Floor (m)	Total Discharge of Off-taking Canals (m^3/s)
Tarbela Dam	1976	146	……			
Jinnah	1946	67	26,905	42	8.4	212
Chashma	1971	270	31,153	52	11.1	756
Taunsa	1959	340	21,240	53	7.8	796
Guddu	1962	190	33,985	64	7.8	1,223
Sukkur	1932	500	42,481	54	9.0	1,345
Kotri	1955		24,781	44	12.9	1,170

Source: WAPDA Data, 2007

In the Indus Plains, river is generally running on the ridge, particularly in the section between Guddu to Kotri. Therefore to contain the river within its banks construction of embankments became necessary. The width of this floodplain between the embankments on the average is 14 km. This system of barrages and embankments besides regulating the river in high flood season, allowed substantial groundwater re-charge with significant regenerated flows during the following low flow season. Progressive hydrologic changes as a result of construction of barrages and implementation of Indus Basin Project (IBP) over the last so many decades have now essentially stabilised. Therefore, introduction of Diamer Basha Dam Project in IBIS is unlikely to have any further significant adverse impact on hydrologic regime of the Indus River.

After traversing the delta the Indus River below Kotri Barrage flows into the Arabian Sea. Indus Delta is naturally influenced with its tidal (mean daily) and seasonal intrusion of saltwater from the sea. The high seasonal fluctuation of the Indus River water creates a marked difference between winter (low water, stronger salt water influences) and summer (high water, stronger fresh/water influences).

Before construction of barrages on Indus River starting with Sukkur in 1932, the sea water intruded into Indus River up to about 30 km. Since then, due to progressive reduction of flows as a result of upstream abstractions the surplus water in Indus River has reduced significantly. Currently, flow below Kotri Barrage is only available for 80-100 days from July to September. Thus, no freshwater is released below Kotri Barrage for a period of about nine months. That is why, the salt / water intrusion from the Arabian Sea is now-a-days coming up to Sujawal Bridge (90 km against the previous 30 km). To ameliorate this situation, three special studies were got conducted by the Ministry of Water and Power of GoP in fulfilment of the requirement of Water Apportionment Accord (1991). These studies were conducted by international consultants and reviewed by an International Panel of Experts (IPOE). 'Final Report of IPOE for Review of Studies on Water Escapages below Kotri Barrage' was issued in November 2005'. Accordingly, it has been recommended and concurred to by the provinces, that a minimum flow of 142 m^3/s should be released throughout the year below Kotri Barrage to cater for the ecological needs. It is expected that the storage water made available through Diamer Basha Dam Project could significantly contribute towards fulfilment of this requirement of sustenance of Delta ecology.

D.2 Biological Environment Baseline

D.2.1 Terrestrial Plants and Plant Communities

D.2.1.1 Methodology of Plant Investigations

Systematic vegetation investigations were conducted by Environmental Team of DBC in summer 2006 and repeated in spring 2007 in order to confirm the results from 2006 and to extend the investigations with regard to the annual plants, which are growing and flowering only in spring.

Due to the large project area, the test site approach was applied. DBC investigations, led by Dr Muhammad Arshad, Cholistan Institute of Desert Studies, Bahawalpur University, selected typical sites with regard to geomorphology, soils, and vegetation cover. The plant compositions of perennial and annual plants, abundance of plants per species, density of all plants (soil coverage) were recorded.

D.2.1.2 Natural Conditions and Vegetation Cover

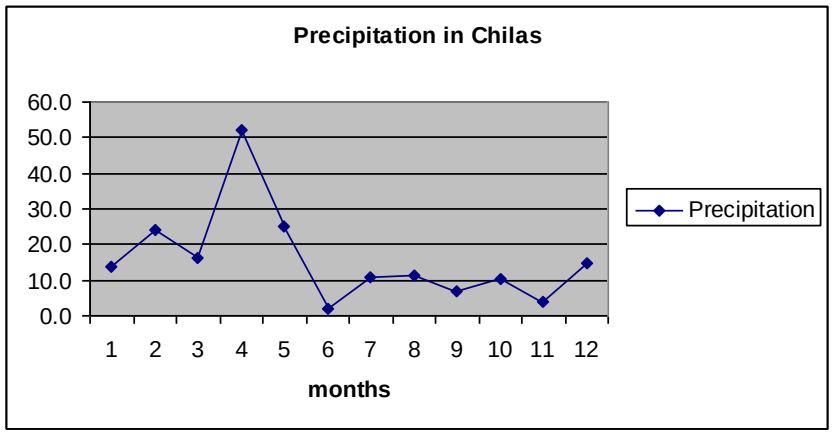
Project area along the Indus River consists of a medium to high barren valley on both sides, adjoined by mountain ranges up to approximately 2,000 masl elevation. The area is rocky and almost devoid of vegetation except at the places where tributaries join Indus River. During windstorms, the dry sand with white appearance is blown and deposited in main valley and on adjoining mountain slopes. At some locations in the side valleys, clay lenses can be seen, whose size and extent is variable.

The river beds are determined by rock outcrops, partly cliffs, and big boulders and washed gravels. Outside of the locations where the nullahs are perennially supplying water for irrigation of cultivated land there is no littoral zone at all. The peculiar situation has been caused by the active river due to the climatic-edaphic conditions and human impacts. The annual Indus River water fluctuation of some 12 meters, the permanent erosion of soils along steep slopes and uncontrolled grazing make growing of plants impossible.

The only lifeline in the impact area is the perennial flow from streams, nullahs or gahs, running into the Indus River. Regular irrigation and cultivation along the nullahs involving ploughing and mulching has formed some patches of deep humus soils. The nullahs are quite narrow and due to their predominant north south stretching the land gets temperated only during noon time. Cool air in summer from higher elevations moves towards the lower valley reaches and outlets into the Indus River. This contributes to a mild local climate in the side valleys.

The mean yearly precipitation in Chilas is 191.3 mm (refer Table D-3). About 70 % of which is received during winter and spring season from January to May. This enables growing and flowering of annual plants as well as supplying moisture to perennial plants in the dry steppe and semi-dry desert zone. However, the vegetation cover is still very sparse. For the remaining summer and autumn period (June to December) almost no precipitation is available and vegetation is drying out in this period. This is evident from monthly distribution of precipitation shown in Figure D-10.

Figure D-10: Monthly Distribution of Average Precipitation in Chilas



On the permanently wet beds of the perennial nullahs, besides cultivated land, one can observe narrow meadow strips. The streams and these meadows are main conduits for migration and geographical distribution of plants and animals. This alluvial zone is the breeding area for insects, amphibians and reptiles, in particular. Some nullahs supply water during summer and snow melting period, while other remain dry during the whole year.

D.2.1.3 Vegetation Cover and Prevailing Plant Communities

Project area between 950 to 1,500 masl elevations is very sparsely covered by vegetation. Except in the villages, there are no trees or bushes. This is caused by the dry climate, precipitation below 200 mm/year and extreme hot summer season. Table D-12 lists plant communities of the project area.

Table D-12: Plant Communities of Project Area

Habitat	Characteristic Area	Plant Composition	Natural and Environmental Conditions
Artemisia dubia steppe on moraine/terrace slopes with rocky-sandy deposits	Moraines, terraces close to Shatial	Vegetation cover 30-35%, nil trees and bigger shrubs, only some lower shrubs of *Artemisia dubia*, *Chrozophora plicata*, *Heliotropium dasycarpum*, some annuals	Sand deposits, summer drought, severe winter grazing
Artemisia dubia dry steppe relicts on rocky-sandy slopes in nullahs	Short nullah slopes in Khanbari Valley	Vegetation cover 10-20%, nil trees and bigger shrubs, only plant species is *Artemisia dubia*, none annuals	Rock slopes, sand deposits, summer drought, severe permanent grazing, severely degraded, severe winter grazing
Artemisia dubia dry steppe on flat rocky areas dominated by stones	Rocky areas close to Thak Das	Vegetation cover 3, nil trees and shrubs, beside *Artemisia dubia* only some plants of *Heliotropium dasycarpum* none annuals	Rock, only very little sand deposits, almost no soil, summer drought, severe permanent grazing, severely degraded.
Heliotropium dasycarpum dry steppe on sandy flat area covered by stones	Sand areas close to Bunar Das	Vegetation cover approximately 19%, dominant plant species *Heliotropium dasycarpum,* co-dominant is *Artemisia dubia*, rare plant species *Stipa hohenackeriana*	Sandy flat areas, highly degraded by grazing, overall vegetation very poor
Heliotropium dasycarpum and *Artemisia dubia* dry steppe on	Sand areas close to Ges Pain and Ges Bala	Vegetation cover approximately 14%, dominant plant species *Heliotropium dasycarpum,* co-dominant is Artemisia dubia, rare	Sandy flat areas, highly degraded by grazing, overall vegetation very poor

Habitat	Characteristic Area	Plant Composition	Natural and Environmental Conditions
sandy flat area covered by stones		plant species *Stipa hohenackeriana*	
Echinops Sp. Dry steppe on windblown sand deposit	Sand areas close to Thurli Nullah	Vegetation cover approximately 25%, low shrubs of Echinops Sp., Chrozophora plicata, Artemisia dubia, Heliotropium dasycarpum, big shrubs Calotropis procera	Sand deposits close to the Indus River, extreme summer drought, severely degraded by winter grazing /because of severity of summer season and overgrazing of winter season
Heliotropium dasycarpum dry steppe on windblown areas	Sand areas close to Hodar Nullah	Vegetation cover approximately 15%, dominating plant *Heliotropium dasycarpum* (some were green but very poor growth), other plants *Artemisia dubia, Stipa hohenackeriana, Tribulus terrestris,* and *Chrozophora plicata*	Sandy deposits, almost no top soil, highly degraded due to winter grazing, general vegetation condition very poor
Heliotropium dasycarpum and Capparis spinosa dry steppe on rocky flat areas covered by stones	Rocky, sandy areas close to lower Muniar Nullah	Vegetation cover 33%, relatively diverse plant composition dominated by *Heliotropium dasycarpum*, very closely followed by *Capparis spinosa*, furthermore *Tribulus terrestris* (rare plant of the area having minimum importance value), other plant species *Artemisia dubia*, Stipa *hohenackeriana*,, *Capparis spinosa, Tribulus terrestris*. In low areas with more conserved water *Cynodon dactylon*, *Xanthium strumarium, Conyza canadensis* and *Mentha arvensis*	Rocky, sandy flat sometimes sloped area, vegetation condition despite divers plant spectrum very poor, degraded habitat, severe winter grazing

Source: Vegetation Composition Assessment Report, Dr Muhammad Arshad, DBC, 2007 (refer Appendix C of Volume III)

Vegetation coverage with the increase of elevation between 1,500 to 2,000 m and above gets denser, but never exceeds 50 % (see Photograph D-2). The higher parts have some wide standing shrubs, particularly trees. The trees are coniferous type such as: juniper; and at higher places pine; fir; and spruce.

Appendix-C in Volume III presents 'Vegetation Composition Assessment in Project Area'.

Photograph D-2: Artemisia Dubia Dry Steppe

Source: DBC, 2007

D.2.1.4 Environmental State of Plant Communities

The environmental situation in the entire project area is influenced by lack of industrial threats, including wastes emitted into the air or dumped in water. The only stress is due to the human population, with the following impacts:

- Overgrazing as utmost dominant threat to the vegetation around the villages.
- Excavation of rock and earth material for domestic construction activities.
- Firewood cutting.
- Collecting of medicinal plants.
- Dumping of solid waste.
- Sewage running into nullahs, groundwater and Indus River.
- Exhaust gases from vehicles along Karakoram Highway.

Most significant adverse impact is overgrazing by sheep, goats, some cows, and donkeys. The domestic animals are in such a large number that their needs exceed the very low biomass capacity of the natural vegetation. In addition, the extreme scarcity of cultivated land results in insufficient provision of fodder (dominating crop is maize) including the winter period. Thus, the vegetation is extremely degraded, which includes:

- Reduced plant diversity: Annual plants species (growing in spring season using the small precipitation) are eliminated mostly due to grazing.
- Degradation of plant composition: Domestic animals are fond of special species, which degrades the original (natural) plant compositions severely.
- Reduction of biomass: Grazing reduces the biomass of the plants in general.
- Soil erosion: Due to grazing the soil is degraded severely and loses its original productivity.

In summary, the vegetation is severely degraded by overgrazing and the other kinds of exploitation by the local population.

D.2.1.5 Nature Conservation Status of Plant Communities

Due to the low natural diversity and the predominant threat by the local population, there are no plants or plant communities having significance from the nature conservation point of view.

D.2.2 Wildlife

D.2.2.1 Insects

i. Methodology of Insects Investigations

During 2006 ground investigations DBC focussed on insects. This work was carried out by Mr. Muhammad Abbas of Pakistan Museum of Natural History in Islamabad and the results are contained in Appendix D in Volume III titled 'Study of Insects in Project Area'. The main objective of this exercise was:-

- Investigating insects as part of the flora and fauna diversity.
- Collecting information about the food conditions for amphibians and reptiles.
- Assessing the present and future risk for malaria (and other infectious diseases).

Due to the large area, only test polygon investigations were carried out. During night time the compositions of insects for typical natural locations and habitats were conducted. Two special tents (see Photograph D-3) were operated for catching the insect fauna of a certain area during some days.

Photograph D-3: Tents for Collection of Insects

Source: DBC, 2007

The ecology of insects is highly diverse, as these have a high relevance as indicators. Often insects dominate or even predict food chain and food web in the biomass. In particular, they are important in the ecological functioning of natural ecosystems through diverse activities ranging from decomposition of organic matter to provision of food for fish, reptile and wildlife. In fact, insects play pivotal role as predators, parasites, herbivores, saprophages and pollinators. This indicates the pervasive ecological and economic importance of this group of animals in both aquatic and terrestrial ecosystems. Some of them are also useful as producers of products such as honey, silk, and lack.

ii. Diversity and State of Insects

Despite the efforts of some early entomologist, the insect fauna of Northern (Gilgit-Baltistan) Areas of Pakistan have only been marginally explored. This is because of the fact that the area is extremely difficult with very limited infrastructure and other facilities. The conditions were even worse in the past, which did not encourage the people to go there. Secondly, as the insects are cold-blooded they are more sensitive to the environmental condition as compared to birds and mammals.

Northern (Gilgit-Baltistan) Areas is rich in biodiversity of insects including beetles, butterflies, dragonflies, bugs, bees, mosquito, snail and some other minute insects. The insect fauna observed and collected during the survey of DBC was mainly represented by:

- Hymenopterans
- Grasshoppers
- Butterflies
- Beetles
- Ants, and
- Mosquitoes.

Other arthropods including scorpion and centipedes were also seen. The resulting species and habitats conditions of insects are summarised in Table D-13.

Table D-13: Species and Habitats of Insects

Natural conditions	Insects	Diversity
Rocky habitat with steppe slope	Hymenoptera and Orthoptera, Vespidae (3 specimen), Mantids (2 specimen), no butterflies	low
Rocky flat area covered by stones	Abundant: Family Acredidae, order Orthoptera and formicidae order Hymenoptera Furthermore: Dipterans and Coleopterans	low
Sandy flat areas covered by stones	Abundant varieties of Arthopterns, especially family Acredidae, further several formicids	relatively rich
Wind eroded sandy deposits	Family Acredidae order Orthoptera were abundant	low
Farm land Areas	Hymenopterans, Katididae, Hemiptera, Odonata, Hymenoptera, Lepidoptera, Coleoptera and families Tiphidae, Sphecidae, Vespidae, Evaniidae, Tipulidae, Apidae, Formicidae, Pompildae, Gomphidae, lycaenidae, Pieridae, Scarabaeidae, Elatridae, Crabaeidae and one specimen of cerambacidae. Katididae was not seen in all other habitats. Butterflies anticipated but not recorded. Furthermore Pieridae, Nymphalidae and Lycaenidae butterflies	rich (various micro-habitats)

Source: 'Study of Insects in Project Area', Appendix D of Volume III

iii. Nature Conservation Status of Insects

There are no threatened or endangered species in the area (refer IUCN red list and CITES in Appendix D of Volume III).

D.2.2.2 Amphibians and Reptiles

i. Methodology of Inventory of Amphibians and Reptiles

The inventory of herpeto-faunal composition in the project area was done by the DBC Group in three sessions. Two sessions were conducted in 2006 in spring and July led by Dr. Khalid Javed Baig (who unfortunately died in a tragic road accident during November 2006) and in spring 2007 led by Mr R Masroor, both belonging to Pakistan Museum of Natural History, Islamabad. Findings of this exercise are contained in Appendix E in Volume III titled 'Study of Amphibians and Reptiles in Project Area'.

The investigations were mostly based upon special literature studies, because the Northern (Gilgit-Baltistan) Areas of Pakistan have been only marginally explored. This is because of difficult logistics and accessibility, and very sensitive behaviour of amphibious and reptiles against local climate, noise and vibrations.

Investigations and hand picking was done during both day and night Scoop nets for catches in shallow water, cast nets in large water bodies were also used. For frogs and toads, auditory detection of mating calls at their breeding sites was applied as well. The species collected or observed during the survey were photographed. The necessary field data including GPS based coordinates and elevations were recorded including collection of samples

ii. Results of Inventory of Amphibians and Reptiles

Only one amphibian species could be observed. The other one had been either recorded previously or could not be observed during the catches. Amphibians require both water and land. Moreover, despite the dominance of the Indus River and availability of water, its shoreline is not suitable for amphibians. This is due to the high velocity and turbulence of water, the frequently fluctuation water level and the absence of littoral zone, where insects would provide the food basis. Table D-14 lists the amphibious and reptiles surveyed in the project area.

Table D-14: Amphibians and Reptiles in the Project Area (2006 and 2007)

Family	Sub-family	Common Name	Scientific Name	Local Name	Observed	Reported or likelihood
Amphibia	Bufonidae	Marbled Toad	Bufo stomaticus	Boghzoo		x
		Batura Green Toad	Bufo pseudoraddeii baturae	Boghzoo	x	x
Reptilia Squamata : Saruria	Gekkonidae	Yellow-bellied House Gecko	Hemidactylus flaviviridis	Barkunzik	x	x
		Brook's House Gecko	Hemidactylus brooki	Barkunzik	-	x
		Thin-toed Rock Gecko	Cyrtopodion sp.	Barkunzik	x	x
		Karakorum Thin-toed Gecko	Tenuidactylus stoliczkai	Barkunzik	-	x
	Agamidae	Farooq's Garden Lizard	Calotes versicolor farooqi	Dodoor	-	x
		Caucasian Rock Agama	Laudakia caucasia	Dodoor	-	x
		Pakistan's Rock Agama	Laudakia pakistanica	Dodoor	x	x
		Khan's Rock Agama	Laudakia pakistanica khani	Dodoor	x	x
	Lacertidae	Punjab Snake-eyed Lacerta	Ophisops jerdoni		-	x
	Scinidae	Mediterranean Eastern Dwarf Skink	Ablepharus pannonicus		-	x
		Himalayan Ground Skink	Scincella himalayana		-	x
	Varanidae	Bengal Monitor	Varanus bengalensis	Shalagoo	x	x
Serpentes	Colubridae	Cliff Racer	Coluber rhodorachis	Aai	x	x
		Mountain Racer	Coluber ravergieri	Aai	-	x
		Dhaman	Ptyas mucosus	Aai	-	x
		Checkered–keel back	Xenochrophis piscator	Aai	-	x
		Royal Snake	Spalerosophis atriceps	Aai	x	x
	Elapidae	Oxus Cobra	Naja oxiana	Aai	x	x

Source: 'Study of Amphibians and Reptiles in Project Area', Appendix E of Volume III.

It will be noted for Table D-14 that predominant species are reptiles as well geckos, agamas, and warans as snakes. In total 13 species of various sub-families of reptiles were observed. Obviously, this is caused by the climatic conditions particularly the summer heat, which clearly is favouring reptiles. Another natural condition is the in-accessibility of this sloppy and rocky terrain. Resting and breeding places are located beneath stones, in narrow cracks and other hidden places. Water should be available and that is why the nullahs provide the lifeline for those animals.

iii. Habitat and Breeding Conditions of Amphibians and Reptiles

Table D-15 illustrates the habitats of most important species of amphibians and reptiles distributed in the project area. Accordingly, the most diverse spectrum of amphibian and reptile species has the following habitat types:

- Rocky flat area covered by stones: 17
- Farmland areas and human settlements: 15

The other three habitat types have only 5 to 7 species. The sand deposits formed by wind deflation mostly close to the Indus River, are very juvenile terrain and have the lowest diversity of those species.

Table D-15: Habitat Distribution of Amphibians and Reptiles in the Project Area

Family	Sub-family	Common Name	Scientific Name	Local Name	Rocky Habitat with Steppe Slope	Rocky Flat Area Covered by Stones	Sandy Flat Areas Covered by Stones	Wind Eroded Sandy Deposits	Farm Land Areas and Settlements
Amphibia	Bufonidae	Marbled Toad	Bufo stomaticus	Boghzoo		X	XX		XXX
		Batura Green Toad	Bufo pseudoraddeii baturae	Boghzoo		X	XX		XXX
Reptilia	Geckonidae	Yellow-bellied House Gecko	Hemidactylus flaviviridis	Barkunzik					XXX
Squamata: Saruria		Brook's House Gecko	Hemidactylus brooki	Barkunzik	X	XXX			XX
		Thin-toed Rock Gecko	Cyrtopodion sp.	Barkunzik	XXX	XX			
		Karakorum Thin-toed Gecko	Tenuidactylus stoliczkai	Barkunzik	XXX	XX			
	Agamidae	Farooq's Garden Lizard	Calotes versicolor farooqi	Dodoor					XXX
		Caucasian Rock Agama	Laudakia caucasia	Dodoor	XXX	XX			X
		Pakistan's Rock Agama	Laudakia pakistanica pakistanica	Dodoor	XXX	XX			X
		Khan's Rock Agama	Laudakia pakistanica khani	Dodoor	XXX	XX			X
	Lacertidae	Punjab Snake-eyed Lacerta	Ophisops jerdoni			XX		X	XXX
	Scinidae	Mediterranean Eastern Dwarf Skink	Ablepharus pannonicus			XX			XXX
		Himalayan Ground Skink	Scincella himalayana			XX			XXX
	Varanidae	Bengal Monitor	Varanus bengalensis	Shalagoo		XX	X		XXX

Family	Sub-family	Common Name	Scientific Name	Local Name	Rocky Habitat with Steppe Slope	Rocky Flat Area Covered by Stones	Sandy Flat Areas Covered by Stones	Wind Eroded Sandy Deposits	Farm Land Areas and Settlements
Serpentes	Colubridae	Cliff Racer	Coluber rhodorachis	Aai	XXX	XX	X		
		Mountain Racer	Coluber ravergieri	Aai		XXX	X	X	
		Dhaman	Ptyas mucosus	Aai		XX		X	XXX
		Checkered–keel back	Xenochrophis piscator	Aai					XXX
		Royal Snake	Spalerosophis atriceps	Aai		X	XX	XXX	
	Elapidae	Oxus Cobra	Naja oxiana	Aai			XX	X	XXX

Source: 'Study of Amphibians and Reptiles in Project Area', Appendix E of Volume III.

It leads to the conclusion that most of the species recorded in the project area have a wider range of occurrence. This is determined by similar natural conditions in the five habitat types. Very little vegetation cover, dominance of stones and boulders, and the extreme summer drought in all areas has created similar living conditions.

Amphibians and reptiles, except monitor lizards and large snakes, have a limited wide foraging range and may not go out of one square km area. Geckoes and skinks only prefer microhabitats.

The breeding time of amphibian and reptiles in general is from spring until beginning of the winter, in October/November. The activity of the herpeto-fauna is linked with the active food chain period when insects and other animal species, which are the major source for amphibians and reptiles, are apparent in the area. Hibernation period therefore starts from November and lasts until March normally.

iv. Nature Conservation Status of Amphibians and Reptiles

Table D-16 represents the nature conservation status of amphibious and reptiles.

Table D-16: Nature Conservation Status of Amphibians and Reptiles in the Project Area

Family	Sub-family	Common Name	Scientific Name	Local Name	Nature Conservation status		
					CITES	IUCN Red List	Red List Pakistan
Amphibia	Bufonidae	Marbled Toad	Bufo stomaticus	Boghzoo			
		Batura Green Toad	Bufo pseudoraddeii baturae	Boghzoo		X	X
Reptilia Squamata: Saruria	Geckonidae	Yellow-bellied House Gecko	Hemidactylus flaviviridis	Barkunzik			
		Brook's House Gecko	Hemidactylus brooki	Barkunzik			
		Thin-toed Rock Gecko	Cyrtopodion sp.	Barkunzik			
		Karakorum Thin-toed Gecko	Tenuidactylus stoliczkai	Barkunzik			
	Agamidae	Farooq's Garden Lizard	Calotes versicolor farooqi	Dodoor			

Family	Sub-family	Common Name	Scientific Name	Local Name	Nature Conservation status		
					CITES	IUCN Red List	Red List Pakistan
		Caucasian Rock Agama	Laudakia caucasia	Dodoor			
		Pakistan's Rock Agama	Laudakia pakistanica pakistanica	Dodoor			
		Khan's Rock Agama	Laudakia pakistanica khani	Dodoor			
	Lacertidae	Punjab Snake-eyed Lacerta	Ophisops jerdoni				
	Scinidae	Mediterranean Eastern Dwarf Skink	Ablepharus pannonicus				
		Himalayan Ground Skink	Scincella himalayana				
	Varanidae	Bengal Monitor	Varanus bengalensis	Shalagoo	Annex I		
Serpentes	Colubridae	Cliff Racer	Coluber rhodorachis	Aai			
		Mountain Racer	Coluber ravergieri	Aai			
		Dhaman	Ptyas mucosus	Aai			
		Checkered–keel back	Xenochrophis piscator	Aai	Annex III	X	
		Royal Snake	Spalerosophis atriceps	Aai			
	Elapidae	Oxus Cobra	Naja oxiana	Aai	Annex II	X	X

Source: 'Study of Amphibians and Reptiles in Project Area', Appendix E of Volume III

Red Data Book of Pakistan on endangered species observes:

- Batura Green Toad (Bufo pseudoraddeii baturae) and
- Oxus Cobra (*Naja oxiana*).

Some other species are listed in CITES Agreement. These are: Bengal Monitor (*Varanus bengalensis*) in Annex I, Oxus Cobra in Annex II and *Xenochrophis piscator in* Annex III. In addition, *Oxus cobra* and *Xenochrophis piscator* have also been included in the Red List of IUCN as deficient.

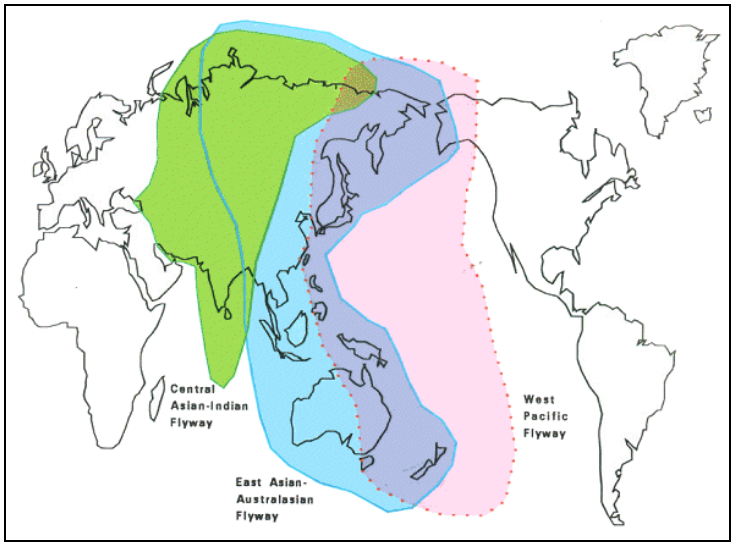
Other species named in Table D-16 are not listed in the CITES, IUCN and Pakistan Red Data Book. These species are not endemic in the project area and have rather very wide distribution (refer Appendix E of Volume III).

D.2.2.3 Birds

i. Methodology of Bird Investigations

During 2006, two field investigations were carried out by DBC under the leadership of Expert, Dr. Aleem Chaudhry. The first was in July and the second in November 2006. The summer period mainly focused on the bird species breeding in this area, During the second period of winter the availability and spectrum of migratory birds along the Central Asian-Indian Flyway was targeted (refer Figure D-11). Results of this exercise are contained in Appendix F titled 'Study of Birds in Project Area'.

Figure D-11: Central-Asian-Indian Flyway



Source: IWC International Wetland[1]

The intention for the intensive field investigations was to identify species such as white stork, cormorants, crane, duck, wild geese, and others returning from western Siberia and Central Asia towards South Asia.

The birds were recorded mainly in early morning and evening visits in different habitats using special binoculars. Photographs were taken to confirm the identification. Field guides were also used. The distribution was tallied with that reported by Roberts (1991-1992). The checklist of birds seen in the area during the period and their status is given in Table D-17).

ii. Results of Birds Inventory

During both the investigation periods of 2006, in total 36 species were recorded (refer Table D-17). Two further waterfowl species of ducks (*Anas*) were also reported to be regularly present.

Table D-17: Inventory of Birds

Common Name	Species Name	Resident	Summer Migrant	Winter Migrant	Local Migrant	Passage Migrant	Summer Breeding
Eurasian sparrow hawk	Accipiter nicus melaschistos						X
Eurasian kestrel	Falco tinnunculus	X					
Chukar	Alectoris chukar	X					
Blue rock pigeon	Columba livia	X					
Laughing dove	Streptopelia senegalensis						X
Hawk cuckoo	Cuculus varius						X
Koel	Eudynamys scolopacea		X				
Common kingfisher	Alcedo atthis	X					
European beeeater	Merops apiaster						X
Euracian roller-kashmir race	Coracius garrulus						X
Himalayan (or Red crowned jay)	Garrulus glandarius	X					
Crested lark	Galerida cristata	X					
Masked wagtail	Motacilla alba personata						X
Hodgeson's pipit (or Rosy pipit)	Anthus roseatus						X
White cheeked bulbul	Pycnonotus leucogenys	X					

[2] http://www.wetlands.org/IWC/awc/waterbirdstrategy/Intro.htm

Common Name	Species Name	Resident	Summer Migrant	Winter Migrant	Local Migrant	Passage Migrant	Summer Breeding
Blue whistling-thrush	Myiophoneus caeruleus	X					
Blue rock thrush	Monticola solitarius	X					
Rock thrush	Monticola saxatilis						X
Rufous back shrike	Lanius schach					X	
Black drongo	Dicrurus macrorhyncus						X
Jungle crow	Corvus macrorhyncus	X					
Golden oriole	Oriolus oriolus		X				
House sparrow	Passer domesticus	X					
Paradise flycatcher	Terpsiphone paradisi				X		
Plumbeous redstart	Rhyacornis fuliginosus				X		
Black redstart	Phoenicurus ochruros	X					
Grey tit	Parus major					X	
Hume's wheatear	Oenanthe alboniger	X					
Mallard	Anas platyrhynchos			X			
Northern pintail	Anas acuta			X			
Wigeon	Anas penelope			X			
Northern shovelor	Anas clypeata			X			
Common teal	Anas crecca			X			
Gadwell	Anas strepera			X			
Black necked stork	Ciconia nigra rara		X	X			
TOTAL		**13**	**3**	**7**	**2**	**2**	**9**

Source: 'Study of Birds in Project Area'. Appendix F of Volume III

It can be seen from Table D-17 that there are 13 residents, living all over the year in the project area. Further nine species are local birds from Northern (Gilgit-Baltistan) Areas coming likely from higher regions for breeding in the Indus River valley. Four species are local respective passage migrants.

Migratory birds in sizeable number are 10 species. All winter migrants are ducks and black necked stork (refer Appendix F of Volume III).

D.2.2.3.1 Habitats of Birds

Most of the birds were recorded in and around villages where cultivated land and diverse natural conditions offer the best living environment. Here also many trees offer good nesting conditions including nutrition by insects and fruits.

Table D-18 lists habitat of birds in the project areas. This reveals that most relevant habitat areas for birds are:

- Farm land, associated with streams and riverine (littoral) zone.
- Rock dominated foothill and fan areas.

Suitable habitats of ducks are the river bed, especially along bends where the flow of water is slow and provides suitable conditions for the birds to rest. In addition are the small Gini Bala Lake and the nullahs, in particular where marshy places with *Typha angustatus* and *Phragmites karka* were growing. These are the only locations with remains of littoral zone where birds would find suitable living conditions.

Table D-18: Habitats of Birds in the Project Area

Common Name	Species Name	Foothills mountain ranges	Rocky habitat with steppe slope	Rocky flat area covered by stones	Sandy flat areas covered by stones	Wind eroded sandy deposits	Farm land areas, settlements, associated with stream and riparian zone
Eurasian sparrow hawk	Accipiter nicus melaschistos	X					
Eurasian kestrel	Falco tinnunculus	X	X				
Chukar	Alectoris chukar	X	X	X			
Blue rock pigeon	Columba livia	X	X	X			
Little brown or Laughing dove	Streptopelia senegalensis	X	X	X			
Hawk cuckoo	Cuculus varius						X
Koel	Eudynamys scolopacea						X
Common kingfisher	Alcedo atthis						X
European beeeater	Merops apiaster	X	X	X			X
Eurasian Roller-Kashmir race	Coracius garrulus	X	X	X			X
Himalayan (or Red crowned jay)	Garrulus glandarius	X					X
Crested lark	Galerida cristata	X	X	X			
Masked wagtail	Motacilla alba personata						X
Hodgeson's pipit (or Rosy pipit)	Anthus roseatus						X
White cheeked bulbul	Pycnonotus leucogenys						X
Blue whistling-thrush	Myiophoneus caeruleus						X
Blue rock thrush	Monticola solitarius						X
Rock thrush	Monticola saxatilis			X			X
Rufous back shrike	Lanius schach						X
Black drongo	Dicrurus macrorhyncus						X
Jungle crow	Corvus macrorhyncus	X					
Golden oriole	Oriolus oriolus						X
House sparrow	Passer domesticus						X
Paradise flycatcher	Terpsiphone paradisi						X
Plumbeous redstart	Rhyacornis fuliginosus						X
Black redstart	Phoenicurus ochruros						X
Grey tit	Parus major						X
Hume's wheatear	Oenanthe alboniger	X	X	X			
Total		**11**	**8**	**8**	**0**	**0**	**20**

Source: 'Study of Birds in Project Area', Appendix F of Volume III

D.2.2.3.2 Nature Conservation Status of Birds

None of the species listed in Table D-18 are endangered or rare as per IUCN or Pakistan Red Data Books.

D.2.2.3.3 Threats to Birds by Hunting

The bird investigations by DBC revealed that some hunting is being done in the project area. For hunting, an official license has to be obtained. District Administration issues this license after payment of a yearly fee. The hunter is obliged to follow the prescribed closed days. Observations of DBC revealed that hunting, predominantly of waterfowl (ducks mostly), was done without license. The intensity, as assessed was moderate, due to the relatively low number of available birds. Hunting period was usually spring time when waterfowls visited the region.

D.2.2.4 Mammals

A special inventory of mammals was not carried out by DBC. This decision was influenced by the habitat requirements of mammals except some rodents. Big mammals such as deer, snow leopard, or jackal have a large habitat area and live mostly far from villages. They, rarely come close to the riverine area, which potentially is going to be inundated. Thus, the mammals would not be affected at all from the construction and operation of the Diamer Basha Dam.

However, all biological investigations monitored the appearance of mammals were accomplished by reconnaissance visits of the various fauna and flora teams.

These observations and interviews of local residents by DBC revealed that there were no mammals at all. This may have been caused by severe hunting.

D.2.2.5 General Status of Terrestrial Plants and Animals

In general, status from nature conservation point of view of terrestrial plants and animals is very limited as far as the diversity of species and their number is concerned. This, predominantly, is due to natural conditions of the prevalent semi-desert and dry steppe ecosystem in the lower zone of the Indus River valley which allow a limited biodiversity. Especially the low precipitation, extreme high summer temperature and evapo-transpiration are limiting factors. Furthermore, the low winter temperature and lack of nutrition (soils and water) for animals reduce number of species. Another natural factor is the high vulnerability of terrain against earthquakes, sliding, deflation and erosion. That is why, only a limited number of species is relevant.

In addition, there is high human pressure on plants and animals, mostly because of the poverty and low education of the local population. Plants and animals are lastly threatened significantly by the human activities such as:

- Reduction of vegetation diversity and damage of vegetation cover for fire-wood cutting
- Damage to vegetation due to overgrazing
- Damage to meadows due to excavation of earth material
- Killing of reptiles such as agamas, snakes and geckos by cars accidents and due to general fears (all reptiles are recognised by the local people as deadly poisoning)
- Hunting of animals, mostly mammals and birds.

The highest diversity of plants and animals in general, is in the settlements and the adjoining cultivated areas. The diversity of the adjacent sand banks of the Indus River itself (outside of habitations) is extreme low.

D.2.3 Fish Stocks and Aquatic Life

D.2.3.1 Methodology and Sampling Stations

In 2006 detailed investigations on fish species, aquatic conditions and fishery were carried out by DBC in the project area led by Dr. William George, Professor of Biology, F.C. College University Lahore. Results of this effort are contained in Appendix G titled ‘A Study of Fish and Fishery Aspects of Project Area’.

After first reconnaissance and interviews with fishermen, nine most representative fish sampling stations were selected to identify fish species, their population (frequency) and conditions for breeding and feeding. Relevant water bodies for this inventory were the Indus River itself with three stations. Adjoining nullahs, in particular at their lower courses were chosen for the remaining six stations.

Basic information for selection of sampling points was obtained from the local Fishery Department, which not only runs the two hatcheries in the area, but also precisely knows the nullahs with the

highest relevance of fish stocks. In addition, interviews with fishermen in the project area provided bases for the selection of sampling stations, which are listed in Table D-19.

Table D-19: Selected Fish Sampling Stations (April and June-July 2006)

Sr. No.	Sampling Station	Location
1	Khanbari Nullah	1½ km upstream from confluence of Khanbari Nullah and Indus River
2	Thor Nullah	3½ km upstream from the fall of Thor Nullah near Bridge
3	Indus River at Thor Nullah	Immediately after confluence of Thor Nullah confluence
4	Buto Nullah	4 km upstream of Buto Nullah confluence with Indus River near Hydro Power Station
5	Thak Nullah	5 km upstream from confluence between Bridge and Hydro Power Station
6	Kiner Nullah	1 km upstream from Thalpan Village
7	Bunar Nullah	2 km upper stream of confluence
8	Indus River at Raikot Bridge	110 km from Dam site at Raikot Bridge

Source: A Study on Fish and Fishery Aspects of Project Area - Appendix G of Volume III

The selected nullahs also represent those streams having the highest discharge of water. The other nullahs either do not have perennial flow or only carry very little water during winter. These nullahs therefore do not offer good conditions for fish especially for breeding. Khanbari Nullah is a high flow stream with a relatively mild slope offering shallow water areas, where the breeding conditions are excellent.

At the margins of the Indus River and various nullahs two investigations (April and June-July) were carried out by DBC during 2006. In order to assess the fish, relevant water conditions have to be determined, which need the following data:

- Water data: temperature, pH, dissolved oxygen, transparency, hardness, and conductivity
- Flow data: discharge, length, depth, width, area of nullahs and Indus River
- Biologic data: vegetation at banks, phytoplankton, zooplankton, benthos, other aquatic organisms, and
- Species data: types of species, stock size, structure, growth pattern, spawning grounds, breeding habits, mortality, survival rates of different species, nature protection status (rare, endangered, indigenous).

D.2.3.2 Natural State of Indus River and Nullahs for Fish Stocks

The natural conditions for fish stocks in the Indus River and adjoining tributaries (nullahs) in project area are seriously impacted by cold water regime. Some of the nullahs are sourced by glaciers directly. It does not allow exceeding mean monthly water temperatures during hot season above 14° C (which is the July-August temperature for the Indus River itself). The observations on Indus River made in June-July 2006 revealed slightly higher water temperatures (17 to 19° C), which could be due to the sampling of the water at the stream/river banks as well as from the surface of the water body against the standard requirement of 1 m depth. Some other natural conditions unfavourable for the fish are:

- High velocity of water in Indus River and nullahs
- Lack of spawning locations (shallow water areas) in Indus with only some locations in the lower parts of nullahs
- Lack or limitation of biological mass such as phytoplankton and zooplankton (due to the overall conditions), which does not provide a sufficient nutrition base for fish
- High load of suspended sediment such as silt, clay and sand in the Indus River

- Very low suspended load content of nullah waters, excepting some rare heavy rain, due to snow and glacier melting source, and

During investigation by DBC some physical and bio-chemical parameters of the water were derived from the samples and are listed in Table D-8.

D.2.3.3 Fish Species

Catches of fish during April and June-June 2006 revealed a broad natural fish stock spectrum. In total 14 species were identified, belonging to four families namely Cyprinidae, Noemacheilidae, Sisoridae, and Salmonidae and are detailed in Table D-20.

Table D-20: Spectrum of Fish Species in Project Area (April and June-July 2006)

Taxa	Locations		Khanbari Nullah	Thor Nullah	Indus River below Thor	Indus River at Chilas	Buto Gah	Thak Gah	Kiner Gah	Bunar Nullah	Indus River at Raikot Bridge	Frequency in %
Family name	Species	Local Name										
Cyprinidae	Schizothorax plagiostomus	Gahi	+++	++	+	+	+	++	+	+	+	23.0
	Schizothorax esocinus	Chakhat	++	+	-	-	-	++	+	-	-	10.5
	Schizothorax intermedius	Khadule	++	+	+	-	-	++	+	-	-	12.3
	Ptychobarbus spp	Siarrian	+	+	-	-	-	+	+	-	-	7.0
	Racoma labiata	Chohan	++	+	+	+	+	++	+	-	-	15.8
	Cyprinus carpio	China carp	+	-	-	-	-	+	-	-	-	3.3
	Carassius auratus	Gold Fish	-	-	-	+	-	-	-	-	-	1.8
	Ctenopharyngodon idella	Grass Carp	+	-	-	+	-	-	-	-	-	3.5
	Aristichthys nobilis	Silver Carp	-	-	-	+	-	-	-	-	-	1.8
Noemacheilidae	Triplophysa gracilis	Jungli Chemo	+	-	-	-	-	-	+	-	-	3.5
	Triplophysa microps		+	-	-	-	-	-	+	-	-	3.5
Sisoridae	Glyptosternum reticulum	Konozobo	+	-	-	-	-	-	+	-	-	3.5
Salmonidae	Salmo trutta	Angrazi	-	-	-	+	-	+	-	-	-	3.5
	Salmo gairdneri	Chemo	-	-	-	+	-	+	-	-	-	3.5

Source: A Study on Fish and Fishery Aspects of Project Area - Appendix G of Volume III

D.2.3.4 Main Fish Water Bodies

North Pakistan belongs to the southern part of Palaearctic region of fish, where the fish fauna of high mountain lakes and rivers is coldwater determined. However, there is some influence from Oriental fish species living in southern Pakistan and Afghanistan. The fauna is dominated by the cyprinid subfamily *Schizothoracini,* distributed especially in Central Asian Mountains, such as Pamir and Tien Shan. However, also few species are present in the area south of Himalaya and Hindukush. The Indus River fish fauna due to the original link (since 1974 the Tarbela Dam blocks the Indus River) with southern Pakistan is influenced from Oriental fish region[2]. Interestingly in Central Asian rivers and lakes the typical coldwater species predominate at altitudes of 1,200-2,000 m. Below, and especially above this zone, the number of coldwater species declines. One can assume (also considering fish investigations made in Khanabad and Kunduz River on the northern slopes of the Afghanistan' Hindukush Mountains) that similar conditions are also relevant

[2] see also http://www.fao.org/docrep/003/x2614e/x2614e01.htm

for the Northern Pakistan water bodies. However, it has to be mentioned that fish had been introduced in this area since long time. Two hatcheries in Khanbari and Buto are working and releasing thousands of species, in particular Salmo Trutta. In addition, fish also migrate upstream from Tarbela, where since 1974 fish had been introduced in big numbers.

The results of fish investigations revealed (see Table D-20) that the Indus River has lesser fish species than the adjoining nullahs. In particular the catch at the upper course of the Indus River at Raikot Bridge revealed only one species (however, with Schizothorax plagiostomus a very common one in Northern (Gilgit-Baltistan) Areas).

In contrast to the Indus River, the highest diversity of fish stocks is in the nullahs, particularly those with lower velocity and higher summer water temperature. The following two nullahs have the highest fish diversity:

- Khanbari: nine species (64% of all recorded species)
- Kiner and Thak: eight species (57% of all recorded species).

The situation that the Indus River in the Chilas section has a significant higher diversity (seven species) than upper section of the project area may be directly connected to the situation that both streams Kiner and Thak outfall just upstream of Chilas. Further upstream, the fish diversity is reduced, much likely due to the dominating cold-water input from nullahs like Bunar (where only one species had been recorded).

Most of the fish recorded are benthopelagic[3] species such as Schizothorax, Ptychobarbus, Triplophysa, Racoma, which have adapted to conditions where the benthos at the bottom and in mid water areas are used for living and feeding. As there is only very little plankton, the fish has the most important feeding basis in the benthos layer at the bottom.

D.2.3.5 Nature Conservation Status of Fish

None of the fish species recorded in the Indus River and nullahs (refer Table D-20) has any nature conservation status, neither the Red Data Book of Pakistan nor international lists.

Table D-20 also reveals that only three species of fish are native. However, *Glyptosternum reticulum* has some importance due to its rarity. Six out of 14 species were caught in the project area and adjoining nullahs. Widespread, especially are the *Ca*rp and *Salmon* species. *Salmo trutta* for example is bred in the upstream Jaglot Hatchery since years and introduced in the Indus River (refer Appendix G of Volume III).

D.2.3.6 Reservoir Fisheries Management Plan

While none of the fish species recorded in the Indus River and Nullahs has any nature conservations status, the reservoir created by the dam will provide a very large potential for development of the fishery. This is proposed to be exploited through 'Reservoir Fisheries Management Plan' including in the companion document of Resettlement Plan.

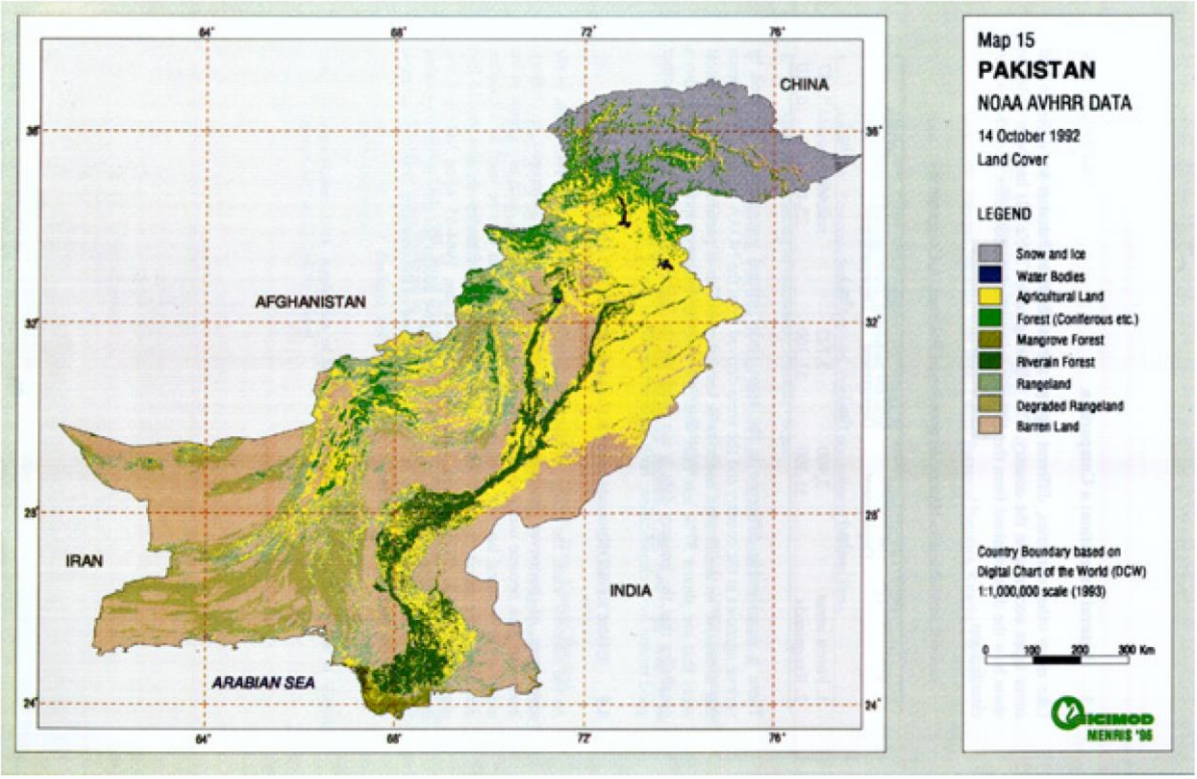
D.2.4 Downstream Biological Conditions

D.2.4.1 Ecosystems of Downstream Indus River Floodplain

Dense riverine forests were the dominant ecosystems on the Indus River flood plain. Historically, all plain area on both sides of the meandering Indus River was confined within embankments and covered by a dense riverine forest (see Figure D-12).

[2] Feeding on benthic as well as free swimming organisms. Many freshwater fish are opportunistic feeders that forage on the bottom as well as in midwater and near the surface, also pertaining to forms which hover or swim just over the floor of the sea, e.g. Halosauridae, Macrouridae, Moridae, Brotulidae; the depth zone about 100 metres off the bottom at all depths below the edge of the continental shelf. (See http://filaman.ifm-geomar.de/Glossary/Glossary.cfm?TermEnglish)

Figure D-12: Land Use Map of Pakistan



Source: IUCN Website

The riverine forest along the middle and lower sections of the Indus River (refer Figure D-13) mostly comprise scrub and low bushes of varying densities. Dominant tree species in the area are Babul (*Acacia nilotica),* Kandi (*Prosopis cineraria),* Bhan *(Populus euphratica)* and Lai (*Tamarix dioica).* Any one of these species can be dominant depending on the land formation and soil conditions. For instance, the land with high ground water table determines as to which species are dominant. Drought conditions in the recent past contributed to the dominance of Devi *(Prosopis juliflora, P. glandulosa*).

D.2.4.2 Wildlife of Indus River Floodplain

Potentially rich wildlife was habitating these ecosystems, to which belong the following mammals:

- Hog deer *(Axis porcinus)* (once a common species now close to extinction)
- Jungle cat (Felis chaus)
- Fishing cat (Felis viverrine)
- Mongoose (Herpestes javanica, H. edwardsi)
- Porcupine (Hystrix indica)
- Hedgehog (Hemiechinus spp.)
- Fox (Vulpes bengalensis)
- Jackal *(Canis aureus)* (can still be found)
- Wild boar *(Sus scrofa)* (population has reached pest levels)
- Otter is rare, and only a fraction of a once thriving population.

Following amphibians and reptiles were very common for this ecosystem:

- Gavial (*Gavialis gangeticus*) (have long been extinct)
- Marsh crocodile (*Crocodylus palustris*) (remains to be confirmed)

- Indian monitor lizard *(Varanus monitor)* (still common)
- Indian python *(Python molurus)* (critically endangered)
- Dhaman (Ptyas mucosus)
- Bloched king snake (*Spalerosophis diadema*)
- Glossy bellied racer (*Coluber ventarmaculatus*)
- Striped keel back (Amphiosma stolata)
- Saw scaled viper (Echis carinatus)
- Indian cobra (Naja naja oxiana)
- Fringe toed lizard (Acanthodactylus cantoris)
- Indian garden lizard *(Calotes versicolor*)
- Indian flap-shelled turtle *(Lissemys punctata)*
- Brilliant agama (Trapelus agilis isolepis)
- Marbled toad (*Bufo stomaticus*)
- Kittering frog (Euphlyctis cyanophlyctis)
- Tiger frog (Euphlyctis tigerina).

The above named amphibians and reptiles are native to muddy riverbanks with thick grasses and other vegetation such as *Typha, Tamarix* and *Prosopis.*

Native settlers of the Indus River, coming from the Arabian Sea are the Blind Dolphin (*Platanista minor*). Still few hundred dolphins are living in the lower parts of the Indus River as shown in Table D-21.

Table D-21: Blind Dolphin Population in the Indus River

River Reach	Estimated Population (2006)
Jinnah-Chashma	1
Chashma-Taunsa	82
Taunsa-Guddu	44
Guddu-Sukkur	1,200
Sukkur-Kotri	4
Below Kotri	0
Total	**1,331**

Source: WWF, December 2007 (Dr A Chaudhry)

Fish population is represented by 350 species. Two native fish species Palla (*Tilisha*) and Dhangri (*Lates calcarifer*) are living in the estuarine area and migrating, for breeding in the upstream Indus River. Other riverine forests support grassland birds such as doves (Streptopelia decaocto, S. Tranquebarica, S. senegalensis), finches (Estrilda amandava, Lonchura malabarica), larks (Mirafra erythroptera, Eremopterix grisea, Calendrella cineria, C. raytal), weaverbirds (Ploceus philippinus, P. manyar), Indian sand martins (Riparia paludicola), Indian River tern (Sterna aurantia), Demoiselle crane (Anthropoides virgo), and Common crane (Grus grus). Some of these birds are regular visitors on their migration route to south in autumn and north in spring.

D.2.4.3 Threats to Indus River Floodplain Ecosystems During Last Decades

During the last decades these ecosystems have been severely degraded. Many investigations have also been carried out to prepare a precise inventory and assessment of most important causes for this degradation.

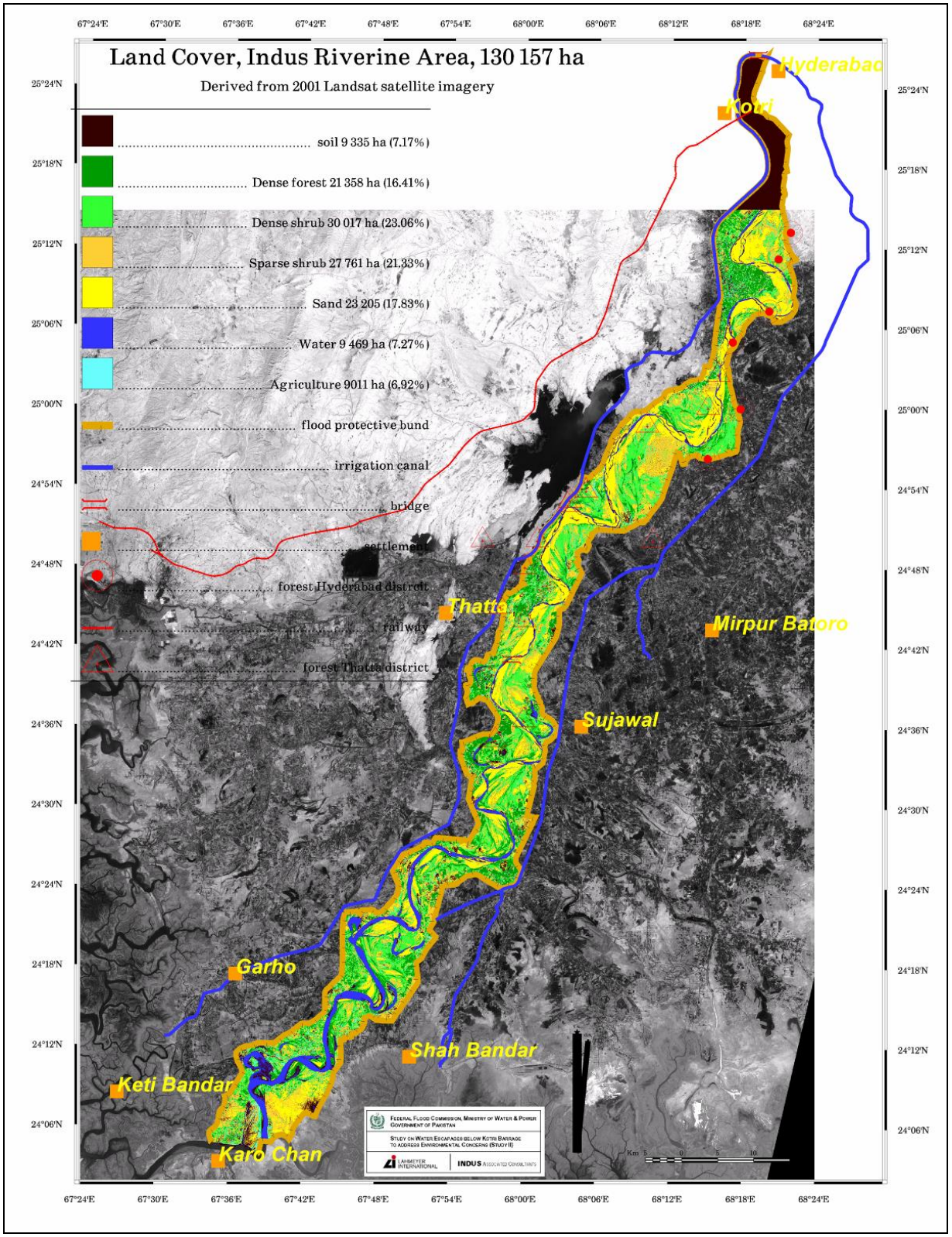
Cutting of forest trees for agricultural land, for timber (in particular Shisham, *Dalbergia sissoo* used for furniture and lastly for firewood), regulated Indus River and lowering of water level are the causes of dominant impacts on these unique ecosystems and habitats. Some parts of the original riverine forests between the embankments of the Indus River still exist with the plant community composition of Babul, Kandi and Devi.

The lowest section of the Indus River below Kotri Barrage has a gross area of 620,000 ha (refer Figure D-13). Out of the active, mean tidally inundated, Indus Delta (131,000 ha) or approximately 55 % of the area is covered by Mangroves. Dominant species are shrubs such as Tamur *(Avicennia marina* and *Rhizophora mucronata).* Occasionally *Ceriops tagal* and *Bruguiera conjugate* are present. Mangrove forests together with tidal mudflats support a variety of flora and fauna (10 species of mammals, 143 species of birds, 22 species of reptiles including eight sea snakes and three marine turtles, over 200 species of fish, and many invertebrates including 15 species of shrimps; reference IUCN 2004, and chapter 9 on References and Bibliography at S. No. 8).

High percentage of birds (56 %) is migratory species in the mangroves of the Sindh coast (44 % resident). Most common species is Indian little ringed plover *Charadrius dubius jerdoni*.

Most severe degradation in this area has come through progressive regulation of Indus River since construction of Sukkur Barrage in 1932. In particular, sometimes in-adequate amount of flooding during summer, when mangroves and other plants are germinating and animals breeding, was the most important adverse impact.

Figure D-13: Riverine Forest Area Along Indus River Below Kotri Barrage



Source: Kotri Barrage Study-II (Chapter 9 on References and Bibliography at S. No. 30)

D.3 Socio-economic Environment Baseline

D.3.1 Methodology of Socio-Economic Surveys

D.3.1.1 ADB Requirements

This section provides the categories and current efforts to collect socio-economic baseline data for Diamer Basha Dam Project (DBDP). According to the guidelines of ADB, a check list on 'Socio-economic information' requires:

- Review of existing data to determine the level of information required to meet policy standards, and choose appropriate data collection methods
- Coverage of affected population groups including any host population
- Establishing clear definitions of: project affected peoples (PAPs), family or household, loss, and entitled persons
- Establishing a cut-off date for eligibility in PAPs list
- Preparing mapping of affected villages including land-use, cropping patterns, common property and use of natural resources
- Publishing the list of PAPs for information of and verification by the stakeholders
- Including interdisciplinary skills in the core and involve local government and/or agency staff, PAPs and NGOs in data collection
- Establishing a computerized socio-economic database and a program that will facilitate identification of all information on households and individuals for project implementation as well as provide baseline for monitoring and evaluation (M&E).

D.3.1.2 Survey Types and Methods of Data Collection

D.3.1.2.1 Broad Scope

Socio-economic and resettlement data collected by NEAC for the Feasibility Report (2004) was reviewed by Diamer Basha Consultants (DBC) during the detailed design stage. This brought out the need for updation due to change in the project design and lapse of time (over three years) since completion of the Feasibility Report in 2004. This was accomplished through: -

i. Collecting socio-economic data of 31 affected villages through structured surveys during 2006 (refer Annex D-2).
ii. Developing 'Village Profile' of each affected village based on the collected socio-economic data (refer Annex D-3).
iii. Women Household Questionnaire Survey during 2007 (refer Annex D-4 and D-5).
iv. Cadastral Survey of all the affected households conducted during 2007-08 jointly by the Revenue Department of Diamer district of Northern (Gilgit-Baltistan) Areas and WAPDA with advice / assistance of DBC.

D.3.1.2.2 Updation of Data

According to ADB's related policy, resettlement plans and implementation need dependable and accurate data reflecting the precise impacts on PAPs so that appropriate entitlement policies can be developed. In pursuit of these objectives, the pervious information collected by NEAC was updated by DBC and covered: -

i. Population data.
ii. Tribal structure.
iii. Social hierarchy including gender.

iv. Community assets.

v. Government assets.

vi. Analysis of vulnerable people including disabled and landless people.

vii. Conducting of Cadastral Survey to verify the immoveable / moveable assets of PAPs as well as the government.

viii. Proposed resettlement measures.

D.3.1.2.3 Survey Types and Methods of Data Collection

In most countries, for the purpose of land acquisition and resettlement, at least three basic surveys are required. These comprise: land acquisition survey; census survey; and a socio-economic survey. These surveys were conducted by DBC with due consideration of ADB's checklist.

The methodology basically adopted for initial socio-economic surveys (2006 & 07) was participatory rapid appraisal (PRA). The information was collected with the help of pre-designed / tested questionnaires and proformae and related to: -

i. Inventory of affected population and infrastructure (Questionnaire).

ii. Village profile (Proforma).

iii. Gathering information during scoping sessions with PAPs (Proforma).

iv. Meetings with local responsible functionaries of various agencies (Interviews).

v. Consultation with N(GB)A Administration and NGOs (Interviews).

As part of consultation and public participation

vi. Data of disabled and landless people (Proforma).

vii. Gender (Women) Survey through questionnaire filled during interviews with female PAPs based on random sampling.

In addition, Cadastral Survey was conducted (2007-08) covering all the affected households in 31 villages to verify the socio-economic data collected / updated previously. Thus, the results of socio-economic initial survey was superceded by the Cadastral Survey in respect of affected assets and population of PAPs.

D.3.1.3 Cadastral Survey 2007-2008

For preparation of a Resettlement Plan, it is necessary to have an accurate inventory of the land and assets to be acquired in connection with the project. Normally in the settled provincial districts of Pakistan, the basic Revenue Records are available for public and private land, other immovable assets, and infrastructure.

However, no such record and data exist for the Northern (Gilgit-Baltistan) Areas. Consequently, Diamer district, where almost the entire socio-economic impact of the project will occur, did not have this facility. To overcome this deficiency, a special effort in the form of Cadastral Survey had to be mounted through the joint efforts of involved institutions including Revenue Department of Diamer district, Project Director Diamer Basha Dam Project, WAPDA Chilas, with advice / assistance of DBC. This also facilitated verification of some other important socio-economic data, particularly the census of PAPs conducted by DBC previously.

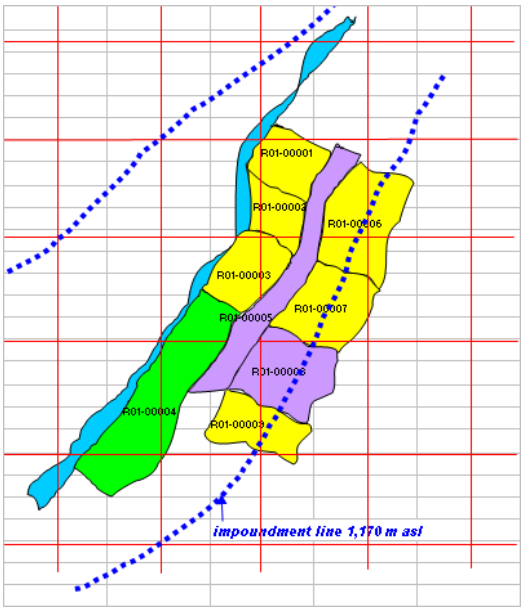
To initiate the process, in November 2006, DBC prepared the Socio-economy Survey concept, particularly covering: population; land and infrastructure objects; and other assets (private business, domestic animals, trees) of the area to be affected by the project.

The Cadastral Survey itself was conducted over the period of January 2007 to June 2008 under the overall supervision of Project Director, Diamer Basha Dam Project, WAPDA, Chilas. Two independent survey teams were formed as below:

- Land survey team comprising Patwaris (both from Revenue Department and WAPDA) and supervising Officers from Revenue Department (Tehsildar) and WAPDA (a retired Assistant Commissioner).
- Infrastructure team comprising WAPDA's Sub-Engineers supervised by Executive Engineer and Deputy Director.

All information was collected village-wise through Urdu versions of Proforma. Compilation of this village-wise collected data was done using Khasra No. as the primary unit. This was also supported by a manually prepared Khasra-wise Revenue Map of each village called 'Shajra' to form the basic record (see Figure D-14). Revenue data were assembled by land categories such as: plots with numeration, size and land use; type of land subdivided into cultivated, residential, barren, soil fertility including slope and water availability; and trees including their age and kind.

Figure D-14: Cadastral Survey Revenue Map



Source: DBC IM-ENR-017

For the purpose of benchmark, reference and further utilization in determination of entitlements and compensation, the village-wise Cadastral Data was transcribed to the prescribed English Proforma. This provided the basis for preparation of the overall inventory of cadastral objects for inclusion in the Resettlement Plan (RP).

D.3.1.4 Computerised Socio-economic Database

In accordance with requirement of ADB, a computerized socio-economic database should be established. For this purpose, DBC have utilized ADB's APTRAK model in MS Access with the following format:-

a. Socio-economic survey of Project Affected Peoples:
   - Part 1: Population:
     - Household: Number, composition, male/female, children,
     - Education
     - Income and expenditures
   - Part 2: Land inventory
     - Land data: Size (in marla and kanal), type of land (residential, cultivated, grassy, uncultivated, or barren)

- Land ownership data: Occupied by owner, or tenant
- Cultivation by: owner or tenant (or both)

- Part 3: Built-up properties including infrastructure (private and public)
  - Housing data: Number of buildings including animal sheds and stores, type of house (various categories), total covered area, number of rooms, number of kitchens, bedrooms, bathrooms or latrines, others
  - House utilities data: In-house water supply, electricity, sewerage etc.
- Part III: Domestic animals: Number of heads per type of livestock per household
- Part IV: Trees: Fruit, non- fruit and age per household.

b. Tribal affiliations: number of people per tribe, per village

c. Women Survey: Qualitative and quantitative data from > 300 gender interviews: Numbers, trained birth attendants, female diseases, education level of women (literacy), occupation of women including working on farms and land ownership by women

d. Relocation option: For resettlement in model villages or lump sum cash compensation[4].

e. Village Profiles

Various types of data gathered by DBC were initially transformed into Excel format. Later on, these were converted in MS Access to establish a combined and unified database. After completion of the exercise, it was realised that substantial data gaps would need to be filled to complete the database besides authentication of available information through field verification. This would be accomplished through supplement / focussed surveys.

D.3.2 Administrative Set-up of Northern (Gilgit-Baltistan) Areas and North-West Frontier Province (Khyber Pakhtunkhwa)

D.3.2.1 Northern (Gilgit-Baltistan) Areas

Previously Northern (Gilgit-Baltistan) Areas have the status of Federally Administered Area. Authority of Chairman for the region vested in the Federal Minister for Kashmir Affairs, Northern (Gilgit-Baltistan) Areas, States and Frontier Regions. Chairman was assisted by a Chief Executive, elected by majority of the members of the Northern (Gilgit-Baltistan) Areas Legislative Assembly. Chief Executive enjoyed the status of a Federal Minister of State and assisted by six (6) Advisors appointed by the Chairman, in consultation with the Chief Executive, from amongst the members of the Northern (Gilgit-Baltistan) Areas Legislative Assembly. Advisors enjoyed the status of a Provincial Minister.

The judiciary comprised the Chief (Apex) Court, Appellate (High) Court and district courts headed by Session Judges.

N(GB)A Administration was being run through a Secretariat headed by the Chief Secretary assisted by Secretaries for various departments (12 numbers). N(GB)A has been divided into six districts of Diamer, Ghizer, Gilgit, Ghanchi, Astore, and Skardu. Each district is headed by the Deputy Commissioner. Local administration is run by an elected District Council headed by a Chairman. A chart with the previous 'Administrative Set-up of Northern (Gilgit-Baltistan) Areas' is shown in Annex D-6.

In September 2009 the, Government of Pakistan awarded an autonomous / provincial status to N(GB)A under the title 'Gilgit and Baltistan' to be administered by a Governor. Elections for the

[4] through a separately conducted survey of each household, as per details in Annex G-5

Legislative / Regional Assembly were held in October 2009. This followed formation of the publicly elected government under a Chief Minister assisted by the Cabinet. Thus, the current administrative set-up of Gilgit-Baltistan Area was almost similar to the other four provinces of the Federation.

The project with the dam site and reservoir is almost entirely located in the Diamer District of Gilgit and Baltistan Area.

D.3.2.2 Northern-Western Frontier Province (Khyber Pakhtunkhwa)

There is a small left bank part close to the dam site lying within Kohistan District of NWFP (Khyber Pakhtunkhwa) (refer Map 1) with headquarter in Dasu. In addition, some isolated patches of barren land will be acquired between the dam site and downstream village of Shatial for construction contractor's camps, workshops and storage areas. However, not a single household of Kohistan District is expected to be dislocated by construction of the project.

D.3.3 Settlements, Demography and Tribal Affiliation

D.3.3.1 Settlements

Project impacted area extends over about 102 km of Indus River reach (reservoir stretch of 94 km) upstream of the dam site almost entirely lying within Diamer District of N(GB)A with its headquarter at Chilas in the middle. Furthermore, the only areas suitable for housing and cultivation are along the Indus River itself and adjacent to many streams, local name "*nullah*" or "*gah*", at their outfalls. Water courses of these nullahs are often quite long and populated by many people, especially when they have sufficient water all over the year. Mostly the people in one valley belong to one ethnic group or tribe. That is why the population in each valley has a peculiar feeling of communal cohesion, and maintain intensive inter-village relationship. The valleys determine optimal interactions due to cultural, social and religious beliefs. Significant manifestation is marriages between the families living within the valley.

Besides Chilas, some larger settlements such as Bunar Das and Gonar Farm have developed since completion of Karakorum Highway in 1977. Going upstream from the proposed dam site, the following sequence of 19 villages along Indus River can be found in the valleys (nullahs) on the left bank (also refer Map 4):

- Minar Nullah: Lower Minar (1)
- Thor Nullah: Villages Sine Huch, Thor Das, Khotobat, Bazakal, and Muruski (5)
- Thurli Nullah: Villages Thurli Das and Chikka (2)
- Ghichi Nullah: Ghichi Village (1)
- Buto Nullah: Lower Chilas (1)
- Thak Nullah: Lower Thak (1)
- Gini Nullah: Lower Gini Village, local name 'Gini Hotel' (1)
- Bunar Nullah: Lower Bunar Das (1)
- Gonar Nullah: Lower Gonar Farm, Soniwal Hit, Mani Pain (3)
- Gandlo Nullah: Gandlo Village (1)
- Jalipur Nullah: Jalipur Village (1)
- Yashokal Hit Village (1)

In the project area opposite to Gas Pain Village (right bank), there is a small village located on the left bank of the Indus River, which was previously established by Soniwals of Khia only for seasonal purpose of gold extraction from sandy sediments on the river banks. Nowadays this village is permanently settled and named as Yashokal Hit. Going further upstream towards Raikot Bridge, there is Tata Pani, where a hot water spring exists. At this point, Frontier Works

Organisation (FWO) has established a camp. Truck drivers are stopping here for resting and praying although no permanent dwellings exist.

Upstream of the lower nullah courses on the left bank in the Project Area, there are 149 settlements located in the upper stretches. Most of these have access through link roads with existing Karakorum Highway. These access conditions will not only be restored but substantially improved through linkage with relocated Karakorum Highway.

Following 12 villages in the valleys (nullahs) are located close to the Indus River right bank while going upstream from the proposed dam site (also refer Map 4):

- Khanbari Nullah: Nima and Narar (2)
- Hodar Nullah: Sine Huch, Nusry Das, Dalojil, Segali Hit, Balokish (5)
- Kiner Nullah: Thalpan and Lower Thak (2)
- Ges Pain Nullah: Ges Pain (1)
- Ges Bala Nullah: Ges Bala (1)
- Shing Nullah: Lower Shing (1)

Further 77 villages are located in the side valleys of right bank nullahs, which except Kiner Nullah, are accessible only from the Indus River via suspension bridges. Thus, there are 31 settlements closely located to the Indus River and subject to inundation from the potential reservoir. Beyond these directly affected 31 villages, there are another 226 indirectly affected settlements in the wider project area.

D.3.3.2 Demographic Structure of Local Population

Population of the entire Diamer district according to 1998 Census, spread over an area of 11,936 km², was 207,107. Thus, the population density of the district was 17.3 persons per km². Most of this population is living along the Indus River and Karakorum Highway with main population centre of Chilas city, though there are long side valleys with many settlements.

In accordance with the above list of valleys, the total population living in the affected 31 villages of the project was 28,650 (2008 survey) with an average of 6.92 per household. In the wider project area the estimated population was 63,901, living in 226 villages located in the upper parts of side valleys.

According to 1998 censes the total population of Diamer district (207,107) comprised 52% males and 48% females. Corresponding age structure was as below:

i. Population below 15 years: 50.25%

ii. Working age group (15-64 years): 47.24%

iii. Population above 65 years: 2.51%

Females in reproductive age (between 15 and 49 years) were 33.3 % of the entire female population. From this group of women: 77 % were married; 2 % widowed; 0.4% divorced; and around 20 % un-married.

The married women had different numbers of children as indicated below:

i. Childless 6.3%

ii. One Child 8.1%

iii. 2-4 Children 35.0%

iv. 5 Children 11.0%

v. Above 6 children 39.6%

D.3.3.3 Tribal Affiliations

There is a distinct tribal structure in the project area (refer Annex D-7). It can be seen from Table D-22 that main local tribal clans are Sheen, Yashkun and Kameen. These local tribes represent about 55 % (15757 people) of the total affected population. They are engaged in cultivation, livestock, and forestry. Remaining 45 % of the population in the inner project area are 'so called' non-locals and comprise: Soniwals; Gujar; and Swatis besides the settler tribes of Kohistani, Pattan, Woolmaker, Jalkoti, Lohar and Kashmiri.

Even 'Non-Local Tribes' arrived in the area from different parts of the country centuries ago. However, in the project area, majority of these ethnics have less land, limited work opportunities, lower incomes, inferior housing, and more afflicted by mal-nutrition and poor physical and mental health. The non-local tribes are generally engaged in cultivation and animal husbandry. Their status of the ownership is only limited to few purchase(s) or land leases from local tribes. However, the majority of relatively effluent shopkeepers in the project area belong to non-local clans. Particularly in Chilas, there is a group of rich Soniwals, who are the owners of business properties such as hotels, shops, petrol pumps, workshops and saw machines.

The tribal system in the project areas follows its own codes of conduct and justice. The tribes are very closely organised and bounded through kinships. Tribal leadership is still intact and codes are rigidly implemented. Efforts made previously by the Government to bring socio-economic changes have been largely unsuccessful for the simple reason that basically the physical power was used as an intervention.

Community is divided along the lines of tribes. As mentioned above, there are two types of tribes living in the project area: local; and non-local. A very important self-governing community vehicle is the *Jirga.* This is an assembly of the eldermen, which deals with all aspects of social life of the entire community including conflicts about land, water, family and religion. etc.

In addition, at Tehsil level in the tribal areas, a council of elders is appointed. It comprises one or two notables from every village in the area. Each member of this council is called Jastero. The number of Jasteros from each village depends on the size and population. This council convenes as and when necessary. A parallel counterpart is the Tehsil Council, which is the body of elected public representatives.

Inter-village relations in the valley, often with members of the same tribe, are quite cordial. In most cases, peoples from villages close to the Indus River have their lands also in the upper valleys, which strengthen the inter-valley relations. The larger settlements, particularly Chilas, Bunar Das and Gonar Farm, are composed of various clans both from local and non-local tribes. Here the communication between the families of different tribes and clans is basically limited to economic activities including business. Comparing with other parts of Pakistan, all tribal people in the project area, both local and non-local, regardless of their ethnicity, lead a hard and materially poor life.

Local and non-local tribal clans have perennial differences regarding ownership of land and properties under occupation. Notwithstanding this, during the long period of co-existence in the area, a mutual relationship has been established. This covers not only business but social participation in ceremonies like marriages and funerals and borrowing food and cash. Also in religious and political affairs, the tribes cooperate with each other. Inter-marriages are, however, not practiced between Sheens and Yashkuns on the one hand and Soniwals and other non-local tribes on the other. Village-wise composition of the tribal structure in the project area is summarized in Table D-22.

Table D-22: Population and Major Tribes in the Project Area

Name of Valley	Name of Village	Village ID [a]	House-holds [b]	Population [b]	Main Tribe	Estimated Percentage of Main Tribe	Other Relevant Tribes
I. Right Bank of Indus River							
Khanbari	Nima	R01	134	1,165	Soniwal	100	
	Narar	R02	72	470	Soniwal	100	
Hodar	Sine Huch	R03	209	537	Soniwal	80	Yashkun
	Nusry Das	R04	37	1,56	Yashkun	70	Sheen
	Dalojil	R05	60	420	Sheen	80	Soniwal
	Segali Hit	R06	20	141	Yashkun	90	Soniwal
	Balokish	R07	45	435	Sheen	99	
Kiner	Thalpan	R08	189	1020	Yashkun	70	Soniwal
	Lower Thak	R09	34	214	Swati	100	
Ges Pain	Ges Pain	R10	225	1648	Yashkun	95	Sheen
Ges Bala	Ges Bala	R11	92	833	Sheen	98	Yashkun
Gorabad	Lower Shing	R12	5	33	Sheen	100	
Total Right Bank			**1,122**	**7072**			
II. Left Bank of Indus River							
Minar	Lower Minar	L01	5	35	Sheen	100	
Thor	Sine Huch	L02	48	313	Soniwal	100	
	Thor Das	L03	161	881	Sheen	90	Yashkun
	Khotobat	L04	40	259	Gujar	99	
	Bazakal	L05	19	128	Gujar	95	Soniwal
	Muruski	L06	15	86	Yashkun	60	Gujar
Thurli	Thurli Das	L07	28	198	Sheen	100	
	Chikka	L08	45	274	Gujar	100	
Ghichi	Ghichi Village	L09	2	20	Gujar	100	
Buto	Lower Chilas	L10	1,866	15251	Soniwal	40	Sheen, Yashkun, Swati
Thak	Lower Thak	L11	9	60	Soniwal	100	
Gini	Lower Gini Village	L12	29	120	Sheen	100	
	Yashokal Hit	L13	20	210	Soniwal	100	
Bunar	Lower Bunar Das	L14	435	2,108	Sheen	50	Yashkun
Gonar	Soniwal Hit	L15	69	382	Soniwal	100	
	Lower Gonar Farm	L16	101	628	Sheen	60	Yashkun, Pattan
	Mani Pain	L17	44	232	Kohistani	80	Sheen
Gandlo	Gandlo Village	L18	17	155	Sheen	90	Sheen
Jalipur	Jalipur Village	L19	60	238	Yashkun	100	
Total Left Bank			**3013**	**21578**			
Grand Total (Left and Right Bank)			**4135**	**28650**			

Source: DBC, 2007

a) As per Map 4
b) As per Cadastral Survey 2007-08

D.3.4 Occupation and Employment

D.3.4.1 Occupational Status

i. General Situation

Statistics about the occupation status of potentially affected households has been compiled by DBC relying on the head-counting socio-economic survey. Village-wise position is shown in Annex D-8 with a summary in Table D-23.

Table D-23: Occupational Status of Households in Project Area

Sr. No.	Occupation	Occupational Status of Household	
		Number	Share (%)
1	Agriculture / Farming	1386	33.5
2	Semi or Unskilled Workers (construction mostly) a)	434	10.5
3	Skilled Workers a)	686	16.6
5	Government Service a)	786	19.0
6	Business a)	626	15.1
4	Private Employment a) (in various enterprises including agriculture)	194	4.7
7	Security Forces (Army & Police)	23	0.6
	Total i. Overall	**4135**	**100**
	ii. Agriculture Dependent	**3918**	**94.7**

Source: DBC, 2007 and subject to verification

a) Supplemental income source in addition to agriculture

iii. Unemployment

In accordance with the definition applied in Pakistan, the unemployment rate of the households is zero. This situation is due to the fact that every household has some land. Thus the head of the household is counted to be a farmer. The inaccuracy of the present definition and above figures is also determined by the fact that women are not included. They beside all house works are the major persons working on the cultivated plots.

iv. Female Labour

There are only very few job opportunities for females mostly offered by the Departments of Education, Health, Social Welfare, active NGOs like NADP and some vocational centres.

Except few females working as doctors and nurses in the hospital or teachers, women have no occupation in governmental institutions or business concerns. On the other hand, the females are mostly working in domestic agriculture, often doing the hardest works on land and livestock breeding, all round the year. Many women and girls of the Soniwal tribe are also engaged in extracting gold from sand of the Indus River.

v. Child Labour

Some children, of the age 10 years and above, are working part time at various automobile workshops, wood factories, construction works, newspaper stands, shops and hotels. The reasons for this compulsion are:

- High level of poverty, which forces the parents to send the children to work.
- No educational opportunities in the villages after primary school.
- Lack of facilities for any special vocational education (that is why many boys are forced to assist in shops, workshops and other places to become candidates for a future job and training positions).

Children are also working as per traditional family system in the agriculture, mostly involving grazing and feeding of animals.

Based on initial assessment, the number of child labour in the project area is not large.

D.3.4.2 Occupations in Agriculture, Fishery and Forestry

i. Subsistence Farming and Agricultural Occupations

The traditional subsistence farming system and animal husbandry is widely practised since generations in the project area. It is the predominant economic system, which, in general, supplies the people with most of the daily needs. More than 94% of the affected households are basically dependent on agricultural farming (refer Table D-23) growing for their livelihood including livestock. On these farms, most of the daily consumer goods such as wheat, maize, potatoes, vegetables, fruits, milk, butter, eggs and meat are being produced for self consumption. Therefore, agricultural farming is the prevailing livelihood system of self-reliance and sustainability in the project area.

Agricultural products are not generally sold in the local markets. Selling in the markets or to neighbours is resorted to only in two cases. Firstly, when the plot size or the yield of harvest exceeds the family food demands; and secondly, when families are forced to sell their food products in order to get some cash (for marriage, purchasing of products such as salt, tea, batteries, clothes, shoes, medical service, transport, education etc.) In some cases they barter with other farmers a few goods they need. Milk from cows and buffalos is sold but the quantity is limited due to lack of storage, preservation and transport facilities.

Not all family members of a household are engaged in full time agriculture. Animal husbandry (one buffalo, one cow, one donkey, some sheep and goats and poultry) in each family is handled by the grand parents and children. Women are mostly required to put in hard field labour. Males only perform the preparatory works of: levelling; construction and maintenance of irrigation channels; construction of terraces and stone walls; and ploughing of the plots.

Most of the people working in agriculture and animal husbandry are family members and not hired. They work on the farmland and are supervised by the household head either husband or his wife, who is either land owner or tenant. Due to above conditions, most of the farms do not employ outside workers. Further, the small farm land holdings neither offer much work nor the farmers are able to pay for these additional farm workers.

Host community of Buto tribe around Chilas was claiming to be the real owner of ‘Dases’ proposed as relocation sites in the form of Model Villages. On the other hand, Chief Court of N(GB)A had ruled that this land belonged to the Government. Therefore, the host community was demanding that ownership dispute should be amicably resolved before construction of the Model Villages. During August 2009, negotiations were held between N(GB)A and Land Acquisition and Resettlement Issue Resolution Committee and an understanding reached to settle this dispute outside the court. This issue was later on referred to Ministerial Committee constituted by the Prime Minister of Pakistan, particularly to resolve the issues of land acquisition and resettlement in consultation with PAPs. This Committee also endorsed the approach of settling this dispute outside the court. During July 2010, the Federal Cabinet approved this proposal along with the land compensation rates negotiated between PAPs and the Government through good offices of the Ministerial Committee.

In case of Kino Das, the host community belongs to Gorabad. Gorabad is located on the right bank and rich in natural resources and wildlife. Agriculture and livestock are the main sources of livelihood for Gorabad. Its presently estimated population is about 6300 living in joint family households of 10-12 people. Similar to Chilas, the main host tribes are Sheen and Yashkun. Their attitude towards resettlers from other, non-local tribes is also identical to Chilas.

ii. Livestock and Animal Husbandry

Despite traditional self-sustaining farming on small land holdings, livestock breeding and animal husbandry make a significant contribution to the family income. Each household has at least one buffalo and one or even more cows for milk production, butter and meat. Bullocks and buffalos are generally used for ploughing. The household donkey, sometimes a horse, is used for transportation

in the valleys. Average population of livestock per household according to the Cadastral Survey was about 16.

Each family has a number of sheep and goats as part of the livestock. These herds are brought in spring to upper meadows above 1,800 masl, where they find reasonably good feeding conditions. There is a traditional 'Gujar System', under which herds are allowed to graze throughout the year in the vicinity of the habitations. However, due to scarcity of vegetation trans-migration system of bringing herds of sheep and goats to high altitude meadows in different regions of Northern (Gilgit-Baltistan) Areas is quite common. Mostly, the animals are brought in early summer to upper valleys, which are not regularly habituated, and have good conditions for grazing.

Quality of milk cattle is very poor and reflected in their small and emaciated size (average of 2 litres/day for buffalo and 3 for cow). Due to limited fodder availability, the cattle barely supply the household needs of dairy products or meat.

iii. Fishery Occupations

Fishery, though performed on commercial basis in the project area, is limited due to very low fish population. According to Fishery Department Chilas, there are 46 full time and 53 part time fishermen, performing the activity for commercial purposes. In a year, they work for 200 days on the average. A group of 22 fishermen including 15 part time workers were interviewed by DBC and findings are summarised in Table D-24.

Table D-24: Fishery Occupations in Project Affected Area

Sr. No	Name of Fisherman	Nullah	Part time	Full time	Catch in average [kg/day]	Income in average [Rs./month]	Remarks regarding income
1.	Asghar Khan	Khanbari	1		5	2,000	Insufficient
2.	Hazrat Khan	Khanbari		1	8	6,000	Insufficient
3.	Bihsam Shah	Khanbari	1		4	3,000	Sufficient
4.	Asad Ali	Khanbari	1		5	2,000	Sufficient
5.	Ajmal son of Faqir	Thor	1		4	3,000	Sufficient
6.	Ayub son of Iqbal	Thor	1		3	1,500	Insufficient
7.	Azam son of Abdul Hamid	Thor		1	6	3,000	Sufficient
8.	M. Bashir son of Ayub	Thor	1		4	3,000	Sufficient
9.	Bilal son of Siwan Khan	Thor	1		5	3,000	Sufficient
10.	Sher Badshah son of M. Jan	Thor	1		5	3,000	Sufficient
11.	Atta Ullah	Thak	1		5	2,000	Sufficient
12.	Hakim son of Bux	Thak	1		5	2,000	Insufficient
13.	M. Khan son of Selha	Thak		1	10	8,000	Sufficient
14.	Sher Ahmad	Thak	1		5	2,000	Insufficient
15.	Dildar Khan son of Abdullah	Thor	1		5	2,000	Insufficient
16.	Nizam uddin son of Aslam	Thak	1		5	2,000	Insufficient
17.	Ghulam Dastigir	Thak		1	8	6,000	Sufficient
18.	Sher Ahmad son of Khalid	Thak		1	8	6,000	Sufficient
19.	Hashmat son of M. Qasim	Thor	1		4	2,000	Sufficient
20.	Shahid Irshad	Thak	1		4	2,000	Sufficient
21.	Asad Ali son of Sirbland	Thak		1	8	6,000	Sufficient
22.	Abdul Wahid son of Gul Khan	Thak		1	8	6,000	Insufficient
	Total		**15**	**7**	**124**	**75,500**	
	Average				**5.6**	**3,431.8**	**Largely Sufficient**

Source: Office of Fishery Department Assistant, Fishery Department, Chilas

It can be seen that the average of fish catch by these fishermen is 5.6 kg/day. Some of them sell fresh fish on the river bank while others fry it for marketing at almost double the price. Part time fishermen from Thak Nullah conceded that approximately 60% of their family income came from fish catches. However, they seemed to be dissatisfied due to insufficiency of fish catch. On the other hand, DBC's survey revealed that most of the full time fishermen considered the income as sufficient.

In addition, some individuals do perform angling as a recreational activity. They are mostly visitors and tourists, who stay overnights during their travelling to Gilgit, Hunza, Skardu and other parts of Northern (Gilgit-Baltistan) Areas.

D.3.4.3 Occupations in Industry, Service and Government

i. Construction Works

Any sizable industrial or manufacturing enterprises do not exist in the project area. Furthermore, no legally registered construction companies are located in Chilas or other settlements. Construction of private residential houses is done by the owners themselves. For public or other medium scale private investments, bunch of workers are engaged for labour inputs. However, the largest number of occupations result from construction workers engaged as daily wagers. They are not regularly employed by the construction entity. Every day they assemble in the morning at some specified locations in Chilas, Bunar Das and Gonar Farm and can be hired for full or part of the day.

Most of the public works in road construction and rehabilitation, new construction and maintenance of irrigation facilities, suspension bridges, and other infrastructure are funded by the government. These jobs are partly allotted on day-work basis but mostly on contract.

Some construction and reconstruction works currently going on in the region are Babusar Valley road, Dudishal-Khanbari road, irrigation channels such as Khotobat and Thor Das, mini hydropower plants in Thor, Bunar Das, Thak and Buto nullahs, water supply project for Chilas, and Boys and Girls Colleges, District Headquarters Hospital, and City Park in Chilas.

ii. Manufacturing Activities

Other occupations in this sector are offered by workshops for vehicle maintenance and repairs. Many of these are located along Karakorum Highway particularly in lower Chilas. Some others are located in Thor Das, Bunar Das and Gonar Farm. Some saw mills are now offering timber and carpentry services for construction of houses. Few shops for manufacture of furniture also exist in Chilas.

iii. Handicraft

Handicraft industry is not widespread and mostly working through girls and women in the houses as cottage industry. The products such as tablecloth, napkins, and wooden works for house and kitchen are offered on a limited scale in the local market at Chilas or other display centres in N(GB)A.

iv. Shop-keeping and Hotels

Private shop-keeping is occupation of many peoples. In total, there are 453 shops (see Table D-25) in the project area, which mostly deal with supplying products for the daily consumption in the form of grocery. Some other shops offer cloth, pharmacy products, paints, and construction material. Besides Chilas, these shops are operating in many large villages, particularly on the left bank, comprising Thor Das, Bunar Das, and Gonar Farm. More than 40 shops are located in Shaheen Kot Village (lower Chilas area) along Karakorum Highway.

These shops are working during all week days from early morning up to late night. Some of them are also working round the clock. They are mostly owned by the people from local tribes of Sheen and Yashkun. In Chilas, however, many shop keepers are Soniwals. Each shop owner mostly works himself all day, often supported by his son or other family members. Many children are also caretaking in these shops, particularly during prayer timings. Only in very few cases the

shopkeepers hire a regular worker on monthly basis. Shopkeepers in the project area are relatively affluent people due to the regular source of income. Their earnings vary between Rs. 10,000-15,000 per month depending on type and location of the shop.

Only along Karakorum Highway, aside from driver hotels in Thor Das, lower Gini Village, Bunar Das and Gonar Farm, there are number of tourist quality classified hotels in Chilas. Employees in these classified hotels are engaged on monthly salary basis, but mostly during the summer tourist season of April-November.

Along Karakorum Highway have also developed some facilities of vehicle repairing, fuel filling and service stations, where few jobs are available. Many people along Karakorum Highway, particularly in distant villages, are maintaining their personal transport.

Due to lack of access, there are extreme distortions in business and job opportunities on the right and left bank locations as illustrated in Table D-25.

Table D-25: Comparative Major Job Opportunities on the Right and Left Bank of Indus River

Name of Valley / Village	Major Job Offering Business Activities (No.)			
	Shops	**Driver Hotels**	**Classified Hotels**	**Petrol and Fuel Fill Stations**
I. Right Bank of Indus River				
Khanbari Valley	3	0		
Hodar Valley	10	0		
Kiner Valley	2	0		
Ges Pain/Ges Bala	11	0		
Total (I)	**26**	**0**	**0**	**0**
II. Left Bank of Indus River				
Thor Das	56	6		1
Lower Chilas	152	7	11	4
Lower Thak	3	0		
Lower Gini Village	3	1		1
Lower Bunar Das	63	0		1
Lower Gonar Farm	150	6		1
Total (II)	**427**	**20**	**11**	**8**
Total (I+II)	**453**	**20**	**11**	**8**

Source: Cadastral Survey, 2007-08

Due to scarce job opportunities on the right bank side the settlements of Chilas, Gonar Farm, and Bunar Das on the left bank offer attractive avenues. That is why many males, from the right bank villages are hitch-hiking in the morning to these places to find some day work.

v. Governmental Jobs

Governmental jobs are generally of two types: regular jobs on a monthly basis for civil servants; and casual or daily-wage support staff. Employees of the first type are mostly located in Chilas and comprise Diamer District Administration, WAPDA, Police Department, FWO, and NAPWD. Employees in some other governmental departments work at nurseries in Bunar Das, Gonar Farm, and Nusry Das, in hatcheries in Khanbari and Chilas, in the jail, the meteorological station Chilas, the union councils, and municipalities. People, in particular from Ges Pain, Bunar Das, Gonar Farm and Chilas, are mostly working in government outfits located in Chilas.

As mentioned above, other types of jobs existing in the area are through the contractors engaged by NADP, WAPDA, NAPWD, National Database Registration Authority (NADRA), Forest

Department and Agriculture Department. However, most of the jobs under these contracts are of technical nature with limited scope for locals due to high illiteracy rate.

Majority of executive governmental jobs in the area are occupied by representatives of the local tribes. These positions, having regular monthly income with relatively high salaries, make these civil servants affluent and well respected in the area.

vi. Job Opportunities at National and International Levels

As in other rural areas, many males, mostly young and un-married, are working in other parts of the country. That includes locations of Abbottabad and Mansehra in NWFP (Khyber Pakhtunkhwa) followed by, Islamabad and Karachi. Most of these jobs are self-sought and include drivers, construction workers, cleaners, cooks and others. Very often the family decides that a certain enterprising young man should go for working in another area of Pakistan or even a foreign country such as United Arab Emirates or Saudi Arabia. Such employees are obliged to repatriate a large proportion of their earnings back to their families. Only after working for some years in these attractive earning positions, they are allowed to marry under a parental decision.

D.3.5 Land and Holdings

D.3.5.1 Land Use

i. Cultivated Land

The land use pattern (see Map 3) is directly affected by the natural conditions, which are, in turn, dependent on the semi-arid to arid local climate and area relief. Cultivated land is only to be found in locations close to the perennial nullahs, where all settlements have been established.

There is almost no rain-fed agriculture. However, at some locations groundwater supplies along the wider alluvial fans of some nullahs are available. Due to running in deep gorge and high seasonal fluctuation, there can be no supply of irrigation water from the Indus River.

ii. Rangeland

Under the local climatic conditions, the prevalent vegetation in the area is a sparsely grassed steppe characterised by *Artemisia plant associations*. In general, all this land outside of the villages and platiness of the adjacent ranges called ‘Dases’ is used for grazing. Quality of this rangeland for livestock support is very poor. However, rangeland on moraines and terraces is more productive than that on rock outcrops covered only by thin alluvial deposits.

Wet rangeland exists at very few places, where permanent and occasional ground or floodwater is available. These wet rangelands like at Thor Nullah, Buto Nullah, Thak Nullah, Khanbari Nullah, and Kiner Nullah, enable growth of high productive perennial grass.

iii. Rocky and Sandy Areas

There are many rock outcrops, cliffs, rockslides, and also sand banks and dunes, which do not have any vegetation cover. Very often, they are adjoining the rangeland areas.

iv. Residential Land

Land use, depicted in Map 3, illustrates the dispersed locations of residential area. The typical pattern in the project area is that residential land, except in upper Chilas Town, adjoins the cultivated land even in lower Chilas.

v. Land for Business Facilities

Business facilities are mostly located on the left bank of Indus River along Karakorum Highway covering small plots. To this land use category belong: built-up land with shops including wooden cabins; hotels; workshops; petrol / fuel filling stations; timber storage places; saw mills; and a few open landscapes.

vi. Land for Public Facilities

In the villages, a significant portion of land is occupied by public facilities such as schools, hospital (in Chilas only), medical dispensaries (Basic Health Units), mosques, shrines, and graveyards.

D.3.5.2 Land Ownership Status

Due to the historical genesis of Pakistan the land ownership conditions in Northern (Gilgit-Baltistan) Areas are quite different as compared to settled areas. Since independence from British colonial rule in 1947, Pakistan has exercised sovereignty over N(GB)A. Although N(GB)A is not defined as Pakistani territory under the 1973 Constitution, it is being governed by the Federal Government since 1951 (In September 2009, the area was granted autonomous status by the Government of Pakistan and renamed 'Gilgit and Baltistan'). Thus, some tribal rules and former principalities have continued to be applied. Management and institutions of natural resources are governed by a combination of legal instruments including common law dating back to the colonial administration of India (Land Acquisition Act 1894 predominantly), and Pakistan federal and provincial statutes. Cultivated and residential land in the vicinity of settlements was initially given to the migrant population virtually as tenancy. Adoption of current 'Northern (Gilgit-Baltistan) Areas Nautor Rule' (1980) envisages that the occupant of land will be treated as its owner. All other land beyond the settlements, mostly barren in the form of 'Dases', will belong to the Northern (Gilgit-Baltistan) Areas Administration. As already mentioned this has been a cause of prolonged dispute between the tribes and N(GB)A in the courts. However, as mentioned earlier that the parties have now shown willingness for an out of court settlement.

As already mentioned, in the project area, land records are almost non-existent. Neither a landowner nor a tenant has any document, record or certificate about his property. No revenue map is available with the District Administration except lists (handwritten) of households occupying the land including its use for residential and agricultural purposes. The ownership on land, tenure-ship, possession of houses and other properties are confirmed by Jirga of the village in cases of dispute. To overcome this difficulty, a Cadastral Survey had to be conducted during 2007-08.

All cultivated and residential land in vicinity of the settlements is in private hands. Within this area, there is no governmental land. Over 55% of this land is owned by the local tribes of Sheen, Yashkun and the remainder 45 % by the non-local tribes. The basis for this determination is contained in Annex D-10. Local tribal population has the rights to use range and forestland but the Government administers its management.

D.3.5.3 Land Occupation and Tenancy Status

Out of 94.7% agriculture dependent households (refer Table D-23), the owner-cultivators and tenants occupy 92.9 and 7.1% of the farm land. Supportive Information on land occupancy status in project area is summarised in Table D-26 with supporting details in Annex D-11.

Table D-26: Land Occupancy Status in Project Area

Occupancy Status	Number of Households	Proportion (%)
Owners (Self Cultivation)	3639	92.9
Non-Owners (Tenant Cultivation)	279	7.1
Total	**3918**	**100**

Source: DBC, November 2007

Regarding tenancy, the following three kinds of occupation are being practiced:

i. Permanent tenants: The tenants are living on the land and responsible for management of cultivation and animal husbandry. They normally pay to the landowner, one third (in some cases 50 %) of the harvest in kind. This group of tenants is a permanent and secure labour resource for larger farmers. Because of their tenuous ownership status, they are bound to

remain in the village. Thus, they are also available for additional local employment to larger farmers.

ii. Short-term tenants: These tenants normally do not live on the land permanently. They also follow the crop sharing system in which the gross produce is shared by landlord and tenant. However, here usually the share is 1:1 and only in some cases 2:1. The production inputs such as seed, machinery, fertilisers are provided by the landowner. Tenant's responsibility is to manage the crop production including irrigation.

iii. Lease *(Kalong)* tenancy system: The third group comprises those land holdings, which are given to a tenant on lease basis. Especially, landowners of large forms are using this system of tenancy called *Kalong*. Usually the lease is for several years, and the tenant pays in cash after the annual harvest. These tenants are mostly independent of the landlord in their decisions on cultivation, improvement of soil quality, irrigation and other land development measures. This system is practised only in Khanbari Valley and Ghichi Village. Actual owners of Khanbari land are living in Darel Tehsil of Diamer district. The owners of Ghichi lands are living in Buto Nullah near Chilas.

Majority of local tribes (Sheen, Yashkun and Kameen), besides their land holdings in the lower Indus Valley, also own lands in upper parts of the side valleys in nullahs. This land fulfils at least the following two functions:

i. On the one hand, it is alternative land where the people live with their families and livestock during hot summer season. In summer, at the lower altitudes, there is a lack of fodder for domestic animals. That is why Sheen, Yashkun and Kameen occupy rangeland and also forest land in higher elevations. The families together with their animals move to these summer meadows in the spring.

ii. On the other hand, this land is put to additional agricultural use. Therefore, the people close to the rangeland and forests have mostly constructed wooden houses. In the areas up to 1,800 masl, they raise two crops as in the lower parts (winter wheat and summer maize, potatoes and vegetable). In higher areas above 1800 masl, they can only cultivate summer crops.

D.3.5.4 Land Holdings

Compared to other parts of Pakistan, the land holdings are very small. This is particularly important from the point of view of lack of alternative income sources. Main reasons for this situation are:

i. Unfavourable natural climatic conditions: semi-arid to arid; and very low precipitation <200 mm/a.
ii. Lack of irrigation water outside of the nullahs.
iii. Rocky and slopy terrain, offering mostly barren land.
iv. Fragmentation of holding due to division among successors.
v. Intensive requirement of various inputs for rendering barren to cultivable land.

Investigations by DBC on size of farmland (see Table D-27) revealed an average cultivated land per household of 5.12 kanals. This also included built-up land with the small residential 'Kacha' houses and cattle pens.

Table D-27: Sizes of Land Holdings in the Project Area

Name of Affected Village	ID of Village	Population (No.)	Households (No.)	Total Area of Village (kanals)	Land Per Household (kanals)
Nima	R01	1,165	206	1,304	6.3
Narar	R02	470			

Name of Affected Village	ID of Village	Population (No.)	Households (No.)	Total Area of Village (kanals)	Land Per Household (kanals)
Sine Huch	R03	537	371	2,969	7.9
Nusry Das	R04	156			
Dalojil	R05	420			
Segali Hit	R06	141			
Balokish	R07	435			
Thalpan	R08	1,020	223	2,187	9.8
Lower Thak	R09	214			
Ges Pain	R10	1,648	225	1,623	7.2
Ges Bala	R11	833	92	911	9.9
Lower Shing	R12	33	5	200	40
Total Right Bank		**7072**	**1122**	**9194**	**8.19**
Lower Minar	L01	35	5	201	40.2
Sine Huch (Thor Valley)	L02	313	48	388	8.1
Thor Das (Thor Nullah)	L03	881	161	363	2.3
Khotobat (Thor Nullah)	L04	259	40	415	10.4
Bazakal (Thor Nullah)	L05	128	19	178	9.4
Muruski (Thor Nullah)	L06	86	15	169	11.3
Thurli Das (Thurli Nullah)	L07	198	28	50	1.8
Chikka (Thurli Nullah)	L08	274	45	164	3.6
Ghichi Village	L09	20	2	58	29
Lower Chilas	L10	15,251	1,866	5,465	2.9
Lower Thak	L11	60	9	46	5.1
Lower Gini Village	L12	120	29	211	7.3
Yashokal Hit	L13	210	20	1	0.05
Lower Bunar Das	L14	2,108	435	2,827	6.5
Soniwal Hit	L15	382	69	138	2
Lower Gonar Farm	L16	628	101	805	8
Mani Pain	L17	232	44	110	2.5
Gandlo Village	L18	155	17	96	5.5
Jalipur Village	L19	238	60	311	5.2
Total Left Bank		**21,578**	**3,013**	**11,996**	**3.98**
Grand total		**28,650**	**4,135**	**21,190**	**5.12**

Source: DBC, March 2007

It can be seen from Table D-27 that there is significant variation between the right and the left bank. Average right bank land holdings of 8.19 kanals are higher than left bank figure of 3.98 kanals, with an overall average of 5.12 kanals. Variations differ from village to village, caused by landowning conditions (ethnic affiliation), natural conditions including availability of plain area, availability of water and irrigation facilities.

D.3.5.5 Succession Customs

In Pakistan, as per Islamic law, the succession of land (and other property) passes on as heritage from the father to the sons and daughters in a ratio of 2:1. In practice, however, the land is inherited only by sons on equal basis. The daughters normally are deprived of getting any land or other properties. Notwithstanding this, the land holdings are continuously becoming smaller and smaller through fragmentation.

D.3.6 Agriculture, Fishery and Forestry

D.3.6.1 Soils and Fertility

Project area is dominated by barren land and rocks caused by extreme climatic conditions. Thus, the natural soils in the project area are of semi-arid aeolian origin with very little humus.

Land holdings inside of the villages, mostly under intensive irrigation and mulched with stocks of maize and wheat straw, have the highest soil fertility. These soils (so-called *cultosols* or *hortisols*) have deep humus horizon (30-50 cm) with very little boulders. These fields can be rated as medium to high fertility level depending on the type of cultivation. The soil pattern in the project area is summarised in Table D-28 (also refer Maps 5).

Table D-28: Soil Types in the Project Affected Indus Valley and Nullahs

Geological Condition	Soil Composition	Water Availability	Vegetation Cover	Soil Fertility
Rock cliffs and outcrops	Rock	No water	No plants	No soil cover
Rock sliding area	Boulders, gravels	Mostly no water	Almost no plants, older areas with grass, bush, small trees	No soil cover
Alluvial fans	Gravels, sand, some boulders	Water in deeper horizons likely	Some vegetative cover, Artemisia Steppe	Some soil cover in lower parts of the fan
Remains of old alluvial terraces	Clay, silt	Some groundwater (springs)	Mostly no vegetative cover	Eroded soils
Terraces and moraines	Sand, clay in various layers, partially with boulders	Water above deeper layers likely (some springs supporting this assumption)	Some vegetative cover, Artemisia Steppe	Greyish semi–sandy soil, good water absorption potential, availability of nutrition from minerals, some parched water table available in upper horizon
Aeolian sand deposits	Deep sand	Ground water mostly deep	Only some single standing pioneer plants	Almost no soil cover due to lack of water, plants and permanent defoliation
Alluvial sand banks of Indus River and lower nullahs	Deep sand	Higher groundwater from river	No plants, only some single standing pioneer plants	No soil cover due to permanent shifting of river bed sand bars

Source: DBC, 2007

The soils suitable for cultivation should be either alluvial or glacial in origin. Cultivable soils are, therefore, located where flat terraces are available along with some soil moisture. This is mostly along the nullahs. Deposits of clay and silt also support vegetation (either after winter rain or from irrigation) and provide some nutrition. Some isolated deposits of clay and silt, as remains from previous alluvial accumulations, are also found inside the river active flood plain and at places along the Indus River.

Some organic matter in the upper soil horizon is available, which gives the soil a greyish colour. This soil is of medium fertility, if water is available for irrigation.

Alluvial soils near Indus River or nullahs and the barren land generally contain sandy and sometimes boulder deposits. But these are very poor from nutrition standpoint.

Land holdings inside of the villages, mostly under intensive irrigation and mulched with stocks of maize and wheat straws have the highest soil fertility. These soils (so-called *cultosols* or *hortisols*) have deep humus horizon (30-50 cm) with very little boulders. These fields can be rated as medium to high fertility level depending on the type of cultivation.

D.3.6.2 Irrigation

Since no irrigation water can be extracted from the Indus River, communities have constructed irrigation channels in the side valleys. The water in the nullahs at higher elevations is diverted from the stream in order to bring it on to the cultivated lands in downstream locations.

Due to limited irrigable land in the narrow valleys, most of the irrigation channels are small. The intakes are made up of stone masonry. The local people have knowledge and experience from ages as to how the intakes can operate under fluctuating water level in the stream. However, these small channels are often in an ill state of repair and maintenance.

In the recent times, some relatively larger irrigation canals have been built by community participation with the support of Northern (Gilgit-Baltistan) Areas Public Works Department (NAPWD). In general, these channels are built by a contractor as part of irrigation schemes. Even these bigger canals are unlined and thus suffer large conveyance losses.

D.3.6.3 Cropping

i. Crops and Cropping Pattern

Irrigated cropping pattern in the area is dominated by wheat (winter) and maize (summer) as can be seen from the related statistics for the entire Diamer district listed in Table D-29.

Table D-29: Estimated Cropped Area and Yields in Diamer District

Crop	Area (Hectares)				Average Yield (t/ha)
	Winter Crop	Summer Crop	Total	(%)	
I. Winter					
Wheat	6,678		6,678	50.0	1.8
II. Summer					
Maize		5371	5371	40.3	2.0
Barley		253	253	1.9	1.6
Potato		520	520	3.8	25.0
Vegetable		530	530	3.9	20.0
Sub-Total (II)	**6,678**	**6,674**	**6,674**	**100.0**	
Annual Total (I+II)	**6,678**	**6,674**	**13,352**	**100.0**	

Source: IUCN, Northern (Gilgit-Baltistan) Areas Strategy for Sustainable Development, 2003

Main winter crop of wheat is grown between November and April-May. Moisture is only needed at pre-planting stage in autumn after maize harvest. Later on, winter rain feeds the wheat plants. Wheat is the staple food of the population and its straw is also used as fodder in dry form.

Immediately after wheat harvest, the summer crops are sown. It can be seen from Table D-29 that in summer most (around 80%) of the cultivated land is covered by maize, which is also used for flour production including fodder stock for the domestic animals in winter. Some of the other crops are barley and potatoes. Besides home consumption, the farmers with relatively large land holdings also sell potatoes in the market for export to Abbottabad, Mansehra and Islamabad. Different types of beans such as Soya, Mung and Mash are some time also grown in maize as intercrops.

Essentially, a similar cropping pattern is followed in all the valleys, with minor variation in areas under different vegetables. During field investigations by DBC, a healthy wheat crop was noted in Bunar Das Valley with resultant increased yield through good management.

Vegetables such as tomato, potato, spinach, swanchal, pumpkins, okra (ladyfinger) onions, chillies are grown successfully in the area. Due to the small size of land holdings, only nominal surplus of vegetables is marketed in Chilas. In addition, there are serious limitations in transportation and marketing. These conditions prohibit growing of vegetable on a commercial scale.

Cropping intensity at present is around 200%, where two crops are grown in a year at altitudes upto 1,800 masl. It is rarely more than 200% in a situation where one short duration crop (a vegetable) is taken between the two major crops. Above altitudes of 1,800 only one crop can be produced.

ii. Seed Rate and Crop Varieties

There is no formal measurement system for area, size and weight like the one practised in settled areas of Pakistan. The seed rates are based on the traditional wisdom matching the size of field. Farmers make use of their own seed individually saved from the previous crop. Seed is sown by broadcast and there is no concept of drilling or row planting. Usually, more seed is put to get the thick stand of crops (wheat, maize). Later on, some of the plants are uprooted / cut and fed to the livestock, which is a good practice for getting fodder but at the expense of reduced yields.

Wheat and maize varieties currently being used are a mixture of many varieties. These seed blends are used by the farmers year after year and the movement of seed from one place to another is not common.

iii. Fertilizer and Other Inputs

Very small amounts of Nitrogenous fertilizers may be in use. Pesticides are also not in use. Agriculture Extension Services practically do not exist.

D.3.6.4 Medicinal Plant Collection

Diamer district is famous for some medicinal plants. Apart from black cumin (*kala zeera*), which is mostly used as spices, some medicinal plants are also collected for trade. One relevant species is a mushroom locally called "*Ghuchi*", having great medicinal value. Other species are *Ephedra* and *Artemisia*, which are found in abundance in the area. However, both are rarely used for treatment or drug making. Grinded Ephedra is added as flavour for food (called locally "*sonf*").

Generally, the medicinal plants grow on grassy lands above 1,300 masl. They are mostly collected by 5-10 persons in the respective valleys. After collection, these are dried and sold in the market for Rs. 4,000 to 5,000 per kg. A person, who is in this business on full time basis, can earn an average of Rs. 10,000 per month.

D.3.6.5 Orchards and Fruit Growing

Although there are no regular orchards in the project area, many fruit trees are grown. According to Cadastral Survey data there are 525,775 affected trees comprising 54% fruit trees and 46% non-fruit varieties. Fruit trees consist of walnut, almond, fig, apricot, pomegranate, grapes, peaches, apple and others. Trees grow on the private land in and around the villages. Fruit trees outside of the settlements are non-existent.

The conditions are quite favourable for fresh fruits such as, pomegranate, nuts from walnut and almond and dry fruits from apricot, mulberry, and grapes. The Census Report (1998) recorded that 900 tons of different fruits were harvested in the Diamer district, produced almost by private farmers.

Fruits, and especially dry fruits, have traditionally high importance as a healthy food in winter time for supplying vitamins. Dry fruits also often provide an important source of cash to the farmers. For instance, normal local price of one kilogram of walnut is Rs. 80. Normally, a walnut tree yields about 50 kg, which could fetch Rs. 4,000, thus significantly contributing to the household income. Obstacles to commercialise the fruit cultivation are limitations in tree nursery capacities, transportation and marketing.

D.3.6.6 Tree Nurseries

Fruit and non-fruit tree nurseries existing in Gonar Farm, Bunar Das, Khanbari and Nusry Das, are being run by the Agricultural and Forestry Department of Diamer district (refer Table D-30). These

provide good quality orchard plants, but are unable to meet full demand of the area. The main reason is paucity of funds for these governmental nurseries.

Table D-30: Government-Run Fruit and Non-fruit Tree Nurseries in Project Area

Name of Village	ID of village	Type of Tree	Area (Kanals)	Permanent Employees (No.)	Seasonal Labourers (No.)	Seedlings (per year)
Nima (Khanbari)	TN-01	Fruit	8	2		1,500
Nusry Das (Hodar)	TN-02	Non-fruit	8	2		10,000-15,000
Lower Gonar Farm (Gonar Farm)	TN-03	Fruit	150	12	6	2,000-2,500
Lower Bunar Das (Bunar)	TN-04	Non-fruit	111	3	3	15,000-20,000

Source: DBC, 2006

D.3.6.7 Forestry

Forests, though essentially located above 1800 masl, 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, wood choppers, timber cutting and selling through governmental leasing.

Forests around the project area comprise the natural forests of conifer in higher elevations (above 1,800 masl, which are mostly pine (*kail*), fir and spruce (*deodar*). Scrub on the rangeland in the foothills of the surrounding mountains is also classified as forest area. In addition, there are some non-fruit trees planted in the settlements mostly for improving the climatic conditions around the residential houses.

Natural forests in the project area are common property of the local tribes (Sheen, Yashkun and Kameen) and communities and usually termed as communal forests. Commercial exploitation was first started in 1949. Later on, practice of marking trees and awarding cutting contracts by owners was started in 1957. Presently, the management of communal forests vests mainly in the committees formed by the owners of a particular forest area.

Management and supervising of all governmental forests is with the Department of Forest in each district. Contracts are recommended by the community itself and finally approved by the Deputy Commissioner or Assistant Commissioner. Since 1972, communal forests are being managed under working arrangements prescribing 10-15 years ago for felling and simultaneous regeneration with seedlings provided by the Forest Department. In general, the Forest Department is managing the following tasks:

i. Supply of seedlings for new plants through 4 existing nurseries in the area including planting by employees of Forest Department.

ii. Launching and issuing contracting permits for wood chopping and transport to markets. With a share of 80% for the community (from this amount the wood choppers would be paid for their labour) and 20% for the District Administration represented by the Deputy Commissioner

iii. Controlling and applying sanctions for illegal forest harvesting and cutting (fines of Rs. 130-160 per cubic feet depending on the quality of wood).

The contractor, who generally employs the woodchoppers, has to pay in advance. This includes the salaries of the woodchoppers (average between Rs. 36,000 and 40,000 per season) and royalties going into: Forest Development Fund; District Welfare Fund; and development charges for the District Administration. Only then, the contractor can transport the trees to a certain timber storage place. Harvesting months are from February to July. Trees are felled manually using axe and saw, and collected at one point from where they are rolled down the slope to forest roads using dry slide or "*pathru*". The trees are then floated along the nullahs and finally down to the Indus River to the timber storage places mostly located close to Karakorum Highway. In these areas trees are converted into logs and scants using hand saws or saw mills established temporarily. Timber is then transported by jeeps or small trucks to down country markets like Dargai and

Havelian of NWFP (Khyber Pakhtunkhwa). In these markets, the contractors sell the timber at prevailing rates.

The proceeds received from the contractors are paid, mostly in advance, to the community (Jirga Nazim). The community then distributes among the owners, comprising local residents of the community, on per head basis. A female gets half of the amount received by a male member. Shares of children and adults are the same.

Forestry in the area is not sustainable due to very weak writ of the Forest Department and lack of funding. Generally, in the harvested areas the sheep and goats are grazing freely which inhibit sprouting of any seedlings.

The existing system of forest management has its own advantages and disadvantages. It encourages forest conservation in the areas where the owners are conscious of the importance of forest wealth. But majority of the owners favour this system because it gives them the right of disposing the forests according to their wishes and make more money. Disadvantages of the system are:

- Contractors and owners make huge profits as the volume of wood extracted is far more than allowed in the working permit.
- Government is deprived of royalties as the output volume declared officially is much less than actually exploited.
- Rates fixed for royalty are insignificant and often not paid.
- Forests are depleting at an alarming rate with little hope for renewal.

The imposition of ban on forest harvesting since 1993 has resulted in reduced supply of timber and escalation in prices and proved a temptation for smugglers to indulge in large-scale illicit cutting of trees. As a result, forests in the Thak and Chilas ranges have been ruthlessly cut in the recent years leaving behind deserted mountains. A similar situation may arise in Thor and Gonar ranges where forests are said to be still intact, as the ban on commercial felling has proved a disincentive for the owners and concessionists.

Scrub forests also belong to private owners. These forests are not managed on systematic lines. All the local inhabitants have equal rights on these forests for collection of fuel wood and leaves for fodder. Over-exploitation of useful vegetation has resulted in severe degradation of the environment. In order to check the resource from further deterioration the owners have introduced a system locally called “Zaitu Nizam” for protection of oak forests. The committees formed under the system impose fines for cutting green oak trees. However, there are still no restrictions on lopping for fuel wood and fodder.

Most people use fuel wood for cooking and space heating, as it is the cheapest and easily accessible source of energy in the area. Fuel wood consumption is quite high due to harsh climatic conditions. Almost 100 % of domestic energy requirements are met from wood. The Forest Department has estimated the fuel wood consumption of 0.9 m^3 per capita per year in the Northern (Gilgit-Baltistan) Areas. A ten-member family roughly burns about 4 tons of fuel wood during winter and half of it (about 2 tons) during summer season.

D.3.6.8 Animal Husbandry

Some livestock like bullocks, buffaloes, goats and sheep are kept by the residents in the project area. Bullocks are used for agricultural farming, whereas cows, goats and sheep are reared for milk and meat and hides. Some of the stock goats and sheep (5-10%) are sold from time to time to meet the financial needs of the family. Some donkeys are also seen in the area and used to carry small loads including carriage of grains to the nearby flourmills.

Health standard of livestock is generally very poor. Probably, the farmers cannot afford to put sufficient areas under fodder at the expense the staple crops of wheat and maize.

The goats and cows are the main livestock of the project area and are kept in large numbers (11 goat and 3 cows per house-hold on average). The goat herds are variable having different number of heads. Generally, a herd consists of 50-200 heads. The herds are looked after by the shepherds throughout the year.

Some poultry is also raised by the farmers which mostly meets requirements of the family. Taking care of poultry is the responsibility of females while livestock rearing is the responsibility of males. Mostly the poultry birds belong to some local breed with egg laying capacity of 60-80 eggs per year against 120-150 eggs per year in some hybrid breeds. In low lying valley of Hodar, ducks are also raised with egg production as low as 20-40 per year.

D.3.6.9 Fishery

Fishing activity in the project area is regulated and controlled by the Department of Fishery, which is part of the Department of Agriculture of Northern (Gilgit-Baltistan) Areas. Statute for this is the 'Fishery Resources, its Regulation and Development Planning and Enforcement of Fisheries Act, 1962'. It regulates control of fish stocks, breeding of fingerlings in hatcheries, and release in water bodies. It also enacts fishing rules and regulations for conservation. Violators and defaulters have to face charges and judicial punishments.

Department of Fishery issues fishing licences including payment of nominal fees. Its major responsibilities are mobilisation of fishery resources, enhancement of fish production, development of infrastructure and staff capacity building, promotion of fish culture and aqua-cultural activities, and conservation measures to protect the endemic species.

Indus River main stream is not being used for fishing activities but adjoining streams attract the anglers and fishermen due to their fish stock. The best catches are possible (likely due to the fish stocks and availability of water) in Thak, Thor, Buto and Khanbari nullahs. Angling and fishing activities require obtaining a license from the Fishery Department. The seasonal license for fishermen costs Rs. 300 per cast net, while a gill net license is charged at Rs. 1,000.

There are two existing hatcheries in the project area: one near the outfall of Khanbari Nullah; and the other at the Buto Nullah in Chilas. These are in very poor state of operation and maintenance basically due to lack of appropriate funding.

D.3.7 Mineral Resources and Gold Washing

The geological conditions due to the dominant, though highly folded, ultra-basic rocks are unsuitable for mineral resources such as coal, oil and gas. Even limestone or marble for production of cement or other construction materials are not available in the project area. Only rocks, gravels and sand suitable for construction of small houses, walls and fences between the cultivated plots are found in abundance. The only mineral resource, sold on the local markets, is some precious stones such as opal, aquamarine, emerald, and ruby.

The alluvial sediment between Bunji and Shatial, seasonally deposited along the banks of the Indus River (coming from upstream sources), contains a very small proportion of gold. Gold occurs in small sand like grains and has an extremely low concentration in the sediments. Therefore, from industrial point of view, this extraction is uneconomical. However, gold washing from the local point of view is a significant occupation and an important income source of about 500 Soniwal households, predominantly from villages such as Nima, Sine Huch, Soniwal Hit and Chilas. Opposite to Ges Pain, directly on the left bank of the Indus River Soniwal people have erected 20 very poor kacha houses since the last few years. This location is now-a-days permanently settled and named Yashokal Hit.

Soniwal gold washers are well experienced to search the locations of gold extraction through a difficult and laborious procedure. During collection season along the Indus River banks from September up to the rise of water level in spring and early summer, the entire families of Soniwals are moving with tents along the river sand banks.

The experience in the project area reveals that mainly three members of a Soniwal family (often children) are involved in the gold washing process. One family working 30 days a month during the six months period can extract up to three (3) tolas (34.98 grams). At the current (2010) gold prices of about Rs. 35,000 per 10 grams, this amounts to Rs. 122,500 per family per season. The corresponding average monthly income per year comes to about Rs. 10000, which can allow survival under the local conditions.

D.3.8 Technical Infrastructure

D.3.8.1 Water Resources and Water Supply

i. Surface Water

The main source of surface water is the Indus River with an estimated annual average flow of 62 BCM at the proposed site of Diamer Basha Dam. However, due to the typical mountainous topography of the area, none of this resource is being used in the project area for municipal or agricultural use. Therefore, the main reliance of the population for drinking as well as irrigation purposes is on the nullahs falling into the Indus River between Raikot Bridge and the dam site.

ii. Domestic Water Supply

Mostly the peoples in project area take water from nullahs. Water of the household has to be carried from nullah mostly by girls and adult females, sometimes supported by donkeys in special iron canisters. In few cases, like Chilas, Sine Huch, Soniwal Hit, Yashokal Hit or other villages directly located near the Indus River, water is carried to the homes for cooking, washing and house cleaning. Laundry is normally practiced directly on the banks of Indus River, nullah or irrigation canal.

Despite some hydro-geological potential in the moraines, scree and alluvial terraces, groundwater is non-existent. Mostly in small settlements, spring sources in the valleys are used by the local population for human consumption. Usually the spring water is cooler and less contaminated than nullah.

Primary and most important water source for the local population are the nullahs. Notable nullahs on the right bank are Khanbari (average flow of 15.23 m^3/s); Kiner (5.80 m^3/s); and Hodar (4.28 m^3/s). On the left bank, the largest flow is in the Bunar Nullah (12.93 m^3/s) whereas the next ranked are: Thak (9.55 m^3/s); and Buto (5.10 m^3/s). Some of the nullahs deliver very little or no water, particularly in low water years. For example, during summer Thurli Nullah is normally dry. That is why Thurli Das people since generations used to move during summer to their land in the upper Thurli Nullah.

Water consumption rate differs between the villages and Chilas. In Chilas, where water from Buto and Thak nullahs is supplied through open irrigation channels and water pipes, the consumption is estimated to be higher than in the distant isolated villages.

Piped water supply (coverage of about 40 %) is provided in Chilas urban area (upper parts of town), and some parts of Gonar Farm, Ges Pain and Khanbari (Nima and Narar). Most of other settlements are established on slopes and the piped water supply system is operated by gravity. However, due to lack of maintenance most of the systems are completely out of order.

Water quality of the Indus River, despite some suspended sediment, is good. The best quality water is found in springs in upper locations of nullahs. Water quality concerns in the project area appear where open channels or pipes are in close vicinity of sewage disposal. There is no treatment of communal sewage water. Often the water from the open irrigation channels is taken for human and animal consumption and is contaminated by local pollution from animal and/or human faecal.

iii. Dominance of Nullah Water Supply

The local population meets its water needs for drinking and irrigation predominantly from the nullahs, which are mostly perennial. However, there are some nullahs where during summer the water is not sufficient (like Thurli).

In cases where houses are located directly on the shoreline, the local population takes the water from the Indus River, such as Chilas along Karakorum Highway, Soniwal Hit, and Yashokal Hit. Some of the 31 affected villages in the project area are partly supplied by springs. Over 50 springs have been identified, which are being used for providing human drinking water needs.

iv. Prevalent Channel System

The water in most cases is taken from the nullahs and conveyed through a system of open channels to the villages (also partially in Chilas) for further distribution. These channels are a symbol of regions ancient history involving indigenous and collective efforts. Many of them were built centuries ago, cutting through rocks and difficult terrain. These channels are generally 0.6-1.2 m (2-4 feet) wide and in Buto nullah (lower part of Chilas) even up to 1.5 m (5 feet), wide and of similar depth. Only in some rare cases, they are made from concrete in order to avoid leakage of water. Due to favourable topography the water is generally conveyed through gravity. Sometime, these channels are working with a piped system fed through a water reservoir (tank). In Chilas there is a piped supply system using two lines, which deliver water from two tanks (with capacities of 456,000 and 152,000 gallons or 80650 and 26880 m^3) to the houses or public taps.

The water in the open channels is used for irrigation, drinking, and activities like washing clothes, utensils and foodstuff. Animals are also drinking from these channels. The surplus water in the channels generally escapes into the nullahs and sometime into the Indus River.

In many cases, the people collect water directly from the nullah. There are many places in the project area, where raw sewage is continuously discharging into the nullah (sometimes even into the channels). Downstream villagers are regularly using this contaminated water for drinking and cooking. To maintain sufficient capacity these water channels have to be de-silted and repaired by villagers on self-help basis continuously.

Basic administrative responsibility for water supply rests with Diamer District Local and Rural Development Department. It is looking after 16 existing water supply schemes in the project area. However, most of the people directly use nullah water for irrigation and household because they do not like to be dependent on any Governmental institution.

D.3.8.2 Electricity Generation and Supply

Due to high mountain relief in the surrounding area of the Indus River, there is significant hydropower potential on the contributing nullahs. On the other hand, meagre annual precipitation and lower glacier melt contribution to local nullahs, restricts this potential. However, some of the nullahs have relatively high and perennial flow such as: Khanbari (mean flow of 15.23 m^3/s); Bunar (12.93 m^3/s); Thak (9.55 m^3/s); Buto (5.10 m^3/s); Kiner (5.80 m^3/s); and Hodar (4.28 m^3/s). The most critical element is the minimum water flow in winter, which coincides with the highest power demand, making the choice of hydropower development quite difficult.

However, despite this resource, in practice the entire Diamer district is suffering from lack of power supply and only about 50% of the total population has access to bare electricity. However, the Indus River section, around the district centre of Chilas, is better supplied with this facility. Over half of 31 project affected villages have no electricity supply as shown in Table D-31.

Table D-31: Access to Electricity in Project Affected Villages

Village		Electric Supply Status		
Name	**Identification**	**Central Supply**	**Partly Supplied by Small Hydropower Generators**	**None**
Nima	R01			X
Narar	R02			X
Sine Huch	R03			X
Nusry Das	R04			X
Dalojil	R05			X
Segali Hit	R06			X
Balokish	R07			X
Thalpan	R08	X		
Lower Thak	R09	X		
Ges Pain	R10	X		
Ges Bala	R11	X		
Shing	R12			X
Lower Minar	L01			X
Sine Huch	L02		X	
Thor Das	L03		X	
Khotobat	L04		X	X
Bazakal	L05			X
Muruski	L06			X
Thurli Das	L07			X
Chikka	L08			X
Ghichi Village	L09			X
Lower Chilas	L10	X		
Lower Thak	L11	X		
Lower Gini Village	L12	X		
Yashokal Hit (Goldwasher houses)	L13			X
Lower Bunar Das	L14	X		
Soniwal Hit	L15	X		
Lower Gonar Farm	L16	X		
Mani Pain	L17	X		
Gandlo Village	L18	X		
Jalipur Village	L19	X		
Total		13	3	15

Source: DBC, 2007

It may be pointed out that even the settlements supplied from small hydropower plants do not have reliability of service. In particular, during winter, when the water for operating the turbines is not sufficient and the demand is high there are breakdowns and regular power cuts. Some of the villages, without central electricity supply, have deployed their own, small capacity generators by tapping hydropower potential of smaller nullahs.

The usage of electric supply in villages is limited to very small consumption of one or two light bulbs. In Chilas, there are almost no refrigerators, television sets, and radios except few houses. In winter, wealthy families use electrical heaters. In the area, there are four existing / planned mini hydropower plants belonging to NAPWD, with a total installed capacity of 3.3 MW as per details in Table D-32.

Table D-32: Hydro-power Plants in the Project Area (Present and Planned)

Hydro-power Plant	Location from Karakorum Highway	Villages to be Supplied	Installed Capacity (MW)		
			Existing	Planned	Total
Bunar Das	4 km	18 villages including Gini Hotel, Ges Pain, Ges Bala, Bunar Das, Gonar Farm, Gandlo, Shing, Draing, Gorabad	1.0	-	1.0
Thak	10 km	28 villages including entire Chilas, Thalpan and Kiner, and Thak valley	2.0	-	2.0
Buto	10 km	11 villages including entire valley of Buto Nullah and parts of Chilas	0.2	-	0.2
Thor Phase 1	14 km	14 including almost all villages of Thor valley	0.1	-	0.1
Thor Phase 2	25 km from Karakorum Highway	Thor valley, Hodar valley and part of Chilas		1.6	1.6
Khanbari	Mero Jut, 18 Km	Khanbari valley villages		2.0	2.0
Total			**3.3**	**3.6**	**6.9**

Source: DBC / NAPWD, 2007

Furthermore, three private mini- hydropower stations are operating in Thor Das, Sine Huch (Thor) and Khotobat.

It can be seen from Table D-32 that in order to improve the electricity supply in the settlements, two small hydro power plants in the project area are being planned. One of these plants with installed capacity of 2 MW in Khanbari Valley is located at 1,638 masl about 18 km above the confluence of Khanbari Nullah with Indus River. This will supply electricity to Khanbari Valley and Dudishal. Planning agency in this case is NAPWD. The second hydropower plant of 1.6 MW is located in Thor Valley 25 km above confluence of the nullah with Indus River.

In near future, there will be need for further local hydropower generation to supply / supplement electricity to the proposed: Project Colony in Thor Valley; and Model Villages (in the long run this will come through the proposed 132 kV transmission line from dam site to Gilgit via Chilas). Some conceptual planning by DBC in this regard is already under way.

There are 11 kV transmission lines from the above mentioned hydropower stations towards down valley for supply to users mostly near Karakorum Highway. Such transmission lines, owned by NAPWD, are often damaged by vehicular traffic, rock falls and landslides. Most of this distribution system (about 100 km) will be submerged in the reservoir.

D.3.8.3 Roads

This area got linked directly to the south through the construction of Karakorum Highway (1966-1977). It was built by Frontier Works Organization (FWO) of Pakistan Army under very difficult conditions. FWO was supported by specialists from China, mostly for building of the bridges such as Thakot (close to Besham), Dasu, and Raikot.

The Karakorum Highway was built along the famous 'Silk Route' connecting South-Asia with Kashgar in Western China. Before 1977, the area was accessible either via Swat-Chitral-Gilgit or Kaghan-Babusar-Chilas through treacherous jeep roads.

Presently, Karakorum Highway is the most important artery for transportation of goods such as fuel, petroleum, cement, bricks, steel, coal, wheat, vegetable, beef, chicken, and various industrial products (if not coming from China) from the south towards Northern (Gilgit-Baltistan) Areas and Gilgit. From the Northern (Gilgit-Baltistan) Areas, the transport of goods, such as potatoes and dry fruits, to the down country is only possible via Karakorum Highway. The Karakorum Highway is administered by National Highway Authority (NHA), but FWO continues to look after its maintenance.

Karakorum Highway, over the length of about 94 km from the dam site near Basha Village to Chilas and Raikot bridge runs along the left bank of the Indus River at elevations between 1,000 and

1,200 masl. From Raikot Bridge on, Karakorum Highway shifts to the right bank of the Indus River for onward journey to Gilgit. Width of this two lane asphalted road is 6 m. As the highway is mostly located along steep slopes of the Indus gorge, it is frequently subjected to landslides at a number of locations thus disrupting the traffic. Especially in spring time, after thawing of snow and rains, the road is often blocked for some hours or even days due to landslides.

In general, the left bank of the Indus River between Shatial, Chilas, Bunar Das, Gonar Farm and Raikot Bridge has adequate road capability. However, in this section of Karakorum Highway, the average speed, due to poor maintenance, difficult road sections, and passages through many villages and the town of Chilas, is low (around 40-50 km/h).

There is an alternate route via Babusar Road (close to Chilas running through the Thak Nullah, (previously named Babusar Nullah) for reaching Mansehra, Abbottabad and Islamabad. However, this remains blocked during winter due to accumulation of snow at Babusar Pass. As already mentioned, FWO is now engaged in constructing an all weather alternate road from Mansehra-Kaghan-Babusar Pass down to the existing Karakorum Highway.

D.3.8.4 Bridges

Many right bank habitations in the project area are only accessible from Karakorum Highway through suspension bridges across Indus River while going upstream from the dam site. These, along with a suspension bridge downstream of the dam site, are listed in Table D-33:

Table D-33: Suspension Bridges Across Indus River for Access to Right Bank

Sr. No.	Location of Suspension Bridge	Distance to the Next Bridge (km)	Provision of Access To		Remarks
			Valley	Villages	
1	Dudishal	8 km to Khanbari	Dudishal	Dudishal	Located downstream of the dam site and suitable only for light traffic; a new District Council Road is under construction on the right bank from Dudishal to Khanbari over the proposed dam site
2	Khanbari	23 km to Hodar	Khanbari Nullah	Nima, Narar	For light traffic only
3	Hodar	17 km to Kiner	Hodar Nullah	Nusry Das, Sine Huch, Dalojil, Balokish	For light traffic only; no access to Khanbari or Kiner
4	Kiner	21 km to Ges Pain	Kiner Nullah	Thalpan, Thak	For light traffic only; no access to Hodar or Ges Pain
5	Ges Pain	14 km To Shing	Ges Pain Nullah, Ges Bala Nullah	Ges Pain, Ges Bala	For light traffic only; no access to Thalpan or Shing
6	Shing	10 km to Draing	Shing Nullah	Upper Shing	No road after the bridge and only foot path; no access to Ges Bala or Draing
7	Draing	9 km to Raikot	Draing Nullah	Draing and Gorabad	For light traffic only; no access to Shing but an old alignment of Karakorum Highway on right bank leads to Raikot Bridge

Source: DBC, March 2007

These seven bridges were originally designed as foot bridges. However, except Shing Bridge (only for pedestrians) these are now being used for light traffic, which is often overloaded. Due to the intensive abuse by the local population, bridge structures get damaged and need frequent maintenance and repair.

The only highway bridge for trucks and other heavy traffic is at Raikot on Karakorum Highway where the road crosses over to right bank of Indus River. This bridge will not be inundated by the reservoir impounding.

D.3.8.5 Navigation

There is no navigation on the Indus River or on the nullahs. This is due to: high flow velocity; low depth of the water; and turbulent flow conditions. There are only some local people, mostly using inflated rubber tubes, who cross the Indus River in order to get to places where no suspension bridge is located.

The Indus River is used for floating of the chopped logs of coniferous trees (spruce, fir, pine) towards downstream locations. The logs from side valleys are moved into the Indus River to enable their further transportation towards the downstream storage locations.

D.3.8.6 Telecommunication

National telecommunication network is not yet widely spread in the project area. Most of the villages do not have any telephone link. The only telephone connections outside of Chilas are at the police stations, check posts or FWO camps. In Chilas, there is a network, which is mostly used by governmental administration or private entrepreneur like classified hotels. Most of population in Chilas do not have telephone connections. However, for telephoning many private PCO shops are operating. Along the Indus River and the Karakorum Highway there is a fibre optic land telecommunication link constructed by Special Communication Organization (SCO) of the Army for connecting Chilas to Gilgit.

In 2006, Special Communications Organisation (SCO), originally only for governmental agencies, established a mobile network in Chilas, which was also offered to the public. During 2007, private cellular service providers 'Telenor' and 'Mobilink' also started coverage in Chilas and its vicinity, which has improved the position significantly. However, the general connectivity level between Chilas and villages in the side valleys of the area remains poor.

D.3.9 Social and Community Structure

D.3.9.1 Religious Structure

Population of the Diamer district is almost entirely Muslim and constitutes 99.6 %. In addition, there are very few Christians, Hindus Qadianis and Ahmadis, who constitute 0.4 % of the total population and are living in urban areas.

Religious leaders, as compared to other areas in Pakistan, have large influence on the local population. Most of the people belong to Hanfi Sunni Sect. Local religious leaders have strong hold on the social set-up of the area. There prevails a sense of suspicion about outsiders, particularly, about development agencies and NGOs having some hidden agenda of social change. In particular, NGOs are considered as a threat to the existing social structure and traditions. Thus, the information disseminated through *Imams* of the mosques is considered more reliable.

Due to influence of Islamic leaders and the distance from other parts of the country, dissemination of daily general information is very limited. Electronic media such as television is still very much abhorred by the local religious leaders. Newspapers are not easily available in the villages. Anyway, due to the high illiteracy rate only few people would be able to read them. Thus, most of the information is disseminated by the Imams through sermons of Friday prayers.

D.3.9.2 Education

The affected villages in most cases have only primary schools, which due to the tradition in this area, are only for boys. The girls are almost excluded from any education. Most of the parents, particularly men in the project area are not convinced about sending their daughters to the school. Therefore, the illiteracy rate is high. The Census Data of 1998 reported that the overall illiteracy rate was around 63.50 % with women illiteracy at 91 %. The status of education facilities varies between villages, with a significantly better position in Ges Bala, Ges Pain and Chilas. The overall picture of education facilities can be judged from Table D-34.

Table D-34: Educational Facilities Available in Project Affected Areas

Sr. No.	Location	Status	Gender
1	Nima	Primary School	Boys
2	Narar	Primary School	Boys
3	Nusry Das	Middle School	Boys
4	Nusry Das	Primary School	Girls
5	Sine Huch	Primary School	Boys
6	Dalojil	Primary School	Boys
7	Thal pan	Primary School	Boys
8	Thak	Community Primary	Girls
9	Ges Pain	Primary School	Boys
10	Ges Pain	Community Primary	Girls
11	Ges Bala	Community Primary school	Boys
12	Khotobat	Primary School	Boys
13	Chikka	Primary School	Boys
14	Lower Chilas	Primary School	Boys
15	Lower Chilas	Primary School	Boys
16	Lower Chilas	Primary School	Boys
17	Lower Chilas	Community Primary School	Girls
18	Lower Gini village	Primary School	Boys
19	Lower Bunar Das	Primary School	Boys
20	Lower Bunar Das	Community Primary school	Girls
21	Lower Gonar Farm	High School	Boys
22	Mani Pain	Primary School	Boys
23	Lower Shing	Primary School	Boys
24	Jalipur village	Primary School	Boys

D.3.9.3 Household Budgets

i. Income

Under the prevailing socio-economic conditions in the project area, income of an average household is predominantly from cultivation on a few kanals of land with some domestic animals. This non-cash income is derived from self production of wheat, maize, vegetables, fruits, milk, butter, meat and eggs for the daily consumption. Some smaller portion of the family income comes from cash.

Besides non-cash incomes from self-sustaining agriculture, the households are required to have supplementary sources of income. One source is from exploitation of natural resources in the upper side valleys and the mountains. In particular, the landowning tribes of Sheen and Yashkun have additional lands in the upper side valleys for cultivation (often even two crops) and for grazing of their domestic animals. Furthermore, they have the exclusive right to the natural resources such as: fruit harvesting; gold washing; livestock; labour (only for non local tribes); wood-chopping; timber harvesting; and collecting of *Chilghoza* (pine nuts), minerals, and medicinal herbs (to produce traditional medicine like *Salajit* from different herbs and lichens).

To make both ends meet, most of the average households are often forced to sell some portions of their agricultural products on local markets despite their own demand, or barter them within the village against some other products for domestic consumption.

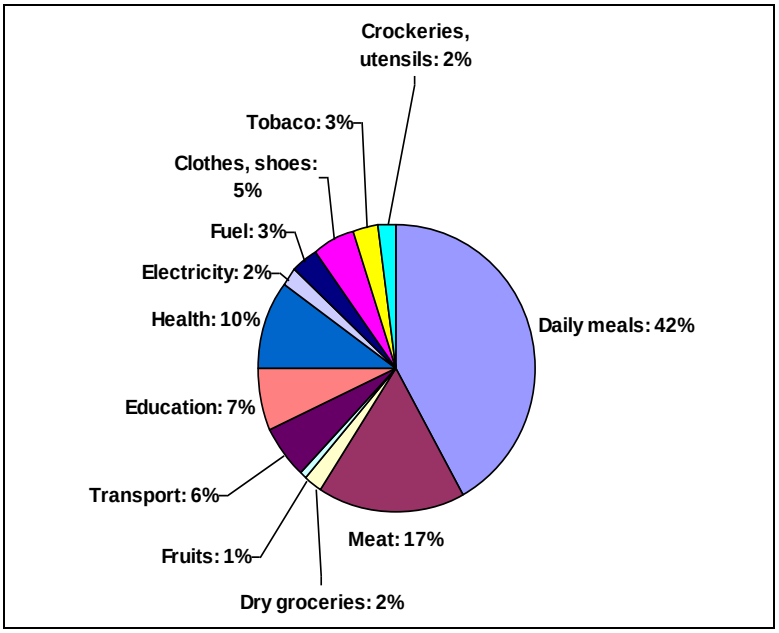
Estimated (2007) mean family income per household was between Rs. 7,000 and 10,000 per month. However, there were cases with family income less than Rs. 2000 per month. There were also some groups, in particular land-owners, businessmen and governmental employees living mostly in Chilas, Ges Pain and Ges Bala, in Lower Bunar Das and Lower Gonar Farm, who had a higher monthly income. In this category fell the local tribes of Sheen, Yashkun and Kameen due to renting of their landed properties in the valleys and income from their additional agriculture in uplands.

It has been estimated by DBC that ratio between cash and non-cash income in the households is 30:70. Cash income in the households of local tribes may be somewhat higher who, besides land, have supplemented sources of monthly salary or net profits from their business.

ii. Family Expenditure

In most of the families, meagre income allows expenditures only for the daily consumables necessary for survival. Payments for expenditures on such items as salt, sugar, tea, spices are often not affordable. Most of the people only possess a single dress and one or two pairs of shoes. Thus, additional expenditures for education, medical care, transportation in emergency cases or marriages, are not available.

Figure D-15: Distribution of Average Household Expenditure



Source: DBC 2007

Only in very few cases, predominantly in Chilas, the income exceeds the expenditure, where the household often enjoy relative prosperity. It is estimated that about a third of the population in large families cannot even meet the daily expenditures for food and fibre and has to be supported by other members.

Figure D-15 depicts that, on the average expenditure on food is around 60 % of the total income, which comes mainly from the self-subsistence agriculture. Out of this, about 42 % of the expenditure is for daily meals, which rarely contain meat.

However, there are many families, in which the full daily demand of food products such as milk, meat, eggs and even flour (wheat and maize) is not available. This is caused first of all by the small land holdings for cultivation due to natural conditions (lack of land, soil, and water) and secondly by the fragmentation of land holdings from year to year due to establishment of new family units in the household.

In particular, the gender investigations revealed that the adult females do not get enough nutrition. The best food is mostly reserved for the husband, adult male family members and the children; and the remainder for adult females. Substantial portions of the household income are spent on transport, health and education and, if something left, for clothes.

D.3.9.4 Health Facilities, Insurance and Diseases

i. Responsibilities and Public Health Facilities

In general, the health services are extremely poor due to the lack of medical facilities and doctors, in particular female doctors.

Healthcare in project area is the responsibility of Diamer District Administration. Aside from the District Headquarter Hospital, available health facilities in the project area are nominal and often partly functional or totally closed due to various reasons. Even the functioning health facilities lack adequate staff and medicines. In particular, women for any medical treatment have to travel all the way to Chilas some time more than 40 km to avail appropriate health facilities. Medical facilities outside Chilas are located only in the following areas.

- Three basic health units in Thor Das, Lower Gonar Farm and Khanbari
- Four civil dispensaries in Thor, Lower Bunar Das, Lower Gonar Farm and Nima
- Seven first aid posts in Thalpan, Nusry Das, Sine Huch (Hodar), Buto Village in Chilas, Lower Bunar and Ges Bala

ii. Health Insurance and Pension System

There is no system of health insurance, either in the public or private business sectors. However, all governmental employees in public service are provided free medical treatment. In addition, they are entitled to get pension after putting in a minimum service of 25 years. The normal retirement age is 60 years for both males and females.

iii. Common Diseases

Health situation in the project area is basically influenced by very poor living conditions of the majority of population. Particularly, unhygienic living conditions in the houses, absence of any sewage water treatment, close contact with domestic animals, lack of potable water and even fuel for proper boiling and unsuitable clothing during winter are the root causes of many diseases.

Most of the common diseases in project area are water borne. Although the quality of water at source is generally good, almost all water supply systems in the project areas are contaminated with human and animal faecal pathogens. These pathogens are bacteria, viruses, protozoa or parasites. Investigations on Coliform bacteria in drinking water samples taken from relevant project area locations indicate that in 93% of cases, the prescribed WHO standards are not met. Thus, water borne diseases such as diarrhoea, typhus, hepatitis B, cholera, stomach worm diseases and amoebic dysentery are widespread. These are primarily caused by use of water from irrigation channels, which are often contaminated by local sewage. Also the water supplied through pipes in Chilas, Bunar Das and Gonar Farm is not fit for drinking. Many skin diseases are also reported.

Most of the above listed water borne diseases are particularly widespread in children. In addition, children are suffering from acute respiratory infections of asthma and pneumonia.

Malaria is also prevalent although not of the magnitude as in other hot-humid areas of Southern Pakistan. Furthermore, many people are having Goitoir and Shigellosis. There are estimated 0.29% disabled people, both mentally and physically. Physical disability is mostly caused by poliomyelitis and polio-arthritis.

Because of heavy exertion by all family members in the fields and otherwise, obesity is almost non-existent. Consequently, cardiovascular diseases are un-common in the area. Extremely harsh living conditions have their expression in a physical robustness. Though reliable official health data are missing, it is believed that the population has low life expectancy and high pregnancy-related and children mortality. Annex D-11 outlines the ‘Health Related Issues of Project Area’.

D.3.9.5 Indigenous People and Ethnic Minorities

ADB's working definition on Indigenous People stipulates that these should be regarded as:

> *"those with a social or cultural identity distinct from the dominant or mainstream society, which makes them vulnerable to being disadvantaged in the processes of development"*.

Similarly, the ethnic minorities may encompass:

- Descendents from population groups present in the area, most often before modern states or territories were created and their borders defined.
- Groups of people maintaining identity through social, economic, cultural and political institutions separate from mainstream or dominant society. Over recent centuries, some tribal groups or cultural minorities migrated into the areas and are no longer indigenous. On the other hand, they have established a presence and continue to maintain definite and separate social and cultural identity. In such cases, the latter identifying characteristic should carry greater weight.
- Additional characteristics, often ascribed to ethnic minorities, may also be relevant such as:
  - Self-identification as part of a distinct indigenous cultural group and display of a desire to preserve that cultural identity;
  - a linguistic identity different from that of the dominant society; and
  - unique ties and attachments to traditional habits of ancestral territories.

Keeping in view the social and inter-tribal relations in the project area between the locals and non-locals, the criteria of ethnic minorities seem relevant to only Soniwals and non-local minority tribes.

In the project area, there are many active and dormant conflicts between local and non-local tribes. For instance, local tribes get more cash income from their land rents, shops and other businesses. On the other hand, non-locals are deprived of many rights including use of natural resources. A glaring example is the biggest tribe of the ethnic minority known as Soniwal. They are much more hard working than local tribes of Sheen, Yashkun and Kameen. They are cultivating as tenants the lands owned by major tribes of Sheen and Yashkun as well as involved in timber harvesting, pine nut collecting and animal rearing. One of their basic occupations is gold extraction from sand of Indus River. However, some of them are also engaged in governmental jobs and business activities around hotels, shops and workshops.

Notwithstanding apparent affluence, Soniwals and other non-local tribal people feel deeply under-privileged leading to occasional ethnic tensions. This is evident from the fact that only a few villages are jointly inhabited by local and non-local tribes. Though in Chilas the Sheen, Yashkun and Soniwals live as neighbours, in the surrounding villages the population is composed of either local or non-local tribes.

In some consultation meetings of DBC with PAPs, there was interaction with Jirga representatives of Soniwals belonging to villages of Nima and Narar (Khanbari Valley), Sine Huch (Hodar), Soniwal Hit, and Yashokal Hit. They indicated their unwillingness to get involved in the proposed resettlement process and instead receive cash compensation for voluntary relocation to places of their own choice. This was based on the apprehension that Sheen and Yashkun, the dominant local tribes and owners of land, would not go out of the area proposed for local resettlements. Under this status-quo of perpetuating deprivation and coercion, majority of Soniwals did not see any secure future by resettling in the vicinity of project area.

Gold washing is the basic occupation and an important income source of about 500 (about 40%) out of 1,255 households of Soniwals. They belong to the villages of Nima, Sine Huch, Soniwal Hit, Chilas and Yashokal Hit. As already mentioned, Soniwal gold washers are well experienced to search the locations of gold extraction along the Indus River banks through a difficult and laborious procedure. During the low flow season from September to May, Soniwals do the gold extraction. Usually, three family members (often children) are involved in the gold washing process. During a

working season the family can extract gold worth over Rs. 120,000. Corresponding average monthly income comes to over Rs. 10000, which can allow survival under the local conditions.

Therefore, after submergence due to reservoir, significant adverse impact would occur on gold washing activities of Soniwals. However, only 500 out of 1255 households would be potentially affected, while the remaining 755 households in Chilas are engaged in the attractive business / commercial activities.

D.3.9.6 Women and Gender Situation

i. Women Health Status

Health status of women is the poorest of all groups of local population. They are exposed especially to: poor nutrition; air pollution from internal cooking procedures; early marriage; and frequent childbirths.

As already mentioned, according to the prevailing family tradition, women have the lowest priority in getting food. Food taboos not only deprive women of protein and iron sources, but also reduce calorie intake. They are allowed to eat, when their husbands and other males and children are fully fed. Therefore, women in the Northern (Gilgit-Baltistan) Areas are generally afflicted by nutritional deficiency diseases. The most prevalent symptoms in the project area are: protein-energy malnutrition; iron deficiency anaemia; iodine deficiency disorders; and vitamin A deficiency. Gender differentiation in this regard is evident from the fact that three out of four women are suffering from malnutrition. Iron deficiency anaemia is the most widespread nutritional problem among women and has severe consequences for both their reproductive and productive roles. The prevalence of protein-energy malnutrition is significantly higher among women. Iron deficiency anaemia and goitre are more prevalent among adult women than men. On the other hand, vitamin A deficiency appears to be more prevalent among boys than girls.

Pregnancy related problems and complications are quite common. The basic causes are: high fertility rate; lack of midwives in the remote villages; lack of female doctors in the only hospital in Chilas; non-availability of drugs for any complications; and extreme unhygienic conditions. Consequently, 81% of deliveries in the Diamer district are carried out at home by untrained formal birth attendants (*Dais*). These result in a considerable drain on the energy of women and prolonged post-pregnancy return to normal life.

Low food intake during pregnancy is common. Studies have shown that women consume little or no extra food during pregnancy, and may even consciously limit their intake for fear of large foetuses and difficult labour. Prominent cause of women death was found to be the delivery of child. Most of the right bank villages do not have even basic health facilities. Especially in serious cases of delivery, the patients have to walk on foot for 5 to 10 km to reach a road from where to travel for medical help in the District Headquarter Hospital in Chilas. Such females often expire before reaching the hospital due to high bleeding and lack of hygiene and unawareness of the accompanying husbands.

Foregoing poor health status in most of the affected families is further complicated by the conditions such as:

- Poor housing
- Joint living of humans and domestic animals
- Unawareness about sanitation and hygiene because of very low level of education
- Lack of medical facilities including staff and medicines
- Malnutrition
- Lack of resources to pay for medical services and even transport to the Hospital in Chilas.

ii. Family Structure and Traditional Life

Families are run by typical patriarchal traditions. The elder male of the family controls the household affairs. Family structure is a mix of nucleus (husband, wife and their children) and extended joint family systems (husband, wife, their children and grand father, grandmother brothers, sisters, and immediate children). Male members continue to dominate the decision-making in most family relationships. Women are almost excluded from these decisions. Traditionally, the people are marrying early. The total number of household members, on the average, including parents and their children and grand parents is between 8 and 20. A number of families are still polygamous in accordance with the 'Islamic Shariah'.

iii. Gender Discrimination

Gender discrimination is very prominent. Males dominate all occupations in shops, restaurants, hotels, service facilities. Women, even in the public places of villages, are mostly invisible.

Particularly, in many villages away from Chilas, women are deprived of school education and excluded from most decision-making processes. The gender situation is further complicated by:

- Early marriage of girls
- Restriction on women's mobility
- Poor domestic sanitation conditions
- Long working hours (both for girls and women) including working on the farms
- Too much miscellaneous chores
- Preference to sons over daughters, and
- Very few girl schools in the villages with consequent high illiteracy rate.

In the daily life within their villages women contribute vitally to the economic survival of the poor households. This includes working in the house for cooking, laundry, child care, cultivation and tending of agricultural crops on their land and livestock breeding including poultry. Thus, despite overall deprivation, women are major contributors to the household life.

Initially, DBC's efforts for meetings with female activists and groups of women in the villages distant from Chilas were seriously hampered by complaints and concerns of related husbands. To cope with this difficulty, DBC engaged female experts, one speaking the local language Sheena and the other speaking Urdu. After some initial problems to enter the villages, both these female experts became acceptable as representatives of WAPDA and DBC. Inventory by these experts in most of the villages was the first ever contact for women (for detail refer to Annex D-5). All the contacted women supplied detailed information about many social activities including:

- Daily work of a female in housekeeping, laundry, cooking and taking care of animals
- Seasonal occupations of female family members
- Gold and *Chilghoza* collecting activities of Soniwal women
- Obligations of females for agricultural activities regarding major crops (wheat, maize) and vegetables
- Educational constraints including desire of female for more facilities
- Occupational preferences including desire for jobs
- Family income including contribution by the women
- Family expenditure
- Health situation, particularly: birth deliveries; vaccinations; water-borne diseases; and mal-nutrition
- Social disparities between tribes in one community and tribal interrelations.

This 'Women Household Survey' (refer Annex D-5) provided some new insights about social structure of the project area as a whole, and its effect on villages and tribes. Two major emerging aspects are elaborated in the following.

Majority of girls and women desire to get education. Almost every girl in the age of up to 15 years is keen to go to school. Older girls above 15 years announce, in general, that they would like to work in some preferred occupations such as midwives, schools and religious teachers, health guides in governmental and in non-governmental organisations such as NADP or AKRSP. Further, they would like to work in these jobs without any male intervention. Majority recommendation by many interviewed girls and women was establishment of separate girl schools, and vocational training centres (for fruit processing and preservation, embroideries, dairy processing and wood working). They expressed their willingness and desire to work also on suitable jobs related to dam construction.

A further reason, which influences this situation, is the poverty of the people. For attending one of the three primary schools running in Chilas, Rs. 400/month has to be paid, including Rs. 200 for school and another Rs. 200 for transportation. Therefore, only very few girls from outside locations are sent to Chilas for education by their parents to avail the facility up to High School level.

And lastly, the totally neglected educational facilities for girls in the villages are making the situation worse. Primary schools are only working in Chilas and large villages while in all other affected settlements of the project area there is no school facility for girls.

As already pointed out, women not only perform all home tasks but also girls and women do most of the agricultural chores. The only responsibility of the male family members is ploughing before crop cultivation. Women wake-up first in the morning and after prayers they feed the domestic animals before preparing breakfast for the entire family. While the husbands and other adult males go to Chilas mostly for gossiping, women work on the fields until noon time. After lunch and Zohar prayers (around 1 pm) the females start working on embroideries, which are often sold on the local markets. If some work on the fields is left in the morning, the females go back in the afternoon and return home before sunset for dinner preparation.

Main part of the family meal is Chapati *(or 'Naan')*, the traditional bread made on owen (or tandoor). Most of the people cannot afford rice *(or 'chawal')*. Family rules allow women to eat after males and children.

Special gender investigations by DBC revealed that the average family income is around Rs. 7,000. The family has to spend all cash money for the daily food supply thus leaving no spare money for other essentials.

In summary, girls and women are making vital contribution to the economic survival of the poor households. Therefore, despite overall discrimination, women are responsible for effective management of daily family life and economic performance (refer to Annex D-12 on 'Gender Issues of Project Area').

Moreover, the gender investigation revealed the following situation of women in the project area:

- Gender disparities exist in local society and many families tend to become aggravated at times of social and economic stress.
- Women do not have landownership and property rights.
- Women have lower levels of education, skills, heath, and nutrition than those of men.
- Women work in the informal sector, such as agriculture and collection of forest produce, but they are equally concerned with sources of livelihood.
- Restricted mobility and lack of exposure to the outside world are two of the gender-specific factors resulting in lack of ability of women to adjust to new situations.
- Women bear responsibilities for basic household needs like fuel, fodder, nutrition, water, and sanitation; and thus loss of these has a far greater impact on women than on men.

- Breakdown of community and social networks affects women more than men as social networks are a source of help in times of crisis and provide security for the household.
- Gender disparities embedded in social practices and traditions render women vulnerable to violence and stress and any situation of economic and social distress creates more scope for violence against women, adding to their vulnerability.
- Nutritional status of women is lower than that of men, while mortality and morbidity rates are higher and economic and social distress can aggravate the situation and cause further deterioration of women's health.
- Adverse effects on women have a bearing on the well-being of the family, particularly children and elderly.

Vulnerability of women can also be viewed in relation to control of the resources, access to opportunities, provision of services and rights of women in expressing their opinion. Women's mobility is culturally restricted and controlled through the purdah systems in the project areas. They do not allow even any interaction between women of their area and women from outside their village. Traditional laws regulate the relationship between men and women, giving men a dominant position. Due to these social taboos the allocation of resources, education, health and skills favour men. Only 54 (1.3 %) out of the affected 4,135 households are headed by women. Women have to learn how to be good wives and mothers. Consequently women have minor access to all resources. A disruption of their daily routines makes them more vulnerable than other societal groups.

It is proposed to improve the lot of women in the project affected area through a 'Gender Action Plan' included in Appendix D in Volume III of RP.

D.3.9.7 Community issues

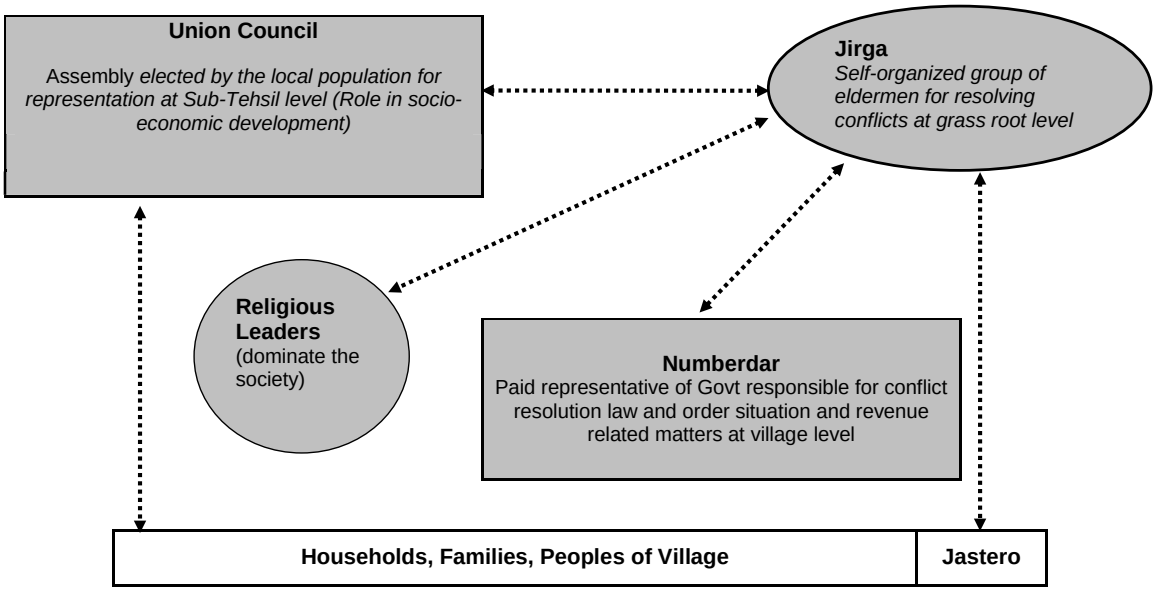
i. Jirga and Local Power in the Villages of the Project Area

As pointed out already, an important part of social hierarchy is the Jirga. Membership of Jirga is not hereditary and subject to selection by the villagers. Selection criteria for membership are age, wisdom, moral integrity, and ability to serve impartially. Jirga is also responsible for supervising development work in the village, selecting watchman, overseeing village security, supervising water management and resolving all village disputes.

The Jirga is not a legal institution. However, decisions made by Jirga are implemented as a moral and social obligation. The review of IUCN's Report on Customary Laws of Northern (Gilgit-Baltistan) Areas show that there is wide variation in the representative structure of the Jirga. In some regions of Northern (Gilgit-Baltistan) Areas, the Numberdar the village headman acts as the head of the Jirga.

Whereas the Numberdar is an inherited position in the village, in some other regions several Numberdars select one Head Numberdar. This Head Numberdar along with two members of the village committee and 10 respected people of the village constitute the Jirga (see Figure D-16).

Figure D-16: Community Structure in the Project Area



Source: DBC July 2009

In some other cases six to ten member form a Jirga depending on the situation and need. Therefore, in many cases it is not a permanent body. In some of the valleys, every village has a Jirga with four to five members. The membership of the Jirga comes from the Numberdar, Union Council President, and member of the local councils. People select the members *(Jirgadars)* by consensus. In a dispute, the affected parties select three *Jirgadars* each and Numberdar presides over the Jirga and has deciding vote after the hearing of the dispute. In some of the areas, male descendent of the royal line heads the Jirga with four members. In some of the regions, the Jirga is not an old institution. It is formed at village level and normally comprises 10 members but cannot exceed 20. It has president, vice president, and treasurer. With time, the Jirga structure is losing its authority, and in some regions, being replaced with formal social welfare committees.

These varied arrangements of Jirga, however, are used to levy fines for destruction or overuse of natural resources (land, forest, water, and crops) and personal disputes.

In view of above background. Jirga can be used as a participatory community institution in the specific situations and circumstances, for the resolution of disputes related to land among the tribes.

Member of Jirga is called Jastero and he represents a group of notables or families (refer Figure D-16). Number of Jasteros in a village Jirga depends on the size of the population. A parallel counterpart is set-up of the village Union Council with members elected by the peoples. In addition, there is a Numberdar in every village. He is an employee / representative of the Government, responsible for law and order situation within the village including revenue related matters of the village.

The last but not the least part of social hierarchy is the religious leader. He has a dominant role in social set-up of the project area. Access to electronic information media is abhorred by the local religious leaders. There prevails a sense of suspicion about outsiders, particularly about development agencies including NGOs. Thus information disseminated through Imams (religious leaders) particularly through Friday prayers plays a vital role in social hierarchy of the project area.

'Community Structure in the Project Area' is depicted in Figure D-16.

ii. Non-Governmental Organisations

Though a number of non-governmental organizations (NGOs) are registered in the area, most of them are dormant. The most active NGO is Northern Area Development Project (NADP). It is

working since nine years in Diamer district with the main office in Chilas (now reportedly in the process of being phased out). The core areas of activity are Chilas, Darel and Tangir sub-divisions of Diamer district, with coverage in terms of community and infrastructure development.

NADP, co-financed by International Fund for Agriculture Development and the Government of Pakistan, focused on:

- Improving food security through increased crop and livestock production and irrigation;
- Enhancing agriculture and livestock related activities; and
- Improvement of rural roads to open up the areas to nearby markets.

To pursue the above objectives, NADP activities included the components of: Community and Women's Development; Village Infrastructure Development; Agriculture Development; Livestock Development; Social Forestry and Range Management; Valley Roads Construction; and Strengthening of Regional Agriculture Support Services.

As part of its activity, NADP is also supported cottage activities by supplying sewing machines to the females. Some support is also provided through providing loans for purchase of embroidery materials. Religious leaders in Chilas were opposed to these women-supporting activities and favour status-quo.

Another most important and outstanding NGO of Northern (Gilgit-Baltistan) Areas is Agha Khan Rural Support Programme (AKRSP) with headquarter at Gilgit. However, due to some religio-political reasons, AKRSP is not active in Diamer district. Other relevant NGOs are International Union for Conservation of Nature (IUCN) and World Wildlife Fund (WWF) with their regional headquarters in Gilgit. Local NGOs are recognized only after registration with the Department of Social Welfare of Northern (Gilgit-Baltistan) Areas. Reportedly, 71 NGOs are registered with this Department in Chilas, out of which only 36 are involved in some activities.

In Gonar Farm, there is an actively working NGO named "Islamic Organisation". Besides imparting knowledge based on 'Quran' and 'Sunnah', the focus is to train females so that later on they could spread the message in the villages of project area.

In the context of construction and resettlement activities of the project, some NGO activity was observed in the past. In early 2006, a so-called "Anti-Dam-Committee" was founded in Chilas. As a reaction, a "Pro-Dam-Committee" was also formed and is still working. However, both these committees could not help DBC/WAPDA in evolving the overall process of resettlement and resort had to be made to the public consultation including scoping sessions. As already mentioned for further improvements and resolving issues related to implementation of resettlement, appropriate project level fora are being inducted by the Government including constitution of a Ministerial Level Committee under instructions of the Prime Minister of Pakistan.

D.3.10 Cultural Heritage

D.3.10.1 Architecture

The investigation of architecture objects in the project area by DBC revealed that there was no object having cultural heritage character or even legal protection as listed by the Department of Archaeology and Museums, Ministry of Culture and Tourism, GoP.

There are mosques in every settlement in the project area, but none of them with any special historical or architectural significance. Often, closely connected are graveyards but those also without any historical importance.

D.3.10.2 Rock Carvings

i. Heritage Relevance

The entire Karakorum Valley however had been lifeline for previous civilisations. Since four thousand years humans are painting and carving scenes and inscriptions on the rocks and boulders along / adjacent to the Indus River. These rock carvings, in the project, are part of the national heritage. However, besides the project area, rock carving objects are known to be existing in other parts of Northern (Gilgit-Baltistan) Areas like Hunza Valley, Skardu and Gilgit.

ii. History and Methodology of Rock Carvings Inventory

In Diamer Basha Dam Project area, particularly around Chilas and Thalpan, a large number of important rock carvings and inscriptions of the last four millenniums are found, including religious Brahma and Buddhist themes, multi-languages inscriptions, secular and zoo-morphological themes including hunting scenes.

Since 1984, archaeologists from the Heidelberg Academy of Science and Humanities (Germany), initially led by Prof. Dr. Karl Jettmar and now headed by Prof. Dr. Harald Hauptmann, have conducted research on rock carvings in Northern (Gilgit-Baltistan) Areas. This institution, supported by Department of Archaeology and Museums of the Ministry of Culture and Tourism of Pakistan, Islamabad, is still carrying out detailed field research on rock carvings and inscriptions in the Karakorum Valley from Shatial to Gilgit and beyond.

These comprehensive studies have yielded a detailed inventory of rock carvings. In general, rock carvings objects are differentiated in the form of:

- Station: named like nearby villages, such as Chilas, Thalpan, Hodar.
- Stone: mostly composed of various rock carving and registered in dual system, first the name of the area and second the number of stone in a particular area.
- Carving, including inscription: single scene or text information.

The results of yearly expeditions of German archaeologists, focusing normally on one area, are well documented and published in separate volumes. These books in German language describe in great detail the area, the historical situation of rock carvings, the value, and finally each stone and most important scenes. These volumes are illustrated by many drawings showing scenes and inscriptions. These volumes are available in Pakistan in two copies, both in the Department of Archaeology and Museum in Islamabad and Karachi. At the end these volumes also summarise the most important rock carvings in Urdu language.

iii. Results of Inventory

The locations of the stones had been determined by their geographical coordinates and elevations, due to lack of topographical benchmarks corresponding to official system adopted by the Survey of Pakistan. The locations of these stones have been transformed by DBC onto Topographical Maps prepared by Survey of Pakistan. The results are illustrated in MAP-7.

The overall result of the rock carvings inventory in the project area are as follows (refer also Annex D-13):

- 52 stations (assemblies of inscriptions on closely connected stones or boulders)
- 5202 stones (several scenes or inscriptions located on one stone or boulder)
- 31423 single scenes or inscriptions.

iv. Geographical Distribution

MAP-7 shows that locations of the stations and stones are mostly distributed directly along the Indus River. Most important rock carvings areas (“stations”) are close to Chilas, Thalpan, Ges Bala and Ges Pain and Shing. It explains that the lifeline of the people in ancient times was also the shoreline of the River and the nullahs, such as Buto nullah (today Chilas), Thak nullah (Thak

village) and Kiner nullah (Thalpan). Mostly the rock carvings are located on big boulders and cliffs. Many of them have been damaged by excavating and painting.

v. Threats to the Heritage Rock Carvings

Unfortunately, many of these rock carvings are already lost or at least threatened by painting, damaging and partial utilisation as construction materials. Unfortunately, the local population of Chilas and other villages neither knows their heritage status nor respects them.

Furthermore, it has to be taken into account that due to religious reasons, the local population does not respect pictures at all. In addition, none of the rock carving scenes focussed on Islamic culture. In fact, the rock carvings in the project area depict only scenes from the life of previous non-Muslim eras, such as Brahma and Buddhist periods.

vi. Cultural Heritage Impact Assessment

This exercise was completed in November 2009 through engagement of a specialist group named Rogers Kolachi Khan & Associates.

vii. Cultural Heritage Management Plan

To document and mitigate the rock carvings threatened by DBDP, a 'Cultural Heritage Management Plan' has been prepared and is included in Appendix D in Volume III of RP. This duly considers the inputs from:-

- The research conducted by Heidelberg Academy of Science and Humanities including identification of most important rock carvings.
- Department of Archaeology and Museums of GoP, particularly regarding the basic approach of documentation / mitigation of the most important rock carvings through 3-D computer scanning and replication (refer Annex-D-14).
- Cultural Heritage Impact Assessment Report of November 2009 by M/S Rogers and Kolachi Khan & Associates.

E ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

E.1 Overall Impact Assessment

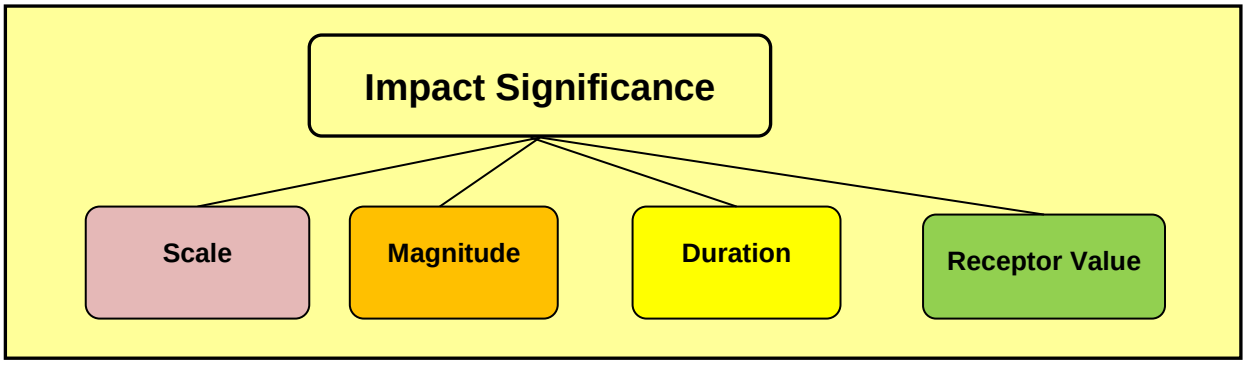
E.1.1 Methodology of Impact Assessment

The overall goal of the Environmental Impact Assessment (EIA) is the investigation and consideration whether various technical impacts caused by construction of Diamer Basha Dam Project (DBDP) and its subsequent operation would be relevant for the environmental receptors (environmental components and values) or not. Consequently, the criteria address the following:

- Significant adverse impact
- Significant adverse impact, for which a design or/and operation solution can be developed
- Adverse impact, which is potentially significant but requires further studies
- Insignificant adverse impact, and
- Significant environmental enhancement.

The methodology is based upon the assessment of “impact significance” and its various factors and conditions are shown in Figure E-1.

Figure E-1: Impact Criteria for Environmental Assessment



Source: DBC 2010

‘Scale of the Impact’ addresses the territory, where effects will occur. The area depends on the scope of impact and its characteristics are outlined below:

- Physical impacts: such as excavation, noise and dust emission temporarily during construction. The range of impacts normally is only some meters to decametres.
- Biological impacts: such as degradation of habitats due to inundation, dumping of earth material, construction of dam and appurtenant facilities. Here also often local effects are relevant. However, some animals have a larger space for their migration, which might cause effects in a larger area (for example birds and fish). Under certain conditions as changes of the downstream hydrograph severe adverse impacts might be caused in aquatic ecosystems such as the mangroves and their wildlife.
- Hydrological impacts: such as change of hydrograph and pollution results in a potential change of conditions in downstream area. These impacts might have a much larger impact area depending on the catchment.
- Economic and social impacts: such as damage of houses, cultivated land, deteriorating the social cohesion of a community. Often only limited scope of impacts, but sometimes a village might be affected from an impact far away.

The impact assessment therefore cannot determine the scope of impacts in metres and depends on the concerned parameters. Mostly, the investigated impacts in DBDP are area specific. However, it might be possible that some downstream effects are also relevant (downstream tunnel erosion and sedimentation).

'Magnitude of the Impact' addresses whether a technical process is severe or has only minor effect on the relevant receptor.

'Duration of the Impact' addresses the time character of an impact, whether it is of a short-term or long-term environmental value.

'Receptor value' determines the sensitivity of subject against the impacts. For example humans or biological objects (animals, plants) are much more sensitive compared to geological or soil values.

Some other aspects of impact assessment are:

- Reversibility: to address whether the specific environmental objects after the impact will get back to the original status
- Causality: the character of an impact might be direct (e.g. damage of structure, collapse of state or organism) or it affects negatively (or positively) another object, which itself might impact the environmental value
- Planning character: mostly various impacts are relevant to the planned measures. However, unplanned effects might be relevant as well (such as accidents or Glacial Lake Outbursts).

This particular chapter attempts a detailed assessment of any adverse (and also positive "enhancing") effects as a consequence of the project. Main stages of impact assessment are: construction; and operation.

Filling of the large Diamer Basha Reservoir, as part of commissioning of the project has been assessed under the operation stage. Decommissioning of the dam structures has not been investigated due to the long-term character of providing storage and hydropower.

E.1.2 Other Planned Projects Closely Connected to the Diamer Basha Dam

Basic aim of this EIA is to investigate the state of the environment and the anticipated impacts which are caused by the construction and operation of DBDP. However, there are some smaller projects / works closely connected to DBDP, but not covered by this EIA. These, with insignificant potential impacts, are not covered by EIA and comprise:

- Relocation of 140 km Karakorum Highway from dam site up to Raikot Bridge
- Essential Upgradation of 324 km Karakorum Highway from Havelian to the dam site
- Upgradation of 36 km Babusar Pass KKH road
- New construction of about 140 km Right Bank Periphery Road from downstream of the dam to upper end of reservoir
- 765 kV transmission lines from Diamer Basha Dam switchyard to downstream areas
- 132 kV transmission line from dam site to Gilgit.

The above projects will be designed / implemented by other agencies of the Government with impacts, in most cases, limited to the local area. Individual EIA's for these projects will be carried out, if considered necessary. The appropriate agency to rule on this will be Federal Environmental Protection Agency (Islamabad).

E.1.3 Synopsis of Environmental Impacts

E.1.3.1 Impact Matrix

'Matrix of Environmental Impacts' (see Annexes E-1 and E-2) reveals the synopsis of most distinguish between construction and operation stages. In accordance with international standard, the impacts should cover the final categories as shown in Table E-1.

Table E-1: Impact Assessment Categories

Significant Adverse Impact	Potentially Significant Adverse Impact, Where Solutions can be Developed	Potentially Adverse Impact, Requiring Further Studies	Minor or Insignificant Adverse Impact	Significant Environmental Enhancement
The receptor such as climate, water quality, social life, occupations or others due to the respective technical impact caused by construction and operation will be changed, damaged or deteriorated significantly.	The receptor due to the respective technical impact would be changed, damaged or deteriorated significantly. However, design, construction and operation matters could be changed avoiding significant adverse effects.	There might be impacts, where the today knowledge about the receptor answer is unclear. However, there is the suspicion that significant adverse impacts might occur. This requires research in order to avoid adverse impacts.	There might appear only insignificant changes, damages or deterioration of the respective environmental receptor. In some cases there is even not any adverse effect.	This category addresses the positive impacts, where due to the technical measure an improvement of the environmental status would appear.

E.1.3.2 Impacts During Construction

The most significant adverse impacts during construction are (see also Synopsis of Impacts in the so called 'Impact Matrix for Construction', included in Annex E-1 and cover:

- Air pollution by road traffic along the Karakorum Highway to dam site
- Damage to amphibian and reptile wildlife
- Threats to bird wildlife
- Damage to transportation

There are other adverse impacts, which might be avoided by developing sound design and construction solutions such as:

- Damage to geology and seismic conditions
- Contamination of soils due to solid waste disposal
- Overuse of Indus River and nullah water
- Pollution of nullahs/Indus River
- Increase of Indus River and nullah sediment load
- Damage to forestry activities
- Deterioration of social structure including community and gender
- Damage to cultural heritage and rock carvings

On the other hand, there are some impacts, which during construction might even improve the environmental conditions as follows:

- Improvement of transportation
- Improvement of education and vocational training
- Improvement of labour market and demand on vocational training
- Improvement of recreation.

E.1.3.3 Impacts During Operation

The most significant adverse impacts during construction are (see also Synopsis of Impacts in the so called 'Impact Matrix for Operation' included in Annex E-2 and cover:

- Loss of land due to reservoir impounding
- Degradation of fish spawning areas in lower nullahs due to impoundment
- Damage of fish at dam facilities
- Damage to settlements, houses and population
- Damage to cultivation
- Damage to trees and fruit production
- Damage to animal husbandry
- Degradation of fishery activities in nullahs
- Degradation of water supply
- Damage to electricity generation and supply
- Damage to river-crossing transportation service
- Deterioration of recreation
- Deterioration of Labour Market and Business Activities after construction
- Damage to Cultural Heritage and Rock Carvings due to submergence.

There are other adverse impacts, which might be avoided by developing sound operation modes such as:

- Downstream water reduction during initial reservoir filling
- Change of water quality during operation
- Loss of amphibians and reptiles due to submergence
- Loss of birds due to submergence of their habitats
- Damage of fish at dam facilities
- Degradation of ecosystem and wildlife downstream of Tarbela Dam
- Damage to forestry activities
- Degradation of health situation especially acceleration of Malaria.

On the other hand, there are some impacts, which during operation might even improve the environmental conditions as follows:

- Carbon dioxide reduction due to avoidance of emissions
- Extended lifetime of Tarbela reservoir due to reduced sedimentation
- Improvement of natural conditions for migrating birds
- Enhancing fish habitat conditions
- Improvement of housing conditions in new settlements
- Enhancement of cultivation by recession agriculture
- Improvement of fishery activities in reservoir
- Improvement of electricity supply
- Improvement of river up and down transportation system
- Improvement of recreation.

E.2 Mitigation and Compensation

E.2.1.1 Mitigation

Many mitigation actions, in particular those during construction, are low cost or even no cost measures. However, it should be considered from the very beginning that mitigation measures requiring some additional costs for equipment or installation are mostly cheaper in the long run. Many examples in the world demonstrate that costs for alleviation of induced environmental problems such as insufficient drinking water supply, inadequate water quality, loss of harvest of crops and trees, induced water born diseases – often in a large area - will cost much more than prior mitigation.

The design, in particular the identification of locations for quarries and additional construction facilities such as camps, storage places and roads has been guided by following considerations:

- Selecting either within the reservoir submergence area below 1,160 masl or locations away from the project.
- Avoidance to the extent possible, settlements including cultivated land, houses and other properties of the local population
- Preference for satisfaction of natural resource needs (water, construction materials including wood etc) of local population.

Though the land beyond the affected villages is generally barren, its relevance for ecosystems and human resources has to be duly considered. This may cover exploitation for quarries, material dumping areas and construction facilities with special attention to any construction works. Similarly, any measures in the area above land acquisition zone of 1170 masl and downstream of the dam site, particularly around Dudishal and Shatial Villages would warrant careful consideration during implementation.

Deterioration of economic, social, including religious and traditional life of the local population of the project area will need to be avoided through design and development of satisfactory solutions.

E.2.1.2 Compensation

Environmental Impact Assessment (EIA), along with the Environmental Management Plan (EMP), also aim to address compensation measures. Construction contractor(s) and WAPDA will be responsible to implement these mitigation measures accordingly. The following overall principles in accordance with ADB's 'Safeguard Policy Statement 'have to be taken into account:

- Mitigation will have to be preferred over compensation. Application of later will be applied only, when former is not possible. Consequently, the requests of involved parties for compensation instead of mitigation would be entertained only after their voluntary willingness.
- Compensation measures, where proposed, should be justified in accordance with international requirements and practice. Compensation should duly substitute the lost environmental value/asset. Compensation of degraded environmental values should enable improvement as compared to the current state.

In cases where substitution of environmental values is not feasible, for example non-availability of land due to submergence, compensation will have to be paid by WAPDA as well as aimed at contributing to the developments such as:

- Improvement of infrastructure, in particular those related to soil, water, and vegetation
- Provision of alternate land for cultivation and rangeland to the extent possible
- Establishment of alternative or new work places
- Facilitating increased prosperity in the project area (including education, medical services, vocational training, gender equality, public participation).

E.3 Impacts on Physical Environment and Mitigation Measures During Construction

E.3.1 Damage to Geology and Seismic Conditions

i. Assessment

Dam, including two powerhouses and appurtenant works, will occupy an area of about 730 ha located in the narrow Indus River gorge, dominated by steep rock slopes on both riverbanks. At this site, mostly magmatic rocks such as gabbro-norites and associated with metamorphic rocks, are widespread but not peculiar from the environmental point of view. On the right bank, the dominant rock outcrop is associated with about 50 m alluvial sediment deposits over the river bed. All of these will have to be excavated up to the level of ±900 masl, to provide firm rock foundation for the dam. Most of this excavated material will be used later for the RCC dam construction. However, this will require initial dumping of large excavated material on the areas identified approximately 6 km upstream of the dam site on the left bank (see Figure C-4). In addition, some rock gravel and clay material may be required from quarry locations between Dam site and Raikot; though most of them will be submerged in the reservoir with level of 1,160 masl.

The risk of triggering seismic movements even from the huge weight of the dam and its appurtenant facilities has been analysed through detailed Seismo-tectonic studies and duly incorporated in structural design. Another issue is the triggering of land and rockslides due to excavation works. This aspect has been also analysed in detail and incorporated in tender design and specifications.

Damage to geology and seismic conditions is summarized below:-

Significant adverse impact	**Potentially significant adverse impact for which design and construction solution can be developed**	**Adverse impact, which is potentially significant but requires further studies**	**Minor or insignificant adverse impact**	**Significant environmental enhancement**
	X Triggering of rock and landslides due to excavation can be avoided by appropriate safety preparations		X Excavations located in the inundation area up to 1,160 masl with low environmental value of geological objects	

In general, these works for excavation, erection of construction facilities or dumping are of minor significance from environmental point of view due to the dominant rocky character in the project area. There is no scarcity of other rock areas, no special rock types are going to be exploited, nor any geological site are used from scientific point of view. The dumping of excavated materials will also not harm the geology. Much of the rocks will be used for the construction of the dam and appurtenant facilities.

Another fact is that the selected quarry or dumping areas will be located close to the dam site and generally not above FRL of 1160 masl. The quarry or temporary or permanent dumping areas will be inundated after filling of the reservoir.

ii. Mitigation Measures

Mitigation measures are not required due to the abundance of rock areas, boulders and stones. The risk of triggering seismic movements, especially earthquakes, has been duly addressed n the design and therefore does not need any mitigation. Triggering rock and landslides is an issue of safety and has to be taken into account by the contractor(s).

E.3.2 Loss of Land

i. Assessment

For the construction of the dam, its appurtenant structures including powerhouses and switchyards an area of about 730 ha will be affected (see Map 2). This land is covered by following land use types predominantly:

- Riverbed of Indus by the dam itself
- Alluvial sand areas on the right bank
- Rocky areas on both banks forming the dam flanks.

In general, the land is barren and devoid of any vegetation. Even otherwise, vast areas are rocky / sandy without any vegetation. All these land types are available along the Indus River section in abundance (see MAP-3). There is no special value or scarcity of these land use types. In the dam area or in the vicinity there is no settlement, agricultural land or land under use for other economic purposes.

Some additional land may be required for temporary construction facilities such as labourer camps, batching plants, stock piling areas for different materials (rock, sand, gravels, timber, and steel) and roads. Due to very narrow gorge of the Indus River at the dam site, there is the need to allocate additional areas outside of the immediate dam site. All such areas are located downstream of the dam site due to topography and ease of access from south of Pakistan as shown in Table E-2 (refer Figure C-4).

Table E-2: Proposed Downstream Locations for Temporary Construction Works

No.	Designated Location [km downstream from dam site]	Site Description	Land (ha)
3	2.5 km	Labour Camp Lot 1 to 5	5
4	8.5 km	Stock Pile Rock Excavation	61
5	9.5 km	E&M Yard	18
6	12 km	Staff Camp	17
7, 8	18.5 and 21 km	Equipment and Machinery Storage	72
Total			**173**

It can be seen from Table E-2 that all sites proposed for temporary use are planned to be located along the Karakorum Highway downstream of the dam (to Shatial settlement, approximately 21 km downstream of the dam site). The relatively large distance to the dam site demonstrates the scarcity of plain land in this hilly region.

All these locations for the construction period of 10 years or even more will be used for temporary needs as storage or camp area. The plain land between the river and the foothills with a good accessibility from Karakorum Highway is used as rangeland (see Map 3 Land Use). While some portions may be under use for business activities like timber storage, some might have been used also for cultivation in the past. Impacts of these temporary construction works on the local population could occur as shown below:

ii. Loss of Land for Temporary

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Land to be used for construction structures does not include settlements, cultivated land or other relevant land use types.	

Notwithstanding this low natural value of land types all impacts from land acquisition should be minimised by limiting further land take. If additional land is required for allocation of new structures and facilities, it should be preferably barren.

Due to the dominance of rock area in the region no specific mitigation measure would be required for these land use types. With regard to the permanent and temporary occupation of rangeland at the dam site on both banks of the Indus River, the following aspects would need attention:

- Reduction of rangeland area around the dam site, although only minor portion of the 730 ha is occupied by this type of land.
- Establishment of alternate route for the herds moving up and down the Indus River valley (also as part of the seasonal transhumance) through early construction of Shatial-Thor Valley Bypass as part of Relocated KKH.
- Any deterioration of business activities, especially at the timber storage place.

iii. Mitigation Measures

Appropriate environmental measures might have to be devised in order to minimise the above aspects. They should be included in the Rangeland Management Project [see also Chapter I on Environmental Management Plan (EMP)] with focus on:

- Information and consultation with communities
- Preparation / construction of bypassing routes for herds, if necessary for transhumance
- Consultations with shepherds about:
  - construction work schedule
  - extent of rangeland occupation
  - compensation for any damage of fodder resources

Compensation of business losses and offering of locations for replacement could be a further mitigation measure for the owner and workers of the timber storage.

After completion of the construction works, the land not needed for further use could be resituated to the villagers and owners.

E.3.3 Loss of Soils

i. Assessment

The soils where dam and appurtenant facilities, quarries and temporary construction camps will be located are of less environmental significance mainly due to the absence of upper soil horizons. Most important soils types affected are as follows:

- Alluvial sediments along the Indus River mostly comprising cobbles, gravels and sand
- Rock areas without any soil cover.

The use of these dominant soils for excavation and dumping of materials will not have any significant adverse impact on the environment. However, two soil issues will have to be addressed and handled with appropriate mitigation measures. First one will be soils in the nullahs, predominantly used for cultivation (This has been discussed under Impacts on Agricultural Activities). The second one will be the relevant ecological functions being performed by the soils as part of natural ecosystem. They are important for filtering and de-nitrification of pollutants from air and water. This function in some areas could be degraded to some extent.

The overall loss of soils will be insignificant as shown below:

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Soils used for construction works are mostly of low environmental value (river bed sediments, sand areas, rock areas)	

ii. Mitigation Measures

It can be seen from above that loss of soils will be of minor nature due to the low environmental value of the rock dominated soils. Notwithstanding this, the construction works would be generally directed towards protection, where a relevant soil horizon exists.

E.3.4 Contamination of Soils Due to Solid Waste Disposal

i. Assessment

Construction processes and accommodation of workers will produce much solid waste. Solid waste components are paper, timber, plastic, iron, non-iron metals, and glass. At the construction site and all labourer camps, a trash disposal system shall be implemented in order to collect all materials.

For proper disposal, recycling or treatment facilities will have to be established at one place. Waste material such as metals, plastic, timber, and paper would be treated accordingly for transport towards down locations in Pakistan. Some of the solid material, in order to avoid additional transport, could be used for meeting local energy needs. However, strict international requirements on emission standards will have to be kept in view. As shown below in the Impact Matrix, there will be less significance with regard to soil pollution if various rules and procedures established in a Waste Management Plan of the contractor(s) are followed carefully.

Contamination of Soils Due to Solid Waste Disposal

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	X			

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	Significant impacts might be avoided by proper solid waste disposal (in accordance with international requirements)			

ii. Mitigation Measures

If various rules and procedures established in a Waste Management Plan are followed carefully by the construction contractor(s), mitigation measures will not be required.

E.3.5 Air Pollution By Heavy Machines and Vehicles in Dam Area

i. Assessment

The construction work over 10 years will generate frequent transportation between the labourer camps and the work sites. Emissions polluting the air in the project area will be mainly carbon dioxide, particulate material (mostly soot), and nitrogen gases. Main emitters could be as follows:

- Driving of large number of excavators, bulldozers, and trucks at the dam site, appurtenant works up to Khanbari nullah, where the upstream cofferdam will be constructed
- Aggregating and processing of batching plants including cement mixers
- Excavation of quarries and stock piling areas
- Driving along the temporary roads

Essentially the emissions will affect large number of workers. Due to location of the dam site far from any habitation, no local population will be affected. Only few shepherds and car travellers on the Dudishal-Khanbari road (right bank) and on Karakorum Highway bypass around the dam site (left bank) will be affected. The labourer camps will be located downstream between 2.5 and 12 km from the construction area and therefore, would not be affected by the emitted gases.

As far as the dust is concerned, the natural conditions are already prone to significant production of fine material like wind blown sand from the vegetation free barren land in the valley. This process will be accelerated by various construction works. However, the overall impact of the construction on pollution of air will be minor as shown below:-

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Minor threats to local population due to complete absence from site	

ii. Mitigation Measures

Due to very distant location of various project construction sites, the threat of air pollution is negligible. However, the construction contractor(s) will be under obligation to minimise emissions and direct impact on receptors. This will be achieved basically through the use of modern machinery and vehicles with low emissions.

E.3.6 Air Pollution by Road Traffic Along Existing Karakorum Highway to Dam Site

i. Assessment

The large number of trucks, buses and cars driving to and from the dam site during the 10 year construction period would induce a heavy emission of exhaust gases (as described above). Vehicular traffic generated by the long distance transport of goods such as cement from Rawalpindi industrial area towards the Diamer Basha and same number of empty trucks going back) steel, fuel etc along the only existing route of Karakorum Highway has to be considered. Considering that about 500 vehicles (trucks, light vehicles and buses) would be plying each way, around 1000 vehicles may use this 300 km long stretch of Karakorum Highway. This would bring a high traffic load to the road and the many towns and settlements to be crossed. On the average, aver 40 vehicles per hour would pass Karakorum Highway (each vehicle after 1.5 minute).

Upgradation of Karakorum Highway from Havelian to Dam site is being completed by NHA in sections as shown in Table E-3:

Table E-3: Proposed Upgradation of Karakoram Highway

Section	Length (km)	Remarks
1. Havelian-Abbotabad	15	Under ongoing improvement programme of NHA
2. Abbotabad-Batgram	95	
3. Batgram-Thakot	27	
4. Thahkot-Besham Qila	28	Only essential improvements of removing curves and rock overhangs
5. Besham Qila-Pattan	38	
6. Pattan-Dasu	37	
7. Dasu-Sazin	59	
8. Sazin-Dam site	25	
Total		**324**

Source: Feasibility Report, NEAC 2004

As indicated in Table E-3, upgradation of KKH between Havelian and dam site is being handled by NHA through their separate programmes. On the other hand, its relocation from dam site up to Raikot will be implemented separately by NHA as part of Diamer Basha Dam Project. Environmental assessments and related mitigation measures including monitoring were duly covered under 'Feasibility Report on Upgradation and Relocation of Karakorum Highway (KKH) for Basha Diamer Dam Project' completed by NEAC-KKH Consultants in May 2004.

The corridor of KKH between Havelian and the dam site would be exposed to high carbon emissions especially soot, carbon dioxide, carbon monoxide and nitrogen gases, which might affect significantly the environment in this 324 km long road stretch (the most affected sections of KKH will be those passing through towns and settlements) as shown below:-

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X In towns and settlements to and from dam site due to emission from frequent and heavy transport				

ii. Mitigation Measures

Mitigation measures would be required as outlined below:-

- Use of modern vehicles with low emission standards
- Plying of heavy traffic during night time in order to minimise exposure of people against emissions
- Reconstruction of KKH bypassing the settled areas.

To be implemented by the prime construction contractor(s) of DBDP

- Detailed monitoring and any necessitated mitigation measures will be undertaken by the implementing agency of NHA.

E.3.7 Change of Local, Regional and Global Climate

i. Assessment

During construction stage of over 10 years continual related processes will be in place. However, affects on climate, especially on air temperature, wind, and precipitation, evaporation, or air humidity are irrelevant. Changes of those climatic elements are only to be observed in the vicinity of plant, vehicles, or construction works. Processes of setting free thermal energy by concrete mixing are unlikely to have an influence on the local temperature. Changes of temperature and wind regime as direct impact of albedo changes, which may occur after deforestation, would not have relevance due to the present absence of vegetation. The albedo properties of barren land and of construction area would not differ much.

Furthermore, direct impact on regional and global climate is not relevant. Significant is the emission of greenhouse gases, which may have an indirect influence on global warming. However, compared to a thermal power plant (which also during construction would emit greenhouse gases) the benefits on the carbon emission side of the hydropower plant are obvious.

The insignificance of this assessment is shown below:-

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Changes of climate are not relevant due to relatively low magnitude of construction works and the persistence of climatic elements	

ii. Mitigation Measures

Mitigation measures are not required. However, during the entire construction period - and if only to a minimal extent – impacts on climatic elements due to certain construction works (change of albedo, emission of energy, emissions) should be avoided.

E.3.8 Change of Indus River Hydrograph

i. Assessment

Construction activities during the approximate 10 years working schedule would involve large scale excavation, removal, and movement of gravels and rocks from the riverbed in order to establish following facilities:

- Upper and lower cofferdams
- Diversion canals and tunnels
- Embankments

MAP-2 (Sheet 2) shows the locations, where both cofferdams will be placed. The works for construction of cofferdams and diversion of the entire Indus River through the open canal and tunnels has been designed in such a way that:

- River flow is not blocked at any time
- Random dumping of earth material is avoided.

These activities may potentially generate high level of suspended solids, increase turbidity around the dam site and repel the fish stocks. However, under the condition of careful planning and handling, significant adverse impacts due to this activity would be avoided due to very turbulent river. In general, significant changes are not expected in the Indus River hydrograph at dam site due to diversion through canal and tunnels at the right bank as shown below:-

Change of Indus River Hydrograph

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Dam related works to be designed and implemented carefully in order not to affect the Indus River hydrograph	

ii. Mitigation Measures

Mitigation measures are not to be taken because of the situation that the river hydrograph during the construction works will not be affected significantly.

E.3.9 Overuse of Indus River and Nullah Water

i. Assessment

During the construction period of about 10 years, there will be large demand on water for construction itself and drinking water in the labourer camps for a large number of workers. However, the nullahs are the most important water resource in the area. Therefore, the nullahs are

almost the sole source for drinking and irrigation water needs of the local population. Potential adverse impact on this local water resource by the construction might be:

- Derivation of water for construction camps from nullahs
- Contamination of nullah bed and water due to excavation and dumping
- Pollution of nullah water bed (vehicles crossing, washing, spilling of fuel and lubricants)
- Damages to channels and/or water supply pipes.

The water intakes for these needs from the Indus River might be first of all in the vicinity of the dam site thus limiting the impact to a short course of river or nullahs. Furthermore, in this vicinity there will be no impact on either any settlements or agriculture.

The proposed Project Colony in Thor Valley will also have no impact on Thor Nullah water regime and quality because it will be provided with the modern water supply and sewerage facilities.

Most probably, these impacts would have medium-term effect and that too established after completion of the project. Due to the situation that the impact area is closely located to the dam site, where no nullahs are used by the local population (except 40 people in Minar Village) overuse of Indus or nullah water is of less significance as shown below:-.

Overuse of Nullah Water

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	X Water supply schemes, if based on extraction from any nullah, to be developed by the contractor(s) after local consent / arrangements with the stakeholders			

ii. Mitigation Measures

Unless the impact / magnitude corresponds to substantial diversion of water from the local nullahs, no mitigation measures will be needed. Therefore, the main contractors will normally limit the water extraction from the main Indus River. In case the water is to be extracted from the nullahs, after prior consent of the stakeholders, the location should be downstream of traditional area for withdrawals (for drinking, irrigation) by the population.

E.3.10 Damage of Groundwater and Spring Resources

i. Assessment

Despite lack of groundwater investigations, it is safe to assume that due to the extreme arid climate and specific geological conditions, the existence of any groundwater aquifers is unlikely. Due to prevailing high evaporation, infiltration is almost impossible. On a conservative basis, some ground water presence could be expected under the following two conditions:

- Springs releasing water at the mountain slopes, bringing water from higher elevations
- Groundwater in the Indus River bank storage (both terraces and moraines).

Bank storage on the Indus River is un-utilizable due to: high fluctuations of the river water level; and drainage back into the parent river channel. Some small springs have been identified in the project area and are mostly used for local supply of drinking water.

Some terraces or moraines are going to be used for construction such as:

- Excavation of quarrying material
- Spoiling for temporary storage
- Land coverage for construction works
- Diversion of river into canals or tunnels

In the above cases, significant adverse might not be relevant as shown below:

Damage to Groundwater

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Careful planning and implementation of excavation and dumping works may prevent adverse impacts on the few springs	

ii. Mitigation Measures

The construction activities will have to be planned carefully in the few areas, where springs and groundwater is available. Contractor(s) will be obliged to investigate before hand whether springs or/and groundwater resources would be potentially affected.

Locations in Gini, Buto, Thurli and Thor valleys, where springs are intensively used by the local population for drinking water supply, will have to be protected against any contamination. This will have to be coordinated between the contractor(s) and the Environmental Management and Monitoring Cell of WAPDA. In case any negative impacts are foreseen, appropriate solutions would have to be developed and implemented. The best solution would be to choose alternate locations.

E.3.11 Pollution of Nullahs/Indus River

i. Assessment

During construction activities predominantly at the dam site, there could be the risk of potentially affecting the water quality of Indus River and/or nullahs through:

- Cement and concrete from construction works
- Fuel (petrol and diesel) from vehicles and machinery spilled into the river/nullahs
- Lubricants from vehicles and machinery
- Sewage effluent (human faecal, composed by phosphorous and nitrogen associations, partially bacteria, and detergents) from camps, offices, etc.

The risk of pollution of the water bodies could be significant, due to the large amount of materials and fluids to be used over the 10 years construction period. However, Best Environmental Practice by the contractor(s) in handling of all these processes should avoid any significant damage of water bodies and quality.

A relevant positive condition is very large water quantum and turbulence of Indus River. The extreme torrential behaviour protects essentially the water quality of river. Moreover, due to the situation that downstream local population does not use at all the Indus River for drinking water and irrigation the human risk is almost nil. The overall situation is depicted below:-

Pollution of Indus River/Nullahs

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	X To be mitigated through Best Environmental Practice to be applied in the construction			

ii. Mitigation Measures

Despite lower significance of adverse impacts on the water quality of Indus River, the construction contractor(s) will be obliged to manage the following activities:

- Appropriate design
- Careful construction methodology
- Thorough supervision of the construction works
- Permanent monitoring of water quality

In accordance with the 'Best Environmental Practice" sound construction methodologies have to be designed and carried out avoiding any discharge of fluids or chemicals to open water bodies.

Under the condition that the water bodies are polluted (in comparison to the period before starting the construction) cash compensation will have to be paid to the local population. It might be pointed out that the Pakistan legislation on clean water supply will be applicable to the works under Diamer Basha Dam Project as well.

E.3.12 Increase of Indus River/Nullah Sediment Load

i. Assessment

Indus River due to the high flow and turbulence especially in summer (snow-melting) season, is dominated by high content of suspended sediment load. However, during works carried out in close proximity to the Indus River or nullahs, addition of material into the water bodies might be induced from excavation, cofferdams establishment and other works. Any increase in suspended load of Indus River due to these activities would be of consequence and need careful planning and implementation. Further, the suspended load during active construction will have to be monitored at the downstream gauging site of Shatial for any timely action, if needed. In general, this impact will be of minor significance as shown below:-

Change of Indus River/Nullah Sediment Load

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	X Minor significance when contractor(s) fulfils the prescribed requirements			

ii. Mitigation Measures

Most appropriate solution will be to avoid any release of earth materials into the Indus River or nullahs. 'Best Environmental Practice' will have to be applied also in this sensitive area by the construction contractor(s). Construction of the upstream cofferdam and diversion tunnels will have to be particularly executed in a manner so as not to increase the sediment load of river water. Furthermore, the relevant bidding documents will bind the contractor(s) to mitigate any disproportionate increase in sediment load of the Indus River caused by construction activities.

E.4 Impacts on Biological Environment and Mitigation Measures During Construction

E.4.1 Loss and Degradation of Natural Plants

i. Assessment

Impacts during construction both for temporary and permanent use will affect the vegetation in the project area through the following actions:

- Permanent coverage of large vegetated areas (unless the vegetation is not very dense and high)
- Permanent damage of plants due to excavation
- Temporary damage of vegetation area due to dumping of material
- Degradation of grass and some small bush vegetation by vehicles, blasting, or other methods
- Temporary coverage of vegetation by dust.

As the Vegetation Baseline Investigations[5] revealed, plants and plant communities have a very low status with regard to nature conservation due to the following reasons:

- Dormant vegetation due to climatic and soil conditions dominant is the dry steppe plant community
- Diversity of the dry steppe vegetation severely degraded due to previous exploitation and pressure by the local population
- Absence of endemic and endangered plants.

There is no importance from the nature conservation point of view as no endemic and rare plant species or plant communities were recorded.

The highest natural status has the dry steppe area close to Shatial located outside the project area. In particular, the large upper terrace (upstream of Shatial Nullah) is less degraded.

In general, damage or/and degradation of the very scarce vegetation cover, will not cause any significant reduction of the ecological status of the land in the project area as shown in the table below. However, the reduction of dry steppe area resulting in decrease of rangeland will have to be assessed separately.

Loss and Degradation of Natural Plants

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Natural dry steppe vegetation is severely degraded already.	

[5] DBC's 'Vegetation Composition Assessment in Project Area' during vegetation periods 2006 and 2007 as contained in Appendix C of Volume III

ii. Mitigation Measures

Although the biological value of the potentially affected natural vegetation is very low, the contractor will be obliged to apply 'Best Environmental Practice' in order to protect any vegetation site and natural plant community.

E.4.2 Damage of Insect Wildlife

i. Assessment

The insect wildlife (as outlined in the Baseline Chapter D) in the project area is poor. Only in areas of sandy flats covered by stones diverse insect fauna was recorded. Cultivated land, which has the highest diversity of insects, is not affected during the construction stage. The rangeland areas downstream of the dam, foreseen as sites for temporary construction facilities such as labourer camps, storage places for rock, earth material, cement, timber storage, and excavation have slightly higher density and diversity of insects. It is assumed that the affected insects would move to similar habitats in the neighboured.

The living conditions for insects are favourable only in areas with more vegetation cover and stones. In other areas, dominated by rocks far from any habitations insects are not relevant. In addition, endemic and rare insect species (in accordance to the Pakistan and IUCN Red List) are absent from the area. Thus, construction measures in general would either not affect at all or only affect marginally the insignificant insects and insect habitats. Noise from heavy machinery and blocking of roads due to heavy traffic would also not harm insects significantly.

In the temporary labourer camps, insects would grow due to the water availability, sewage water and solid waste disposal areas, which would even increase insect diversity.

The overall impact in this case will be insignificant as shown below:-

Threats to Insect Wildlife

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X No significance of insects with regard to nature conservation	

ii. Mitigation Measures

Specific mitigation measures are not required. The relevant preventive measure would be to avoid any damage or degradation of vegetated areas such as rangeland.

E.4.3 Damage to Amphibians and Reptiles

i. Assessment

Amphibians and reptiles in the mountainous dry steppe - together with birds - are the most important species. Especially geckos, agama and snakes are relevant for the project area. There are three endangered species, where the loss would be significantly adverse (refer to 'Study of Amphibians and Reptiles' in Appendix E of Volume III).

Potential impacts on amphibians and reptiles during construction are relevant due to following activities:

- Establishing barriers for specimen crossing the road on the surface
- Withdrawal of habitats by excavation and dumping of rock and borrow materials
- Killing of specimen during hibernation in nests in the upper soil, below stones, in cracks
- Expulsion of species from their habitats due to noise and vibrations
- Killing of individuals along roads due to severely increased traffic
- Temporary withdrawal of habitats for labourer camps, workshops, and storages.

Due to the high sensitivity of amphibians and reptiles against vibration and noise induced by the construction works, it might be assumed that during spring until autumn they would escape and recover new habitats. However, it has to be taken into account that those species mostly have a very distinct microhabitat. If such type of microhabitat is not available in the nearby surrounding there is no alternative habitat for the individuals.

Specimen of amphibians and reptiles hibernating in upper soil horizons, under stones and in cracks would be lost due to excavation or dumping.

On the other hand, a growth of reptiles in and around labourer camps is expected due to the availability of water (fresh water and sewage) and nutrition (insects and garbage).

The overall impact in this case will be significant as shown below:-

Threats to Amphibians and Reptiles

Significant adverse impact	**Potentially significant adverse impact for which design and construction solution can be developed**	**Adverse impact, which is potentially significant but requires further studies**	**Minor or insignificant adverse impact**	**Significant environmental enhancement**
X Significantly increased mortality and damage of amphibians and reptiles in the construction, excavation and dumping areas				

ii. Mitigation Measures

Mitigation will be required to protect amphibians and reptiles through the following measures:

- Basic monitoring immediately before start of construction
- Detecting frequently used road crossings (especially the rock agama habitats larger habitat areas, including access to river or nullah) by Herpetologists
- Removal of reptiles habitating the dam site area, camps and excavation places by Herpetologists before commencing construction measures, including use of light during night, vibration and noise in order to expel the specimen
- Fencing against re-covering the area by bigger species like agama
- Limiting, to the extent possible, blasting, excavating and dumping only during spring-summer period (only during this period the specimen would have any chance to survive when escaping into other areas)
- Building small culverts for crossing of reptiles at certain locations.

Despite the 'Best Environmental Practice', loss of amphibian and reptiles specimen will be unavoidable, which may require mitigation measures such as:

- Re-cultivation of degraded rangeland
- Establishment of new habitats with specific protection measures
- Institution of 'Monitoring and Research Programme on Species Such As rock Agama' in Northern (Gilgit-Baltistan) Areas through support to Pakistan Natural History Museum (Islamabad) including improvements of laboratory, collections and research in the various areas of Herpetology.

E.4.4 Threats to Birds

i. Assessment

As the baseline investigation revealed (refer 'Study of Birds in Project Area' in Appendix F of Volume III) there is relevant bird wildlife in the project area mostly because of the availability of water and less human pressure. The main bird habitat areas are the river banks, dry steppe areas, and the settlements with the cultivation areas along the nullahs. The entire Karakorum Valley is an important stepping stone for water fowl such as white stork, cormorants, crane, duck, wild geese, and others migrating seasonally between western Siberia/Central Asia and South Asia.

Impacts on birds are relevant in at least two aspects:

- Permanent increase of noise and vibrations due to the frequent heavy vehicle traffic along the road corridor from Shatial to Dam site and further to Chilas
- Blasting, excavation and dumping in bird habitats around the dam site and quarries

Potential damage to birds will kill single specimens, but in general expel most sensitive bird species. Under the condition that the construction (causing much noise and vibration) would start before breeding period, the individuals will have to search for new habitats. Under the condition when breeding period has already started, severe damage to nests and clutches of eggs could also occur. The impact assessment is shown below:-

Threats to Birds

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Significantly increased dislocation of specimen along left bank construction and transportation corridor and mortality of single specimen during breeding period				

ii. Mitigation Measures

Mitigation will be to protect birds, which are of specific wildlife value, Through the following measures:

- Basic bird monitoring immediately before start of construction
- Blasting, excavating and dumping only outside of breeding period

Specific compensation measures due to the losses of bird specimen and bird habitats could be:

- Re-cultivation of degraded rangeland
- Monitoring and Research Programme on species such as 'Migrating Water Fowl'

E.4.5 Hunting of Wildlife Associated With Project Staff and Workers

i. Assessment

Similar projects are often associated with increased levels of hunting, by project staff and workers. As there is no evidence of any mammal species, Illegal hunting in the project area has only very low probability.

The only group of animals, where there is relevant risk for hunting is the waterfowl. Various species of duck presently are coming during the migration in spring to the project area. The risk for accelerated hunting by construction workers including foreign employees is relevant but due to very limited number of waterfowl is of minor significance. The impact assessment in this regard is shown below:-

Hunting of Wildlife

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Wildlife to be hunted consist only of water fowls (migratory geese, ducks, others); other huntable animals like mammals missing	

ii. Mitigation Measures

Notwithstanding insignificant adverse impact, the contractor(s) should be obliged to establish basic rules and procedures to prohibit any hunting in the project area.

E.4.6 Degradation of Natural Fish Stocks by River Diversion Including Cofferdams

i. Assessment

Due to various conditions as outlined in the Baseline Chapter D (also refer 'A Study on Fish and Fishery Aspects of Project Area' in Appendix G of Volume III) in the Indus River the fish stock conditions are poor. The most diverse fish stocks areas are the nullahs, such as the natural fish stocks in the Khanbari. However, in general, endemic and endangered fish species do not appear.

The related construction works mainly at the dam site will include:

- Excavation of construction area along the river banks (canal and diversion tunnels)
- Raising of cofferdams (upper and lower) by dumping of excavated material
- Diverting the water through canal and tunnels.

It can be assumed that due to vibrations from heavy machines, noise from blasting works and dumping, the few fish (species and specimen) will avoid this area. When the water is diverted into the tunnels and canals the fish can negotiate as before As no barrier will be created. In general, the impacts on fish stocks during these construction works are not relevant as shown below:-

Threats to Fish Stocks

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Fish stocks in the Indus River are poor. Erection of cofferdam will not significantly harm the few fish species and specimen.	

ii. Mitigation measures

There will be no special mitigation measure required to protect natural fish stocks in the Indus River, whereas the nullahs remain unaffected.

E.4.7 Degradation of Fish Stocks by Water Pollution

i. Assessment

Pollution, by liquids and other chemicals, of Indus River and nullah water might have an influence on fish stocks indirectly. There are some construction measures, which may have an impact on water quality, such as:

- Leakages of fuel, oil, and lubricants from machinery and vehicles
- Accidental spillage from the fuel tanks
- Sewage effluent from labourer camps including lavatories, and
- Incidental addition of cement, concrete and other materials.

Fish may get enriched from residues of these chemicals. Similarly, biological waste from sewage or other sources would contribute to natural growth of the fish without having a negative impact on fish organisms. In general, these potential impacts would not have a high significance from environmental point of view as shown below:-

Degradation of Fish Stock

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Minor impacts during construction (cofferdam) and due to liquids (oil, fuel, sewage)	

ii. Mitigation Measures

Mitigation measures should aim at avoiding pollution from liquids used by the contractor(s) during construction. The need for such measures will be based on the results of proposed water quality monitoring of the Indus River.

E.4.8 Degradation of Mangrove and Riverine Ecosystems in Downstream Areas

i. Assessment

Along the downstream courses of the Indus River natural ecosystems of high diversity and conservation importance are distributed. To them belong the riverine forests and mangroves in the very south. These areas are settled by unique wildlife including the blind dolphin.

The downstream river course up to Tarbela reservoir is confined into a gorge. In this environment of high seasonal and episodic fluctuation of the water level, no perennial plants and wildlife has developed. Therefore, this reach of the Indus River will not be relevant for any destruction of ecosystems. Regarding river course downstream of Tarbela, the impact of the project will not be significant for the reasons recorded under the preceding Sub-section D.2.4. Therefore, the overall threats to downstream ecosystem will be insignificant as shown below:-

Threats to Downstream Ecosystems

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Minor impacts during construction also because of the poor state of downstream ecosystems; the rich ecosystems in the very south of Indus River are not reached by the construction effects.	

ii. Mitigation Measures

No mitigation measures will be required to protect the downstream ecosystems from the impacts caused by construction of the project.

E.5 Impacts on Socio-economic Environment and Mitigation Measures During Construction

E.5.1 Damage to Settlements, Houses and Population

i. Assessment

The habitations, as outlined in the Baseline Study Chapter D are not affected by the construction works. Neither houses nor residents would be directly damaged by the construction works of dam, tunnels, diversion canal, power plant, switchyard and others. Also the labourer camps will be established on the left bank downstream of the dam site towards Shatial village (upto a distance of 21 km) and would not directly harm the local population. Proposed locations for quarrying and dumping of excavated material has been selected also only in areas with no population.

Thus the impact on settlements, houses and population would be insignificant as shown below:-

Threats to Settlements, Houses and Population

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Settlements, houses and population are not affected directly due to absence of any habitation in the dam site area and other locations.	

ii. Mitigation Measures

No mitigation measure will be required to protect settlements, houses and population due to their complete absence from the proposed areas of construction.

E.5.2 Damage to Cultivation

i. Assessment

As outlined in the Baseline Study Chapter D, there is neither any cultivation nor related activity in the vicinity of main construction areas. The other construction related activities such as labourer camps, quarries and dumping areas have been selected in areas without any cultivation. Therefore, any adverse impacts on cultivation would not appear as shown below:-

Damage of Cultivation

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Cultivation activities are not affected due to absence of any cultivation plot in the dam site area and other locations.	

ii. Mitigation Measures

No mitigation measure will be required to protect cultivation due to the absence of any cultivation activity in the related construction areas.

E.5.3 Damage to Animal Husbandry

i. Assessment

Construction area of 730 ha covering the dam and appurtenants will occupy rock terrain in the narrow gorge of Indus River. Most of this area is without any vegetation worth the name. However, some of the following areas may have some utility as range land:-

- Labourer camp sites on the left bank downstream of dam site towards Shatial village
- Some quarry and dumping areas to be mostly inundated by the reservoir

Due to the scarce vegetation the sheep and goat herds of the neighboured villages from downstream (Shatial and Dudishal) and upstream (Khanbari and Hodar) villages may be using the related areas for grazing. The potential occupation of those rangeland areas due to construction activities despite the very low productivity could impact the rangeland and animal husbandry activities of the local population. The other main issue will be relocating of the moving herds as part of the seasonal transhumance, due to construction activities. This will be taken care of through the alternate routes of: Shatial Thor Bypass section of relocated KKH on the left bank; and completion of the under-construction link road from Dudishal to Khanbari.

Another issue could be high risk of accidents for sheep and goats when passing construction sites. Thus, the impacts on animal husbandry due to construction could be significant for the local population, if not mitigated by the timely completion of the above mentioned alternate routes for the moving herds. The overall impact in this regard will be as shown below:-

Degradation of Animal Husbandry

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Through timely provision of alternate routes for unhindered passage of moving herds, especially around the dam site area of 730 ha	

ii. Mitigation Measures

No specific mitigation measures may be required to protect animal husbandry during the 10 year period if unhindered passage of moving herds around the dam site area is provided on time. Some additional facilitating measures may be provided by the contractor(s) such as:

- Specific information to villagers and herdsman through proper signage
- Providing fenced corridors on the banks, where necessary, for assuring safety of herds

E.5.4 Damage to Forestry Activities

i. Assessment

Karakorum Valley due to climatic and geomorphologic conditions does not support any forest. On the other hand, trees are found only in the settlements for fruit growing and shade. As tree chopping and pine-nuts harvesting by the local population are only confined to the upper elevations (above 1,800 masl or even higher), there is no direct impact of the project on these activities.

Log rafting in the higher elevation forests is managed by the local residents under administration of the Forest Department of Diamer district. There could be a potential conflict during diversion of Indus River through tunnels and canal if rafting of logs is disrupted. However, due to very limited use of rafting, even this element may be of minor significance.

Impacts on forestry activities due to construction except the log rafting issue, would not be significant for the local population as shown below:

Deterioration of Forestry Activities

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	X Log rafting, though very infrequent, may require special attention, if necessary		X Forestry activities are not adversely affected directly due to absence of forest in the related construction areas.	

ii. Mitigation Measures

Mitigation measures to protect forestry activities over the 10 years construction period are not relevant except some special measures for log rafting, if needed during diversion of the Indus River.

E.5.5 Deterioration of Fishery Activities

i. Assessment

Fishery in the Indus River is not used because of the small amount of fish and high turbulence. However, there is some fishery actively in the project area through a confined focus only to nullahs. The main fishery activities are concentrated on Khanbari and Buto Nullahs, where fish hatcheries are also located.

Construction activities mainly focused on the dam site area would not have any significant adverse impacts on the local fishermen as shown below:-

Deterioration of Fishery Activities

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Fishery activities in the Indus River not relevant.	

ii. Mitigation Measures

No mitigation measures for protection of fishery activities in the project area will be not required.

E.5.6 Degradation of Water Supply

i. Assessment

Water supply for settlements and irrigation are far away from the sites earmarked for construction. In particular, in the dam site area, water supply will not be affected adversely as there is no settlement.

During the construction period between of about 10 year, there will be substantial demand on water for construction itself and drinking water in the labourer camps for a large number of workers. However, nullahs are the most important water resource in the area for drinking and irrigation water needs of the local population. Thus, potential adverse impact on this local water resource by the construction might occur if:

- Water for construction camps is derived from nullahs
- Nullah bed and water are contaminated due to excavation and dumping
- Pollution of nullah water bed is polluted through vehicles crossing, washing, spilling of fuel and lubricants
- Channels and/or water supply pipes are damaged due to construction related activities.

In case, the water intakes for these needs are located in the vicinity of dam site, the probable impact on settlements and agriculture may not be relevant. Furthermore, the basic construction activities in the dam site area would invariably draw water from the Indus River and thus cause no harm to local water supply from nullahs and springs as shown below:-

Degradation of Water Supply

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Local water supply in the settlements will not be affected adversely due to the distant location of the dam and other work related facilities	

ii. Mitigation Measures

Mitigation measures to protect degradation of local water supply will not be required.

E.5.7 Damage to Electricity Generation and Supply

i. Assessment

As outlined in Chapter D Socio-economic Baseline, the existing electricity generation and supply in the project area are insufficient. There is no central electricity supply system and many settlements do not have access to this facility. The only relevant source is some existing minor hydropower plants located in the nullahs upstream of the proposed dam site. Therefore, implementation of Diamer Basha Dam with its large constructions including camps, storage places and workshops will not affect at all these small hydropower stations and their local distribution network. Therefore, impact on local electric supply and generation facilities will be insignificant as indicated below:-

Degradation of Electricity Generation and Supply

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Local water supply in the settlements is not affected adversely due to the distant location of the dam and other work object location.	

ii. Mitigation Measures

Mitigation measures to protect the generation and supply of electricity to the local population are not required during construction except avoiding any damage of transmission lines and their poles due to accidental construction activities, which will be restored by the concerned contractor.

E.5.8 Damage to Transportation Services

i. Assessment

Transportation for the project will be basically by roads as outlined in Chapter D Baseline. Railway does not exist at all and navigation on the Indus River is not feasible due to high velocity.

Backbone of the road transportation is existing Karakorum Highway (KKH). From KKH, some smaller roads, mostly unpaved, are leading into every nullah. Seven suspension bridges link the left bank and the right bank of the river in the project area (refer Table D-33).

Construction works concentrated at the dam site will not affect the suspension bridges and most of the link roads.

Existing KKH has the following characteristics:

- Only river parallel transport line (the alternate Babusar Road presently under upgradation)
- Most of the traffic of goods and passengers is to and from Gilgit (Northern (Gilgit-Baltistan) Areas capital)
- Only two lane paved width, which makes crossing of heavy vehicles difficult
- Existing paved road surface in state of disrepair
- Crash barriers on the river side almost non-existent
- Many sections are susceptible to occasional land slides and traffic blockage due to location at the foot of unstable slopes

Under the above conditions, increased traffic on KKH may raise serious problems. Worst conditions could be caused in many towns and settlements being crossed on the way specially from Havelian to dam site. As mentioned above, this stretch of KKH will be suitably upgraded before start of active construction. The likely damage to transportation services on the existing KKH will be significant as shown below:

Damage to Transportation Service

Significant adverse impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Rapid increase of transportation for the dam construction will threaten smooth flow of the local traffic (traffic jam, blocking, noise, accidents, emissions)				

ii. Mitigation Measures

Mitigation measures have to be taken up on priority basis. In fact, upgradation of the section between Havelian and Thahkot is already under way including construction of new bride at Thahkot. The remaining portion from Thahkot to dam site is also proposed to be taken up shortly. The upgradation of KKH will have to focus on:

- Completion before start of active construction of Diamer Basha Dam
- Paving with improved curves and approaches
- Re-establishment of crash barriers
- Providing appropriate bypasses, where possible, to avoid densely populated towns and villages
- Provision of appropriately designed retaining walls in slide prone areas
- Improving the drainage system along the highway

- As already mentioned, construction of Permanent Access Bridge downstream of the dam site (Dudishal) will be constructed by the prime contractor for Lot 1.
- For uninterrupted work activities at the dam site, Shatial-Thor Valley Bypass of the Relocated KKH will be completed also on.

E.5.9 Improvements For Transportation

i. Assessment

It is expected that upgradation of / relocation of KKH and new bridges (Thakot and Dudishal) besides fulfilling the construction needs will contribute to a significant improvement of the transportation and livelihood conditions, particularly in Diamer district and Northern (Gilgit-Baltistan) Areas. However, if active construction starts before the requisite improvements, local transportation conditions may somewhat deteriorate due to: permanent traffic jams; frequent blocking due to construction activities; accidents; noise; and increased emissions. The overall impact in this regard is shown below:-

Improvement of Transportation Service

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Without timely completion of requisite improvements, the rapid increase of transportation for the dam construction may deteriorate the local traffic conditions (traffic jam, blocking, noise, accidents, emissions)				X Substantial improvement is expected from upgradation / relocation of KKH and construction of the new "Dudishal Bridge" downstream of the dam site linking the right bank to all weather road on the left bank

ii. Mitigation Measures

Mitigation measures are not required as timely completion of the proposed improvements will substantially enhance the existing conditions.

E.5.10 Damage to Education

i. Assessment

There will be no direct impact of construction on the education facilities in project area, which are only basic primary and secondary level. Thus the existing schools and other education facilities will not be impacted at all due to the fact that settlements are quite distant from the construction sites.

Under the condition that the rapidly increased traffic after starting construction will cause some traffic jams, there could be some small negative impacts on the school children commuting during morning and afternoon. The overall impact will be minor as shown below:-

Deterioration of Education

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X There is no damage or deterioration of education facilities and system.	

ii. Mitigation Measures

Mitigation measures to protect education facilities or structures are not required.

E.5.11 Improvement of Educational Atmosphere

i. Assessment

It is envisaged that after implementation of the Resettlement Plan (RP), the proposed educational facilities will become more attractive for young generation in the project area. Presently, the situation is dominated by the lack of employment opportunities. Thousands of job opportunities, to

be created by construction of Diamer Basha Dam, will significantly improve the educational atmosphere as shown below:-

Improvement of Education

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Education atmosphere presumably will be improved which will have significant positive effects on the basic education.

ii. Mitigation Measures

Any exclusive mitigation measures to improve the educational atmosphere during construction will not be required.

E.5.12 Improvement of Labour Market and Demand on Vocational Training

i. Assessment

Presently, the labour market in project area (may be the entire Northern (Gilgit-Baltistan) Areas) is very weak due to the following reasons (also explained in detail in Chapter D on Baseline):

- Very limited construction activities and almost no industry
- Very poor construction quality and rudimentary skills of native workers
- Dominance of subsistence farming and shepherding
- Compulsive child labour for economic reasons
- Absence of any female workers in manufacture, trade or services
- Very low education of available human personnel with the specific gap of appropriate skills including computers.

The plans to offer thousands of working places in construction and allied activities of cleaners, cooks, security personnel, and drivers would significantly improve the labour market in the project area as shown below:

Improvement of Labour Market

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X The expectations are quite high that many of the 10,000 construction related jobs will be given to local residents, especially young people, which would significantly improve the labour market in entire Northern (Gilgit-Baltistan) Areas.

ii. Mitigation Measures

Supporting measures to overcome the above described unfavourable conditions are as follows:

- Strengthening of existing vocational training facilities in Chilas with WAPDA and other concerned national / regional agencies to improve employment prospects of locals
- Development of basic education and vocational training facilities, particularly in the Model Villages to resettle PAPs
- Specialization to impart computer skills to the locals through introduction of preparatory measures in the basic education and vocational training as well
- Preferential employment of locals, particularly for non-skilled jobs through standing arrangements between WAPDA / contractors and Northern (Gilgit-Baltistan) Areas Administration

In this regard, WAPDA is already working on a plan for 'Capacity Building to Produce Skilled Work Force' in collaboration with the concerned national / regional agencies.

E.5.13 Improvement of Business Activities

i. Assessment

Business Sector is also very weak in the project area. Only some hotels, driver hotels, shops, workshops and fuel stations are operating. Mainly they are located in Chilas and larger settlements upstream along KKH on the left bank of Indus River.

Project construction works will not adversely affect the business activities. On the other hand, start of Diamer Basha construction would tremendously boost the business conditions leading to substantial increase of the following business services:

- Hotel accommodation
- Food and other grocery stuff
- Transportation
- Safety personnel
- Creation of capacity for infrastructure and road construction

Over the 10 year construction, the business will progressively grow instead of any deterioration as shown below:-

Improvement of Business Activities

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X All business activities will grow significantly.

ii. Mitigation Measures

Mitigation measures to protect the local business against construction will not be required. However, it is recommended to provide advice to the local business community to adapt their activities to the ground requirements. Specific focus could be given to: prepare the atmosphere and facilities for productive business activities; and introducing to use of computer in business management.

E.5.14 Improvement of Recreation

i. Assessment

So far recreation in the Northern (Gilgit-Baltistan) Areas is almost negligible except visitors to the world famous mountains and heritages such as: Nanga Parbat; Karakorum Valley; and unique rock carvings. Even in this case, there are only few visitors from downstream area of Pakistan with majority from foreign countries (Japan, United Kingdom, France, Germany).

Construction works, therefore, will not affect any recreation related activities. However, there is strong possibility that improved transportation and service in the area will attract more visitors as indicated below:-

Improvement of Recreation

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Recreation activities will grow significantly.

ii. Mitigation Measures

Mitigation measures are not required.

E.5.15 Deterioration of Social Structures Including Community and Gender

i. Assessment

Society of Diamer district is dominated by very stable and traditional Muslim social structures and relations. Majority of population is Muslim belonging to the Sunni Hanfi Sect, following traditional Islamic values. Most notable situation is that females are not allowed by their husband or other male family members to participate in the public life. They are allowed to work in: houses; child care (6-10); cultivated lands; and tending of household animals. On the other hand, they are mostly restrained from public activities, education, working in public places and even visiting markets or shopping areas.

Over 10 years, a peak requirement of over 10,000 workers is expected for the five (5) core construction lots. These workers will live in labourer camps and colonies or surrounding villages. From here, in multiple shifts, every day thousands of workers, mostly males will travel by buses or vehicles towards the construction sites. It is expected that a significant proportion of workers will come from foreign countries bringing new culture, traditions, and behaviour to this part of Northern (Gilgit-Baltistan) Areas. These workers will have different or no religion, and may belong to a different race or even speak different languages. Many of them will be keen to learn about living conditions of the local population in Northern (Gilgit-Baltistan) Areas of Pakistan. So, during their free time they may travel to Chilas, Gilgit, Fairy Meadows, Hunza, Skardu and other locations upstream and downstream to Dasu and further destinations.

The construction works may cause social tensions, which have to be avoided. However, due to the peculiar situation, where construction sites and camps will be away from villages and settlements, the inherent risk of social tensions is very low. Further, very close traditional family life confined to the four walls of houses in the villages or in Chilas will protect against any conflict with the traditional and religious customs of the local population.

The construction contractor(s), in close cooperation with the Diamer District Administration and WAPDA, will implement appropriate mitigation measures to reduce the risk of deterioration of social life as indicated below:-

Deterioration of Social Structures including Community and Gender

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	X Inducement of potential tensions and conflicts through 10,000 male workers from Pakistan and other countries, may not materialize primarily due to: majority of local origin; and distant locations of villages in relation to construction sites and labourer camps. However, well defined rules of behaviour will have to be prescribed by the contractor(s) for the workers particularly of non-local origin			

ii. Mitigation Measures

Mitigation measures should be guided through the prescribed strict rules of conduct and behaviour in the project area for the male workers. Contractor(s) security personnel including their public relation staff would be prepared for this aspect and to do everything possible to avoid any tensions. Most valuable and regular advice to expatriate construction workers will be to respect following Islamic values:

- Prohibition of alcohol
- Prohibition of drugs (opium, others)
- Prohibition of any contact with local females
- Prohibition of prostitution
- Sanctity of prayer timings and Ramadan, and
- Respecting religious festivals.

Contractor(s), in cooperation with Diamer District Administration and WAPDA, will introduce a regular monitoring processes to watch implementation of any appropriate mitigation measures for reducing the risk of deterioration of social life

E.5.16 HIV / AIDS and Other Sexually Transmitted Diseases Brought by Construction Workers

i. Assessment

HIV / AIDS in the Northern (Gilgit-Baltistan) Areas, particularly in the project area, is not a current issue. However, due to the high number of construction workers from other parts of Pakistan and abroad, the risk of HIV / AIDS or other sexually transmitted diseases (STDs) cannot be ruled out.

However, if the construction workers do respect the traditional and religious values, the probability is very low. The proposed labourer camps are distant from the villages, where the local population,

in particular the females are living. Normally, there would not appear any direct contact of male workers and local females but it is proposed to address this issue through a management plan to be enforced on the workforce of construction contractor(s) as shown below:-

Communicable Diseases Transmitted Through Construction Workers

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Preventive and monitoring measures to be enforced on the work force of prime construction contractor(s) through 'Human Immunodeficiency Virus (HIV) and Sexually Transmitted Diseases (STDs) Management Plan (refer Appendix G, Volume III of RP); additional focus will be on avoidance of any contacts with local females including medical advice to construction workers	

ii. Mitigation Measures

Notwithstanding this situation, the contractor(s) will be required to do everything to avoid transferring of HIV and other diseases within and outside the labourer camps. Each construction worker will need screening against HIV and hepatitis. Anyone having positive evidence will not be allowed to enter any construction camps or facility. This is proposed to be enforced on the contractor(s) labour through a 'HIV and STDs Management Plan' as indicated above (included as Appendix G, Volume III of RP).

E.5.17 Noise Pollution of Humans by Heavy Machines and Vehicles

i. Assessment

During construction over about 10 year period, continual noise will be generated from various works. This will adversely affect humans in an area of at least 200 m around the source. Following sources of noise reaching in all cases 85 db level[6] (partially much more as for blasting) are relevant:

- Dam site, including permanent access bridge, cofferdam construction and rock excavations
- Batching plants, cement mixers, stock piling areas at location of proposed installations
- Quarry areas at proposed locations and along their transport routes (about 36 km length)
- Quarry areas at proposed locations, single noise events from blasting
- Transport of goods and persons along Karakorum Highway.

The overall pollution risk will be minor as shown below:-

[6] Permanent noise of 55 db and more are seen as limit value beyond which health problems would occur.

Noise Pollution

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Minor threat to local population around works and along transportation routes due to distant locations of settlements	

Due to the situation that in the vicinity of the main construction there is no settlement, the impacts on the local population from noise will be only of minor magnitude. However, there are severe threats to workers on constructions sites, labourer camps and workshops.

ii. Mitigation Measures

Contractor(s)will be obliged to reduce, as much as possible, the noise pollution. This will require measures such as:

- Using modern equipment including heavy vehicles and trucks
- Using appropriate protection devices for workers
- Avoiding any drives into settled areas, specially at night

E.5.18 Damage to Cultural Heritage and Rock Carvings

i. Assessment

As outlined in the Baseline Chapter D there is no cultural heritage except the very important rock carvings in the entire Karakorum Valley. During construction, potentially adverse impacts may affect heritage rock carving objects in the following manner:

- Excavation of rocks containing carvings for construction works (dam, power houses, diversion facilities)
- Excavation of rocks containing carvings from quarries
- Excavation or damage to rocks containing carvings for levelling of areas needed for camps, temporary and permanent roads, storage areas.

The risk of loss to rock carvings due to construction would be significant as shown below:-

Damage to Rock Carvings

Significant adverse Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	X Rock carvings may be protected by avoiding the usage of those area/objects for rock excavation through appropriate provision in the bidding documents			

ii. Mitigation Measures

A specific 'Cultural Heritage Management Plan' has been developed in this regard and included as Appendix C in Volume III of RP. This plan based on already conducted detailed inventory will be implemented by the Department of Archaeology and Museums through creation of an exclusive unit at Chilas. This will include the following mitigation measures required either to avoid or reduce negative impacts:

- Review / refinement of the available detailed inventory of the rock carvings in the project area
- Prior supplemental field investigations at various construction sites for identification of additional objects in close cooperation with Dept. of Archaeology and Museums of Pakistan
- Confirmation of the list of identified 'Most Important Rock Carvings'
- Determining feasibility of relocation among the 'Most Important Rock Carvings'
- Documentation of the remaining 'Most Important Rock Carvings' through 3-D Scanning and Replication
- Construction of Rock Carvings Exhibition Centre in Chilas to display the salvaged rock carvings

Out of 31423 carvings on 5202 rocks, about 109 would be replicated including a few relocated, if possible. As mentioned above, this is proposed to be accomplished through a 'Cultural Heritage Management Plan'.

E.6 Impacts on Physical Environment and Mitigation Measures During Reservoir Operation

E.6.1 Damage of Geologic and Geomorphologic Values

i. Assessment

There are no significant losses or damages on the geology in the reservoir area. The rocks are usually widely distributed. However, the geomorphology of the Indus River valley will be changed significantly. The narrow gorge will be inundated in the lower 200 to almost 300 meters. Though this will irreversibly change the view from various points, it would also enhance the scenic beauty through a large lake in an arid environment as indicated below:-.

Damage of Geology and Geomorphology

Significant adverse Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Loss of geological objects such as rocks is insignificant. However, the view of narrow gorge of the Indus River might become a loss for the scenery of Karakorum Valley.	X Creation of scenic beauty in an arid environment through a large lake

ii. Mitigation Measures

Mitigation measures are not required as far as the geology is concerned. In the case of landscape beauty the loss of the typical high mountain valley seems to be balanced with the establishment of a beautifully high mountain "lake". The reservoir operating agency (WAPDA) will be well advised to support enhanced recreation and tourism in the region in cooperation with the concerned regional / national agencies.

E.6.2 Enhancement of Landscape Beauty

i. Assessment

Conversion of the Indus River gorge into a large lake might appear as improvement of the landscape beauty. Lakes of such value, located in the mountainous regions, significantly improve the scenery and balance the loss of the previous landscape value as indicated below:-

Enhancement of Landscape Beauty

Significant adverse impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Development of reservoir "lake" located in the mountainous landscape will substantially enhance the scenic beauty.

ii. Mitigation Measures

Mitigation measures are not required.

E.6.3 Downstream Channel Degradation

i. Assessment

According to DBC's study on 'Reservoir Operation and Sediment Transport', outflow from the reservoir through various facilities (powerhouses, low level outlets and spillway) during a typical year will vary between 750 and 5,800 m^3/s. Due to trapping of the sediments after initial impounding, the out flowing water will cause initial degradation, particularly in the reach immediately downstream of the dam site.

Valley, for some hundred meters downstream of the dam site, is a narrow gorge with very steep slopes. The approximate width at the mean water level is 150-180 m. Some locations have exposed bedrock and boulders of up to 2.0 m size. At other riverbed locations, predominantly fine sand and silt material prevails. Modelling of these flows reveals that the areas with boulders would not be affected at all and in fact, resist any erosion due to armouring effect.

On the other hand, alluvial deposits would be subjected to erosion of between 7 to 9 m close to the dam site. Discharge from the dam in a range of 3,500 m^3/s (average of 2,000 m^3/s) over the high flow period of about 3 months would help in formation of an armouring layer with higher resistance. It is estimated that in the initial 10 years or so of reservoir operation, a maximum degradation of about 4.5 m could occur immediately downstream of the dam site. This may gradually fizzle out over a distance of about 20 km upto Shatial.

Photograph E-1 Indus River Between Dam Site and Dudishal Suspension Bridge

Source: Google Earth, DBC November 2007

Village Dudishal (see Photograph E-1) in middle of the northern bank area is located just downstream of the dam site on Indus River. At this location, the riverbed may go down by about 4.5 m but may not severely degrade riverbed or the rocky banks.

As mentioned above, the river bed degradation would extend to around 20 km downstream. Therefore, at Shatial (19 km downstream) its magnitude would be almost zero with normal seasonal water level fluctuations of the Indus River.

In view of the above situation, adverse impacts on the local population in Dudishal and Basha village (located mostly in the Basha Nullah) or Shatial would not occur due to river bed degradation immediately downstream of the dam site. Furthermore, the right bank unpaved road (visible as light line right from the Dudishal Nullah in Photograph E-1), would not be affected at all as shown below:-

Downstream Channel Degradation

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Minor due to the absence of any environmental objects in the section up to Shatial	

ii. Mitigation Measures

Mitigation measures in view of the self healing phenomena of channel erosion are not required. However, the operating agency (WAPDA) will have to conduct regular monitoring by observing the sedimentation and erosion processes in the downstream channel up to Shatial.

E.6.4 Damage of Geologic Objects Due to Sliding Along Reservoir Periphery

i. Assessment

Seasonal reservoir fluctuation of 100 m (between FRL of 1,160 masl and MOL of 1,060 masl) could trigger rock and land sliding processes. These could be the effect of:

- Steep slopes (above 25°) depending on the local geology
- Presence of material and soils prone to water erosion and abrasion including saturation (moraines)
- Lack of vegetation cover or low density of grass and shrubs.

This aspect was studied by DBC for various critical locations along the reservoir periphery and documented in the 'Report on Landslides and Slope Stability'. Accordingly, out of 101 km identified slide prone areas along the reservoir periphery, the hazard was assessed below:

i. 73 km is flatter than 25° and hence globally safe.

ii. 20 km has inclination between 25° to 40°, will be flattened by collapsing of steep or weak sections but the slope may globally slide and adjust to stable inclination of 30°.

iii. Only 8 km of moraine deposits (away from main settlements) are too steep and expected to collapse under initial impoundment. Even these may not pose a hazard provided marked at the surface and prohibited from entrance, settlement, and other impacts.

In general, there is low risk for triggering of sliding processes along the Diamer Basha Reservoir as shown below.

Development of Sliding along the Reservoir Periphery

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Assessments revealed low risks of sliding provided the locations are marked at the surface and prohibited for any construction or human activity.	

ii. Mitigation Measures

The operating agency (WAPDA) in close cooperation with the Diamer District Administration (and the National Highway Authority as well, as far as the Relocated Karakorum Highway is concerned) will have to prepare the following mitigation related measures:

- Preparation of 'Monitoring Programme of Land and Rockslide Around the Reservoir' taking into account additional road construction issues (Karakorum Highway, Right Bank Periphery Road, Babusar Road, Nullah-linking roads) focusing on following protection measures:
  - Marking of high risk areas (prohibited from any entry and use)
  - Fencing

- Gabions and other protection measures
- Aforestation.

- Preparation and implementation of 'Land and Rockslide Protection Plan', if needed

E.6.5 Loss of Land Due to Reservoir Impounding

i. Assessment

Although FRL of Diamer Basha would be 1160 masl, the land acquisition zone will go upto 1170 masl to cater for safe routing of probable maximum flood (PMF). This would cover an area of 127.65 km² (refer Table E-4 and MAP-3). Out of this, 111.99 km² would comprise terrestrial soils as shown in Table E-4.

Table E-4 Land Use Types Impacted By Land Acquisition Zone For the Reservoir (up to 1,170 masl)

Land Use Type	Area Under Reservoir Related Land Acquisition	
	Area (km²)	Proportion (%)
Sand Areas Without Use	37.99	29.76
Rock Areas Almost Without Vegetation	19.89	15.58
Rock Areas with Sparse Vegetation < 10%	42.75	33.49
Rangeland with Vegetation Cover > 10%	0.58	0.46
Forest and Shrub Areas	0	0
Cultivated Land (Including Partially Built-up Area)	10.12	7.93
Built-up Areas (Uncultivated Land)	0.08	0.06
Commercial Areas	0.58	0.45
Terrestrial land	***111.99***	***87.73***
River Bed	***15.66***	***12.27***
Total	127.65	100.00

Source: DBC December 2007

It may be pertinent to not from Table E-4 that no forest (including shrubs) will be affected. Most of area (about 79.3 %) will be without any vegetation or only very sparse grass cover (consisting of rock and alluvial sand). The impacts on local population due to their dependence on the cultivated land (almost 8 % of the total land) will be assessed later from socio-economical point of view. Though the impact will be significant from the stand point of land loss, the socio-economic significance be basically confined to the cultivated land as shown below:

Loss of Land Due to Reservoir Related Land Acquisition

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Totally, 127.65 km² land will be consumed within the land acquisition zone upto 1,170 masl.				

ii. Mitigation Measures

No mitigation measure will be possible and addressed through various compensation measures such as:

- Resettlement Plan: for resettlement issues
- Integrated Land Management Plan (part of Chapter I. EMP): for rangeland issues

E.6.6 Loss of Soils Due to Reservoir Related Land Acquisition

i. Assessment

As mentioned already, land acquisition zone for FRL of 1160 masl will extend up to 1170 masl. Table E-5 summarises result of the inventory for various soil types impacted by this process (refer also MAP-5).

Table E-5 Various Soil Types Impacted By Land Acquisition For Reservoir

Soil Type	Soil	
	Area (km²)	Proportion (%)
Alluvial sand areas directly beside the Indus River, frequently flooded, without any soil formation	6.72	5.26
Alluvial sand areas on slightly upper terraces of Indus river, with some initial soil formation	39.15	30.67
Dry rock areas on various locations of the foothills, only at plain areas beginning soil formation	23.48	18.39
Scrape slope areas of the foot hills, covered often by scree, talus, rock debris, without any soils	14.87	11.65
Xeromorphic greyish soils on glacio-fluvial sand material (river terraces with gravels and sand, sometimes alluvial fans) with 1-3 dm upper humus horizon	2.76	2.16
Xeromorphic greyish soils on clay-silt material from glacial origin (mostly moraines, lacustrine deposits)	2.50	1.96
Alluvial sediments, mostly sand, in the nullahs, with gleyic soil formation due to permanent or seasonal water-logging adjacent to the stream	5.31	4.16
Hortisols (soils under intensive cultivation) on irrigation fields on sand and clay deposits, mostly along the nullah or on Indus River sand terraces	5.81	4.55
Aeolian sand along the river and some higher locations, partially with some initial soil formation	11.39	8.92
River Area	**15.66**	**12.28**
Total	**127.65**	**100.00**

Source: DBC December 2007

It can be seen from Table E-5 that the most significant is loss of Hortisols (about 4.6%) cultivated around the villages. The other significant type is greyish soil (about 2%) formed by the clay and silt sediments on moraines and terraces. However, the major portion (almost 75 %) is soils on rocks and sand (including aeolian sand) which though available in abundance in the Karakorum Valley, are not economically significant as shown below:-

Degradation of Soil

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Minor adverse effects on soils and natural ecosystem due to small proportion of relevant soil types in the reservoir	

ii. Mitigation Measures

Mitigation measures are not possible. Compensation and substitution measures are required for

- Soils of cultivated land and for animal husbandry: addressed in the Resettlement Plan
- Soils which are important for vegetation cover: addressed in EMP Chapter I.

E.6.7 Loss of Groundwater and Springs Due to Reservoir Impounding

i. Assessment

Large moraines and terraces in the project area accumulate water from rainfall in the lower catchment. However, most of the water will be supplied via infiltration from the surrounding mountains. This groundwater source shows up in the form of springs. It has been inventoried that over 50 springs are being used in the project area for local water supply. Approximately 10 % of the population in the project area is presently using springs for drinking water and 2 % for irrigation.

Submergence of moraines and terraces in the reservoir will affect the groundwater formation and consequently the supply of water by springs. Potentially, most of these springs would be inundated in the reservoir area including complete loss in some cases. However, due to no future use within the reservoir, this impact will be of minor significance as shown below:

Loss of Springs/Ground Water due to Reservoir Impounding

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Ultimate loss of groundwater reserves and springs through reservoir impoundment will be of minor significance due to no future use	

ii. Mitigation Measures

Mitigation measures are neither possible nor needed. However, the population affected by this phenomena will be compensated through:-

- Restoration of water and or irrigation supply under significantly improved conditions in the Model Villages through appropriate infrastructural development as part of the Resettlement Plan
- Compensation of lost springs for any remaining settlements on the reservoir fringe through provision of alternate means.

E.6.8 Change of Local Climate Due to Reservoir Impounding

i. Assessment

It is presumed that the local climate in the upstream Indus River Valley, after impoundment of 10 BCM of water and formation of large surface of 115 km^2, would not be changed considerably. Energy balance, compared with the present river water with high velocity and turbulence, which cannot accumulate energy, could be affected as below:

- Summer: slight decrease of air temperature above and around the reservoir due to absorption of energy by the water and evaporation
- Winter: slight increase of air temperature.

In both seasons, this would induce an increase of air moisture in vicinity of the reservoir. Whether this ‘cooling effect’ would have any significant impact on human ailments (for example increase of bronchial and asthmatic diseases) may need to be investigated separately.

The other potential impact could be development of fog along the reservoir during spring and autumn time, when the temperature differences between water and air are prone to this phenomenon. However, the risk for the traffic on Karakorum Highway is very low due to its relocation at higher elevation. In general, a significant change of the local climate is not relevant as shown below:-

Change of Local Climate

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Only minor effects (increase of air moisture, cooling in summer and winter) on the local climate would appear.	

In the context of overall climatic changes in Northern Pakistan – particularly the increase of precipitation – there is likelihood that frequency of mudflow events will increase. This is based on the 50-60 % increase of those events in the Northern (Gilgit-Baltistan) Areas between 1961 and 1990.

ii. Mitigation Measures

No specific mitigation measures are called for. However, in an attempt to stabilise the local climate and to reduce the potential risks of accelerated mudflow in the vicinity of reservoir, the following measures could be contemplated subject to availability of 'suitable land and support of local population:-

- Rangeland development
- Aforestation of slopes

These measures, if feasible, could contribute to the environmental improvement through soil conservation and enhanced slope stability, balancing fluctuations of climatic elements such as air, moisture, extreme air temperatures, and also supporting recreation and animal husbandry.

E.6.9 Contribution to Global Warming by Reservoir Induced Methane Development

i. Assessment

Since years, a controversial discussion has been going on about the ecological soundness of hydropower in the context of further increase in the global warming due to methane emission from big reservoirs. UNEP Paper "Climatic Change and Dams" (2000) summarises this ambivalent topic as outlined in Box E-1.

There were also some recent publications of International Panel for Carbon Control (IPCC). Notable among these are:

- IPCC Report of March 2007, in Bangkok ("Renewable Energy sources that are inherently renewable such as solar energy, hydropower, wind, and biomass"

Box E-1: UNEP Statement on Environmental Soundness of Hydropower

"First, studies indicate that hydroelectric power reservoirs can emit substantial amounts of methane, which, as a greenhouse gas, is 24 times as potent as carbon dioxide. Methane is emitted from reservoirs that are stratified and where the bottom layers are anoxic, leading to degradation of

biomass through anaerobic processes. Where the water is well oxygenated, degradation of biomass generates carbon dioxide, not methane. Reservoirs that risk being potent emitters of methane, therefore, are those in warm latitudes, where vegetation was cleared before flooding, and which are extensive and stratified with anoxic layers.

But, second, dams can, on the other hand, serve a positive role in energy policies in the context of carbon dioxide reduction programmes, as hydroelectric power offsets thermal generation. Hydroelectric power has the potential therefore to reduce the GHG (greenhouse gas) emissions of the electricity sector."

Source: UNEP Paper "Climatic Change and Dams" (2000)

- IPCC Special Report Carbon Dioxide Capture and Storage, Annex I, Glossary, p 50).

Based on above scientific investigations, EU Summit in Brussels (2007) confirmed clearly that hydropower is "low emission energy technology" together with nuclear, wind, solar and geo-thermal energy.

Methane generation, as discussed in Box E-1, is relevant for shallow water reservoirs in tropical areas, where abundant organic matter is available over the year. Consequently, a stratified reservoir water body is developed leading to oxygen reduction in the hypolimnion, where no oxidation of biomass carbons would appear. The biomass detritus from phytoplankton, zooplankton, benthos, aquatic plants, and fish under permanent redox reaction will thus be converted into methane (CH_4), which would potentially contribute to global warming.

However, in Diamer Basha reservoir, there is no risk for methane emission from the natural biological and hydrological conditions due to the following conditions:

- Very low total biomass of the semi-desert plants
- Oligotrophic water conditions with extreme little biomass[7]
- Barren land with rock, gravels and sand in the reservoir bottom
- Almost no vegetation submerged by the reservoir
- Cold-water regime all over the year, which does not support dissimilation of vegetation rots. No stagnation due to perennial release of water through the dam outlets.

Regarding carbon dioxide (CO_2), it is stated by certain quarters that 20% of emissions are from the world large reservoirs. There will hardly be any chance of CO_2 emissions from Diamer Basha reservoir through dissolution of carbonic acid (see Table E-6):

Table E-6: Global Warming Due to Methane Emissions From Reservoir

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Minor chances for generation of methane gas due to low stratification (caused also by frequently release of water), low biomass and cold water regime of reservoir	

[7] phyto- and zooplankton, aquatic plants, benthos, fish

ii. Mitigation

The reservoir created by Diamer Basha Dam will not warrant any mitigation measures due to minor chances for generation of methane gas.

E.6.10 Carbon Dioxide Credits Due to Avoidance of Emissions

i. Assessment

One of the key arguments in favour of hydropower over thermal generation is the avoidance of emissions that may influence global warming through combustion of fossil fuel. These emissions along with their main impacts are:

Emission	Impact
Carbon Dioxide (CO_2)	Global warming
Sulphur Dioxide (SO_2)	Acid rain, respiratory problems
Nitrous Oxide (N_2O)	Acid Rain
Particulate material (PM)	Respiratory problems

Carbon Credit is a calculation based upon avoiding very sizeable emissions of CO_2 by substitution of fossil fuel through hydropower. According to the prevailing technology, the estimated CO_2 emissions for power generation through gas turbines fuelled with natural gas are as follows:

Type and Mode of Energy Generation	Estimated CO_2 Emission Per GWh (tons)
Peak power through open cycle gas turbines	620
Base power through combined cycle gas turbines	450

Source: DBC, October 2007

The estimated emissions (in kg per GWh of generation) of other three items are of the following order:

- SO_2: 2
- N_2O: 1,500
- PM: 60.

The mean annual generation related to the Diamer Basha Dam Project would be as follows:

Item	Annual Generation (GWh)		
	Base	Peak	Total
Generation at Diamer Basha	12,687	5,410	18,097
Additional at Tarbela Dam due to conjunctive operation with Diamer Basha	1,111	0	1,111
Total	**13,798**	**5,410**	**19,208**

Source: DBC, October 2007.

Following corresponding quantities of various emissions have been estimated:

Emission	Basis for Quantification	Quantity (tons)
CO_2	[5,400 x 620 t +13,798 x 450 t]	9,563,300
SO_2	[19,200 x 2 kg]	38
N_2O	[19,208 x 1.5 kg]	28,812
PM	[19,208 x 60 kg]	1,152

For estimating the benefits from various avoided emissions, the following assumptions have been made:

- CO_2: Prevailing value in European carbon market of € 20 (US$ 30) per ton.
- SO_2: A wide variation in its prices depending on the location of power generation facility with an assumed value of US$ 500 per ton.
- N_2O: A value of US$ 200 per ton.
- PM: A value of US$ 500 per ton.

By adopting the above values, annual benefit attributable to avoided emission as a result of Diamer Basha Dam Project has been estimated around US$ 300 Million (as shown in Table E-7):

Table E-7 Estimated Annual Benefit from Avoided Greenhouse Gas Emissions

Parameter	Estimated Emission (ton)	Assumed Benefit Per Ton (US$)	Total Estimated Annual Benefit (US $ Million)
CO_2	9,563,000	30	286.899
SO_2	38	500	0.019
N_2O	28,812	200	5.762
PM	1,152	500	0.576
Total			**293.256**
			Say US$ 300 Million

Source: DBC, October 2007.

It can be seen from Table E-6 that benefit due to avoidance of CO_2 emissions alone constitutes about 97.5 % of the total estimate. Therefore, in the context of carbon credit for Diamer Basha Dam Project, a figure of US$ 287 Million per year can be safely assumed.

Creation of the reservoir will induce significant environmental enhancement through avoidance of CO_2 emissions as shown below:-

Avoided Carbon Dioxide Emissions

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Enhancement due to the avoidance of green house gas emissions in comparison to combined gas-fuelled electricity plant

ii. Mitigation Measures

Mitigation measures due to the enhancement character of this positive impact are not required.

E.6.11 Downstream Water Reduction During Initial Reservoir Filling

i. Assessment

As described in Chapter C Project Description' the schedule of initial reservoir filling will be achieved in five stages as shown in Table E-8.

Table E-8 Initial Staged Filling of Diamer Basha Reservoir

Stage	Filling level [in masl]	High Season Runoff a) [million m³]	Water Impoundment [million m³]		Proportion of High Season Runoff (%)	Date
			Total	Incremental		
1	Up to 975	43233	44	44	0.1	2014
2	975-1,060		2119	2075	4.8	2017
Minimum Operation Level			2119	0	0	2018
3	1075		2905	786	1.8	2018
4	1150		8896	5991	13.9	2019
5	1160		10008	1112	2.6	2020
Full Reservoir Level			10008	0	0	2020

a) From 11 June to 10 September

It can be seen from Table E-8 that initial impounding to 975 masl is envisaged during 2014 with river diversion for construction. Further filling over the MOL (1,060 masl) stage up to FRL (1,170 masl) will be achieved through four stages up to 2020.

It may be noticed from Table E-8 that a quantum of 2.119 BCM will be required in order to fill the reservoir up to the MOL of 1,060 masl. In the following three stages, approximately 7.889 will have to be stored reducing somewhat the downstream release. In overall terms, it will require withdrawing the amount of 10.008 BCM water from the Indus River water balance over a long period of about six (6) years.

Regular reservoir filling period will be during the high flow season (snow / glacial melt) from June to August / September, both for initial and regular operation. Designed minimum release at MOL of 1,060 masl of will be about 2,960 m³/s from the two powerhouses and 1,040 m³/s from two low level outlets. In general, the yearly reduction of water flow due to initial impoundment of 2.075 BCM over four years (2014-18) and subsequent storage of 7.889 BCM over two years (2018-20) will be quite small in comparison with the overall discharge of 62.000 BCM for Indus River at the dam site. This impact will not be so significant as indicated below but need to be monitored closely at the time of actual occurrence (equivalent to 4.2 %).

Downstream Water Reduction for Initial Filling

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Though the overall impounding of about 10.008 BCM over a prolonged period of 6 years will not be significant, reduction of water release in the Indus River course will have to be monitored (in connection with Tarbela) under indent based IRSA operation. Furthermore operation modes for high and low water years will have to be developed separately.	

ii. Mitigation Measures

No specific mitigation measures are required except monitoring of the effective discharge during the years of initial impoundment (up to 1,060 masl) and first staged filling (up to FRL of 1,160 masl). Main role in this case will rest with IRSA in case of any abnormality of outflows.

E.6.12 Downstream Impacts Due to Variation of Indus River Discharge

i. Assessment

Gross storage capacity of Diamer Basha is 10.008 BCM, which represents about 12.7 % of the total annual flow of 62.000 BCM. At the MOL of 1060 masl, the dead storage would be 2.119 BCM, thus providing an active storage of 7.889 BCM upto FRL of 1160 masl. Even considering the projected active storage of 8.330 BCM at Tarbela (around 2017), the regulated capability on the Indus River would be limited. Both reservoirs together would only store about 16.219 BCM or about 21% of the total runoff of the Indus River at Tarbela.

Normal reservoir filling will be during about 100 days from June through beginning of September. Conjunctive operation of Tarbela and Diamer Basha would have the impact of somewhat lowering the water level below Tarbela during this 100 day filling period. Starting in June with 0.01 m, this lowering of water level in the Indus River downstream of Tarbela could increase to 0.39 m in August. Though both the reservoirs will be operating conjunctively for delivering water according to irrigation demand still there will be sizeable shortage in Indus Basin Irrigation System (IBIS) pointing to the need of additional storage through further harnessing of surplus flow supplies.

According to the envisaged reservoir operation pattern, the combined discharges from Diamer Basha and Tarbela Dam will increase the downstream releases from October through May with filling starting in June by utilising the rising flows. Table E-9 shows that downstream of Diamer Basha Dam there will be an increase of Indus River water level during winter in the range of 1.2 to 4.8 m and in some months around 4 m. However, in summer (June), there will be an average water level reduction between 0.2 and 2.2 m. According to special simulation study carried out by DBC, the differences in 10-daily water levels downstream of Diamer Basha are also shown in Figure E-2.

The mean water level rise of 1.28 m will be inconsequential for the environment of downstream areas of the Indus River, because of:

- No impact on irrigation withdrawals due to the absence of any such facility on the Indus River up to Tarbela and even beyond up to Jinnah Barrage
- No river navigation
- No natural vegetation along the river course
- No groundwater aquifer in alluvial sediments charged by the Indus River water.

Table E-9 Discharge and Downstream Water Level Simulation at Diamer Basha and Tarbela Dams

Diamer Basha

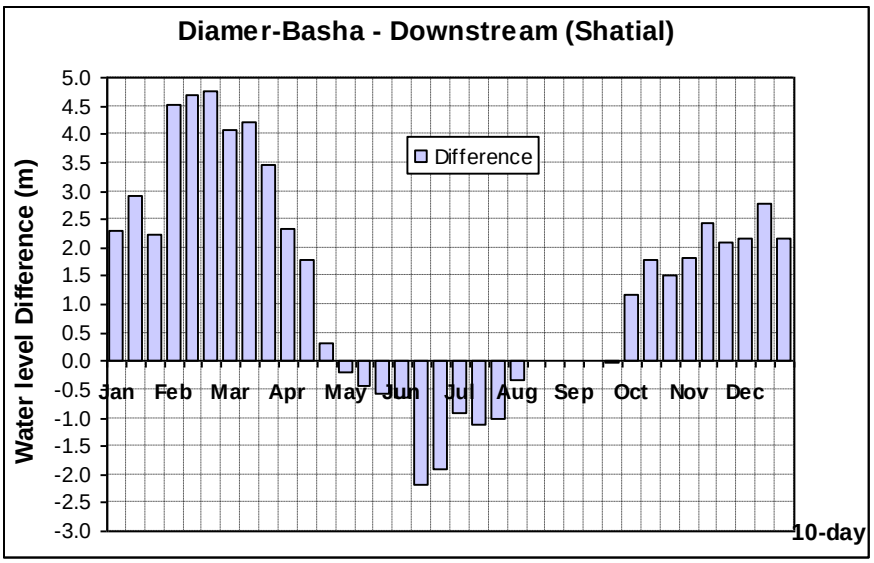
Months	Inflow	Outflow	Water level downstream (m asl)		
	Mean flow	Mean flow	Before	After	Difference
Jan	402.1	706.7	930.8	933.1	2.3
	386.2	794.2	930.7	933.6	2.9
	373.2	645.1	930.5	932.7	2.2
Feb	362.3	1,107.5	930.4	934.9	4.5
	356.1	1,136.3	930.3	935.0	4.7
	348.3	1,130.4	930.2	935.0	4.8
Mar	345.9	948.4	930.2	934.3	4.1
	344.8	974.6	930.2	934.4	4.2
	351.4	824.0	930.3	933.7	3.5
Apr	369.6	657.8	930.5	932.8	2.3
	438.3	681.5	931.2	933.0	1.8
	604.0	652.4	932.5	932.8	0.3
May	874.7	834.4	934.0	933.8	-0.2
	1,326.5	1,187.9	935.7	935.2	-0.4
	1,903.9	1,651.2	937.1	936.6	-0.6
Jun	2,899.3	2,479.4	938.9	938.2	-0.6
	3,972.2	2,323.7	940.1	937.9	-2.2
	5,069.4	3,165.5	941.1	939.2	-1.9
Jul	5,711.7	4,560.9	941.6	940.7	-0.9
	6,229.4	4,756.6	942.0	940.9	-1.1
	6,487.9	5,054.2	942.1	941.1	-1.0
Aug	6,611.3	6,069.5	942.2	941.9	-0.3
	5,887.2	5,882.2	941.7	941.7	0.0
	4,718.0	4,714.0	940.8	940.8	0.0
Sep	3,618.3	3,614.3	939.8	939.7	0.0
	2,530.2	2,526.2	938.3	938.3	0.0
	1,711.0	1,707.0	936.7	936.7	0.0
Oct	1,179.1	1,569.0	935.2	936.4	1.2
	918.3	1,430.1	934.2	936.0	1.8
	752.5	1,094.5	933.4	934.9	1.5
Nov	647.7	1,011.4	932.8	934.6	1.8
	575.1	1,052.5	932.3	934.7	2.5
	521.4	872.7	931.9	934.0	2.1
Dec	479.2	817.0	931.5	933.7	2.2
	446.7	888.9	931.3	934.0	2.8
	419.8	714.9	931.0	933.2	2.2
Mean	1,949.2	1,951.0	934.8	936.1	1.28
Max	6,611.3	6,069.5	942.2	941.9	4.77
Min	344.8	645.1	930.2	932.7	-2.19

Tarbela

Months	Outflow	Outflow	Water level downstream (m asl)		
10-days	Before	After	Before	After	Difference
Jan	742.1	928.4	337.6	337.8	0.19
	703.4	936.4	337.6	337.8	0.23
	645.3	1,115.0	337.5	338.0	0.47
Feb	573.9	1,340.7	337.5	338.2	0.77
	574.3	1,333.2	337.5	338.2	0.76
	591.6	1,352.5	337.5	338.3	0.76
Mar	573.1	1,169.6	337.5	338.1	0.60
	606.1	1,205.6	337.5	338.1	0.60
	666.5	1,098.7	337.6	338.0	0.43
Apr	669.2	971.2	337.6	337.9	0.30
	819.5	1,008.7	337.7	337.9	0.19
	1,029.0	1,011.3	337.9	337.9	-0.02
May	1,233.7	1,246.6	338.1	338.1	0.01
	1,537.4	1,563.5	338.4	338.5	0.03
	2,110.5	2,020.9	339.0	338.9	-0.09
Jun	2,795.8	2,711.3	339.7	339.6	-0.08
	3,658.3	3,163.3	340.4	340.1	-0.37
	4,542.4	3,542.6	340.6	340.4	-0.20
Jul	5,914.8	4,487.6	340.9	340.6	-0.29
	6,601.1	4,635.4	341.0	340.6	-0.39
	6,883.2	5,335.2	341.1	340.8	-0.31
Aug	7,460.7	6,315.1	341.2	341.0	-0.23
	6,930.5	6,263.9	341.1	341.0	-0.13
	5,643.6	5,425.3	340.8	340.8	-0.04
Sep	4,474.5	4,397.2	340.6	340.6	-0.02
	4,567.7	4,567.0	340.6	340.6	0.00
	4,400.8	4,398.1	340.6	340.6	0.00
Oct	2,645.5	2,892.0	339.5	339.8	0.25
	2,030.3	2,470.3	338.9	339.4	0.44
	1,464.4	1,837.7	338.4	338.7	0.37
Nov	1,303.4	1,673.9	338.2	338.6	0.37
	1,008.3	1,518.5	337.9	338.4	0.51
	791.0	1,201.5	337.7	338.1	0.41
Dec	755.5	1,130.7	337.7	338.0	0.38
	690.6	1,139.7	337.6	338.0	0.45
	746.7	1,039.7	337.6	337.9	0.29
Mean	2,455.1	2,456.9	338.9	339.0	0.18
Max	7,460.7	6,315.1	341.2	341.0	0.77
Min	573.1	928.4	337.5	337.8	-0.39

Source: DBC, 2007

Figure E-2 Water Level Differences at Downstream of Diamer Basha Dam



Source: DBC, June 2007

From the environmental point of view (irrigation water, navigation, supply of ecosystems such as riverine forests and wetlands, fish) the raised water level below Tarbela during regular operation is an improvement. This could contribute to ameliorate the environmental degradation, especially

below Kotri Barrage, caused by progressive abstractions of Indus River water between 1932 (Sukkur Barrage) and commissioning of Tarbela Dam in 1977. This will be in the form of contribution to the recommended year round release of 142 m^3/s as recommended in the 'Final Report of IPoE for Review of Studies on Water Escapages below Kotri Barrage'.

Overall impact of variation in Indus River discharges is shown below:-

Variation of Indus River Discharges

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	X Minor changes of downstream hydrological water regime with some reduction of release during summer but excess water during low flow periods			X Increase of Indus River storage capacity for improved irrigation and better flood regulation.

ii. Mitigation Measures

- It is envisaged that Indus River fluctuations during operation should not be severe threats to the immediate downstream area upto Tarbela with the start of reservoir operation, monitoring of downstream water level fluctuations will have to be carried out for timely assessment of any potential damages and relevant mitigation measures.

E.6.13 Downstream Channel Erosion and Sedimentation Due to Sediment Flushing

i. Assessment

An estimated 195.5 million tons of sediment will be annually flowing into the reservoir. Trapping of this sediment will significantly reduce the active storage of Diamer Basha reservoir over a period of 50-55 years. To release water for irrigation and re-mobilising of trapped sediments, outlet facilities being provided in Diamer Basha Dam are listed in Table E-10.

Table E-10 Outlet Facilities Being Provided and Their Sediment Related Functions

Outlet	Size (m)	Function
Spillway	14 Gates 11.5 x 16.24 m	Spilling of excess water
Power Intake Flushing Tunnel Right Bank	1 x 15.4 x 15.4 m D-Shaped	Removal of sediment deposited in front of power intakes
Power Intake Flushing Tunnel Right Bank	1 x 11 x 11 m D-Shaped	Removal of sediment deposited in front of power intakes
Reservoir Flushing Outlets	5 x 9 m diameter	Re-mobilising of sediments and flushing
Low Level Outlets	2 x 7.2 m diameter	Release of irrigation water

Source: DBC Design, 2007

Two different sediment flushing operations are envisaged. First one, the power intake flushing is directed towards re-mobilisation of sediments accumulated in front of the intakes to avoid excessive entry of sand into turbines. For this purpose, two separate intake flushing tunnels will be provided on each bank (refer Table E-10). Against power intake level of 1,045.3 masl, the flushing tunnels will have an invert level of 990 m directly below the power intakes. The outflow of both tunnels will run into the river directly below the dam. Design discharge of these tunnels between elevations 1,060 masl and 1,160 masl will be:

- Left bank tunnel: between 435 and 637 m³/s
- Right bank tunnel: between 891 and 1,272 m³/s.

Flushing tunnel operation will cause formation of a crater above its intake so that space could be created for almost sediment free water into the power intake. Periodic, non-frequent operation of the flushing tunnels may be required after some 15 to 25 years of project commissioning.

The second type of operation, called hydraulic flushing, is expected to be carried out after 45-50 years of reservoir operation or earlier, depending on the actual rate of sedimentation. This flushing will aim at remobilizing and flushing through the reservoir of sediments deposited in the lake behind the dam. For effectiveness, this flushing will need to be carried through at least 40 m pulling down of reservoir below MOL of 1060 m. It will be accomplished through five flushing outlets with a total capacity of 5,461 m³/s at the minimum operating level (MOL) of 1,060 masl. This flushing operation will last for 2-3 months during high flow months with closed power houses.

Large amount of water with the eroded sediments would flow downstream. However, these sediments will predominantly fill the erosion of the river bed caused after initial reservoir operation. Modelling of this sediment routing by DBC does not indicate any damages downstream due to the situation that villages and other exploitations are quite distant from the river bank as shown below:-

Downstream Impact of Sediment Flushing

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
		X Flushing procedures causing erosion and remobilization of sediment from the reservoir will not cause any significant damage downstream but would require to be monitored carefully; conversely the sediment, flushed down the river channel below the dam could reverse the bed retrogression cause by initial reservoir operation.		

ii. Mitigation Measures

Mitigation measures shall have to focus on informing the local population prior to the start of sediment flushing, particularly to remobilize the accumulation in reservoir. However, even the initial activity in this regard is not expected till around 20 years after commissioning of Diamer Basha Dam. Notwithstanding this, WAPDA will be required to introduce regular monitoring of the sediment flushing operations, as and when started.

E.6.14 Extended Lifetime of Tarbela Reservoir Due to Reduced Sedimentation

i. Assessment

Sedimentation pattern in Tarbela reservoir would be significantly changed due to retention of coarse grained (sand fraction predominantly) sediments in the upstream Diamer Basha reservoir. This would substantially reduce the rate of sedimentation in Tarbela. In addition, it is also being planned to build Dasu Dam between Diamer Basha and Tarbela, which may further reduce sedimentation of Tarbela.

It has been estimated that with Diamer Basha alone, sedimentation in Tarbela reservoir over 50 year (2017-2067) period will be reduced by about 50 %. Thus, the expected economic lifetime of Tarbela will be significantly increased by at least 35 years leading to significant environmental enhancement as shown below:-

Reduced Sedimentation of Tarbela Reservoir

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Extension of useful life of Tarbela Dam by about 35 years

ii. Mitigation Measures

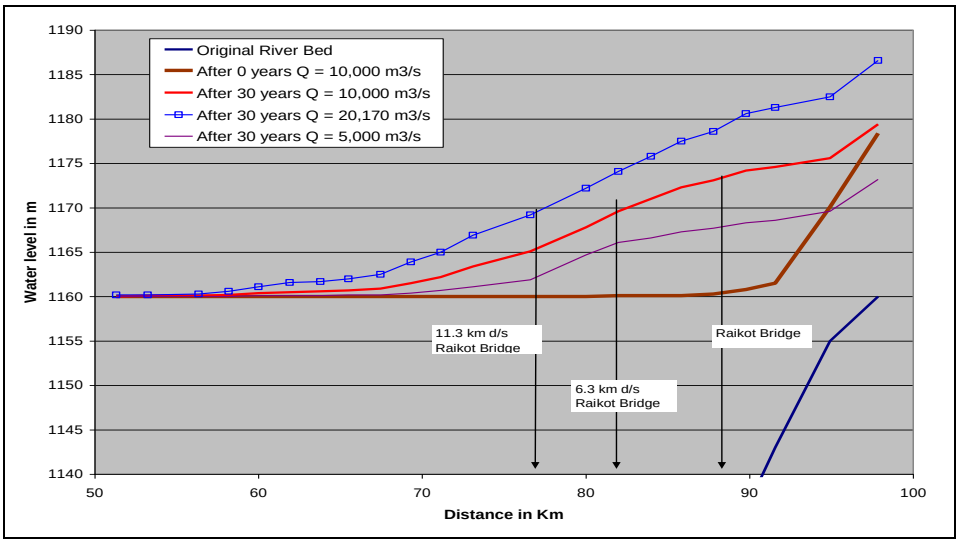
Mitigation measures are not required.

E.6.15 Rise of Water Levels Due to Sedimentation in Reservoir

i. Assessment

Modelling of the sedimentation reveals a rise of the water level in the upper section of reservoir after 30 years (see Figure E-3). It also shows that villages of Batsuri and Draing, in the upper reservoir, may not be affected initially but may be impacted due to sedimentation after about 30 years of operation.

Figure E-3 Reservoir Water Levels after 30 Years of Reservoir Sedimentation



Source: Report on Reservoir Operation and Sediment Transport, DBC, November 2007.

ii. Mitigation Measures

This phenomenon, however, will take some time to materialise as well as its actual prediction is indicative. However, it should not be forgotten over the years. Draing for example, at elevation of 1,180 masl is far above the reservoir FRL of 1,160 masl. In the long run it might be affected (refer Figure E-3) and require monitoring and implementation of some appropriate remedial measures as indicated below:-

Rise of Water Levels Due to Sedimentation in Reservoir

Significant adverse Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
		X Appropriate monitoring; mitigation measures might be needed after 30 years of operation		

E.6.16 Change of Indus River Into Diamer Basha Reservoir

i. Assessment

Change of Indus River into a reservoir with characteristic features of stagnation period due to impoundment would be an irreversible impact with severe environmental impacts. This will be through establishment of a permanent lake though with a seasonal fluctuation of about 100 m.

During summer, the lake level will rise up to 1,160 masl though storage of water with temperature of 12-14° C. At the same time, water will be continuously released for generation of power as well as meeting downstream irrigation requirements. This process will build a lake-like water body with the following hydrological characteristics:

- Creation of a large surface water area
- Warming up of upper water layer by sun radiation during April through September
- Large reduction of flow velocity
- Sinking of cold water to the reservoir floor
- Trapping of coarser sediments (sand) in the upper reservoir area

During May-August, the air temperature over the reservoir surface will be between 30 and 40° C. The relatively dark surface of the water will absorb sun radiation changing short-wave light into long-wave light and energy set free inducing warming up of the upper water layers. This will develop an epilimnion water layer slowly with a depth of few centimetres and a large extent. There is the assumption that during summer months the thermo-cline will divide the lake water column into two layers of thick cold water at the bottom (hypolimnion) and the warmer upper layer (epilimnion).

Yusufeli Reservoir with a 220 m high dam (presently under construction) in eastern intra-mountainous Turkey plateaus has climatic and geomorphologic conditions similar to Diamer Basha. Its numerical modelling revealed seasonal formation of a thermo-cline zone with the following characteristics:

- Winter months of 2 to 4 °C: 5° C at the bottom, 9° C at surface.
- Summer months up to 19° C: 5° C at the bottom and 24° C at surface.

Various investigated scenarios resulted in estimation of duration and thickness of thermo-cline in Yusufeli Reservoir. Under certain conditions the thermo-cline persists all over the year, with thickness varying between 20 and 70 m. The warmer upper layer would be of course prone to eutrophication. However, the conditions in the Indus River at Diamer Basha Dam are quite different because of:

- Perennial downstream release of water for agricultural needs (irrigation)
- Permanent inflow of cold water even during summer

- Some mixing of water at the confluences of nullahs
- Significantly low nutrition.

There are some peculiar conditions of the reservoir which do not favour thermal stagnation of water horizons. Diamer Basha reservoir water body is dominated by the following principal behaviours, which do not enable thermal stratification and formation of a warm epilimnion layer:

- High inflow varying between 1,000-6,000 m^3/s
- Significant downstream release of water even at the time of minimum irrigation demand
- Insignificant storage capacity of reservoir as compared to the annual river inflow (about 12.7%)

During winter period the average of inflow is about 500 m^3/s. During winter and early spring, when the water is being released for hydropower generation up to MOL of 1,060 masl, dominant climatic conditions will cause the upper water layer to cool down. When the vertical water temperature is balancing, no stagnation also will occur.

Originally, the change of the Indus River from torrential river course towards a lake-like reservoir is a significant, irreversible threat to the physical environment. However, due to the available bio-physical conditions in the cold water lake, with dominant mixing tendency and absence of stratification of water body of the reservoir the consequences for water biology and also methane gas generation will not be relevant as shown below:

Change of Indus River Into Diamer Basha Reservoir

Significant adverse impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Significant change of river section from torrential turbulent to lake-like water body; however without severe biological and climatic consequences.	

ii. Mitigation Measures

Mitigation measures against stagnation of reservoir water are not required due to the high throughput during summer periods, in which no stagnation might occur.

E.7 Impacts on Biological Environment and Mitigation Measures During Operation

E.7.1 Loss of Important Plants Due to Submergence in Reservoir

There are no important plants and plant communities in the area of potential reservoir submergence. Due to various reasons, mostly because of the high pressure on the rangeland by the local domestic animals, no nature conservation aspect can be taken into account. No endemic and rare plant species or plant communities were recorded during investigations by DBC. In addition, the dry steppe vegetation is already severely degraded due to over exploitation and pressure by the local population. The risk that, due to submergence large areas under rangeland may be affected, will be discussed under Impacts on Socio-economic Environment.

Because of the annual winter drawdown, the reservoir will not allow developing an extensive ecologically productive margin in a riverine or littoral zone. Thus, no perennial plant cover will be developed. Conditions will be similar to those at Tarbela, where the exposed mud, gravel and rock

in the extensive drawdown zone is sparsely colonised by some grasses. In general, the loss of important plants due to submergence of the reservoir will be insignificant as shown below:

Loss of Important Plants Due to Submergence

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Existing natural plant communities are already severely degraded by local population	

i. Mitigation Measures

Mitigation Measures are not required due to the very low existing diversity and significance of the natural plants in the potential impoundment area of Diamer Basha reservoir.

E.7.2 Degradation of Ecosystem and Wildlife Downstream of Tarbela Dam

i. Assessment

Hydrology of Indus River is dominated by very large seasonal fluctuations. Historically, hydrology of Indus River system was dominated by very large variations between summer and winter flows. Harnessing of these flows, particularly started with construction of Sukkur Barrage in 1932. Progressive construction of further barrages and dams till full commissioning of Tarbela in 1977 substantially reduced high flow period spills of surplus water. Most important negative impact of this process has been reduced annual inundation of the downstream riverine forests and wetlands in lower Indus River reaches including Delta. The aquatic and semi-aquatic ecosystems along middle and lower reaches of Indus River also changed significantly, leading to their degradation.

The establishment of Diamer Basha dam and reservoir should be used as opportunity to mitigate some previous negative influence on the ecosystems downstream of Tarbela Dam. Presently, the simulated mode for conjunctive operation for Diamer Basha and Tarbela reservoirs envisages:

- Increased overall storage capacity of the Indus River (Tarbela and Diamer Basha)
- Reduced water release during summer
  - Below Diamer Basha: May-August up to 2.2 m
  - Below Tarbela: April-August up to 0.39 m
- Increased water release during winter (Both Diamer Basha and Tarbela)

A very conservative assumption could be that even a few centimetres reduction in water levels during summer months would impede plant development and breeding on the Indus River below Tarbela. Under that scenario, there would be a negative impact on the ecosystems including mangroves, other riverine forests and the unique wildlife including migratory birds, blind dolphins, Palla and Dhangri fish, turtles and other aquatic and semi-aquatic animals. On the other hand, the situation could be alleviated through release of stored water from Diamer Basha reservoir for meeting the downstream ecological requirements as shown below:-

Downstream Degradation

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	X Under a very conservative scenario, there could be adverse impact on the downstream ecosystems due to changed operation mode for Tarbela with some reduction in the summer flows; on the other hand, storage releases from Diamer Basha could alleviate the downstream conditions through prescribed releases for ecological needs			

ii. Mitigation Measures

The existing situation has been caused by progressively increased upstream river diversions starting from 1932 (Sukkur Barrage). To alleviate this condition, storage releases from Diamer Basha could be prescribed by IRSA, in accordance with the recommendations of 'Final Report of IPoE For Review of Study on Water Escapages Below Kotri Barrage' of November 2005. IRSA, the national body for regulation of river water, could liase with the concerned institutions of Pakistan (Sindh Wildlife Department, Sindh Forest Department). International organisations like IUCN and WWF could also be consulted for development of the long term national policy for sustainable use of Indus River water.

The operating outfits of WAPDA will also have to develop the operation criteria, especially for the summer months April to August, to minimise the drop in water level in the Indus River downstream of Tarbela.

E.7.3 Blocking Cross-river Migration of Terrestrial Wildlife

i. Assessment

Indus River from natural point of view is a severe barrier for terrestrial wildlife except birds. No mammal is able to cross the turbulent and fast running water. There is the assumption, that during night time some wildlife possibly would use the existing suspension bridges.

After implementation of Diamer Basha Dam Project with the establishment of a more than 100 km long and 1-2 km wide reservoir the barrier effect would grow. However, due to the absence of wildlife, as outlined in the Baseline Chapter D, cross-river blocking would be an in-significant environmental concern as indicated below:-

Blocking Cross-river Migration of Terrestrial Wildlife

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X There is no wildlife which would be hindered in cross-river migration.	

ii. Mitigation Measures

Mitigation measures are not required due to absence of cross-river migrating wildlife (except birds).

E.7.4 Loss of Insects Due to Submergence

i. Assessment

There are no significant impacts on insects due to the absence of endemic and rare species. Although the submergence of reservoir would damage relevant insect habitats, such as *cultivated land* (highest diversity of insects) and the *sandy flat areas covered by stones* (where also a relative diver insects fauna had been recorded), it may be considered that the insect fauna would move to other similar habitats (also refer to Appendix D in Volume III).

The resettlement concept based upon an early relocation of affected people and the immediate establishment of Model Villages would offer to insects excellent conditions at new locations. Thus, there is no significant threat to insects due to submergence of the reservoir area as shown below:-

Damage to Insects

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Insect fauna is not significant, which is why no severe impacts occur.	

ii. Mitigation Measures

Mitigation measures for protecting valuable insect fauna are not required.

E.7.5 Loss of Amphibians and Reptiles Due to Submergence

i. Assessment

With the submergence of lower valley up to 1,160 masl, particularly after the first impoundment up to the FRL of 1,160 masl, there could be a significant impact on amphibians and reptiles due to loss of habitats as indicated below (also refer to Appendix E in Volume III):-

- Amphibians: Inundation of the lower sections of nullahs, mostly covered by small alluvial plains often closely located to settlements, would affect negatively the amphibians.
- Reptiles: Submergence of rock and grass areas could adversely affect agama and gecko species, also loss of villages with densely populated reptile habitat would be another adverse impact.

In general, there is the risk that hibernating amphibians and reptiles will be killed if the impoundment is carried out during November to March, which is very unlikely.

Submergence of the reservoir during the summer period of April to October would potentially reduce casualties giving species and individuals the chance to move to other habitats. However, there could be some concerns such as:

- Other habitats should be available (which sometimes due to steep rock cliffs might not be the case)

- Rising rate should not exceed 1 m per day (equivalent to 100 m water level rise during three months, which is in accordance to general biological information that reptiles are not physically harmed with an average rise 1 m water level per day)
- Adult amphibians may be able to swim away, but their spawn might be damaged
- Though adult reptiles would be able to escape to other higher locations (if available), the eggs would be lost.

In summary, amphibians and reptiles might have some potential to adapt to the changing water conditions. However, there is the apprehension that many individuals of reptile species might not able to survive. The living conditions of the most important species would not be affected adversely as there would be enough habitat area for survival of the species above the reservoir level as shown below:-

Damage to Amphibians and Reptiles

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	X There could be significant loss of amphibian and reptile habitats and individuals during impoundment but it could be avoided by limiting the reservoir level rise to 1 m per day			

ii. Mitigation Measures

WAPDA, in close cooperation with Pakistan Museum of Natural History and help of other national and international nature conservation institutions (such as IUCN and WFF) may have to endeavour that:-

- Normal reservoir impoundment will not exceed 1 m per day
- Filling period will not commence earlier than April, better May, and not go beyond September
- Make arrangements for monitoring of amphibians and reptiles before impoundment and regularly over the operation period
- Prepare / implement a removal programme for selected most important reptile species and habitats if warranted by monitoring preferably through a special NGO.

E.7.6 Improvement of Habitats for Amphibians and Reptiles at Littoral Zone

i. Assessment

In future, the reservoir will play a positive role in increasing the number of insects. This might also become positive factor for amphibians and reptiles as the food basis might be improved due to the large reservoir shore line, the warmer water and the littoral zone.

Improvements of Habitats of Amphibians and Reptiles

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Increased insect fauna will support the future food chain of amphibians and reptiles.

ii. Mitigation Measures

Mitigation measures are not required, however monitoring of the new habitat conditions would be necessary.

E.7.7 Loss of Birds Due to Submergence of Their Habitats

i. Assessment

Birds would be affected when either nests are submerged or the habitat area disturbed. In particular, submerging the cultivated land and settlements would adversely affect the bird population, predominantly the residents. However, there is the assumption that new bird habitats will be established in and around the Model Villages. The resettlement approach is based upon the establishment of those new settlements including surrounding areas of cultivated land, earlier than inundation of the existing habitations. Therefore, for a certain period, this would offer even more land and habitats for birds. With submergence of present villages and the adjacent cultivated areas, the birds may move towards these new Model Village areas or suitable locations in the side valleys.

However, apart from this habitat issue there would be an adverse affect on nesting conditions, when the first impoundment to FRL could damage clutches of eggs on land and trees, particularly during the months of May through July as shown below:-

Damage to Birds

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	X Single stage initial impounding between MOL and FRL could submerge bird nests; however, its proposed further filling in to two stages would prevent significant damage to bird fauna through loss of eggs			

ii. Mitigation Measures

WAPDA, in close cooperation with the Pakistan Museum of Natural History and other national and international nature conservation institutions (such as IUCN and WFF) may have to evolve:

- An initial impoundment schedule to FRL with due account for protection of most important birds
- Make arrangements for monitoring of impoundment for protection to birds.

E.7.8 Improvement of Bird Habitats in Large Reservoir

i. Assessment

Reservoir impoundment would have potentially positive effects on the bird fauna. The large water body with some organic nutrition, increased number of fish, littoral zone development would support strengthening of the Indus River valley relevance as specific area of waterfowl. Especially for the migrating water birds the Indus River might assume more importance as resting or even nesting area as shown below:-

Improvement of Bird Habitats

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Large water body would potentially improve the relevance as resting / nesting area for migrating water birds.

ii. Mitigation measures

Mitigation measures are not necessary. However, WAPDA might have to monitor, through cooperation of the concerned live agencies, future bird fauna development.

E.7.9 Disturbance and Hunting of Wildlife in Area Along Right Bank Periphery Road

i. Assessment

Hunting in the future reservoir area is not very much relevant due to the following two reasons:

- Absence of mammals, which is why water fowl, especially wild duck and goose are relevant
- Restricted accessibility of areas between Khanbari and Hodar Nullah, Hodar and Kiner Nullah, Kiner Nullah and Ges Pain and Ges Bala to Shing and Draing.

Currently, the local population on both river banks is quite distant from potential locations of wildlife. However, construction of the new right Bank Periphery Road will improve the accessibility of wildlife potential areas on that bank.

This new road and also the Relocated Karakorum Highway on the left bank could theoretically support hunting activities of the local population. However, there are no indications of any significant wildlife in this area and the only possible hunting could be of waterfowls such as ducks and goose as shown below:-

Hunting of Wildlife

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X No or only minor appearance of bird hunting (such as waterfowl)	

ii. Mitigation Measures

WAPDA, through cooperation of he Wild Life Department might have to monitor any hunting by the local population and the employees of various institutions involved in operation of the reservoir.

E.7.10 Improvement of Natural Conditions for Migrating Birds

i. Assessment

Presently, in the Indus River valley including nullahs, there are some winter resting migrants, mostly ducks. However, the number of these birds is insignificant, as observed during November 2006 investigation by DBC. This is caused by the following conditions:

- Very torrential and frequently course changing (bed and shoreline) river.
- Lack of riverine (littoral) zone with distinct spatial sequence of aquatic (benthos, plankton, fish) and semi-aquatic plants (reed) and animals such as amphibians.
- Low fish stock of Indus River.

Considering the changes of hydrological conditions after reservoir impounding, there will be two main factors favouring appearance of waterfowl migratory birds. The first one (favourable) will be establishment of new habitat conditions through:

- Large deep water area of the reservoir.
- Long shallow water areas along the shoreline.

It can be assumed that this would enhance the conditions, both for residents and migratory birds. Especially, in the large reservoir waterfowl would find excellent conditions from the point of view of water area.

It is envisaged that future conditions may not favour creation of adequate food basis for birds, particularly big water fowl species such as black necked stork, crane, swan, goose, and duck. These conditions are normally found in littoral zones of freshwater bodies. However, as described already, a littoral zone along the present Indus River is missing. In addition, there is the assumption that future conditions, under which a littoral zone can develop will not be available (A littoral zone in Tarbela reservoir does not exist). For breeding, the reservoir shoreline would not offer suitable conditions. For feeding, only fish would be available, provided its population is increased through feeding. Thus, there is the general assessment that reservoir would only offer limited conditions for an enhanced waterfowl population as indicated below:-

Improvement of Natural Conditions for Migrating Birds

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Enlargement of water body would offer some new bird habitats basically resting for migratory birds

ii. Mitigation

No particular mitigation measures will be required.

E.7.11 Eutrophication of Reservoir Water Body

i. Assessment

As outlined above, even the change of the Indus River from a turbulent river to lake-like water body would not favour development of a stagnating lake potentially tending towards eutrophication. The most important physical condition against stagnation and eutrophication would be the high throughput of water (62 to 90 %) in the reservoir during June to September.

The other important condition would be very low level of plankton and fish biomass. Currently, benthos is only found in the nullahs. Under the condition that the discharge of wastewater (sewage mainly) will be avoided in the future there is no risk for eutrophication of the reservoir. However, there could be a potential risk, with introduction of high fish biomass from hatcheries into the water. The remains of some vegetation (fodder) may pollute the water at reservoir bottom. In addition, detritus of huge number of introduced fish may increase eutrophication to some extent.

Clearance of all vegetation from the reservoir bottom before impounding is important. This also includes clearance of the reservoir floor from any organic material, which might cause a negative change of the hydrological and chemical state of the water through increased phosphate, nitrogen content in the water from rotting processes (timber, grass or other biologic matter). This could cause a reduction of oxygen status of the water and support some eutrophication. In general, the threats to eutrophication of reservoir water body are insignificant as shown below:-

Eutrophication of Reservoir Water Body

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Very little risk for eutrophication despite establishment of stratified reservoir	

ii. Mitigation Measures

It will be important to ensure a continuous flow of the minimum operational release, which in the case of low inflow would be invariably higher than inflow. Furthermore, WAPDA might occasionally monitor eutrophication parameters, e.g. water temperature vertical gradients, water quality, biological status and biomass.

E.7.12 Degradation of Fish Stocks Due to Blockage of Migration

i. Assessment

Construction of Diamer Basha dam will block any downstream and upstream passage of fish. However, degradation of the fish stocks due to the following conditions is not to be expected:

- Very low diversity of natural fish stock
- Important or endangered fish species are missing
- Long-distance migration of fish almost non-existent due to specific ecological demands of fish.

Only some fish species adapted to various conditions may migrate across certain fish-zoological boundaries, where especially water temperature, nutrition (benthos, plankton and other fish) and spawning grounds determine the spectrum of fish species. *Schizothorax* in the Indus River is known to be adapted to more moderate water temperature up to 800 masl. However this fish species is not endemic, but introduced since long time in the Indus River.

As referred earlier (Chapter D Baseline) there is the assumption that the characteristic north-Pakistan coldwater fish population, bound in the fish-zoological Palaearctic region between 1,200 and 2,000 masl, is not affected significantly. Passage of fish below 1,200 masl up to Dasu (almost 900 m) only during colder periods in winter could be expected. Considering ecological demand of this fish, primarily their adaptation to specific low water temperature, it can be assumed that this fish stock will be concentrated mainly in the upper Indus River sections of Gilgit (1,550 masl), Bunji (1,350 masl), and Chilas (1,100 masl).

Some minor changes of thermal and nutrition regime during summer and at the upper water layer and shoreline may be anticipated. However, the general fish conditions of this upper Palaearctic zone as oligotrophic water body would not be changed. In general, it is anticipated that the potential blockage by the dam at 950 masl elevation would have only minor impact on the coldwater fish population as shown below:-

Degradation of Fish Stocks Due to Blockage of Migration

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Low significance of natural fish stock and preference of cold-water fish only in the upper river courses of above 1,200 masl.	

ii. Mitigation Measures

Mitigation measures are not required due to in-significance of natural fish stocks in the relevant Indus River sections.

E.7.13 Change of Coldwater Fish Spectrum

i. Assessment

Presently, the highest mean water temperature is between 12° and 14° C in July-August. Even under the high inflow (1,000-6,000 m^3/s) to the reservoir during summer months, the thermal regime of the water body will not be changed significantly.

There is the assumption that during summer months the upper water surface (possibly a thin layer of some decimetres) under the condition of no or only little wind drift (which might cause some vertical turbulence and mixing of water) will be warmed up to 16-18, even up to 20° C. However, due to the very high throughput of the reservoir, and consequently thermal regime during entire year, the coldwater fish spectrum would not be changed. In winter, due to the withdrawal of energy to the atmosphere, the water temperature in the water body would be equalised. The energy regime of the upper water layer will be quickly reached during October-November and there would be distinct vertical temperature gradient, which allows a mixing of both water layers.

Thus, coldwater fish would find quite similar conditions during winter in the reservoir compared to the present situation. Potential consequences would be that during summer, coldwater fish species might move upstream in the Indus River above Raikot Bridge or the nullahs. In particular, the higher summer temperature of the upper reservoir layer would encourage fish species, which are adapted to a higher water temperature. These could include:

- Rainbow trout (*Salmo trutta*)
- Common Carp (Cyprinus carpio)

- Silver carp (Hypophtalmichthys molitrix)
- Salmon Gardnieri (Aristicthuhus nobilis Rhich).

In summary, there would be minor adverse impact on Indus River coldwater fish spectrum as shown below:-

Change of Coldwater Fish Spectrum

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Minor changes of coldwater fish spectrum	

ii. Mitigation Measures

Mitigation measures are not required. However, WAPDA might have to monitor water state parameters and carry out regular inventory of fish species in order to assess potential changes of the environmental situation ad natural fish stocks. This may be part of the 'Reservoir Fishery Management Plan'.

E.7.14 Degradation of Fish Spawning Areas in Lower Nullahs Due to Impoundment

i. Assessment

Loss of habitats is one of the most adverse impacts in reservoirs, as Larinier (2000) highlighted (on the basis of investigations on Kotri Barrage, also named as Ghulam Mahammed Barrage. Accordingly, sixty (60) percent of one fish species had been degraded due to threats to spawning conditions.

As described under the preceding Baseline Chapter D, the only spawning areas for fish stocks are located in the lower parts of the adjoining nullahs, where slightly higher water temperature, lower velocity, and turbulence are suitable for spawning. These areas will be totally inundated and become part of the reservoir floor, which potentially will result in significant adverse impact of destroying the spawning grounds of the fish stocks in the project area as shown below:-

Degradation of Fish Spawning Areas

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Loss of spawning areas due to submergence of lower nullah sections In the reservoir				

ii. Mitigation Measures

Mitigation measures will involve increasing breeding measures in the re-established fish hatcheries in the upper parts of related nullahs in the reservoir margin.

E.7.15 Improvement of Fish Spawning Areas

i. Assessment

With the creation of a very large reservoir, conditions would become conducive to development of new spawning are because:

- Shallow water areas would be created along the shoreline, where velocity and turbulence would be reduced significantly. Additionally, during stagnation periods of the reservoir level the water temperature would be raised improving spawning conditions.
- Fish species would use the nullah sections above the reservoir.

However, there is the apprehension that any spawn laid during May-June (though unlikely) would be washed away during the following reservoir filling. In general, there will be significant environmental enhancement as shown below:-

Development of New Fish Spawning Areas

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Development of new spawning areas along the reservoir shore line and fringes in side nullahs due to less turbulent and more temperate water.

ii. Mitigation Measures

Mitigation measures may have to focus on researching the most important species including enhanced facilities for breeding. The emphasis would be on:-

- Development of new spawning (even extended) areas in the reservoir
- Breeding of most endangered species in new hatcheries.

E.7.16 Damage of Fish at Dam Facilities

i. Assessment

Fish passing through hydraulic turbines and other low level outlets would be subjected to various forms of stress and mortality. This could be caused through:

- Probability of shocks from moving or stationary parts of the turbines (guide vanes, vanes or blades on the wheel)
- Sudden acceleration or deceleration
- Very sudden variations in pressure and cavitation
- Dropping through a very large height along with the water columns.

Fish investigations reveal large variations in mortality rate from under 5 % to over 90 %, depending upon type of turbines, operational head, species and size of the fish. High mortality rates of fish occur in Francis turbines, which would be installed in Diamer Basha dam. Thus, it is assessed that there would be a significant adverse impact on fish, requiring certain mitigation measures, although the possibility is quite remote (refer table below).

It has been observed at Tarbela that after the initial years of operation, the fish have become 'wise' to keep away from the water passing through the turbines and other low level outlets.

Damage of Fish at Dam Facilities

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Damage to facility for safe passage through various dam outlets	X Experience at Tarbela shows that over time the fish have become 'wise' to keep away from the water passing through turbines and other low level works			

ii. Mitigation Measures

Mitigation measures, if possible, might have to be developed through special protective screens / racks in front of the outlets. In all probability, as experienced at Tarbela, over time the fish may become 'wise' to keep away from the water passing through the hazardous low level outlets particularly the turbines.

E.7.17 Increased Exposure of Fish to Predation and Fishing

i. Assessment

There is the experience (see WCD, Dams and Fish Migration, 2000) that predation near dam installations has increased. Predators are either fish or birds. In addition, there is the likelihood that also the population, particularly young people, will catch the fish from those accessible locations at both shorelines close to the dam.

In general, these impacts would not cause a severe loss of fish as shown below due to the situation that water birds are currently, and much likely also in future, not available in big numbers.

Increased Exposure of Fish to Predation

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Predation exposure to fish and birds insignificant due to low number	

ii. Mitigation Measures

No specific mitigation measures may by required except monitoring of predation of fish by local people and also birds close to the dam crest.

E.8 Impacts on Socio-economic Environment and Mitigation Measures During Operation

E.8.1 Damage to Settlements, Houses and Population

i. Assessment

The most adverse impact will be submergence of 31 settlements with 3,037 houses and dislocation of home for 28,650 people (see also Map-4). Table E-11 summarizes the potential damages of reservoir impoundment to various villages including households and population.

Table E-11: Submergence Related Impacts on Upstream Villages

Name of Village	Village ID [a)]	Inundation by Reservoir		Number of Households	Number of Population
		Totally	Partially		
I. Right Bank					
Nima	R01	X		134	1,165
Narar	R02	X		72	470
Sine Huch	R03	X		209	537
Nusry Das	R04	X		37	156
Dalojil	R05	X		60	420
Segali Hit	R06	X		20	141
Balokish	R07	X		45	435
Thalpan	R08	X		189	1,020
Lower Thak	R09		X	34	214
Ges Pain	R10	X		225	1,648
Ges Bala	R11		X	92	833
Lower Shing	R12		X	5	33
Total Right Bank	**12**	**9**	**3**	**1,122**	**7,072**
II. Left Bank					
Lower Minar	L01	X		5	35
Sine Huch	L02	X		48	313
Thor Das	L03	X		161	881
Khotobat	L04	X		40	259
Bazakal	L05	X		19	128
Muruski	L06	X		15	86
Thurli Das	L07	X		28	198
Chikka	L08	X		45	274
Ghichi Village	L09	X		2	20
Chilas	L10		X	1,866	15,251
Lower Thak	L11	X		9	60
Lower Gini Village	L12	X		29	120
Yashokal Hit (Goldwasher houses)	L13	X		20	210
Lower Bunar Das	L14		X	435	2,108
Soniwal Hit	L15	X		69	382
Lower Gonar Farm	L16		X	101	628
Mani Pain	L17		X	44	232

Name of Village	Village ID a)	Inundation by Reservoir		Number of Households	Number of Population
		Totally	Partially		
Gandlo Village	L18	X		17	155
Jalipur Village	L19	X		60	238
Total Left Bank	**19**	**15**	**4**	**3,013**	**21,578**
Grand Total	**31**	**24**	**7**	**4,135**	**28,650**

Source: Cadastral Survey, 2007-08

a) As shown in Map-4

A sizeable number of private houses in 31 affected villages will be also lost as summarized in Table E-12:

Table E-12: Number of Private Houses Lost in the Reservoir on Right and Left Banks

Name of Village	Village ID a)	Lost Houses (No.)					
		Class A-1	Class A-2	Class A-3	Class B	Class C	Total
		(Cement Masonry With Concrete Roofs)	(Cement Masonry With T-iron Tiled Roofs)	(Cement Masonry With Wooden Roof)	(Mud Masonry With Wooden Roof)	(Mud Masonry With Thatched Roof)	
I. Right Bank							
Nima	R01	-	-	-	25	71	96
Narar	R02	-	-	-	8	37	45
Sine Huch	R03	-	-	-	92	67	159
Nusry Das	R04	-	-	-	16	14	30
Dalojil	R05	-	-	-	23	27	50
Segali Hit	R06	-	-	-	3	12	15
Balokish	R07	-	-	-	8	22	30
Thalpan	R08	-	-	1	42	107	150
Lower Thak	R09	-	-	1	12	17	30
Ges Pain	R10	-	-	2	72	101	175
Ges Bala	R11	-	-	1	35	24	60
Lower Shing	R12	-	-	-	3	2	5
Total Right Bank		**-**	**-**	**5**	**339**	**501**	**845**
II. Left Bank							
Lower Minar	L01	-	-	-	1	1	2
Sine Huch	L02	-	-	-	15	23	38
Thor Das	L03	-	-	3	30	77	110
Khotobat	L04	-	-	1	10	19	30
Bazakal	L05	-	-	-	5	10	15
Muruski	L06	-	-	-	5	7	12
Thurli Das	L07	-	-	-	9	19	28
Chikka	L08	-	-	-	4	31	35
Ghichi Village	L09	-	-	-	0	2	2
Chilas	L10	10	35	325	676	320	1,366
Lower Thak	L11	-	-	-	7	2	9
Lower Gini Village	L12	-	-	1	5	9	15

Name of Village	Village ID a)	Lost Houses (No.)					
		Class A-1 (Cement Masonry With Concrete Roofs)	Class A-2 (Cement Masonry With T-iron Tiled Roofs)	Class A-3 (Cement Masonry With Wooden Roof)	Class B (Mud Masonry With Wooden Roof)	Class C (Mud Masonry With Thatched Roof)	Total
Yashokal Hit (Goldwasher houses)	L13	-	-	-	0	20	20
Lower Bunar Das	L14	-	-	7	145	183	335
Soniwal Hit	L15	-	-	-	22	18	40
Lower Gonar Farm	L16	-	-	5	35	20	60
Mani Pain	L17	-	-	-	9	16	25
Gandlo Village	L18	-	-	1	6	3	10
Jalipur Village	L19	-	-	-	15	25	40
Total Left Bank		**10**	**35**	**343**	**999**	**805**	**2,192**
III. Grand Total		**10**	**35**	**348**	**1,338**	**1,306**	**3,037**

Source: Cadastral Survey 2007-08
a) As shown in Map 4

Thus, the impact on settlements, houses and population will be highly significant as shown below:-

Threats to Settlements, Houses and Population

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Settlements, houses and population are affected directly due to reservoir related land acquisition upto 1170 masl				

ii. Mitigation Measures

No at site mitigation will be possible. However, the entire livelihood of affected population including settlements, houses and population will have to be restored. These measures form the part of companion document of 'Resettlement Plan'.

E.8.2 Damage to Cultivation

i. Assessment

Reservoir submergence extending over 95 km length and width of 1-2 km will cause the loss of cultivated area. Mainly these areas will be located within the traditional land covered by settlements. Loss of private cultivated land including the impact per household, is shown in Table E-13.

Table E-13 Loss of Cultivated Land

Location	Loss of Cultivated Land		Number of Households	Loss Per Household (Kanals)
	Ha	Number of Kanals [b)]		
Left Bank	672.2 [a)]	13,283	3,013	4.41
Right Bank	465.4	9,196	1,122	8.72
Total	**1,137.6**	**22,479**	**4,135**	**5.44**

Source: Cadastral Survey, 2007-2008

a) Including 151 acres[8] for the Project Colony in Thor Valley outside the land acquisition zone of 1,170 masl.

b) one kanal equivalent to 501 m²

This was originally barren land and developed over centuries by the local population. Very peculiar natural situation with semi-arid climate (below 200 mm average annual precipitation) and the lack of fine material for soil development in the Karakoram Valley, required the farmers to put in a lot of effort to convert it into cultivable land.

Cultivated land is only located in the lower parts of nullahs, where the water is diverted through a dense network of channels. Cultivated land along the Indus River does not appear for the reasons of:

- High seasonal fluctuation of the Indus River
- Extreme scarcity of electricity, which inhibits pumping of Indus River water for cultivation

Soil fertility of cultivated land is reasonable and allows production of wheat, maize, vegetables, etc. to mainly supply the needs of local population. Estimated loss of these products is shown in Table E-14.

Table E-14: Estimation of Lost Harvest due to Submergence of Cultivation

Crop	Area Under Cultivation (kanals)	Mean Yield (kg/ kanal)	Estimated Harvest Loss (kg)	2007 Price in Chilas Market (Rs./kg)	Loss of Estimated Income (Rs.)
Wheat / Barley	16,865	91.1	1,536,401.5	25.0	38,410,037.5
Winter Crops	16,865		1,536,401.5	25.0	38,410,037.5
Maize/Fodder from Maize	14,991	101.2	1,517,089.2	30.0	45,512,676.0
Potato/Other Vegetables	1,874	126.5	237,061.0	10.0	2,370,610.0
Summer Crops	16,865		1,754,150.2		47,883,286.0
Total Annual	**33,730[a)]**		**3,290,551.7**		**86,293,323.5**
		Say	**3300 Tonnes**		

Source: DBC, 2007

a) 150% of the estimated cultivable land of 1138 ha (22487 kanals)

Table E-14 shows that almost 3300 tonnes of various agricultural products would be lost annually. Bearing in mind that these products are for the self-supply of local population, this loss will be significant as well as irreversible as shown below:-

[8] Acres is a non-International Standard unit, equivalent to 4.046,8564224 m²

Damage to Cultivation

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Cultivation will be totally lost due to submergence of all related land in the inundated settlements.				

ii. Mitigation Measures

Mitigation measures will be required to compensate almost 29,000 PAPs through provision of the food supplies. Concept and measures for restoration of cultivation for PAPs in the new settlements forms the part of the companion document of 'Resettlement Plan'. Basic concept of these mitigation measures will be:

- Land for land compensation to each affected household through provision of a 6 kanal (against loss of 5.44 kanals as shown in Table E-13 plot of cultivable land
- Restoration of cultivated land at the new locations of Model Villages
- Assistance to farmers for development of soil fertility (terracing, shifting of humus soils, watering)
- Technical advice to allotees through 'Agriculture Extension Services'
- Encouraging the prospective resettlers to start cultivation at new locations prior to actual relocation, thus enjoying double cultivation for certain period
- In cases where the affectees are unwilling to resettle in the Model Villages, they will be given liberal cash compensation and for relocating either on their existing lands in upper valleys or places of own choice.

The basic principle will be to ensure that the affected population gets the required food supplies through adequate means of livelihood restoration.

E.8.3 Improvement of Cultivation by Recession Agriculture

i. Assessment

There will be the annual reservoir drawdown between elevations 1,160 and 1,060 masl due to release of storage water for supplementing low flow irrigation supplies over the period of October to May. According to the proposed reservoir operation criteria, a sizeable chunk of the submerged agricultural, cultivable and barren land will get exposed for different periods (3 to 8 months). Though, verification of area under different categories and their duration of exposure will be possible during actual reservoir operation, a preliminary mapping based estimation has been made as indicated in Table E-15.

Table E-15: Approximate Area to Be Exposed During Annual Reservoir Drawdown Between 1160 and 1060 masl

Sr. No.	Land Category	Approximate Exposed Area Between 1160 and 1060 masl	
		ha	Acres
1.	Sandy Barren Area	1900	4693
2.	Dases With Sparse Vegetation	950	2347
3.	Rangeland With Vegetation Cover Over 10%	40	99
4.	Cultivated Land	800	1976
5.	River Bed	300	741
6.	Other Areas (Rocky, Built-up, Commercial, etc.)	2760	6817
7.	Total	6750	16673

It can be reasonably assumed that land such vacated would be covered by some sediment thus improving its fertility. Further, the moisture retained by this land would contribute to growth of agriculture crops. Lands vacated in the upper parts of the reservoir could be used for full season winter crop of wheat. However, the lands to be vacated in lower portion of the reservoir for smaller periods could be cultivated with fodder or vegetables. This might be a very significant enhancement factor contributing to improved agriculture as shown below:-

Improvement by Recession Agriculture

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Availability of sizeable additional cultivable land for recession agriculture during the drawdown season of October to May between elevations 1160 to 1060 masl.

ii. Mitigation Measures

No particular mitigation measures will be required but the activity might have to be properly managed. It can be seen from Table E-15 that a sizeable chunk of land measuring 3690 ha (9114 acres) could be brought under recession agriculture through proper planning and implementation. Similar to experience at Tarbela reservoir, the farmers in this case will have the opportunity to cultivate the land vacated during the drawdown period of October to May. The land, containing reservoir moisture, could be beneficially used to grow medium and short term crops, particularly fodders.

For optimum development of this significant potential, active association of the local Agriculture / Forest Departments will be necessary. However, the primary role will be played by the operating agency of WAPDA. It may involve formalization of arrangements to encourage recession agriculture through:-

i. Leasing

ii. Advising the farmers, on season to season basis, about progressive anticipated availability of lands for cultivation.

iii. Advance information for timely evacuation of land according to reservoir impounding schedule.

Regarding agronomic aspects, crop zoning and non-water inputs, the technical advice to farmers will be provided by the Agriculture Department through its Extension Service.

E.8.4 Damage To Trees

i. Assessment

According to 2007-08 Survey (and subject to site verification at the time of actual compensation), 525,775 trees, comprising 283,964 fruit and 241,811 non-fruit fall within the reservoir related land acquisition zone up to 1,170 masl as shown in Table E-15.

Table E-16 Number of Trees Affected by Submergence

Sr. No.	Type	Usages / Produce	Age	Number
1	Non-Fruit Trees (forest and commercial)	Shade trees and trees without fruit used for firewood, construction, furniture, etc.	Infant	141,424
			Child	43,142
			Young	35,886
			Adult	21,359
Sub-Total (1)				**241,811**
2	Fruit trees	Mulberry, walnut, apricot, apple, grapes, plums, peaches, etc.	Infant	134,372
			Child	79,023
			Young	37,145
			Adult	33,424
Sub-Total (2)				**283,964**
Total				**525,775**

Source: Cadastral Survey, 2007-08

This would have various impacts on the affected people, such as:

- Deprivation of fruit consumption for local population (fresh in summer and dry in winter)
- Increase in local market prices for fruit brought from outside
- Deterioration of human health, in particular of children and women, due to lack of vitamins and other important nutrients
- Loss of significant cash income.
- Thus, the loss of trees will have a significant impact as shown below:-

Damage of Trees

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Trees for fruit production and shadow will be totally lost in the reservoir area				

At the time of acquisition as well as determining compensation for affected households, it will be necessary to prepare an authentic inventory of trees to be lost.

ii. Mitigation Measures

Based upon this inventory, appropriate mitigation measures will have to be devised, implemented and monitored. The significant loss of 525,775 trees in the reservoir area could be mitigated through:-

- Full compensation for the lost trees including free salvage of wood
- Removal of some adult trees to the new locations, if possible
- Re-planting of trees in new locations (Model Villages, new / relocated roads and the buffer zone between 1160 and 1170 masl)

Removal of adult trees is being followed in some large international projects. Under this approach, the people are offered transportation to the new resettlement locations. This measure can also create favourable conditions for construction of new houses in the Model Villages. However, this approach for this particular case may fail due to the size of trees and transportation difficulty.

Replanting of trees will need the following basic ingredients:-

- Provision of suitable land: favoured option at new housing locations (see Sub-section H.1.3.2 in Volume I of Resettlement Plan)
- Provision of irrigation water: being provided in the new Model Villages
- Seedlings: presently not available and much effort has to be focused on creation of adequate nurseries in Model Villages
- Labour force and management: firstly in the nurseries, later on the land through active involvement of the local Forest Department.

WAPDA in collaboration with the local Forest Department will have to prepare early a plan to facilitate replanting of:

- Shadow and fruit trees at new locations of Model Villages
- Shadow trees at relocated highways, link roads
- Shadow trees in the buffer zone between 1160 and 1170 masl

As first step, tree nurseries will have to be established in the Model Villages under supervision of the local Forest Department including advice and assistance to all concerned quarters for replanting. A very important feature of this activity will be regular monitoring of all related activities as outlined above.

E.8.5 Damage to Animal Husbandry

i. Assessment

Presently, each of the 4,135 households on average has 16 animals comprising cattle (horses, donkeys, sheep and goats, etc.), which comes to 66,160 heads. Following potential impacts on animal husbandry will be caused by submergence in the potential reservoir area:

- Damage of stables and barns for fodder in the submerged settlements
- Loss of cultivated land and bushes which reduces significantly the fodder basis of animals
- Loss of rangeland in the submergence area
- Loss of access to rangeland on the other reservoir side (due to submergence of suspension bridges).

The local population totally relies on products from their own animals. Production of edibles such as meat, milk, eggs do play an important role in the daily diets of households under the prevalent self-supply system. These impacts on animal husbandry are, therefore, significantly adverse as shown below.

Damage to Animal Husbandry

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Due to submergence of cultivated land in reservoir area, , the fodder supplies for the animals will be cut-off				

ii. Mitigation Measures

It will be necessary to institute appropriate mitigation measures for protecting the state of animal husbandry in the project area, to which might belong the following activities:

- Speedy development of cultivated land at new locations (Model Villages)
- Technical / physical support to farmers on yield increase (in order to produce more fodder in future)
- Encouraging the farmers to grow fodder on the short duration on exposed lands as part of recession agriculture
- Re-establishment and improvement of rangeland areas above the reservoir, where feasible

Assisted by the local Agriculture / Livestock Department, and in close cooperation with the farmers and herdsmen, an appropriate mitigation / management plan will have to be prepared in advance of reservoir impounding.

E.8.6 Damage to Forestry Activities

i. Assessment

No direct impact will be caused upon forestry activities due to submergence as any forests / bush lands are absent from the reservoir area. However, there could be the following indirect impacts on the local peoples:

- Loss of access to forest areas on the other side of the reservoir (although already denied due to peculiar tribal set-up)
- Rafting of logs (already nominal)

Theoretically, due to the existing suspension bridges there is good access for the local people to get to the other side of the river, if their forests are located there. However, due to existing tribal rivalries, there may hardly be any such possibilities.

Rafting of logs on the Indus River has been a traditional activity for bringing the logs from forests areas to the locations of wood demand. However, over time due to improved communication (KKH and side valley roads) this activity has been largely overtaken by road transportation. Though with Diamer Basha reservoir logging / rafting could become a significant activity, it could also pose safety hazard to various structures of the dam. This will require attention of WAPDA in consultation with the local population (the owners/contractors of the logs). Thus, these adverse impacts would need to be addressed through technical solutions as indicated below:

Deterioration of Forestry Activities

Significant Impact	Potentially significant adverse impact for which technical solutions can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
	X Forestry activities are not adversely affected directly due to absence of forest in submergence area; log rafting due to potential hazard for the dam would need special attention			

ii. Mitigation Measures

Mitigation measures to protect forestry activities would be basically focused on the development of special plans for log rafting. This will need close attention by the Department of Forestry of the Diamer District in consultation with any affected villages. If log rafting due to safety reasons at the dam would not be feasible, some special arrangements including cash support for new log collection facilities upstream might have to be prepared and implemented by WAPDA, in close cooperation with the local Forest Department.

E.8.7 Degradation of Fishery Activities

i. Assessment

As already pointed out, fishery in the Indus River is nominal because of the small amount of fish and high turbulence. The main fishery activities are concentrated on nullahs, such as Khanbari and Buto. Here two government fish hatcheries are located but in very poor working condition. However, impoundment and operation of the Diamer Basha reservoir would have the following adverse impacts:

- Inundating the spawning areas in portions of lower nullahs
- Submerging houses and other support facilities of fishermen (as in Thak Village)
- Submerging the existing Buto and Khanbari hatcheries
- Losing fish fingerling9 for introduction in the water bodies from the existing hatcheries
- In the context of existing fishery activities, the impact will be significant as shown below:

Degradation of Fishery Activities

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X				

[9] small five centimetre long juvenile fish.

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
Existing fishery activities in lower nullahs, though nominal, will be significantly damaged				

ii. Mitigation Measures

Mitigation measures on protection of existing fishery activities in the project area would focus on:

- Compensation for drowned fishery activities
- Compensation and/or re-establishment of damaged Buto and Khanbari hatcheries on the reservoir fringes on the same nullahs

E.8.8 Improvement of Fishery Activities

i. Assessment

Impoundment and operation of the large Diamer Basha reservoir with a total storage of over 10 BCM would have a major positive effect on fish production and fishery. Taking into account the proposed re-establishment of the two hatcheries and a significant increase of fish species adapted to the reservoir conditions, the following positive impacts may be caused on fish development:

- Change of turbulent and cold river towards lake-like water body (less turbulence and temperature)
- Biomass development as a result of huge water body

This environment would enable the creation of a sizeable fishery sector in the Northern (Gilgit-Baltistan) Areas with the following positive elements:

- Re-establishment of the fish hatcheries (Buto and Khanbari) with much modern facilities and enhanced capability to feed increased number of fish into the reservoir
- Creation of new work places in hatchery sector
- Availability of more jobs in fishery sector
- Increased fish sales on local market (in particular those with high consumer value).

The creation of reservoir will have significant positive impact on fishery activities as shown below:

Improvement of Fishery Activities

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Fishery activities significantly enhanced due to creation of a large reservoir

ii. Mitigation Measures

In order to support the development of fishery activities in the Diamer Basha Reservoir and to improve the nutrition basis base of local population following activities are envisaged:-

- Development / implementation of 'Reservoir Fisheries Management Plan' (as contained in Appendix F in Volume III of RP)
- Monitoring of breeding, introduction and fishery development activities in the reservoir. An important item of monitoring could be the seasonal fluctuation of 100 m between 1,060 and 1,160 masl, which might influence the fish development.

E.8.9 Degradation of Water Supply

i. Assessment

Presently the local water supply for population, animals and irrigation is based upon the derivation of water by channels from the nullahs. With submergence caused by the reservoir, large areas of settlements would be inundated along with damaging the water supply systems. However, these facilities would be re-established at the new locations (Model Villages) as part of the Resettlement Plan.

Construction activities in general would be focusing on the dam site area with abstractions from Indus River. Thus, under the above scenario, degradation of water supply will be insignificant as shown below:-

Degradation of Water Supply

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X Water supply set free by inundation of settlements will be more than the requirement at new locations with insignificant impact	

ii. Mitigation Measures

No mitigation measures on protection of local water supply are required.

E.8.10 Damage to Electricity Generation and Supply

i. Assessment

Although majority of population does not have access to electricity even now, submergence due to of the Diamer Basha reservoir would damage the local electricity generation and supply facilities in the related settlements. Most relevant damages would be:

- Loss of community hydropower plants (refer Table D-32)
- Loss of a few isolated private small electricity generators
- Loss of electricity transmission lines along the Indus River and in nullahs.

Thus, the adverse impacts on existing electricity generation and supply facilities would be significant as shown below:-

Degradation of Electricity Generation and Supply

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Existing facilities of electricity generation and supply would be damaged totally due to submergence				

ii. Mitigation Measures

At site mitigation would not be possible. However, the damaged electricity facilities would be more than compensated by the following measures:-

- Compensation of damages and losses
- Restoration of electricity generation and supply facilities at new locations of resettlement including general electrification of area through the energy produced at Diamer Basha Dam

E.8.11 Improvement of Electricity Supply

i. Assessment

The most important measure will be to provide electricity facilities in the new locations of Model Villages as well as the general area. To help improve very poor living conditions in the project area, it will be desirable to supply electricity at subsidised rates. Even otherwise, it would be obligation of the Government to share the benefits of the project with the affected population.

These measures would represent a significant improvement as shown below:-

Improvement of Electricity Supply

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Electricity supply i n Model Villages and remaining settlements to be improved as benefit sharing measure

ii. Mitigation Measures

An ‘Integrated Area Development Plan’ including general electrification has been prepared and included as Appendix B in Volume III of RP. Compensation measures (for example damage of small private generators) would have to addressed also before hand.

E.8.12 Damage to Cross-River Transportation

i. Assessment

Main elements of existing transportation across the river will be damaged due to submergence. The following transport access facilities will be lost:-

- Six suspension bridges
- About 94 km length of existing KKH
- Many roads linking to villages in the upper valleys of nullahs

After submergence in the reservoir, existing KKH along the left bank will be relocated at elevation above 1,200 masl over a length of about 141 km from Shatial to Raikot. In addition, link roads from existing KKH to side valleys will be submerged by the reservoir over length of 61 km. About 5 km of streets in lower Chilas will also be submerged as well.

Accessibility from the right bank villages to the district headquarter at Chilas will deteriorate significantly, which might have further negative impacts on economic and social relations and values.

Fog situations, which presently do not appear frequently, could be sometimes induced near the reservoir. In particular, during spring and autumn, when the temperature difference between the water body and the air is quite high, fog may occur with some impacts on the local environment. One important effect could be the risk for transport, especially on Karakorum Highway. However, due to the climatic conditions (wind, generally very low humidity and relevant sunshine also during winter periods) the formation of fog, if any, will only have minor adverse effects. In particular, the road traffic will not be affected due to relocation of Karakorum Highway at higher elevation (1,200 m) as shown below:-.

Damage of Cross-River Transportation

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Loss of transportation system on the right bank relying on KKH through six suspension bridges across Indus River		X Traffic safety might be threatened by risk of fogs, which will require monitoring, and if confirmed, specific safety measures along the reservoir roads might have to be implemented		

ii. Mitigation Measures

Mitigation measures are already proposed through the following works:-

- Left Bank:
  - Relocation of submerged Karakorum Highway to higher elevation above 1,200 masl
  - Upgradation of Karakorum Highway (four lanes with safety strips, crash barriers, rock and land sliding protection facilities)
  - Restoration links to the remaining villages and other areas of access (cultivated and rangeland areas)

- Right Bank:
  - Permanent Access Bridge located downstream of dam site
  - New construction of 'Right Bank Periphery Road' from dam site to upper end of relocated KKH near Raikot (four lanes with safety strips, crash barriers, rock and land sliding protection facilities)
  - Restoration of links to the remaining villages and other areas of access (cultivated and rangeland areas). For this purpose, a block provision is being made in the RP under Annex K-1 on 'Cost Estimate for Land Acquisition, Resettlement and Development Plan'.

In the long run, a 'Reservoir Crossing Ferry System' might have to be developed in addition. This could lead to establishment of certain crossing points along almost 100 km long reservoir. This might be based on the technical and economical evaluation of this concept addressing:

- Locations: Khanbari, Hodar, Chilas-Thalpan, Ges Pain-Bunar, and Shing-Draing
- Type of vessels and docking facilities: to allow operating under 100 m fluctuations
- Funding: purchase of vessels and facilities by WAPDA or credit facilities for private enterprises
- Tariffs: to be subsidised in case of WAPDA funding to sustain the system by ferrymen and encourage passengers (especially frequent passengers working or studying in Chilas)
- Management system: safety measures, training, operation system, maintenance.

E.8.13 Improvement of River Up and Down Transportation System

i. Assessment

It is envisaged that construction of the following facilities will significantly contribute to improvement of river up and down transportation system:

- Relocation and upgradation of Karakorum Highway
- Construction of new Right Bank Periphery Road (parallel to the Karakorum Highway)
- Construction of new permanent access bridge downstream of the dam
- Establishment of dam crest road

This will result in significant improvement of the transportation and livelihood conditions in the Diamer District and Northern (Gilgit-Baltistan) Areas as shown below:

Improvement of River Up and Down Transportation Service

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Significant improvement from the relocated / upgraded Karakorum Highway and new construction of: Right Bank Periphery Road; Permanent Access Bridge; and road over dam crest

ii. Mitigation Measures

No significant mitigation measures will be required.

E.8.14 Deterioration of Recreation

i. Assessment

Recreation so far is not a relevant economic activity in the Northern (Gilgit-Baltistan) Areas notwithstanding the fact that the project area has some of the world famous mountains and heritages such as: Nanga Parbat; Karakorum Valley; and unique rock carvings. There are only very few visitors from downstream Pakistan and some foreign countries (in accordance with DBC's observations during 2006-2007) mostly from Japan, United Kingdom, France, Germany.

Reservoir operation will, therefore, only harm insignificant recreation activities linked to loss of unique rock carvings as indicated below:-

Deterioration of Recreation

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Very small recreation activities will be threatened due to loss of unique rock carvings in the submerged Karakorum Valley				

ii. Mitigation Measures

Mitigation measures for rock carvings will form the part of 'Cultural Heritage Management Plan' (refer Appendix C, Volume III of RP).

E.8.15 Improvement of Recreation

i. Assessment

In medium or long-term, the recreation activities will grow significantly due to the following features:

- Unique Karakorum Valley with impressive high mountains as Nanga Parbat (> 8,000 m elevation)
- A very large reservoir to encourage water-related sports (swimming, sailing, rafting)
- Boat trips to rock carvings exposed during 100 m reservoir drawdown between FRL of 1,160 masl and MOL of 1,060 masl

The present severe lack of recreation facilities such as safe roads, good hotels, trade and services would be significantly improved during the 10 year construction period. This might contribute to a boost of the recreation sector as indicated below:-

Improvement of Recreation

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
				X Enhancement of transportation and services along with lake-like conditions of the large reservoir would significantly boost the recreation sector

ii. Mitigation Measures

No specific mitigation measures will be required and recreation activities would improve as part of 'trickledown' effect. However, the reservoir operating agency (WAPDA) might monitor carefully the recreation sector activities and particularly conditions such as safety, service and transportation.

E.8.16 Deterioration of Labour Market and Business Activities After Construction

i. Assessment

It is envisaged that the labour market during construction period would be substantially improved through large work force estimated to touch a peak of about 10,000. However, with completion of the construction works the labour market would shrink drastically (although alternate job opportunities would be also created for project operation). Also, the business sector will suffer due to completion of construction works. Thus, the activities such as hotels, transport, restaurants, trade and shopping, wood processing, car repair, fuel stations and other will be significantly reduced after completion of construction. This significant impact will be as indicated below:-

Degradation of Labour Market After Construction

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Completion of project construction will cause substantial drop in the labour market leading also to a significant worsening of the related business activities generated during the 10 year prosperous construction period				

ii. Mitigation Measures

No particular mitigation measures may be required as normally, after a small period of stagnation, the business activities start picking up as a part of 'trickledown effect'. This generally takes the form of increase in the following economic activities:

- Extension in agricultural activities due to 'land for land' approach for resettlement
- Recreation, in particular ecotourism
- Fishery including hatchery business
- Rangeland extension and rehabilitation
- Environmental related works including monitoring such as:
  - inventory of reptiles, amphibians, birds
  - investigation of water quality, climatic features
  - observation of dam safety issues
- Handicraft, embroidery and pottery
- Wood processing including manufacture of furniture

In this particular case, there will be another redeeming feature. Upon completion of Diamer Basha Dam Project, or even earlier, two major hydropower projects of Bunji (upstream) and Dasu (downstream) are expected to be taken up for implementation. These will provide a continuous sources for deployment of large skilled labour force trained through DBDP.

E.8.17 Deterioration of Social Structures Including Community and Gender

i. Assessment

After construction, the threats to deterioration of social structures, including community and gender will basically disappear due to repatriation of foreign workers.

The general affluence along with its social vices, may influence the social structure. For instance, under the condition that recreation is increased, increased visitors may come to the area, causing some deterioration of the community structures, traditional and religious norms and the gender. However, on the balance the impact will be minor as shown below:-

Deterioration of Social Structures Including Community and Gender

Significant Impact	Potentially significant adverse impact for which design and construction solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
			X No significant adverse impact after repatriation of construction workers; recreation related impacts are assessed as insignificant.	

ii. Mitigation Measures

No mitigation measures seem to be necessary.

E.8.18 Degradation of Health Situation, Especially Malaria

i. Assessment

With the start of reservoir operation, health situation may not be influenced in a significant manner. There might be the following two issues requiring attention of the Health Department of Diamer district:

- Communication of infectious diseases from downstream Pakistan due to improved transportation
- Enhanced risk of malaria due to creation of the reservoir

With impoundment of water, insect breeding areas, in particular for mosquitoes, might be developed in the reservoir. Along the shallow reservoir littoral zone with higher temperature and still-water conditions, establishment of mosquito breeding habitats may occur. Thus, the risk for malaria infections may be increased significantly as shown below:-

Increased Risks for Malaria Due to Reservoir

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X Huge water reservoir body would offer good breeding conditions for mosquito and other insects				

ii. Mitigation Measures

The following mitigation measures may be required to minimise the risk of aggravating health problems in the reservoir area:

- Monitoring of insect development in the reservoir, particularly mosquitoes
- Adoption of some malaria preventive measures through special training of doctors in the hospitals and dispensaries and public awareness
- Occasional launching of anti-malaria campaigns including provision of medicines in each village around the reservoir

E.8.19 Damage to Cultural Heritage and Rock Carvings Due to Submergence

i. Assessment

As outlined in the Baseline Chapter D, no old and architecturally important buildings, ancient castles and mosques or other objects exist in the project area. Thus, no impact on those cultural heritage objects would occur. However, there is unique heritage of > 31,000 rock carvings in the area, most of which would be lost, due to reservoir impounding and constitute one of the most adverse significant impacts.

A significant number of stones with inscriptions and rock carvings will be submerged by Diamer Basha Reservoir. It can be seen from MAP-7 that a large number of rock carving stations around Chilas, Thalpan, Ges Pain, Ges Bala, and Shing would be lost. As most important scenes are closely located to the Indus River, these would be submerged even at the MOL of 1,060 masl. Thus it will constitute an extreme significant impact as shown below:-

Loss of Rock Carvings due to Submergence

Significant Impact	Potentially significant adverse impact for which operation solution can be developed	Adverse impact, which is potentially significant but requires further studies	Minor or insignificant adverse impact	Significant environmental enhancement
X A majority, almost 80%, of over 31000 rock carvings would be inundated which is an extremely significant impact				

ii. Mitigation Measures

Due to unlikelihood of relocation resulting from physical and logistical constraints, the mitigation measures will focus on documentation and replication of the most important rock carvings. The detailed measures are included in 'Cultural Heritage Management Plan' (refer Appendix C, Volume III of RP). These will basically relate to:

- Physical verification and documentation of already identified 120 or so most important rock carvings
- 3D-Scanning of the most important rock carvings
- Replication of scanned carvings in preferred material (plastic or sinter)
- Establishment of an Exhibition Centre in Chilas for replicated rock carvings
- Sponsoring upto 5 years higher education and research in North Areas / Diamer related to archaeology with particular focus on rock carvings

F ANALYSIS OF ALTERNATIVES

F.1 Non-Project Alternative

Under this alternative, Diamer Basha Dam would not be constructed. It would allow continuation of the existing environmental state, namely:

- None of the almost 29,000 peoples would be relocated
- More than 3,100 houses, mostly of mud and stone, would not be submerged
- Traditional social life, especially family and gender relations, would not be altered
- Cultivation of wheat, maize, vegetables, etc. for self-supply would continue
- Reptiles endangered by killing or submerging would be spared
- Heritage rock carvings would not be lost due to submergence

However, environmental and socio-economic development in Pakistan as well as Northern (Gilgit-Baltistan) Areas would not benefit from the enhancements due to construction and operation of the dam such as:

- About 35 years extended lifetime of the downstream Tarbela reservoir due to reduced sedimentation resulting in accrual of huge economic and social benefits
- Reduction in carbon dioxide emissions due to avoidance of an equivalent fossil fuel based thermal power generation
- Extension of natural conditions for migrating birds, diversifying fish habitat conditions and boosting fishery activities in the reservoir
- Vast improvement in communication facilities such as: upgradation / relocation of KKH; Right Bank Periphery Road; Permanent Access Bridge downstream of dam; access road over dam crest; and significantly improved river up and down transportation system and crossing conditions
- Significant improvement of Northern (Gilgit-Baltistan) Areas' labour market during construction with large positive effects on education and vocational training laying foundation for betterment and prosperity for the young generation
- Improvement of overall livelihood in the new settlements (Model Villages) with modern infrastructure such as water supply, electricity, communication, and education
- Boost of the overall economy of area through irrigated / recession agriculture and recreation

Considering these two alternatives of 'doing nothing' and 'develop the area' through construction and operation of the Diamer Basha Project, the latter should be favoured. Above all, construction of the project will provide a unique opportunity , unlikely to come again, for addressing severe under-development of this Northern region of Pakistan.

Based upon the above arguments, Non-Project Alternative is not preferred.

F.2 Changes of Location Upstream and Downstream

Changes of the dam location have not been investigated as part of the current tender design due to the following reasons:

- The proposed dam site was investigated as part of an overall hydropower inventory and ranking study of Indus River in early 1980's. This study proposed a cascade development of Indus River through a series of dams / hydropower projects from Skardu down to Kalabagh. This particular site, on the basis of techno-economic evaluation, was ranked the best and its conceptual feasibility completed in 1984.

- After completion of conceptual feasibility in 1984 (MONENCO), the site had been investigated by WAPDA including completion of: updated Feasibility Report of 2004 (NEAC); and Review of Feasibility Report and Tender Design (2008) by DBC.
- Extensive seismo-tectonic investigations over a period of about 2 years involving many kilometres of drilling, geologic and field research have established that this particular location possess low earthquake risk in an active seismic zone.
- Even 10 km upstream and 10 km downstream of this location, there is no habitation, which could be affected either during construction or operation.
- Storage capacity investigations have been also carried out confirming the suitability of proposed location taking into account the morphology of the future reservoir and the contributing flow of the nullahs
- As part of planned cascade hydropower of Indus River both the immediate upstream and downstream project (Bunji and Dasu) have been already taken up by WAPDA for conducting feasibility studies

Due to the above mentioned technical / physical reasons, alternative dam site locations were not considered.

DBC survey on the affected population revealed that in the upper 50 m zone, between 1,110 and 1,160 masl, of the potential reservoir approximately 17,000 people (out of the total 29,000) were living. These affected peoples are mainly living in the left bank settlements of lower Chilas, Bunar Das and Gonar Farm. Notwithstanding this, moving the dam location some 50 km upstream or downstream was not investigated either by NEAC (2004) for their EIA of Feasibility Report or DBC during the extensive environmental assessments (2005-2010) due to ample justification of the proposed site. Government of Pakistan, while approving Diamer Basha Dam Project in August 2009 took due account of the suitability of proposed dam location including its water storage, energy output and earthquake risk.

F.3 Location of Hydropower Plant in Other Valley

Changed location of the hydropower plant with similar capacity in another valley was not preferred due the following reasons:

- Besides hydropower, Diamer Basha dam would provide a sizeable storage as well as significantly enhance useful life of Tarbela, which is not possible in any nearby side valley
- None of the nearby valleys can provide even a fraction of the proposed 4500 MW installed capacity of DBDP.

The above factors ruled out even a cursory look at this option by DBC during the tender design studies (2005-08).

F.4 Reduction of Dam Height

This option could substantially reduce the adverse impacts, especially in the following two areas:

- Reduction of submergence with 50 m reduced dam height could save relocation of around 17,000 peoples
- Protect some of most important rock carvings.

However, one has to consider that the 220 m high dam would only provide 61 % water storage for irrigation and only 45 % energy output as compared to the proposed 270 m dam. This would render the project unviable. Therefore, DBC proposed not to reduce the dam height and compensate the adverse impacts through a resettlement and livelihood restoration programme.

It may be worth mentioning that as part of review of Feasibility Report (2004), DBC were able to reduce the dam height by 10 m with consequent lowering of FRL from 1170 to 1160 masl.

F.5 Changed Locations of Individual Dam Elements

At least a theoretical alternative would be to change the locations for some elements to avoid / reduce the adverse impacts. This was considered unnecessary for this particular case as the dam, its underground powerhouses and tunnels and diversion canal are all located in an area completely devoid of any environmental values.

F.6 Project Alternatives to Minimize Resettlement Impacts

These have been dealt with under Sub-section B.6 in Volume I of the Improved Draft of Resettlement Plan. Accordingly, after weighing and evaluating various alternatives for minimizing resettlement and their impacts on corresponding primary project benefits of water and energy, the dam at the proposed location is considered as preferred option. It may also be kept in view that such mega projects, being cost intensive, have to remain within an acceptable level of economic viability to attract funding from the International Financing Agencies (IFIs). It may also be pertinent to point out that even with the adopted project design, the population displaced per million acre foot (MAF) of storage is under 4500 or under 4 per million cubic meters (MCM). This, probably, lies in the lowest range among similar multi-purpose projects in the developing countries, particularly South Asia.

G INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

G.1 Objective

Basic objective of this activity is to have on board the project affected peoples (PAPs), interested non-governmental organisations (NGOs) and related institutions through:-

- Creating awareness about the project including its impacts
- Mustering their support for the project
- Involving them in the process of determining compensation including resettlement and area development

Relevant guidelines of ADB prescribe that the affected population and institutions should be fully informed by disclosing the information relevant to the project impacts, the proposed policy of mitigation and compensation options. Consultation with PAPs is, therefore, the starting point for all these activities to allay misgivings and apprehensions about the project and elicit their acceptability, ensure their participation in planning and managing of resettlement and provide them with opportunity to participate in key decisions that will affect their livelihoods.

G.2 Participation Mechanisms

Participation mechanisms facilitate the consultative process and include information sharing and dissemination, disclosure, and participation of PAPs and other stakeholders in the project related activities of acquisitions, compensation, resettlement and area development.

In the peculiar social set-up of Northern (Gilgit-Baltistan) Areas, it is also important to involve the religious leaders as representatives of the public as well as part of effective communication process. They can provide a very effective medium to bring information to the affected male population through Friday prayers. Local business community, specially the affected one, should also be brought into the process of awareness and participation.

It is of basic importance to involve representatives of PAPs right from the start. The related institutional arrangements should also be in place for continuous consultation throughout the process of planning and implementation of Resettlement Plan.

Policy of the Asian Development Bank (ADB) in this regard states that:

> *"Local government bodies, people's organization and mainstream development NGO, often play a constructive role in facilitating public discussion and dialogue. Their inputs may be beneficial for Govt. decision-making"*

Although a few non-governmental organizations (NGOs) are registered in the project area, most of them are inactive. Northern (Gilgit-Baltistan) Areas Development Project (NADP) at least uptil now, was an active NGO of the project area.

G.3 Identification of Stakeholders

There are three main groups of stakeholders:

- Project Affected Peoples: almost 28,650 affected people comprising 4,135 households spread over 31 villages on the left and right banks of Indus River
- Individuals or groups with interest in the project such as local elected or community representatives including Jirgas, religious leaders, and non-governmental organisations.
- Governmental institutions such as: Diamer District Administration Chilas; Northern (Gilgit-Baltistan) Areas Administration Gilgit; Kohistan District Administration (North-West Frontier Province now renamed as Khyber Pakhtunkhwa); Northern (Gilgit-Baltistan) Areas line agencies of Public Works Department (NAPWD) responsible for all roads and bridges, Forest Department including Wildlife, Local Government and Rural Development Department;

Agriculture Department including Fishery; and National Highway Authority (NHA) in charge of Karakorum Highway.

G.4 Disclosure, Consultation and Participation Process

G.4.1 Awareness / Participation Campaign

G.4.1.1 Initial Efforts by Consultants

This process was started by Diamer Basha Consultants (DBC) as one of the first activities. It was conducted by DBC during April 2006 through meetings in 26 out of 31 affected villages. In this process, 233 PAPs were consulted as per supporting details in Annex G-1.

DBC realized at the outset that among the PAPs there was much unawareness, disapproval and even opposition against the project in general and the resettlement in particular. Consequently, during the scoping sessions in 2006, initially many PAPs refused any support for the project as well as displayed an attitude of detachment. They, at that time, indicated their preference to leave the area and go wherever they liked after receipt of fair cash compensation. Mostly, they showed intention to go to 'downstream' locations, around Mansehra, Abbottabad, and even Islamabad. This initial reaction of PAPs was, probably caused by:

- Lack of trust in functionaries of the government
- Continuous deprivation and discrimination of the non-locals by local tribes
- Unclear perception about the consequences of relocation and resettlement
- Disapproval of suburban living conditions, though with cleaner environment and better civic amenities, without having access to land and self-produced products for sustainability of livelihood, and
- Lack of proper information about the price of land to be charged for cultivable land being provided under the proposed Model Village concept for resettlement of the dislocated population.

The above situation changed substantially after two years (2007 and 2008) of efforts by DBC for creating awareness among PAPs.

G.4.1.2 Special Governmental Confidence Building Measures

Unfortunately, in February 2010 hidden conflicts again appeared (see above Box G-1). Considering gravity of this situation, the High Level Ministerial Committee established by GoP to deal with resettlement issues of DBDP, got into the top gear. It immediately established a Sub-Committee to start negotiations with a representative committee of PAPs including recently elected members of Gilgit-Baltistan Legislative Assembly. Consequently, an understanding was reached between this Ministerial Sub-Committee and PAPs regarding compensation rates for land acquisition and other related issues on resettlement. This package was approved by the Federal Cabinet in July 2010.

Box G-1: Present Dam Conflicts

Although only in its very early stages, the building of Basha dam appears fraught with difficulty, death and disruption. The police fired on protesters in Chilas who were angry at the way in which those affected by the building of the new - and essential - dam were being treated. They were demanding a share of the royalties generated by the dam, an increase in the compensation awarded to them and resolution of the border dispute between Gilgit-Baltistan and NWFP (Khyber Pakhtunkhwa). Two protesters died in the firing, others were injured and the local populace displayed their displeasure by burning down the offices of the assistant commissioner, the superintendent of police and two police checkpoints. They also burned government vehicles and blocked Karakoram Highway in both directions for several hours and all this before work on the dam has got into top gear. Paramilitary forces and police reinforcements have been sent to 'stabilise' the situation.

Source: The News (Pakistan), Saturday, February 20, 2010[10]

G.4.2 Participation of Affectees in Development of Resettlement Concept

G.4.2.1 Key Objectives

Key objectives of this effort by DBC were the public participation and to obtain feedback from PAPs for evolving the concept and a development plan covering resettlement and livelihood restoration. In this connection, the participation of PAPs was solicited for the following two activities:

- Proposed concept and locations of Model Villages
- Identification of alternative potential sites for hamlets in some upper valleys

First round of this consultation was started by DBC in April 2006 and continued till February 2008. It entailed:

- Scoping sessions in all the 31 affected villages.
- Meetings with selected local responsible functionaries of various agencies.
- High level consultations with Northern (Gilgit-Baltistan) Areas Administration and NGOs.

G.4.2.2 Scoping Sessions with Project Affected People

The most relevant and important activity from the point of view of public participation was the scoping sessions conducted by DBC. Over the period of October and November 2006, scoping sessions were held in all the affected villages. These were conducted in an open and frank atmosphere conducive to appreciation of the basic elements of the project and development of resettlement concept.

These sessions were participated by 415 PAPs including representation from Jirgas, elected community and religious leaders (for details refer to Annex G-2 and Annex G-.3). Due to progressive awareness of PAPs, the repeat scoping sessions held during September 2007 not only in Chilas but other villages of the left bank, aroused much greater interest as compared to similar exercise in October 2006 (sample record also included in Annex G-3). In general, there was a wide support of PAPs to this national water and power development project in Northern (Gilgit-Baltistan) Areas. Only very nominal opposition to the project construction was noticed mostly based on the uncertainty about compensation rates to be paid for the land.

In most of the scoping sessions, written memoranda were presented by DBC and openly discussed. These discussions provided DBC, WAPDA and Diamer District Administration with very useful overview of the conditions, requirements and views of PAPs particularly with regard to compensation and resettlement. Serious consideration was given to their genuine concerns and

[10] www.thenews.com.pk/daily_detail.asp?id=225218

demands for development of the resettlement concept and proposals addressing such key issues such as:

- Relocation to the proposed Model Villages was only accepted by Sheen and Yashkun (the main local tribes) from Lower Chilas (basically due to their proposed resettlement on their owned lands in Harpin Das).
- Sheen and Yashkun of Thalpan village would prefer to be relocated in downstream developed areas such as Mansehra, Abbottabad and Islamabad.
- Non-local tribes, in particular Soniwals, totally refused to be relocated to any model village and wanted cash compensation.
- Majority of population did not want to be relocated anywhere by the government and instead demanded fair cash compensation to exercise their choice of voluntary resettlement.

During the scoping sessions held in 2006 and 2007 (refer Annex G-2 and G-3), in some cases, PAPs suggested relocation to the upper parts of their valleys instead of the proposed Model Villages. In order to explore this possibility, 8 scoping sessions were held in different villages during July and August 2007. Besides meetings, specific reconnaissance of the upper valleys was undertaken by the joint teams comprising DBC and representatives of PAPs. The relevant details are given in Table G-1.

Table G-1: Scoping Sessions and Field Visits with Regard to Potential Hamlet Sites in Upper Valleys

Sr. No.	Valley	Villages	Place of Meeting	Date	Joint Field Visit By (No.)			Outcome
					DBC	Represe-ntatives of PAP	Total	
Right Bank								
1.	Khanbari	Nima / Narar	Ali Aman's House	02-07-07	Saleem, Fakhr, Israr, WAPDA Survey Team	14	19	Scarcity of suitable land
2.	Hodar	Sine Huch, Nusry Das, Dalojil, Segali Hit and Balokish	Primary School at Segali Hit	08-07-07	Saleem, Fakhr, Israr, WAPDA Survey Team	17	22	Scarcity of suitable water
3.	Kiner	Thalpan	Primary School	17-07-07	Saleem, Fakhr, Israr, WAPDA Survey Team	11	15	Scarcity of suitable land
4.	Ges Bala	Ges Bala	Middle School	28-07-08	Saleem, Fakhr, Israr, WAPDA Survey Team	9	13	Scarcity of suitable water
Left Bank								
5.	Thor	Muruski	FWO Camp	30-07-08	Saleem, Fakhr, Israr, WAPDA Survey Team	7	11	Proposed location of Project Colony
6.	Gini	Gini Village	Gini Hotel	31-07-08	Saleem, Fakhr, Israr, WAPDA Survey Team	4	8	Scarcity of suitable land
7.	Bunar	Lower Bunar Das	Petrol Station	01-08-08	Saleem, Fakhr, Israr, WAPDA Survey Team	9	13	Scarcity of suitable land
8.	Jalipur	Jalipur Village	Haji Mirjan's House	02-08-08	Saleem, Fakhr, Israr, WAPDA Survey Team	2	6	Scarcity of suitable water

Source: DBC, 2007

The net outcome of this whole activity led to the conclusion that in no upper valley suitable site was available within a reasonable distance from the reservoir periphery for alternate location of hamlets. Consequently, the only available option seemed to be relocation of PAPs to the Model Villages.

To get options of PAPs to the proposed relocation in the Model Villages for resettlement, a Questionnaire Survey was conducted by DBC in 2009 (refer Annex G-4 and G-5). Outcome of this effort indicated that majority of the affectees (about 63%) in these valleys would prefer cash compensation instead of relocation in the proposed Model Villages and resettle either on their lands in upper valleys or places of their own choice.

Most of the international financing institutions including ADB prefer that all PAPs should be brought around to the idea of settling in the Model Villages instead of getting cash compensation. This is based on the apprehension that there would be a gap of about 6 to 8 years between the acquisition of land and assets and physical relocation of PAPs upon active impounding of the reservoir above MOL. Under this scenario, if PAPs are paid full cash compensation in advance, they might have spent this money before implementation of relocation and resettlement plans. Consequently, the implementing agency may be faced with the challenge of handling about 30,000 destitutes, along with very serious financial, administrative, political and social fallout.

As mentioned above, to address this concern of International Financing Institutions (including ADB), a specific proforma was developed (Annex G-4) to elicit options of the affectees for exercising their choice to resettle in Model Villages or places of their own choice. This questionnaire survey, to cover each of 4,135 affected households, was completed over the period of April and May 2009. Village-wise details are given in Annex G-5 while an abstract is given in Table G-2.

Table G-2: Resettlement Options of Affectees

Location of Villages		Affected Households (No.)	Resettlement Option (No.)		
Indus River Bank	No.		Model Village	Voluntary Shifting to Upper Valley	Own Choice
Left	19	3013	1392	367	1254
Right	12	1122	128	52	942
Total	31	4135	1520	419	2196
Percentage			**37**	**10**	**53**

It can be seen from Table G-2 that only 37 % of affected households have opted for resettlement in the Model Villages. Therefore, the original concept of resettling all PAPs in nine (9) Model Villages around the reservoir periphery is required to be reviewed. Consequently, to start with, only two proposed locations of Composite Model Villages in vicinity of Chilas are being taken up for planning and development to accommodate 37 % of the affected households. Notwithstanding this, effort will continue to convince PAPs to relocate, hopefully, through the demonstrative effect of two composites.

G.4.2.3 Meetings With Local Responsible Functionaries of Various Agencies

As part of the consultation process, it was considered desirable to elicit views and concerns about the project from the local responsible functionaries serving in various agencies or departments. For this purpose, during May 2008, DBC held meetings with 19 responsible functionaries of various agencies or departments serving in the area (supporting details in Annex G-6). This covered institutions such as: WAPDA; Line departments of Northern (Gilgit-Baltistan) Areas; District Administration of Diamer; Health Department Chilas; Pakistan Agricultural Research Council (PARC) outfit at Chilas; and NGOs of NADP, IUCN and AKRSP at Gilgit.

G.4.2.4 Consultations With Northern (Gilgit-Baltistan) Areas Administration and NGO's

In order to elicit the views regarding land prices, compensation and resettlement a high level consultation was also considered appropriate with the Northern (Gilgit-Baltistan) Areas Administration [NA(GB)A] and NGOs at Gilgit. This was held at Gilgit during February 2008 (refer Annex G-7) and included 11 high level functionaries of NA(GB)A, IUCN, WWF, and AKRSP.

G.4.2.5 Accomplishments During Consultation Process

Overall activities during the process of consultation, from April 2006 to June 2009, are summarized in Table G-3.

Table G-3: Consultant's Activities During Disclosure Consultation and Participation Process

Sr. No.	Activity	Duration	Supporting Details	Accomplishment
1.	Initial Awareness Campaign of Affectees	06-20/04/2006	Annex G-1	26 meetings involving 233 Project Affected People
2.	Scoping Sessions to Elicit Affectees Views on Compensation and Resettlement Including Model Villages	04/10- 28/11/2006 09-12/09/2007	Annexes G-2, G-3	i. Meetings in 31 villages involving 415 Project Affected People ii. Meetings in six villages involving 72 Project Affected People
3.	Consultative Meetings with Government Employees of Selected Institutions	05/2006	Annex G-6	Meetings with 19 important functionaries of line departments and agencies
4.	High Level Consultations With NAA and NGOs On Issues of Land Prices, Compensation and Resettlement	26/02/2008	Annex G-7	Meetings with 11 functionaries at Gilgit
5.	Reconnaissance of Potential Hamlet Sites in Upper Valleys	02/07-02/08/2007	Table G-1	Scoping sessions in 8 villages
6.	Questionnaire Survey to Elicit Options of Project Affected People for Resettlement	04-05/2009	Annexes G-4, G-5	Completion of survey covering 4,135 affected households

G.4.2.6 Follow-up of Participation and Consultation Process

Based on the feedback from consultations and public participation during 2006-2008, DBC initially prepared a draft Resettlement Action Plan (RAP) in November 2007. This duly considered project impacts, socio-economic baseline conditions, statutory, customary and administrative frame-work, and guidelines of International Financing Institutions on involuntary resettlement. This information was particularly helpful in evolution of compensation and entitlement package, and resettlement principles including conceptualization of the basic vehicle of Model Village located near the place of dislocation.

Pre-final version of RAP was completed by DBC in January 2009. This was also furnished to the key public sector stakeholder of Northern Area (Gilgit-Baltistan) Administration for any comments and suggestions before finalization. Consequently, during February 2009, the Administration requested WAPDA for presentation of draft RAP to the key stakeholders.

A presentation to the Administration and stakeholders was made at Gilgit on 28 February 2009 by a WAPDA/DBC Team. This presentation, chaired by Chief Secretary Northern (Gilgit-Baltistan) Areas, was attended by over 40 representatives of the stakeholders comprising: Advisor to NAA; Chairman Chilas Municipality; members of N(GB)A Legislative Assembly; members of the District Council; and Project Affected Peoples. It covered draft Resettlement Action Plan, Concept of Model Villages, and related land acquisition and compensation issues including demands of affectees formally communicated through Ministry of Water and Power, GoP. The presentation was conducted in a cordial atmosphere and consensus achieved to proceed with priority land acquisition including appropriate determination of compensation prices by DC Chilas in accordance with the prescribed procedures and consultation of PAPs. However, regarding the concept of Composite Model Village in vicinity of Chilas, the affectees had some reservations, particularly the

tribal composition of the resettlers, which was being considered for conceptual planning of two composite Model Villages in Vicinity of Chilas.

As a result of the consultation process conducted by DBC, the PAPs including local population of the area are now fully aware of the project impacts and need for relocation. An important benefit of this effort has been the willingness of PAPs to cooperate and support the project in the interest of the regional and national development. They are now looking forward to this project as an opportunity for betterment of their lot through: enhanced job opportunities; better living environment with availability of modern civic amenities like improved access, piped water supply and sewerage and electricity; and enhanced educational and medicare facilities. Further, the 'trickle-down' effect of massive investment in Diamer Basha Dam Project will manifest in the form of: better restored and sustained livelihood of PAPs, and accelerated socio-economic development of the project area as well as the region.

As a further safeguard to protect as well as promote interests of PAPs, it is being proposed to bring on board an NGO for bridging the gap with implementing agencies. This may include, but not necessarily limited, to the activities of land acquisition, compensation, resettlement, restoration of livelihood and evolution of area development plans.

Notwithstanding the efforts so far put in for public participation, this activity will have to be pursued through the forthcoming implementation phases of the RP. For this purpose, a separate programme is being developed as part of the RP. In particular, the focus will be on improvement and modification of the originally proposed relocation concept based on the construction of nine (9) Model Villages in the vicinity of reservoir. Main features of this concept are outlined in Annex G-8.

H GRIEVANCE REDRESS MECHANISMS

H.1 National Legislation on Grievance Redress

Grievance redress mechanisms are prescribed both in the Land Acquisition Act (LAA) 1894 and the draft Resettlement Ordinance (2002). Accordingly, Project Affected Persons not satisfied with any aspect of the resettlement procedure including entitlement to compensation, compensation of land, compensation of houses and land acquisition etc. will have the right to file a petition against the compensation awards in the higher courts. For timely attention, a Grievance Redress Committee or its appropriate alternate would have to be also established for the project. If a PAPs is not satisfied with the decision of Grievance Redress Committee, he could have the recourse to approach a designated higher form and/or the concerned Court of Law.

H.2 Resolution Mechanism for Concerns and Grievances of Project Affected Peoples

H.2.1 Formation of Committees with Representation of Project Affected Peoples

Establishment of grievance redress mechanism is one of the basic requirements for implementation of any RP. In case of DBDP, a procedure has been devised receiving and facilitation for resolution of disputes and grievance redress through formulating of appropriate fora and committees. Consequently, two committees have been already established by the Northern (Gilgit-Baltistan) Area Administration to facilitate active participation of PAPs in the process.

The **first one**, namely 'Resettlement Issues and Coordination Committee' was established by Chief Secretary Northern (Gilgit-Baltistan) Areas through a notification dated 28 April 2009 having 27 members from among all the key stakeholders (refer Annex H-1). Its composition was as shown in Table H-1.

Table H-1: Composition of Resettlement Issues and Coordination Committee

Sr. No.	Composition	Designation
1.	Secretary Home Northern (Gilgit-Baltistan) Areas	Chairman
2.	Representatives of WAPDA (02)	Members
3.	Representatives of Northern (Gilgit-Baltistan) Areas Government / District Administration (02)	Members
4.	Representatives of Affectees (22 on recommendation by the DC Diamer District and Communities)	Members

This committee shall deal with issues pertaining to Resettlement Plan, land acquisition and compensation rates. This will inter-alia involve: land acquisition and compensation; resettlement; and establishment of model Villages. Working closely with DC Chilas, who is also the Land Acquisition Collector, the Project Resettlement Organization of WAPDA would also facilitate the committee members in arriving at consensus for resolution of various issues.

By initially negotiating land compensation rates with Northern (Gilgit-Baltistan) Areas Administration (N(GB)A) in August 2009, this committee assumed the role of 'Land Valuation Committees' formed in previous projects like Ghazi-Barotha Hydropower Project. However, as already mentioned, this important issue was subsequently handled by the High Level Ministerial Committee of GoP.

The **second one** would be 'Committee for Settling Issues among Communities'. This standing committee would be headed by the Deputy Commissioner (DC) Diamer district based at Chilas with the following composition.

Committee No. 2: Committee for Settling Issues between Communities

Deputy Commissioner, Diamer (Chilas)	Chairman
Representatives From Rival Communities	Members

This committee shall be notified by the Deputy Commissioner (DC) Diamer district as per requirements on case to case basis. DC Diamer district would be standing head of this committee, while the other members from the rival communities would not be permanent. Instead, they would be notified by him, based on the needs and requirements, on case to case basis. This committee would basically resolve the internal disputes of barren land ("dases") between individuals and communities.

Establishment of the above two committees will provide an effective mechanism for participation of the affectees in all the relevant activities of land acquisition, compensation, resettlement, livelihood restoration and sustainability, and area development plan to conform to the social safeguards of International Financing Institutions, particularly ADB.

H.2.2 Establishment of Grievance Redress Committee

As mentioned already, after violent protest of PAPs at Chilas on 10 February 2010 (refer Box G-1), the High Level Ministerial Sub-Committee of GoP conducted negotiations with specially formed Action committee representing PAPs including their recently elected Members of Legislative Assembly.

For grievance and other disputes redressal, High Level Ministerial Sub-Committee also agreed to establishment of a 'Dispute Resolution Committee (DRC); with composition as shown in Box H-1.

Box H-1: Composition of Dispute Resolution Committee

Deputy Commissioner, Diamer	Chairman
Director, Project Resettlement Organization, WAPDA (or his nominee)	Member, Secretary
Assistant Commissioner Chilas / Darel (As the case may be)	Member
President (or his nominee) of Resettlement Issues Coordination Committee (Representative of Project Affected Persons)	Member

It can be seen from Box H-1 that DRC will be headed by the Deputy Commissioner, Diamer and include a member each from: WAPDA; Revenue Department; and representatives of Affectees (Resettlement Issues and Coordination Committee).

Terms of reference (ToR) of this committee will be as below:-

- The Committee will not substitute the provisions of the Land Acquisition Act for redressal of grievances but will rather complement and strengthen the same.
- The Committee will basically focus on day to day irritants arising out of implementation process of Diamer Basha Dam construction where grievances of affectees are not covered y the Land Acquisition Act.
- The Committee will resolve disputes where preference to local population in non-specialized jobs is ignored.
- The Committee may facilitate resolution of disputes where discrepancies occur in description and details of built-up structures, houses etc.
- The Committee will resolve the issue of construction on land being acquired on purely humanitarian grounds but on case to case basis.
- The Committee will act as a forum for liaison amongst the stakeholders.
- The Committee may review the progress and pace of acquisition process from time to time.

It can be seen from the above ToR that DRC will also perform the basic function of grievance redressal.

H.2.3 Project Information Centre

Project Information Centre within Project Resettlement Organization (PRO) of WAPDA at Chilas would act as local point for receiving and filing of any grievance redress cases. PAPs would file their complaints, grievances and disputes with Deputy Director in-charge of Project Information Centre at Chilas (refer Organization Chart in Figure L-1). Project Information Centre would bring these to the notice of the Director (PRO).

H.2.4 Convening of Grievance Redress Committee

Project Director (PRO) WAPDA would evaluate the genuineness and authenticity of the complaints and disputes related to resettlement and environment and activate internal grievance redressal mechanism. Depending upon the nature of complaint(s), he would request the Chairman (DC Chilas) to convene the Committee for deliberation, as and when necessary.

H.2.5 Deliberation by Grievance Redress Committee

Grievance Redress Committee, upon convening, would deliberate upon the referred case(s) and settle them swiftly and effectively.

H.2.6 Right of Project Affected People to Appeal Against Decisions

In case PAPs are not satisfied with the decisions of the Grievance Redress Committee, they could appeal to the 'Resettlement Issues and Coordination Committee'. However, this will be in addition to the basic right of PAPs under the national legislation to fill a petition against the compensation awards in the higher civil courts.

H.2.7 Documentation and Monitoring of Grievance Redress Mechanism

H.2.7.1 Documentation

A register of complaints, disputes and grievances of PAPs would be maintained by the Project Information Centre of PRO to keep a track of grievance redress process. Follow-up of the filed cases would be properly monitored and updated periodically.

H.2.7.2 Monitoring Indicators

Project Information Centre would monitor the progress of grievance redress measures through the following indicators and put up the record periodically to the Committee:

- Numbers of resettlement and environment disputes filed with Grievance Redress Committee
- Number of disputes successfully resolved by the Committee
- Impact after dispute resolution (degree of acceptance of resolved disputes including decrease / increase of goodwill between PAPs)

H.2.7.3 Coordination With Other Related Agencies

On behalf of WAPDA, the overall responsibility for resettlement planning and implementation including grievance redress and dispute resolution would rest with PRO. Therefore, besides PAPs, a close coordination would have to be maintained by PRO with other related governmental agencies, particularly the district administrations of Diamer(GB) and Kohistan (KPK). Most important coordination in this respect would be with Diamer District Administration of GB (this district covers over 97.7% of the land to be acquired and all of 28,650 PAPs). Therefore, almost all the activities relating to land acquisition, compensation awards and allotment of land in Model Villages for resettlement would need to be very closely coordinated with Revenue Department of this district, under the Deputy Commissioner, to avoid or minimize the related grievances / disputes.

In addition, Kohistan District Administration (KPK) may be involved, in some cases of land disputes arising from acquisition (about 2.3% of the total) on left bank close to dam site and for contractor's camps. In this case, if needed, a Committee based on the model of Diamer could be replicated.

I ENVIRONMENTAL MANAGEMENT PLAN (EMP)

I.1 EMP as Integral Part of Construction Bidding Documents

The Environmental Management Plan (EMP) has been prepared in accordance with ADB's 'Safeguard Policy Statement' of June 2009 and the 'Guidelines for the Preparation and Review of Environmental Reports' (Pakistan Environmental Protection Agency, October 1997).

DBC has assessed various environmental impacts, involving the best available national / international experts on the basis of: extensive ground surveys; research on the current state of physical and biological environment especially for fauna and flora; and investigations on rock carvings. Thus the EMP is aimed to achieve the desired compliance by integrating findings and recommendations for best environmental solutions into the project design. Another basic objective of EMP is to mobilise the ownership of WAPDA and participation of contractor(s) for its effective implementation.

Furthermore, the EMP addresses monitoring measures and administrative needs in order to meet the natural conservation restrictions and concerns as emphasised in the international and national guidelines including recommendations in the 'World Commission on Dams Report' (2000).

In accordance with Annex to Appendix 1 of the "Outline of an Environmental Impact Assessment Report" as per ADB's Safeguard Policy Statement (June 2009), the EMP has been developed in close cooperation with WAPDA and addresses:-

- Mitigation measures
- Monitoring
- Implementation arrangements

Bidding documents, prepared by DBC, of the five (5) main contract lots for construction of the core project, represent the presently prescribed 'Best Practices' regarding Environmental Assessment and Construction. The basic approach will be to avoid any damage and/or degradation of environmental values and address them, where necessary, through the construction contracts.

Mitigation and monitoring of livelihood restoration including resettlement, occupation and social safeguards is the subject of companion document of 'Resettlement Plan'.

I.2 Integrated Rangeland Restoration and Development Plan

I.2.1 Approach

Land and soils during construction and operation of DBDP will be under potential adverse impacts. Some land will be used for temporary construction purposes. However, most of the land will be occupied permanently by the construction works and reservoir area of 115.13 km².

Part of the adversely affected area will be privately owned agricultural or rangeland. In the lower parts of Indus River valley up to 1,600 masl, the land is intensively used for grazing and fire-wood cutting. Every green leave or branch of a plant, bush or tree will be eaten by the many animals moving along the valley every day in spring time. The plant community investigations revealed a very high degree of damage or degradation of the dominant *Artemisia* dry steppe ecosystem.

The loss of cultivated land requires development of alternatives for restoration and sustainability of livelihood. These issues are dealt with in the Resettlement Plan.

WAPDA together with the contractor(s) and Diamer District Administration will need to establish and implement as part of the Integrated Land Management Plan the following measures focused on rangeland:

- Avoiding any additional use of land (beyond the areas already allocated)

- Restoring degraded range and bush land by planting
- Fencing of newly replanted zones to protect against any threat (animals, humans)
- Avoiding any degradation of vegetation reducing thereby the rangeland and inducing soil erosion
- Planting shrubs, where feasible, in the sloping risk area around the reservoir for stabilisation of slopes
- Improving the ecological state of the remaining range and bush land
- Financially compensating the loss of income from livestock breeding (under certain conditions)
- Supporting effective rangeland management methods including transhumance and alternative feeding arrangements.

Forestation due to climate with <200 mm/a precipitation in the zone above the reservoir up to approximately 1,600 masl is not feasible. However, planting of bushes and seeding of particular rangeland plant species in accordance with the availability of soil moisture would be important for rehabilitation of rangeland. One viable option will be forestation of 10 m strip of vacant land between reservoir FRL of 1,160 and land acquisition zone of 1,170 masl.

Part of the strategy could be to consider other options for the local population for heating, mostly for cooking. Currently it is totally met by wood from local trees and bushes. This could be initially substituted by use of electricity in the Model Villages and later on through general electrification of area, which would allow withdrawing the traditional use of fire-wood. It would allow as well improve the biodiversity of plants and animals and lastly increase productivity for livestock breeding.

Contractor(s) and Environmental Management Monitoring Cell (EMMC) of WAPDA will cooperate with Local Forest Department and Nature Conservation Organisations (such as Northern (Gilgit-Baltistan) Areas IUCN and WWF in Gilgit) to implement the rehabilitation programme, where feasible, in the margins of reservoir through the following measures:

- Mapping the re-cultivation areas (temporarily used land)
- Mapping the 10 m buffer zone around the reservoir (between 1,160 and 1,170 masl)
- Determining and mapping the sliding risk area beyond the 10 m buffer zone
- Identification and mapping of suitable areas for re-cultivation
- Implementation of re-cultivation and rangeland development measures including:
    - Quantification of the land for the various measures
    - Selection of suitable grass and shrub species (with botanical institutions and Agriculture / Forest Department of Northern (Gilgit-Baltistan) Areas)
    - Quantification of seed and seedling requirements
    - Preparation of seed and seedlings for the amount of land required (in local nurseries, see also Resettlement Plan for tree replanting measures in the Model Villages)
    - Seeding and planting measures on all land designated for re-cultivation and protection
    - Stabilising, foresting and protecting the 10 m buffer zone between 1160 and 1170 masl
    - Protection measures as fencing against any disturbance for the first five years.
    - Substitution of animal fodder by some other sources (under the condition that some animal grazing areas are not available in the first years of construction and operation)
    - Training of shepherds and other concerned peoples on sustainable rangeland management
    - Handing over of rehabilitated rangeland to local communities or the Model Villages, as the case may be.

The monitoring measures are part of the following Chapter on ‘Monitoring’.

Following individual works would need to be implemented for restoration of rangeland as part of 'Integrated Land Management Plan'.

I.2.2 Re-cultivation Measures of Land Returned From the Contractor

Any land withdrawn temporarily for construction purposes, outside 1170 masl zone, would need to be restored after surrender. This land could have been degraded by holes, steep slopes in the case of quarries, destruction of any vegetation, excavation of the upper soil horizon, and contamination by oil, cement or concrete. Re-cultivation measures on this temporarily used land returned by the contractor(s) will include:

- Cleaning from any remains from the construction
- Levelling
- Planting/seeding of grass species adapted to the area
- Planting of shrubs
- Fencing of the areas for certain period to allow recoupment

All compensation issues for the temporary use of rangeland or land for business activities (timber storage) will be dealt with through the Resettlement Plan. Any land, if no longer required for the project, has to be returned to the original land owners as per provisions of Land Acquisition Act, 1894.

I.2.3 Land Protection During Construction

During construction any measures inducing further degradation and soil erosion beyond the areas designated for construction, quarrying and dumping will have to be mitigated. Besides, it will cover temporary routes designated for transportation during construction. Contractor(s) will follow the guidelines such as:

- Any other locations of land for acquisition outside the zone of 1,170 masl will need to be confirmed. No contractor would be allowed to ask for land acquisition of land outside of this area without prior consultation of the affected villages.
- Materials will have to be dumped carefully at designated places.
- Degradation of vegetation (even if very scarce) will have to be avoided strictly.
- Contamination of soil and land with chemicals such as fuel, gasoline, diesel or lubricants will have to be strictly avoided.

I.2.4 Restoration and Re-cultivation of New Rangeland Areas

As outlined in the Baseline Chapter, the following land will be lost during construction:-

- Permanent loss of land including almost the half being used for grazing:
  - Dam facilities including appurtenant structures (730 ha)
  - Reservoir related land acquisition zone of 1170 masl (12765 ha)
  - Project Constructing Colony (61 ha)
- Temporary loss of rangeland:
  - Downstream construction camps and work areas including dumping areas for stock piling of rock excavation (173 ha)
  - Quarries outside 1170 masl (10 ha)

The temporarily lost rangeland would need to be restored after construction.

I.2.5 Mitigation Measures Protecting Against Rock and Land Sliding

During construction, the contractor(s) will carry out all excavations carefully, mitigating any threat to construction workers and local population. This will also include meeting the safety requirements for dumping areas, when located close to villages or to roads, particularly Karakorum Highway.

After impoundment of the reservoir, the enhanced risk of land sliding (though in a limited area) will be also relevant. In order to mitigate this position, following measures will have to be taken:

- Slope stability analyses (based upon field survey before impoundment) addressing most sensitive areas after impoundment: This has since been accomplished by DBC through completion of the 'Report on Landslides and Slope Stability' (refer Sub-section E.6.4) and there are only a few locations
- Potential areas for Model Villages (in particular Kino Das) will have to be marked and excluded from planning: This aspect will be duly considered at the time of development in the light of findings from the above mentioned report of DBC.
- Considering appropriate measures for stabilisation of critical slopes likely to slide: Only 8 km out of 101 km shoreline, as identified in above report of DBC will need attention. Even this may not pose any hazard provided marked at the surface and prohibited from settlement, entrance, etc.

The protection of local population in locations of Model Villages and above 1,170 masl will need attention. Any identified areas thus endangered will have to be reserved in order to avoid trespassing or any erection of structures. For any slope stabilisation, if necessary, either wire nets or planting of shrubs could be deployed.

Shrub planting programme as part of the overall Land Management Plan might have to be established especially in the following two zones:

- Immediate reservoir zone: Between elevations 1,160 masl to 1,200 masl
- Foothills above the Model Villages.

The climatic conditions do not allow planting of forest trees, which have a much higher demand on water than shrubs. Therefore, those shrub species such as *juniperus* and *wild olive* should be selected, which would grow without any additional water delivery (except first planting). This bush planting programme should be started simultaneous with the construction works and would require establishing of nurseries for the selected species in different Model Villages. Measures to protect the planted shrubs against cattle and local population (firewood) will have to be considered as well.

I.2.6 Mitigation Measures Avoiding Land and Soil Contamination by Solid Waste

Solid waste from the construction such as paper, cartons, plastic, glass, metal and organic material will have to be collected carefully at all locations including labourer camps. Contractor(s) will be obliged to organise solid waste reprocessing on the sites of construction.

Priority should be given to recycling of garbage at the location where the waste is produced. Utilization of timber and paper in special incineration plants will be a preferred option in order to avoid long distance transport of solid waste. However, the plant(s) shall have to comply with the prescribed emission standards.

Any disposal of garbage on land outside of the construction facilities or into the water bodies would be prohibited. Bidding Documents have specified development of appropriate environmentally acceptable standards.

I.2.7 Agriculture Improvement Concepts Including Drip Irrigation

Agriculture, both cultivation and livestock breeding in the project area, is performed on a very low level, which results in subsistence farming. Yields in the project area are very low, which is caused by various conditions among them the low soil productivity, low quality of crop seeds and animals, and lastly the outdated cultivation methods.

Pilot research project in this respect could be started by the local Agriculture Department in collaboration with Pakistan Agricultural Research Council (PARC) which already has a research station in Gilgit. This research could cover:

- Selection and usage of better (more productive) crop seeds and livestock.
- Improvement of technology of crop cultivation and growing.
- Improvement of irrigation methods including pilot testing of drip irrigation (tree nurseries for example).

This pilot research could be carried out over a period of five years or so. The aim of this research should be to increase essentially the agricultural yields as an essential part of the regional development for better living conditions and reducing poverty of the local population.

I.2.8 Recession Agriculture

About 1077 ha (21,280 kanals) of land under cultivation in 31 affected villages of the project area will be submerged in the reservoir acquisition zone up to 1170 masl. Some of these lands will be vacated during winter / early summer season due to reservoir drawdown of 100 m (between elevations 1160 and 1060 masl). Efforts, including some related research, will have to be mounted to encourage / monitor cultivation on this vacated land and possibly enhanced areas of new terraces formed up to the shoreline of 1,160 masl (refer also to Sub-section E.8.3). The activity may start prior to the first impoundment to FRL and the following conditions should be investigated:

- Sedimentation within the exposed area with regard to improvement of cultivable soil.
- Suggested sowing of crops especially for fodder of domestic animals during winter in the range of three elevations (1,060-1,100, >1,100-1,130, >1,130-1,160 masl).
- Identification of any additional emerging land for cultivation (over and above the submerged area)

I.2.9 Transhumance System After Impoundment

Under the changed scenario of resettlement through Model Villages, feeding arrangements for cattle will have to be changed. For summer feeding, the existing pastures at higher elevations will have to be used with overall rangeland improvement by the concerned communities through advice / assistance of the concerned line agencies. Some suitable ‘Dases’ in the vicinity of Model Villages may also be developed by the communities for feeding the cattle during winter. Furthermore, the stubs of maize, the main summer crop to be grown in the Model Villages, will need to be stocked for indoor winter feeding of the cattle. Due to post-project increased economic activities, and consequently enhanced local demand of dairy products, in the long run the farmers may find it attractive to switch over to the indoor feeding of cattle through market purchase of fodder.

The total area of rangeland for livestock breeding will be reduced significantly by construction and submergence of reservoir. However, the productivity of the rangeland in the zone up to 1,600 masl is extremely low mainly caused by climatic and geologic conditions and further worsened by severe overgrazing.

It will be desirable to investigate how to improve the livestock breeding under the conditions of transhumance by means of feeding larger herds of animals at more distant meadows. This research may include:

- Present state of livestock breeding and transhumance.
- Potential new locations for distant transhumance.
- Logistical needs for cooperative structures required for far / distant transhumance.
- Administrative arrangements between different districts or tehsils.

I.3 Climate and Air Management Plan

I.3.1 Approach

Climate and air in the project area are determined currently by the overall location in this distant area of Pakistan. Prevalent factors are the mountains, which determine the seasonal behaviour of climatic elements such as clouds, precipitation, temperature, air humidity and wind. As a result, there is a decent seasonal fluctuation of the climate between the extreme dry and hot summer months and quite cold winter, where some precipitation occurs. On the other hand, climate and air are characterised by the very low human influence. Under the present state, there is almost no air pollution due to absence of any processing industry and no greenhouse gas emission.

It will be desirable to initiate a “Climate and Air Management Plan” to foresee any related threats. If necessary, this plan could be extended to monitoring include concrete mitigation measures for sustaining the current excellent state of climate and air. Most important activities having potential influence on climate and air are:

- **Construction Stage**
  - Emissions of exhaust gases (greenhouse gases) such as CO_2, N_2O, particulate material (soot) from machinery and vehicles
  - Emission of dust from excavation including blasting, transportation, crushing plant, stock piling, concrete mixing, etc.
- **Operation Stage**
  - Change of land coverage
  - Formation of large lake-like water body with different energy properties.

Even if a significant change of the local, regional and global climate is not relevant, following measures with relevance to the air conditions and climate will have to be considered:

- Avoiding further land use changes adversely affecting temperature, wind and dust pollutions
- Supporting rangeland management to increase vegetation coverage
- Supporting shrub planting activities
- Improving the local situation of heating media by substituting firewood with electricity.

Particularly, physical elements relevant during construction will be monitored to control activities of the contractor(s). Long term impacts due to reservoir operation will also need to be monitored, as suggested in the following Chapter on “Monitoring”. Some meteorological data already exists for Chilas, observation of which should continue. In addition, another climatologic observatory has since been established near the dam site.

In the following the most important measures avoiding significant changes of the climate and air are considered.

I.3.2 Exhaust Gas Emissions from Vehicles and Heavy Machinery

Contractor(s) will be obliged to perform the construction works under minimal threats to climate and air by avoiding, to the extent possible, the following emissions from machinery and vehicles using diesel:

- Exhaust gases, including CO_2 and particulate material (mostly soot) emitted by excavators, bulldozers and trucks at the dam site
- Exhaust gases and particulate material from batching plants and cement mixers
- Dust from quarry site excavations and around stock piling areas
- Exhaust gases and particulate material along the temporary roads

Predominantly the emissions will affect only workers during the 10 year construction period. Although the settlements are quite away from the main sources of emissions, efforts will have to be made for protecting local people, mostly shepherds, children and travellers along the right bank road from Dudishal to Khanbari Valley and along Karakorum Highway on the left bank. This would be accomplished through:

- Appropriate labour safety measures avoiding excessive exposure to emissions and dust
- Avoiding unnecessary transportation between the labourer camps and the construction sites.

I.3.3 Avoiding Additional Emissions Due to Power Generation During Construction

Most significant adverse impacts are from exhaust gases from the heavy machines including trucks, excavators, and bulldozers using diesel fuels. Under the condition that the total demand for electricity during 10 year construction works would be met through diesel, these may further increase in emissions.

Thus, even supplemental electricity generation using hydropower potential in the nearby nullahs needs to be explored. In fact, this is already being considered for Project Colony (Thor Nullah) and Composite Model Village near Chilas (Thak Nullah). In addition, an inventory of hydropower potential on Khanbari, Darel and Tangir Nullahs is in hand. This would have some positive effects, not only on climate / air but also on the social side as indicated below:-

- Reducing the release of green house gases
- Avoiding health problems of workers and local population
- Enabling electrical devices such as electrically operated conveyer system for transportation of materials from excavation and borrows areas to reduce dust pollution
- Improving the socio-economic conditions in the area

I.3.4 Mitigation of Fog Along Reservoir

Presently, the evaporation in summer months largely exceeds the available moisture. This situation may be somewhat changed due to higher evaporation from the surface of reservoir. Fog situations, which presently do not appear frequently, could be potentially induced by the reservoir. In particular during spring and autumn, when the temperature difference between the water body and the air is quite high, fog may develop. This may have some impacts in the local environment, particularly the risk for transport along the reservoir. However, it may not be relevant as Karakorum Highway will be relocated to higher elevation between 1,200-1,300 masl.

Prophylactic measures avoiding the development of fog might be considered if so warranted:

- Establishing lighting system along the most dangerous sections
- Establishing crash-barrier system on the reservoir side along the entire water body

- Establishing signs for information of most hazardous fog sections
- Broadcasting, if possible, information on radio about fog events along the highway.

I.4 Integrated Water Resources Management

I.4.1 Overall Approach

WAPDA will be responsible for the Integrated Water Resources Management during construction and operation stages. Its implementation may also involve close coordination and cooperation with the with the concerned local / federal line agencies through their related outfits.

During construction stage main issue will be the protection of local water supply and avoidance of degradation and pollution of water bodies. This would include following protection measures:

- Indus River and nullahs against pollution of:
  - Dumping of earthen material
  - Releasing oil and other chemicals from machinery
  - Releasing sewage water from the labourer camps and construction sites
  - Dumping cement and/or concrete
- Water supply if derived from the nullahs (water quantity and quality)
- Springs being used for local water supply

Important part will be the treatment of sewage water from the construction or residential labourer camps. Only dry toilets will operate and faecal remains transported to the treatment plant for cleaning.

After impoundment of the reservoir, special attention will be needed to manage the water resources in the project area considering the following conditions:

- Reservoir formation with potential changes of water quality
- Reservoir and impoundment related water resource issues (including downstream degradation) with any relevance for the local population.
- Water supply arrangements for the new Model Villages (with an initial estimated population of 28,650).
- Water sanitation in the Model Villages (along with sewage treatment) including Chilas with 30,000 inhabitants.

EMMC under WAPDA's operational organisation would act as an important coordinator for all water resources issues.

I.4.2 Mitigation of Damages to Water Bodies From Construction

During construction, every possible effort should be undertaken by the contractor(s) to avoid:

- Dumping of earthen material into the river which increase suspended solids
- Pollution of river and nullahs from oil and other chemicals
- Pollution of river and nullahs by cement or/and concrete

The impacted water bodies during construction will also have to be monitored regularly by EMMC of WAPDA as proposed in the subsequent Chapter J.

I.4.3 Mitigation of Degraded Local Water Supply from Nullahs and Springs

Traditional water rights have to be respected in the project area. The water for construction purposes should be taken only from the confluence of the related nullah with the Indus River or below the diversion points for the local population. The following nullahs could be potentially affected due to construction works:

- Water supply from right bank nullahs of Dudishal and Khanbari from construction at site
- Water supply from left bank nullahs of Shatial, Basha, and Minar from construction and labour camps
- Water supply from Thor Nullah from proposed WAPDA Colony.

All spring sources during the construction period and those above 1,170 masl will have to be protected safely during operation.

Every mitigation measure will be aimed to preserve the prevailing situation of local water supply. Actions on local water rights, which could be potentially affected by the contractor(s), would require prior investigation and confirmation by EMMC of WADA.

I.4.4 Mitigation of Water Pollution Caused by Organic Residues at Reservoir Bed

While impounding, the potential biologic-chemical impacts may appear from degradable materials at the reservoir bed causing pollution of the reservoir. In big water bodies under temperate water conditions, greenhouse gas methane CH_4 might be formed due to the anaerobic conditions at the bottom of the reservoir. Especially, if stagnation of the water body occurs the oxygen content might be reduced to a level where methane gas would be produced. Sources for such type of organic pollution would be:

- Rotting of any organic material including grass, trees (logs), shrubs, human remains
- Disposals of solid organic waste from local villages and construction sites

Before impounding, bed of the reservoir should be cleared from tree logs and other organic material.

Graveyards may require particular attention particularly where for religious reasons some sacred graves may have to be relocated.

I.4.5 Avoiding Pollution of Water During Operation

Currently, there is almost no sewage due to the absence of flushing latrines in most of the project area. With the relocation of 28,650 peoples, hopefully to the Model Villages including improved housing infrastructure and sewage water containing nitrogen, phosphate and bacteria would be produced. Without treatment, this sewage water would run into the reservoir along the ultimately developed new 35 km long ‘settlement belt’ from Harpin Das (downstream of Chilas) across Chilas up to Kino Das.

Additional pollution sources would be diffused runoff from the land (oil residues, soot from cars), pollution from vessels (oil residues), and from feeding of fish (organic components). Furthermore, it has to be taken into consideration that much more detritus will be generated from the higher number of fish. This detritus will settle on the reservoir bed and not flushed down by the turbulent river as at present. Thus self-cleaning / treatment capacity of the present river will be reduced.

Based upon monitoring of water quality of the reservoir and selected nullahs (Thor, Buto, Thak, and Gandlo) appropriate measures may have to be developed and implemented by treating the polluted water before discharging into the reservoir to which would belong:

- Construction of sewage treatment plant in Chilas as part of proposed improvement using mechanical and biological means
- Preferred transport of sewage from construction sites and labourer camps to the treatment plant
- Field testing of natural/biological sewage treatment methods (reeds etc)
- Enforced protection against any release of pollution into the nullahs, Indus River or reservoir
- Improved solid waste disposal

I.4.6 Regulation of Reservoir Releases

With the establishment of Diamer Basha dam and reservoir, the storage capacity of upper Indus River will be significantly increased. First charge on this storage will be to improve irrigation supplies in the area downstream of Tarbela Dam.

Another requirement may be to maintain certain ecologic releases on Indus River, particularly when vegetation, aquatic and semi-aquatic life up to section downstream of Kotri Barrage are active. With the implementation of the proposed recommendation of 2005 studies on 'Water Escapages Downstream of Kotri Barrage', it is envisaged that the conditions in this regard could be alleviated.

I.5 Health Protection and Safety Management Plan

I.5.1 Approach

Health and safety will play a crucial role in Diamer Basha Project during the stages of construction and operation. During construction, the contractor(s) will be obliged to take care of safety of workers and local population, mostly linked to the following activities:

- Transport of goods, often bulk material by heavy vehicles on public roads between Shatial and dam site especially and also between dam site and quarries
- Construction activities at the dam site
- Blasting at dam site and quarries
- Dumping of materials for stockpiling or slope stability.

During operation, potential impacts will have to be assessed from the point of view of changing the local climate and hydrology with increased risk for any diseases. Particularly, all waterborne diseases will have to be monitored indicating the potential sources in respect of hepatitis, typhus and other ailments.

It is also apprehended that large mosquito habitats along the reservoir shoreline could be developed resulting in a higher risk for malaria infections.

I.5.2 Avoiding Accidents From Use of Explosive Materials

For excavation of rocks and tunnelling, blasting will be necessary at various locations, such as: dam site; diversion canal and tunnels; quarries; and other construction site. This has to be done in accordance with *Best Practice of Construction Works* and relevant security measures. Contractor(s) will have special responsibility for safe:

- Transport from downstream areas to the dam site (along the highly frequented highway)
- Safe storage of explosive material according to national regulations
- Blasting and security for workers, local population, and traffic along Karakorum Highway.

Due to the distant location of the dam site and quarries from settlements, there is only minor significance of accidents to local population caused by blasting of rocks.

Explosive material safety has to be handled very carefully including transport to the site (camp, quarry), storing at safe places and utilisation for blasting. The contractor(s) will establish storage places, which will be maintained under special safety conditions. Only skilled and licensed personnel will have to be involved in all handling procedures. For blasting all safety conditions, as per international and national requirements, will be applied by the contractor(s).

I.5.3 Safety of Construction Workers, Local Population and Their Livestock

Contractor(s) will be obliged to reduce any risks to workers during construction from accidents. This will include regular training and advice to all construction staff on related issues and works, development of a Safety Manual, provision of medical aid at the construction sites, recording all accidents and devising measures to enhance safety. This will be closely monitored by WAPDA / Construction Supervision Consultants and the contractor(s). Any accident to workers and local people should not only be avoided but in case of happening investigated to exclude any recurrence.

Construction workers and local population including their livestock will be physically impacted due to almost round-the-clock use of much heavy machinery and vehicles for about 10 years. The relevant hazards will be:

- Accidents caused by vehicles to local population on the public roads/Karakorum Highway
- Accidents with goat and sheep herds
- Accidents with local vehicles and passengers
- Damage to houses and cultivated land caused by vehicles
- Accidents to local people in vicinity of quarries including use of explosive material, mostly herdsmen

Special protection measure will have to be established to include:

- Security guidelines
- Permanent training of personnel on security and safety measures
- Best available equipment and material
- Fencing of hazardous areas such as quarries
- Guarding of special areas such as quarries, storage places of explosive material, others
- Insurance coverage by contractor(s)

Avoidance of accidents caused by construction workers and their machinery and vehicles is a high priority. This may require appropriate regular advice and training to construction workers. It may be noticed that such incidents may affect smooth social relations between the local population and WAPDA and the contractor(s).

I.5.4 Avoiding Disturbance of Local Life by Noise

Avoidance of noise is the best method to diminish disturbances of the local population. The contractor(s) will be obliged to utilise only machinery and vehicles with the lowest noise emission standards. In particular, any works producing noise close to habitations such as blasting will have to be planned only during the day time. Any blasting during night time (22:00 to 06:00 hours) and within a distance of 200 m from houses and villages will not be allowed.

I.5.5 Avoiding Increased Risk of Malaria in the Reservoir Area

Except application of chemical spray against mosquito, no measures are relevant to mitigate higher risk of malaria infection. Basic hydrological conditions (increase of water amount, stagnation of

water level at the shoreline and formation of shallow (and warmer) water) cannot be mitigated when establishing dam with a reservoir.

Thus, use of chemicals through air spray and a careful medical observation and service are the only possibilities to be considered, if needed. WAPDA and Diamer District Health Department will have to:

- Establish exclusive special medical service facilities to combat malaria
- Equip the service with needed medical equipment
- Assign medical staff (one doctor, one nurse) in various health units to monitor / combat malaria, if required
- Maintain an adequate supply of basic anti-malaria drugs
- Periodic training of medical personnel
- Creation of public awareness

I.6 Wildlife Protection Management Plan

I.6.1 Approach

Nature conservation status in the project area is very low. This is mostly caused by the severe degradation of plant communities and animals in the *Artemisia* dry steppe. Except reptiles and birds (including migratory waterfowl) no other biological objects have similar relevance from the point of view of biodiversity and wildlife.

During construction, there will be potential threats to birds and reptiles, due to acquisition of land for excavation (dam and quarries) and dumping of the materials. Rock areas, in particular those more distant to settlements are habitats for lizards such as agamas and geckos. Increased transportation, not only on Karakorum Highway but side and temporary construction roads, will have a negative impact on reptiles while crossing during hot season. Already, quite a few killed reptiles including agama, geckos and snakes are found on the road.

After creation of reservoir large dry steppe areas would be lost totally. Habitats of reptiles and birds will be lost and these animals will have to move for recovering new areas for breeding und feeding, if available in the vicinity.

Despite very low biodiversity a Wildlife Protection Management Plan might have to be prepared through the related agency of Northern (Gilgit-Baltistan) Areas. Based upon regular monitoring and research programme (see following Sections) measures for protection of existing wildlife and development of suitable conditions for animals may have to be established with focus on:

- Reptiles
- Amphibians
- Birds

Based upon the inventory of the above named species, with including assistance and close cooperation from the national and international organisations for nature conservation, appropriate measures such as protection, relocation, breeding and introduction might to be evolved, if considered necessary later on. Obviously endemic mammals are not presently available in the project area.

During construction, there may be need for training and awareness building of the personnel of contractor(s). However, the most important stakeholders will be the local people, particularly those concerned with the rangeland, including shepherds, foresters and farmers.

I.6.2 Avoiding Damage of Animal Habitats

Despite very low nature of conservation status, the contractor(s) will be required to do anything, which may help to avoid unacceptable deterioration of animals living in the project area. Excavation and dumping of construction materials should avoid areas, where potentially relevant animals, in particular amphibians, reptiles and birds are settling. During construction it would be focused on special protection measures of the following terrains:

- Lowest parts of nullahs (the most important habitat areas)
- Locations around springs
- Settlement and cultivated land (with irrigation canals)
- Rangeland with relevant vegetation cover.

Contractor(s) will have to select suitable dumping areas by considering only those locations which are outside of the above listed terrain types.

Some animals including birds are very sensitive against noise and vibrations. Contractor(s) will have to control the following activities for diminishing pressure on birds:

- Avoiding construction works close to sleeping and nesting places of birds during night time
- Operation of machinery and vehicles conforming to acceptable noise and vibration parameters
- Avoiding any traffic (for both construction and leisure needs) through bird habitats
- Fencing, lighting measures for clearing the construction site, but not during breeding period
- Careful execution of construction works.

Representatives of the contractor(s) and WAPDA's EMMC may have to prepare mapping and documentation and provide advice to the technical personnel including truck drivers and labourers. In this respect, help could also be sought from Pakistan National Museum of Natural History (Islamabad).

I.6.3 Preservation of Reptiles and Their Habitats

Reptiles are the most relevant species in the project area. During construction, special measures to avoid their killing would be:

- Investigating the areas to be used for construction (by Herpetologists)
- Fencing, lighting measures for clearing the construction site, but not during breeding period
- Avoiding any construction in reptile areas during the hibernation period
- Relocation of important individuals and species (especially the endangered endemic species).

First filling of the reservoir and the subsequent seasonal impoundment may harm these species. As initial filling will proceed in stages during the high water seasons over six years, the species may get adjusted to this transition. Effective mitigation of the relevant and sensitive reptiles during the reservoir operation phase may need attention to the following:

- Period of reservoir filling: It should not be conducted during winter periods (November-March) when reptiles are hibernating in the earth (highly unlikely under normal conditions).
- Rate of reservoir filling: It should be slow enough (< 1 m per day) during the active summer period so that the reptiles are able to move towards elevated habitats (normal filling of reservoir anticipated during high flow period of about 100 days).

I.6.4 Prohibition of Hunting

As already pointed out, there is very little probability of illegal hunting in the project area due to the lack of mammals and limited number of waterfowl. However, the personnel of contractor(s) will have to strictly avoid any hunting of mammals and/or waterfowl, including wider area of the construction site. Contractor(s) may have to help also in setting up sign boards displaying penalties for illegal hunting.

The related local department charged with wildlife protection will have to play its role in the general project area. In the construction areas, the contractor(s) will provide the necessary cooperation to this line department.

I.6.5 Preservation of Downstream Riverine Forests and Wetlands

As already mentioned, during 2005 the following three related studies were got conducted by the Ministry of Water and Power, Government of Pakistan:

Study I. Water Escapages below Kotri Barrage to Check Seawater Intrusion.

Study II. Water Escapages Downstream of Kotri Barrage to Address Environmental Concerns.

Study III. Environmental Concerns of All the Four Provinces.

These studies were got reviewed through an International Panel of Experts (IPOE). 'Final Report of IPOE for Review of Studies on Water Escapages below Kotri Barrage' was issued on 20 November 2005. Reportedly, this report of IPOE has been accepted by GoP and provinces. Accordingly, the basic recommendation is to allow a constant release of 142 m^3/s below Kotri Barrage, in order to cater for ecological needs.

It is expected that with induction of Diamer Basha storage, the federal regulating agency of Indus River System Authority (IRSA) will be able to better manage the river supplies for fulfilling the above requirements for ecology, as far as possible.

I.7 Fish Stocks Management Plan

I.7.1 Approach

Major impact on fish stocks will occur with the reservoir impounding. Hydrograph and hydrological conditions of Indus River and lower nullah reaches will be significantly changed. Particularly, the spawning areas in Khanbari, Buto, Thak and other nullahs will be changed with adverse impacts on fish stocks. In addition, some fish will be lost when passing through the dam outlets and turbines.

WAPDA will, therefore, have to implement some appropriate mitigation measures.

I.7.2 Migration of Fish Stocks Across Dam Site

Bidding documents for construction would prescribe measures for adverse impacts of construction works on the water bodies and fish stocks of Indus River and nullahs. Related protection measures could be:

- Ensuring safe migration of fish in Indus River through the diversion works of canal and tunnels (no problem anticipated)
- Dumping of earth material in Indus River and nullahs to be avoided.
- Blasting with direct impact on water bodies to be strictly prohibited.

I.7.3 Avoiding Damage of Fish Stocks Due to Water Pollution

Any adverse impact on water quality during construction, which might also affect fish, has to be avoided. This would require following measures:

- Sewage water treatment flowing out of all labourer camps and lavatories
- Tanks of fuel, oil and other liquids to be placed quite distant from any water body
- Washing of vehicles or other machinery in Indus River or nullahs to be prohibited
- Change of oil for engines and other machinery to be only allowed in certified workshops
- All vehicle and machinery to be maintained properly in order to avoid any leakages

I.7.4 Prohibition of Fish Poaching by Labourer and Construction Workers

Fishing by the staff of the contractor(s) will be prohibited through appropriate provisions in the Bidding Documents.

Local Fishery Department, with cooperation of WAPDA will have to control any form of poaching. This will include performing regular surprise inspections and checks at suitable locations of the project area. Some enhancement of prescribed penalties will have also to be enforced by the Fishery Department.

I.7.5 Avoiding Damage of Fish Stocks at the Dam

For various purposes, including material and fish stocks moving downstream there are installations designed avoiding damages of the turbines, power tunnels, sluices, and spillway. The most important measures will be installing protective 140 mm wide trash racks in front of the power intakes. However, the smaller fish stock would not be protected against floating downstream and getting smashed in the dam facilities.

Thus, besides trash-racks fish screens might have to be considered in order to control entry particularly into the intakes. However, as experienced at Tarbela Dam after some time the fish will become ‘wise’ to keep away from these areas.

I.7.6 Change of Natural Fish Stock

Blockage of fish migration across a structure could be catered through a fish ladder system. In general, there are three types of fish ladder: a) dam pool-and-weir b) vertical slot/elevator and c) Denil fish ways. All these fish ladder systems would necessarily require a stable water intake level from the reservoir. Diamer Basha reservoir will be having 100 m seasonal water level fluctuation, which does not permit formation of a suitable flow pattern for upstream and downstream fish migration. Some other factors not favouring a fish way in this case are:

- Extreme length of fish ladder (several kilometres) to negotiate over ± 220 m water level between upstream and downstream (normally the fish can jump across a hurdle of about 0.3 m)
- Fish ways, even if provided, at one or even two valley sides would hardly work as outlet for all fish in the reservoir along the 1.3 km water front (fish screens along the 1.3 km long dam cannot ensure that all fish will find the way to ladder).
- Open fish ladder would enable fish catches in easily accessible stepped water ponds.

Thus, no suitable measure is available to enable permanent fish migration. Moreover, under the existing zoo-geographical conditions that the coldwater fish is restricted to locations above 1200 masl (even higher than FRL of 1160 masl), provision of a fish ladder system does not seem necessary at all.

I.8 Fishery Development and Management Plan

I.8.1 Approach

With the experience of WAPDA at Mangla, Chashma and Tarbela, Diamer Basha reservoir could be used for fishery development. Fishery would become a very important factor of employment, which presently is not the case. In addition, the fish would significantly improve food basis of this distant area of Pakistan, where the nutritional level for most of the people is very poor.

The overall concept will be to develop through 'Reservoir Fisheries Management Plan' (refer Appendix F in Volume III of RP) a sustainable fishery. The Plan will have the following main components:-

- Re-establishing of the existing fishery at Nima (Khanbari Nullah), going to be submerged in the reservoir, in vicinity of land acquisition zone of 1170 masl
- Establishment of a big hatchery in the vicinity of one at Chilas also to be submerged in the reservoir
- Research on most suitable fish species for introduction in the reservoir
- Production / introduction of fingerlings of various species into the reservoir
- Supporting fishery activities including fishermen cooperatives

WAPDA in close cooperation with local Fishery Department would establish as well as run these facilities for the first 5 years of reservoir operation. Subsequently, these would be handed over to the Fishery Department.

Another aim of the Plan would be establishment of Fishermen Cooperative in the project area through the following measures:-

- Development of business plan
- Preparedness for fishery activities including marketing and processing
- Providing a building for management of the cooperative
- Establishing docking facilities (adapted to different water levels)
- Providing (on rent basis) vessels, boats, nets
- Training of managers
- Training of fishermen

Attempt would be to support the fishermen for establishing a sustainable fishery organisation, which within a period of about 5 years would be able to run independently.

I.8.2 Re-establishment of Two Existing Hatcheries

Due to the impoundment of the reservoir, two existing fish hatcheries at Nima (Khanbari Nullah) and Chilas (Buto Nullah) are going to be submerged by the reservoir. These will have to be re-established and made operational before impounding including provision of proper equipment and start of fingerling production. It may be noted that Nima hatchery, though currently not in operation, would be affected even during first stage of the construction works by river diversion through upstream cofferdam with a crest level of 977.5 m.

Both hatcheries would be re-established on the same nullahs. For this purpose, tentative locations upstream of both nullahs in the vicinity of land acquisition zone of 1170 masl have been identified.

It is proposed that the hatchery at Nima be re-established at Narar on the same nullah. Similarly, the hatchery at Chilas would be combined with the proposed large one on Buto Nullah (refer Sub-section I.8.3 below). Re-establishment of hatcheries at Narar would produce about 40 % of the

needed fingerlings. Species to be bred in these hatcheries would be determined taking into account the change of the temperature regime of the Indus River after impoundment.

I.8.3 Establishment of New Large Hatchery

A large fish hatchery would be established to meet the balance 60 % of the fingerling requirement. This new hatchery would be located in the fringe of reservoir at Chilas on Buto Nullah. The following activities would be involved in establishment of this hatchery:-

- Acquisition of land after finalization of the identified site
- Construction of infrastructure for administration, breeding and laboratory
- Establishment of water ponds including related water supply and exchange system
- Establishment of breeding facilities including modern laboratory
- Suitable accommodation including offices and modern office equipment (vessels, nets, other devices)
- Appointment of qualified staff

The hatchery would need to be completed before first full reservoir filling (possibly 2020), to enable release into reservoir the fingerlings in required number.

This hatchery along with the other one at Narar would work for the first 5 years under control of WAPDA and later on transferred to the Fishery Department, Diamer District. Later on, the Fishery Department could also consider transfer to a private enterprise such as Fishermen Cooperative. In the long run, the reservoir fishery may extend its market not only in Pakistan but abroad (for example Tajikistan, Afghanistan and China).

I.9 Rock Carvings Protection and Mitigation Plan

I.9.1 Approach

Rock carvings in Northern (Gilgit-Baltistan) Areas belong to the national heritage of Pakistan. The Indus River Valley during past millenniums was the track and staging area for many people from different cultures and regions. Scientific investigations of German Archaeologists in cooperation with the Dept. of Archaeology and Museum of Pakistan have been made since mid 1980s. The results are also described and published in annual reports, which are available in the above mentioned Department.

Inventory made by the German scientists from the Heidelberg Academy of Sciences and Humanities (HASH) has provided basis regarding mitigation and documentation of rock carvings addressed in this EMP. About 31,423 rock carvings have been identified, distributed on stones often composed of several carvings and inscriptions. The spatial pattern of rock carvings is shown in MAP-7. It can be seen that central area of rock carvings is the immediate river valley between Thalpan and Chilas. These rock carvings would be severely impacted by the reservoir impoundment. Some of the rock carvings could be affected during construction as well due to excavation and other measures. The most severe damage would occur during impoundment of the reservoir when almost all rock carvings would be submerged. Only looking to the most important objects, the proportion would be very high.

Rock carvings located between 1,060 and 1,160 masl, would be only flooded during summer with reservoir impounding. Whether these carvings would get damaged from corrosion by HCO_3 in the water, will have to be observed carefully. However, the basic approach would be to document 109 most important (from the scientific point of view) rock carving objects. This identification has been made by the German Scientists as a result of understanding reached with the Department of Archaeology and Museums (DAAM), Government of Pakistan and obtained by DBC.

Proposed mitigation and monitoring is envisaged through a 'Cultural Heritage Management Plan' (refer Appendix C in Volume III of RP). It will focus on documentation and, if possible, physical relocation of upto 15 out of 109 identified most important objects. Documentation will focus on production in the field, detailed large-size scans of rock carvings. Advanced 3D-Scanning technology developed by German scientists and companies will be acquired and applied. The most difficult task will be the approach to many of these objects and to produce reliable scans. A full electronic documentation will be prepared. WAPDA, through an exclusive unit of the Department of Archaeology and Museums at Chilas would get produced the replicas of these scanned carvings for exhibition in the museum proposed to be constructed in Chilas.

Heidelberg Academy of Sciences and Humanities, supported by the Germany Embassy, during 2006 and 2007 conducted seminars, meetings and discussions. These were held with the Ministry of Culture and Tourism, Pakistan, the administrative ministry for Department of Archaeology and Museums and Northern (Gilgit-Baltistan) Areas Administration to establish a Documentation Centre for rock Carvings in Gilgit. Additional replicas of important rock carvings prepared from 3D-Scanning could also be placed in this museum, when established.

Further measures could be taken to promote archaeological, historical and cultural sciences in Northern (Gilgit-Baltistan) Areas. A chair of professorship at the Karakoram University in Gilgit may be funded over a period of five years. For publishing of scientific results, a quarterly scientific journal could also be funded and rock carving inventory in Urdu language issued. In addition, five scholarships in this discipline for students from Chilas could also be sponsored.

Documentation, removal and relocation and other compensation measures will be covered under the 'Cultural Heritage Management Plan' to be implemented through establishment of an exclusive unit of DAAM at Chilas (refer to Cost Estimate of Environment and Resettlement in Annex L-2).

I.9.2 Damage of Important Rock Carvings by Excavation

Rock carvings are located in the areas, where excavation and other construction work could be undertaken Contractor (s) will be responsible to protect important rock carvings through cooperation with WAPDA and the unit of Department of Archaeology and Museums at Chilas. In particular, a strict procedure will have to be applied in order to protect, relocate and document important rock carvings objects before blasting or other damaging activity. This will be based upon:-

- Rock carving analysis of areas going to be utilised for construction purposes (dam site excavation, quarries, camps, vicinity of potential roads).
- Listing of endangered rock carving objects (distinguishing between most important and other objects).
- Protecting of stones/carvings, against any physical damage (prohibiting excavation).
- Documentation of boulders/carvings before start of excavation, where necessary.
- Relocation of boulders, with most important carvings, where feasible.

I.9.3 Inundation of Most Important Rock Carvings

As mentioned above, before impounding the reservoir, 109 most important rock carving objects will be documented. Based upon this detailed field inventory including 3D-Scanning, decisions for physical relocation of any removable and accessible objects could be taken. If possible, the physical relocation will have to be done before submergence. However, experience from other projects indicates that often physical relocation of carvings is not feasible due to properties of the rock which, while cutting or even transportation, gets cracked and lost. The special task of 3D-Scanning and replication of 105 objects would be assigned to a small enterprise under supervision of the Department of Archaeology and Museums Unit at Chilas.

Besides procuring the related equipment this enterprise would get the related staff properly trained. The task could then be carried out through:

- Procurement of 3D-Scanning camera and related equipment.
- Training of the two specialists from Pakistan in 3D-Rock Carving scanning technology (trained by German company/University).
- Physical identification and captioning of most important rock carvings objects in the field.
- Scanning of all 105 rock carving objects.
- Replicating the carvings on a suitable material (plastic or sinter).
- Investigating the feasibility of removal and relocation of related boulders, stones, cliff areas (supported by a geologist).
- Preparation of proposed removal and relocation measures for those objects.
- Getting accomplished cutting, removal and relocation in the field.
- Storing of the replicated / relocated objects at certain places for later disposition.

Plan for documentation, removal and relocation of the 109 most important rock carvings will have to address the following:

- Location: geographical coordinates.
- Rock conditions: character of rock carving object, state of the rock, weight/volume of boulder, geological and other conditions.
- Accessibility: which riverbank, height, steepness, road access.
- Technical solutions for scanning procedure.
- Technical conditions for relocating: cutting machinery required logistical arrangements.
- Overall management: other logistics and required support.
- Rehabilitation of original locations levelling, cleaning.

I.9.4 Documentation and Exhibition Centre

The concept of acquisition of land in Gilgit and establishment of a Special Documentation Centre has been developed during the last five years by the Heidelberg Academy of Sciences and Humanities, the Germany Embassy, and the Ministry of Culture of Pakistan through its Department of Archaeology and Museums. Seminars, meetings and discussions were held in 2006 and 2007 to further pursue the concept of this documentation centre for rock carvings from Northern (Gilgit-Baltistan) Areas.

According to the present indication, this Documentation Centre will be established in Gilgit, and equipped with modern equipment for exhibition and research. Therefore, its establishment, running and maintenance will not be the liability of WAPDA. As it is now proposed to establish an exclusive premises at Chilas for exhibition of the replicas of most important rock carvings, WAPDA will be responsible only for its initial funding and subsequent running. WAPDA's EMMC could also oversee the working of this Documentation Centre at Chilas. Further, it could prepare some related documentation including boat trips for the tourists to rock carvings objects like Shing exposed due to reservoir drawdown.

I.9.5 Support of Archaeological Science and Education

Further activities as part of compensation of loss of rock carvings due to impoundment of the reservoir could be:

- Funding the chair for a Professor of History and Archaeology at Karakorum International University (five years)

- Preparation, including translation into Urdu and circulation of scientific publication of rock carvings produced by Heidelberg Academy (five years), and
- Publication of a quarterly Scientific Journal on Archaeology and Rock Carvings through a designated institution (5 years).

In addition to the above measures, five scholarships per year for students of Diamer District could be funded for related studies. This will be a welcome gesture for compensating the loss of heritage rock carving objects. It would contribute significantly to development of incentives to improve the educational qualifications of the interested youth in the project area.

J MONITORING

J.1 Overall Objectives

Environmental monitoring is obligatory part of every Environmental Impact Assessment and Environmental Management Plan. It is required to observe and monitor the state of environmental components, which are going to be affected potentially.

The objective is to monitor all sensitive parameters in order to avoid adverse changes. If there are adverse changes a follow-up by the contractor (during construction) and WAPDA (during operation) will ensure prompt actions to ameliorate those conditions. This will require a schedule of observations and monitoring to match the related requirements.

Monitoring of various parameters will be accomplished as illustrated in the synoptic format for following four Annexes:

- Annex J-1: Monitoring of Construction Related Impacts on Physical Environmental
- Annex J-2: Monitoring of Construction Related Impacts on Biological Environment including Health Safety and Rock Carvings
- Annex J-3: Monitoring of Operation Related Impacts on Physical Environment
- Annex J-4: Monitoring of Operation Related Impacts on Biological Environment including Health, Safety and Rock Carvings

Annexes also bring out the need for special knowledge and equipment, which will have to be arranged prior to commencement of construction and operation stages, respectively.

Monitoring will have to be done independently. In case this is assigned to WAPDA's Environmental Management and Monitoring Cell (EMMC), it should not be influenced by the personnel of the sister implementing outfits of WAPDA. Independent support / expert advice will be required by EMMC, particularly in the area of biology, health including malaria and rock carvings.

Monitoring of all mitigation and compensation measures related to the affected population and social-economic assets will be covered under the companion document of Resettlement Plan.

J.2 Monitoring of Construction Related Impacts on Physical Environment

J.2.1 Geology: Sliding of Rock and Land

Monitoring has to be focused on observation of effects on geology such as seismic events, rock slides or landslides, caused by construction. The geological monitoring in this respect has to observe the following issues:

- Triggering of rock slides in the dam and quarry site areas
- Triggering of landslides in the dam and quarry site areas.

Especially during and after heavy rainfalls, visual observations of the risk areas will be required. These locations, will have to be identified, prior to the start of construction based upon the Sliding Risk Mapping (see Annex J-1).

J.2.2 Land: Rangeland and Land Erosion

Monitoring of land, mostly rangeland would need to be carried out in close cooperation with the local Forest Department. An important part will be to monitor locations and area designated for construction. Main monitoring will cover:

- Land occupied by various construction sites
- Any other land beyond designated areas likely to be degraded by construction

- Land erosion triggered by construction

The observed data from monitoring will have to be compared with the benchmark information including an appropriate scale (1:10,000) map. The monitoring will be performed quarterly.

Any hints on land erosion triggered by construction (gully erosion, deflation) will have to be monitored and discussed with the contractor(s) and appropriate protection and compensation measures implemented (see Annex J-1).

J.2.3 Soil: Degradation

Beside the erosion of land and soils the degradation of soils caused by various construction measures has to be monitored regularly. This will include the construction sites and vicinity areas. Degradation of soils could be caused by the following construction related activities:

- Plying of heavy vehicles
- Dumping / storage of materials
- Spillage of heavy fuel and oil residues from vehicles and machinery

Appropriate compensation measures, preferably rangeland establishment and re-cultivation, would be taken by the concerned contractor (see Annex J-1).

J.2.4 Climate and Air

J.2.4.1 Meteorological Base Data

Climatic observations are required for general environmental assessment. Presently, Meteorological Station of Chilas (under Meteorological Department of Pakistan) is located in the middle of Chilas town at 1,251 masl. This is operating since 1970's and observing: daily air temperature; clouds; daily precipitation; daily evaporation; and daily wind (direction and velocity).

These observations should continue during the next years on similar basis. An additional meteorological station has been also established by WAPDA close to the dam site. The special site conditions do require detailed measurements of temperature. For this purpose, special temperature measurements were started during July 2007 at two different elevations on both the river banks at the site of existing cable way upstream of the dam. These observations should continue during the construction period to assess spatial energy balance between air and the surfaces and will also be relevant for the special exothermic reactions induced during concrete preparation and placement of roller compacted concrete (RCC) (see Annex J-1).

J.2.4.2 Exhaust Emissions From Heavy Vehicles and Machinery

Potential change of local air quality could be caused during the long period of construction with thousands of working hours of heavy trucks, bulldozers, excavators, crushing and batching plants. Thus, this element will need to be monitored and appropriate remedial measures taken, if necessary (refer Annex J-2).

The monitoring will have to focus on the main gases such as SO_x, NO_x, particulate matters, floating dust, lead, benzyl, CO, O_3, etc.

J.2.4.3 Water Discharge and Sources

During construction, daily water levels and periodic discharge observations at gauging stations of Shatial, Khanbari Nullah and Bunji will have to be continued by the Surface Water Hydrology Project (SWHP) of WAPDA. During operation, only Bunji and the dam releases will have to be observed and recorded. However, computation of water flow at dam site will also made by accounting for the storage (-) or releases (+) of water.

A monitoring of spring and groundwater reserves after reservoir impounding might have to be conducted also.

J.2.4.4 Water Quality of Indus and Springs

Regular water quality monitoring will continue on the basis of ongoing sampling and investigation of hydro-chemical data between 2003 and 2008 (NEAC, DBC). An important task of the environmental monitoring will be the observation of water quality in Indus River, nullahs and any spring water under human use. Regular hydro-physical data such as pH, conductivity, cat ions and anions, total mineralization would be collected.

For expeditious handling of this assignment, it is proposed to establish a laboratory for hydro-biological investigations in the project area (Chilas). It will have to be equipped also for carrying out the sampling through boats, nets for plankton, electronic deep water temperature measurement, electronic measurement equipment for oxygen and conductivity, and water quality kit for quick field measurements. Water quality sampling will have to include also the sewage water from any labourer or construction camps. For meaningful monitoring, reliable observed data on oxygen (BOD) and bacteria will have to be provided by this laboratory including other parameters as indicated in Table J-1.

Table J-1: Water Quality Monitoring Parameters During Construction

Source	Quality Parameter
Vehicles & machinery	Hydrocarbons
	Oxygen, BOD, COD
Sewage	Oxygen, BOD, COD
	Bacteria: total, coliform
Explosive material	NH_3-N, NO_2, NO_3
Cement , concrete	HCO_3, $HMnO_3$, total hardness, TSS, transparency

Source: DBC, December 2007

Existing sampling stations for water quality monitoring, and also continued during construction, will be as shown in Table J-2.

Table J-2: Water Quality Sampling Locations during Construction

River / Nullah	Location	Remarks
Indus River	No. 1: Raikot Bridge	Existing stations having data since 2003 to be continued
	No. 2: Gini Nullah: 100 m below confluence with Indus River	
	No. 3: Ghichi Nullah: 100 m downstream of confluence with Indus River	
	No. 4: Thor Nullah: 1,000 m downstream of confluence with Indus River	
	No. 5: Dam site: 100 m downstream of dam site	
	No. 6: Shatial Bridge	
Nullahs	No. 7: Jalipur Nullah: shortly before confluence	
	No. 8: Gandlo Nullah: 100 upstream of Relocated Karakorum Highway Bridge	
	No. 9: Thak Nullah: 1,000 m upstream of Karakorum Highway Bridge	
	No. 10: Kiner Nullah: shortly before confluence	
	No. 11: Buto Nullah: 2 km upstream from Karakorum Highway Bridge	
	No. 12: Hodar Nullah: 1,000 m upstream of Hodar Nullah confluence with River Indus	

Source: DBC, December 2007

J.3 Monitoring of Construction Related Impacts on Biological Environment

J.3.1 Plants

Observation of the state of the plants, mainly belonging to the Artemisia steppe, for the areas outside of the main construction should also be a part of the monitoring. For this purpose, special advice / assistance might have to be solicited from the local line agencies including Arboriculturists (see Annex J-2).

J.3.2 Wildlife

Regular monitoring will be required to monitor potential degradation of wildlife or even damage of individuals or species. In this regard, some expert advice / assistance may also be required for the important animals (amphibians and reptiles) and the birds. Annex J-2 describes the indicators, methodology, areas, frequency and other issues of monitoring. An important requirement will be preservation of rock agama, geckos, snakes and other lizards.

Monitoring would have to be carried out in close cooperation with the contractor(s), who would be obliged to evacuate reptiles from the areas to be occupied for any construction. A particular subject of monitoring will be the hibernation period (October-March), during which new constructions areas should not be occupied.

Any hunting will have to be prohibited and, therefore, subject of monitoring (see Annex J-2)

J.3.3 Fish

In the areas of direct potential impact on water bodies, such as at dam site (downstream and above) and some quarries close to nullahs or the Indus River, potential degradation or damage of fish have to be monitored regularly. Annex J-2 defines the conditions.

J.4 Monitoring of Operation Related Impacts on Physical Environment

J.4.1 Geology: Rock and Land Slides

Reservoir impounding upto FRL of 1160 masl and its subsequent drawdown for storage releases, might induce rock and landslides around the reservoir shoreline. This phenomena will have to be monitored carefully in order to early introduction of any needed protective measures (see Annex J-3).

J.4.2 Land

Similar erosion phenomena might also be induced in soft materials around shoreline of the reservoir (see Annex J-3). It would need to be monitored, especially in the 10 m buffer zone above FRL of 1,160 masl in order to provide timely protective measures, if needed.

J.4.3 Climate and Air

Establishment of reservoir may have some influence on changing the present climatic situation. Huge water body will alter the energy exchange between air and water layers. The albedo of lake water will be quite different in comparison with the previous albedo of earth's surface. This could be monitored through the relevant climatic data observed at the Chilas supplemented by the observatory established close to the dam site.

Normal monitoring parameters would be: air temperature; precipitation; wind; cloud cover; and fog. Additional information could also become available from temperature observations at various depths of the reservoir (see Annex J-3).

J.4.4 Water Related Infections

Monitoring of malaria infections in the project area may have to be carried out over a long run. This should compare whether, under the anticipated situation, an increase of malaria cases would occur with creation of the reservoir? For this purpose, the surrounding medical dispensaries of local Health Department should record the cases carefully, starting with the baseline data of construction period. If this monitoring brings out the need for any anti-malarial measures, the local Health Department will have to pursue them through a proper plan. This may comprise:

- Establishment of special medical service facilities for malaria (in Chilas or selected Model Villages)
- Staffing over a 5 year period (one doctor, one nurse) under administration of Health Department
- Supply of pharmaceutical products on malaria
- Training of personnel
- Creation of public awareness

Monitoring of other water-borne diseases, which have an environmental background, should be also carried out. Any hints about sources and conditions should be thoroughly investigated. Maintenance of PC-based records will also be preferable in this case (see Annex J-3).

J.4.5 Reservoir Stratification and Water Quality

i. Eutrophication

One of the most important environmental impact will be the formation and behaviour of reservoir. Many examples in tropical countries show a severe eutrophication after establishment of a reservoir. Present indications are that due to hydro-biological conditions a stagnating reservoir will not be formed thus excluding the possibility of eutrophication. In case of any such future adverse development (though highly unlikely), the information might have to be collected through monitoring as indicated below.

ii. Hydro-physical Data

- Periodic (combined with other data as indicated below) water temperature at 1 m depth at various locations (GPS based coordinates):
  - No. 1: Middle of reservoir near Raikot Bridge (upstream end)
  - No. 2: Middle of reservoir close to Gandlo Nullah
  - No. 3: Middle of reservoir near Chilas (upstream Thak Nullah confluence)
  - No. 4: Middle of reservoir downstream Chilas at Ghichi Nullah
  - No. 5: Middle of reservoir 3 km from dam site (downstream Khanbari nullah confluence)
  - No. 6: Middle of the reservoir close to the dam (about 200 m upstream)
- Weekly water temperature profile at all locations (every 10 m depth)
- Weekly air temperature at 50 cm above the water surface
- Turbidity sampling (during reservoir filling period)

iii. Hydro-chemical Data (at all locations)

- Ph, conductivity, TSS, transparency, NH_3, NH_4, NO_3, PO_4, O_2, BOD, COD, HCO_3, Cl, Mg, Na, hydrocarbons
- Depth of sampling: 1 m, 20 m, 100 m

iv. Hydro-biological Data

- Plankton from water (at various depths):
  - Once during winter and
  - During summer from April to September every fortnight (12 samples)
- Benthos from reservoir bottom in winter:
  - Above six locations
  - Depth of sampling: 1 m, 20 m, 100 m.

The above data collected, if collected during the monitoring, will have to be evaluated by engagement of specialist(s).

From the start of reservoir impounding, the monitoring will be continued on the above mentioned basic hydro-chemical data. However, during this stage, emphasis will be laid on criteria relevant to the potential eutrophication as shown in Table J-3.

Table J-3: Operation Stage Monitoring of Water Quality For Eutrophication

Operation Related Source	Relevant Water Quality Parameter
Sewage	NH_3-N. NO_2, NO_3
	PO_4
	Oxygen, BOD, COD
	Bacteria: total, coliform
Cultivation	PO_4
	NH_3-N. NO_2, NO_3
	Ca, Mg, Na
	Oxygen, BOD, COD

During operation, the proposed sampling stations for water quality measurements will be almost similar to the construction period and are shown in Table J-4:

Table J-4: Water Quality Sampling During Operation

Water Quality Sampling Stations During Operation	
Indus River	Middle of reservoir near Raikot Bridge (upstream end)
	Middle of reservoir downstream of Gandlo Nullah confluence
	Middle of reservoir at Chilas (downstream of Ghichi Nullah confluence)
	Middle of reservoir close to Khanbari (downstream of nullah confluence)
	Middle of reservoir close to dam (100 m upstream)
	Shatial Bridge (downstream end)
Nullahs	Jalipur Nullah: future intake points for water supply
	Gandlo Nullah: future intake points for water supply
	Thak Nullah: future intake points for water supply
	Buto Nullah: future intake points for water supply

Source: DBC, December 2007

J.5 Monitoring of Operation Related Impacts on Biological Environment

J.5.1 Restoration and Development of Rangeland

The zone around the Diamer Basha Reservoir will be subjected to intensified use of land and other resources. Any needed re-cultivation / protection of rangeland in this area on the basis of monitoring results would need special attention.

Basic parameters of monitoring would need special attention as listed in Annex J-4.

J.5.2 Wildlife and Fish

There is the assumption that birds, especially water-fowl, will in future visit the huge reservoir in larger number as breeding and resting area for the inter- and intra-continental migration. This process might have to be monitored carefully through assistance of World Wildlife Federation (WWF).

Monitoring of the existing and the newly introduced stocks in the reservoir will be necessary. The aim will be to check the survival and species-wise growth rate of the introduced varieties. This will be carried out through the Organisation proposed to be established under 'Reservoir Fishery Management Plan'. The results of this monitoring will also provide basis for estimated production of fingerlings in the fish hatcheries created on fringes of the reservoir.

K ENVIRONMENTAL RESEARCH

K.1 Objectives

There are many areas, where the current knowledge is not sufficient. This needs to be investigated, especially the response of environment to creation of the reservoir. These research data will contribute to proper environmental management.

From the stand point of regional development, some relevant investigations and research will also be welcome. Northern (Gilgit-Baltistan) Areas, as compared to other Pakistan regions, is seriously lacking facilities for science and education. To improve the knowledge base, these activities should be carried out, preferably through scientific institutions from Northern (Gilgit-Baltistan) Areas and NWFP (Khyber Pakhtunkhwa). These could, by the way of illustration and not limitation, cover the topics proposed in the following.

K.2 Areas of Further Environmental Research

K.2.1 Downstream Channel Erosion

Initial degradation downstream of the dam will have to be investigated separately by WAPDA after starting the reservoir operation. The main purpose will be to investigate and assess the following:

- Reach of potential channel degradation (expected not to extend beyond 20 km or so)
- Magnitude and trend over time (yearly basis)
- Seasonal regime of erosion (depth and width) and sedimentation (material deposited, period, depth)
- Any potential damage to settlements and other human objects (cultivated land, trees, infrastructure, etc.)

This programme may be started by WAPDA with the initial filling above MOL of 1060masl around 2018. It should also be preceded by the benchmark survey of river morphology at least for the stretch likely to face degradation.

K.2.2 Sliding and Rock Erosion After Impoundment of Reservoir

'Landslide and Slope Stability Report' (2008) of DBC bad indicated very limited incidence of this phenomena to be managed through controlled access to the potential area. However, if monitoring reveals a different picture, an appropriately designed research effort may be required involving:-

- Geological and slope mapping of most vulnerable areas against sliding
- Design / implementation of appropriate protection methods (including cost estimates)
- Selection of most suitable bush species including preparation of seedlings, from the point of view of reducing sliding risks through vegetation.

Regarding protection measures, priority will have to be given to shrub planting, which may also contribute to re-cultivation of degraded land and slope areas, thus increasing vegetation cover around the reservoir.

K.2.3 Eutrophication and Aquatic Life of Reservoir

Investigation of thermal stratification of future reservoir is an important scientific topic, studying the behaviour of the reservoir after first impoundment. After creation of the reservoir relevant hydro-physical, chemical and biological data of the regular monitoring should be used and compared with the biological data on plankton, benthos and fish in order to forecast potential eutrophication. For

this purpose, special advice may be needed from international experts including introduction of analytical modelling, if considered desirable.

This effort may lead to proposals for measures to be taken for avoidance of eutrophication and pollution.

K.2.4 Springs

Existing springs, despite their small amount of water have an importance for the local water supply. The following information this regard may need to be collected and investigated:

- Inventory of springs with relevance for local water supply (including mapping).
- Estimation of amount of water yield with seasonal fluctuation.
- Relevance for village/future Model Village(s).
- Location (above or below the inundation line of 1160 masl).
- Water quality from drinking point of view.

The results may become handy for water supply during construction as well as operation.

K.2.5 Water Sanitation by Natural Sewage Wetland

Future basic measure for treatment of sewage water in the project area will be through establishment of proper treatment plants. It may, however, be desirable to establish in one of the Model Villages (second composite on Harpin Das near Chilas), a pilot project to test the natural treatment of open wetlands. This research pilot project, first in the Northern (Gilgit-Baltistan) Areas and may be in Pakistan, could include the following additional works besides the basic sewerage disposal network:

- Reservation of suitable land at a downstream location close to main sewerage system
- Earmarking of the artificial fields levelled in small terraced plots enabling the slow flow of the water through a sequence of small bordered fields before outflow into the reservoir
- Covering the floors of terraced plots with a semi-permeable natural material (silt, sandy silt, etc.)
- Erection of walls, as borders around each plot, to allow reasonable dwelling time (in days) and slow movement of the water
- Provision of conveyance system for sewage water effluent (pipe or open channel)
- Planting of reed and other perennial vegetation in the plots to help depletion of phosphate and nitrogen
- Fencing of the area against human and animal trespass

During operation, sewage wetland plants would require permanent maintenance for cleaning, cutting of reed, replanting and repair works of walls, fences and other infrastructure.

K.2.6 Introduction of Commercial Fish

Proper research on fish stock development and introduction into Diamer Basha reservoir would be needed based upon the prediction of future water conditions in this high elevation water body. Following main aspects would need to be investigated:

- Forecast of potential behaviour of the natural fish stocks: moving towards a more moderate temperature water body. This would require determination as to which of the species in the reservoir would come under thermal stress, or even be expelled or become dominant?
- Prediction of nutrition basis: This would require determination whether it will allow changes of tropical status from the original oligotrophic water body towards a slightly more eutrophic one?

- Proposal of fish species: Capable of familiarizing with future water conditions as well as complement the potentially remaining species.
- Commercial utilization of fish species: For local consumption / commercial export to other areas

Studies of natural and introduced fish in various reservoirs of the world under similar climatic conditions (relatively high elevation, winter coldness and extensive summer drought period) would need to be reviewed. This necessarily would include other Pakistan projects at Mangla and Tarbela, although established in somewhat warmer and humid climate. Examples from Eurasian countries due to their affiliation to the Palaearctic zoological region with the dominating cyprinid subfamily of Schizothorax may also be relevant.

Feeding might a problem for a large population of fish due to the low nutrition status of the Indus River water (including nullahs). Besides, investigation on feeding of fish, careful monitoring of water quality may also be needed.

K.2.7 Gold Extraction, Processing and Marketing

Gold in very small concentrations appears in the alluvial sediments transported seasonally by the Indus River. Many people, especially belonging to the Soniwal tribe, work on extraction of gold from washing and sieving of these sediments. Due to submergence of the present river bed of the Indus, some of those areas will be permanently lost, while other may re-appear during seasonal reservoir drawdown. The economic situation of this population might deteriorate significantly. Research in this respect may have to be focused with identification of additional areas for continuation of gold washing procedures, covering the following tasks:

- Identification of gold containing sediments in other areas (only those where presently no collection is done and are without tribal dispute or ownership)
- State of exploitation of these locations by other people
- Inventory of sediment and gold content of newly accumulated sands at head of the reservoir and getting exposed during 100 m drawdown period
- Improved technology of gold washing including mechanism
- Exploring the possibility of large scale processing of gold in the region (estimating the required investment, etc.)

This research project may also start prior to the first full impoundment together with collaboration of Soniwals. Findings of this research could be then disseminated among the gold washers for further guidance and implementation.

K.2.8 Tourism Development

Tourism currently does not play a significant role in the project area though it holds promise considering the natural conditions and landscape beauty. However, basic requirement should be to develop only those tourism concepts, which are ecologically sound and respect religious norms and traditions of Northern (Gilgit-Baltistan) Areas. The research project to be launched by the Tourism Department Northern (Gilgit-Baltistan) Areas should investigate the following:

- Attractions from landscape beauty point of view (further enhanced by creation of a large lake)
- Cultural heritage attractions such as rock carvings and architecture exposed during reservoir drawdown between FRL and MOL
- Traditional rural life in the villages including making of handicrafts
- Exploiting the potential created by Diamer Basha reservoir for promotion of water sports
- Improvement in basic service facilities (transportation, accommodation, food, culture, leisure, etc.)

K.2.9 Malaria and Other Waterborne Infections in Reservoir Area

A special research may have to be instituted through the local Health Department for assessing the malaria conditions before and after the first impounding of reservoir with focus on the following:

- Investigation of malaria cases, locations of malaria infections, prevailing current conditions (including system of monitoring, therapy, lack of funding, staffing)
- Prediction of mosquito breeding areas and periods in the reservoir with shallow water (<2.0 m water depth) and relatively long stagnation periods of warming-up and prediction of mosquito growth
- Forecast of potential prevailing areas and periods of malaria cases.
- Medical service requirements.

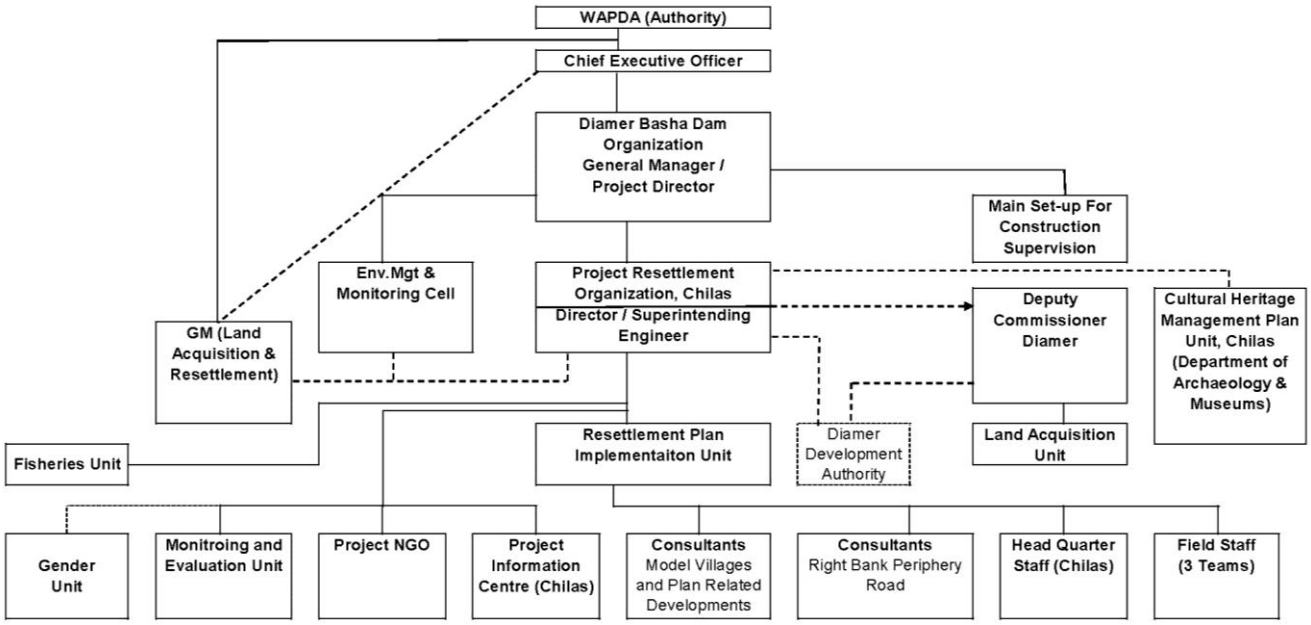
The resultant research will provide the local Health Department with basis for preparation of necessary preventive measures.

L ADMINISTRATIVE STRUCTURE

L.1 Implementation of EMP by WAPDA

'Proposed Overall Organization Chart For Project Implementation' is shown in Figure L-1.

Figure L-1: Proposed Overall Organizational Set-up for Project Implementation



During construction, WAPDA will have to implement both Environmental Management Plan (EMP) and Resettlement Plan (RP) of Diamer Basha Dam Project. The basic implementation instrument for RP will be the Project Resettlement Organization (PRO) located at Chilas. For EMP, an exclusive Environmental Management and Monitoring Cell (EMMC) will be established under the General Manager / Project Director, DBDP at site (refer Figure L-1). Under PRO, Project Information Centre will be also established for liaison with PAPs and other key stakeholders through continuous process of information disclosure, consultation and participation.

WAPDA's task will not end with impoundment of the reservoir but require follow through of many environmental works. These will be conducted through continued creation of EMMC within WAPDA's organisation responsible for operation and maintenance of the project.

As already mentioned, this document has been prepared for addressing adverse impacts on the environment including their mitigation, monitoring and research. All impacts and mitigation measures on population, including economic and social aspects, will be dealt with under the Resettlement Plan to be implemented and managed by the Project Resettlement Organisation (PRO) of WAPDA, being created specifically at site.

As mentioned above, WAPDA's EMMC will pursue the basic tasks under the Environmental Management Plan (EMP). As shown in Figure L-1, this Cell will be the part of WAPDA's setup for construction of Diamer Basha Dam Project. Most of the EMP related tasks will be embedded in the Bidding Documents, to be executed by the international prime contractor(s). The necessary coordination and supervision will rest with the consultants / WAPDA's EMMC. During operational stage of the project, the main responsibility will rest with EMMC as part of related WAPDA's outfit.

Various mitigation, monitoring and research measures to manage adverse impacts on physical and biological environment contained in this EMP are:

- Implementation of mitigation measures on land, water, wildlife, fish and fishery, health and safety, and the rock carvings (mostly through funding support to various concerned line agencies of the public sector).
- Environmental monitoring, in particular for water, water quality, land, and wildlife.
- Relocation and documentation of heritage rock carvings (through an exclusive unit of the Department of Archaeology and Museums to be established at Chilas).
- Environmental research on various essential topics (through concerned agencies, WAPDA, consultants, research institutions, etc.)
- Monitoring of the process including coordination, reporting, mapping, etc. (WAPDA)
- Advice and assistance to the concerned governmental agencies for regional development planning and particularly the project area (WAPDA and/or consultants including Diamer Development Authority proposed to be established at Chilas under the Civil Administration)

Both RP and EMP are companion documents aimed at effective management of all environmental tasks mentioned in the 'World Bank Guidelines on Environmental Assessment' and related documents of ADB.

As mentioned above, WAPDA's EMMC under Diamer Basha Dam Organization will have the overall responsibility and pursue all related activities in close coordination with:

- Consultants to ensure contractor's compliance regarding construction related issues
- Diamer (and for some subjects with Kohistan) District Administration through the concerned line departments
- Department of Archaeology and Museums for cultural heritage management including rock carvings

Initial construction over 10 years and subsequent operation of the dam and reservoir implies permanent role of the WAPDA's EMMC. However, its structure, tasks, number and composition of staff may change from time to time.

L.2 Structure of WAPDA's Environmental Management and Monitoring Cell

This Cell to be established within Diamer Basha Dam Organization in the field (refer Figure L-1) will be responsible for implementation and management of various environmental tasks. This will be headed by a Director with initially proposed key staffing as listed in Table L-1.

Table L-1: Proposed Structure [a)] and Staff Compositions of Environmental Management and Monitoring Cell

Environmental Monitoring and Mapping (3)	Environmental Management (9)	Water and Hydro-chemical Laboratory (10)	Social Development & Medical Team (6)	Construction Monitoring Team / Experts (12)
• Climate and Hydrology Team: Climatologist (1), Hydrologist (1) • GIS Team: GIS specialist (1)	• Biological Team: Section Head (1) Botanist (1) Zoologist (2) • Fish Team: Biologist (2), Ichthyologist (1) • Geology: Geologist (2)	• Reservoir and limnological Team: Hydrologist (1), Chemist (1), Limnologist (1) • Water sanitation: Chemist (2), Biologist (2) • Water Quality Laboratory: Chemist (2), Limnologist (1)	• Resettlement Advisor (2) • Gender Team: Sociologists (2) • Medical Team: Doctors (2)	• Monitoring Team: (10) • Experts: (2)

a) Excluding the Support & Lower staff comprising 22 personnel to be provided by the parent site organization

Establishment, staffing and running of EMMC for about 10 years will be funded through PC-1 (Part 1), 'Acquisition of Land and Resettlement for Diamer Basha Dam Project' modified by DBC as per supporting details in Annex L-1.

L.3 Scope of Work

L.3.1 Construction Stage

L.3.1.1 Monitoring and Evaluation of Project Progress

EMMC will prepare monthly, quarterly, and annual 'Monitoring and Evaluation (M&E) Reports' for submission to the concerned Environmental Protection Agency (EPA), WAPDA, Diamer / Kohistan District Administration and any concerned monitoring and evaluation entity specially established for this purpose.

Data will be collected on a predefined basis and embodied in annual reports. These reports will be submitted to the concerned governmental authorities for determining whether any corrective measures are needed.

For projects with significant adverse social impacts including the displacement of a large number of households and productive lands, like Diamer Basha Dam Project, it may also be required to undertake an external monitoring and evaluation (M&E) on periodic basis. This could be an independent agency such as a competent NGO, an academic and research institution, or a private consultant.

Internal monitoring and evaluation for land acquisition and resettlement will be the responsibility of a separate unit to be established within WAPDA's Project Resettlement Organisation at site (see Figure L-1). This outfit will cover overall parameters to be monitored through:

- Cash and kind compensation associated with loss of access to assets.
- Cash and kind restoration and development associated with the involuntary relocation of the affected households.
- Overall impact and ability of the resettlement programme to improve living conditions of the affected parties.

Programme of environmental monitoring, evaluation and reporting should have to be in place as soon as construction works are started by the prime contractor(s). This will also encompass all the important aspects of implementing the Resettlement Plan (RP). This activity will provide WAPDA / implementing agency with an effective tool to measure physical progress against milestones established in the RP.

To start with, this outfit could be combined with M&E Unit of Project Resettlement Organization of Diamer Basha Dam Project including necessary personnel and funding. As the construction activities pick up, the basic functions could be passed on to the exclusive Environmental Management and Monitoring Cell (EMMC) to be established in WAPDA's Diamer Basha Dam Organisation at site to oversee the project implementation.

L.3.1.2 Obligations of EMMC

As already mentioned, WAPDA will establish in the field organisation an exclusive EMMC responsible for overlooking / implementing all environmental activities on mitigation, monitoring, research and management. During construction period, most of the activities will be conducted by the contractor(s) as specified in related bidding documents. The responsibility during project operation will rest with WAPDA supported by EMMC.

L.3.1.3 Contractor's Obligations

Contractor(s), particularly for the core construction, will have to follow the requirements for a sound environmental construction in accordance with the specifications laid down in the respective bidding documents.

Measures related to the environmental matters as prescribed in the individual 'Bidding Document', will generally need to be implemented prior to the start of construction after approval by WAPDA / Engineer. These measures will be also verified after construction. Furthermore, the contractor(s) will also be responsible for compliance with following environmental obligations:

- Saving any piece of nature on land, rock material, soils, vegetation and animal
- Preserving local exclusive rights of natural resources use (in particular on water and land)
- Deploying equipment and machinery conforming to environmental parameters (noise, emissions)
- Establishing high standard maintenance system for vehicles and machinery
- Applying high standards of skills and responsibility on the assigned staff
- Managing a highly safe construction system
- Organising appropriate environmental management and safety control system

Contractor(s) will also be required to assign highly motivated and capable environmental staff at the site. It will focus on the most important potential environmental risks such as: water supply and sewerage treatment; noise and vibrations; pollution by trucks and heavy machinery; and wildlife.

As already mentioned WAPDA / Engineer will have to monitor all concerned activities of contractor(s) through early establishment of EMMC.

Furthermore, a close coordination will be required between the main contractor(s) for project construction with those engaged on the preliminary works such as upgradation and relocation of Karakorum Highway.

L.3.2 Operation Stage

WAPDA's operational outfit (Diamer Basha Dam Project Organisation) will have to implement various requirements as outlined in the EMP. In particular, the reservoir operation criteria will aim at the overall objective of avoiding, to the extent possible, any deterioration in environmental state of: the reservoir periphery; and immediately downstream area. A relevant upstream consideration may be to avoid very early filling of the reservoir, to the extent possible, to facilitate hibernation of reptiles. WAPDA's operational organization will have also to cooperate closely with Diamer District Administration for maintaining reservoir level with reference to the harvesting of short duration recession agriculture plots.

Sensitive Indus River riverine forest and wetland sections downstream are those below Jinnah Barrage and especially the mangrove ecosystem below Kotri Barrage. It is expected that by implementation of recommendation in special studies conducted during 2005, IRSA will be able to get released the supplies to meet ecological requirements downstream of Kotri Barrage.

L.3.3 Research

Environmental research is an implicit and stand-alone part of the work of the environmental works (see Chapter K). The approach would be to launch this through research institutions of universities and other scientific formations, especially those from Northern (Gilgit-Baltistan) Areas and NWFP (Khyber Pakhtunkhwa).

Overall supervision of the research projects will have to be overlooked by the EMMC of WAPDA including documentation and dissemination.

L.3.4 Environmental Costing

Mitigation, monitoring, compensation and research require funding, which will be provided by WAPDA. The related costs are included in the Annex K-1 of the companion Resettlement Plan. However, for ready reference, the details of total related provisions of Rs. 1.225 billion as extracted from RP, are shown in Annex L-1. These cover:

- Environmental Management and Monitoring Cell (Page 1, Annex L-1): Rs. 675 million (including equipment such as laboratory for water investigations, vehicles, office equipment, office running and salaries for staff).
- Environmental Monitoring and Management: Rs. 320 million (Page 2, Annex L-1).
- Environmental Research: Rs. 230 million (page 3, Annex L-1).

In addition, there is a provision of Rs. 357 million for 'Cultural Heritage Management Plan' including mitigation and documentation of rock carvings (Annex L-2).

M CONCLUSIONS AND RECOMMENDATIONS

M.1 Conclusions

M.1.1 Prevention / Mitigation of Severe Environmental Changes and Threats

Construction of Diamer Basha Dam Project including its reservoir would significantly change the environment of the area through the following impacts:-

- Relocating almost 30,000 peoples from their homes in 31 villages
- Submerging cultivated and rangeland, thus denying the essential food, economic base, particularly of local farmers
- Altering the natural river regime through establishing a reservoir with large seasonal fluctuations, river channel erosion and sedimentation
- Adversely impacting cultural heritage through submergence of a large number of unique rock carvings
- Submerging the habitats of amphibians, reptiles and birds

Under adverse impacts, the most severe would be relocating / resettling a large portion of local population. Submerging their homes, severing their socio-economic activities of cultivation and animal husbandry and deteriorating the social structure of traditional villages and neighbourhoods would have to be considered as the most serious implications.

Since start of investigations on the project in early 1080's, WAPDA has seriously considered the prevention / minimization of sever environmental changes through appropriate adjustments in the design.

On the other hand, there will be accrual of very large positive benefits to economy of the entire Pakistan through: enhanced irrigation supplies; 35 years prolonged useful life of Tarbela Dam; economic growth of millions of Pakistani peoples; contributing over 19000 GWh of energy per annum to the national power grid; and avoidance of sizeable greenhouse gas emissions to retard the global warming. Notwithstanding this, the Government and WAPDA are endeavouring to contain / mitigate negative impacts of the project on the local environment.

M.1.2 Introduction of New Development Dimensions in the Region

As pleaded by the adversaries, not constructing the dam would preserve the existing environment. Thus, the environmental values addressed in this EIA Report would not be lost, damaged or deteriorated.

Let us assume for the sake of argument that Diamer Basha Dam should be scrapped as it would cause large negative environmental impacts. At the same time it might be emphasized that a unique development opportunity for the region and particularly Diamer district will be lost. By way of illustration, and not limitation, the following potential long-term regional development opportunities would be denied:-

- Boosting Labour and Education:
    - Around 10,000 skilled /. unskilled jobs would be created during 10 years construction period (mostly to be filled from locals)
    - Induction of medium and long-term improvements in education including females and vocational training for many jobs and business activities
- Developing Modern Infrastructure:

  - Transport infrastructure, linking Pakistan with the dam area and Gilgit (even China border) will be modernised, thus substantially reducing the travel time from Mansehra, Islamabad, Peshawar and Lahore
  - Provision of electricity, initially in Model Villages, and subsequently through general electrification of the area will support not only provide comfortable daily life, but also boost development
- Establishing Better Livelihood Measures:
  - Model Villages, though proposed to be established for resettlement of PAPs, will offer modern residential areas with electricity, water supply and community services
  - Schools, medical dispensaries and mosques combined with small business areas will become the heart of the new livelihood in Model Villages.
  - Lot of the oppressed gender community will be significantly improve through implementation of 'Gender Action Plan' including dedicated education and health facilities
- Changing the Social Life:
  - Social structures and relations during construction and as well in the following operation period will be moulded by improved awareness building and participation of the affected population
  - Traditional community and tribal structures will be re-established and supported further by new conditions of prosperity, education and participation
  - Women, especially in this new society, will get more education, equality, prosperity and human rights

Denial of the above and many other opportunities have to be considered seriously if the project is not implemented. On the other hand, as outlined in this EIA Report the proposed social and economic dimensions to be added to the area will allow significant improvement in the standard of living of the population and reducing thereby the large regional disparity as compared to the rest of Pakistan.

M.2 Recommendations

M.2.1 Benefit Sharing and Future Tasks

The sponsors, (GoP / WAPDA) should ensure that local population and the area receives some share out of the project benefits. This would, inter-alia, involve: establishing new livelihoods for PAPs through settlements including creation of new cultivation areas; supplying electricity in the general area; and building new roads to the presently inaccessible areas. Basic concept of benefit sharing should aim at supporting economic and social life at least in the project area through:

- Developing partnership with the host population
- Implementation of mitigation and compensation measures as proposed in EIA Report / Resettlement Plan
- Strengthening institutional set-up including medium and long-term support to Diamer District Administration

M.2.2 Compliance By Contractors

Construction contractor(s) will be under obligation to perform certain functions as outlined in this EIA Report. It will have to be ensured by WAPDA / Consultants that various contractor(s) comply with the related provisions in their respective bidding documents.

M.2.3 Project Area Development

The following essential components, as proposed in EIA Report / Resettlement Plan, should be implemented before relocation of PAPs:-

- Restoration of traffic between the right and left bank settlements through: Right Bank Periphery Road; and permanent access bridge downstream of dam site
- Improvement of communication system to the upper side valley through: relocation of KKH; and paving of link roads connecting to the main arteries of Relocated KKH on left bank and new Right Bank Periphery Road on right bank
- Completing preliminaries for undertaking general electrification of the project area (Diamer district particularly to benefit from this basic output of the project)
- Establishment of improved education, vocational training and medicare facilities in Model Villages to act as a model for attracting PAPs to this concept of resettlement
- Supporting in project area the efforts to pursue scientific research and higher education, particularly regarding cultural heritage

M.2.4 Confidence Building Measures With Local Population

This will be the most important, rather crucial, task particularly for the implementing agency of WAPDA. As experienced during the unfortunate recent violent demonstration in Chilas on 18 February 2010, this aspect needs priority attention to avoid any such recurrence in future. Additionally, the following confidence building measures (CBMs) should be taken in right earnest:-

- Activation of the recently (09 August 2010) re-established WAPDA field activities in Chilas particularly to deal with resettlement related issues of the project including provision for PAPs: a focal point of access for consultation; information sharing; and redressal of grievance, particularly day to day irritants.
- Activation, through joint efforts of Diamer District Administration, the ‘Land Acquisition and Resettlement Issue Resolution Committee’ established during April 2009 to create an effective liaison with PAPs

N REFERENCES AND BIBLIOGRAPHY

1. Cyon, Mushrraf Rasool, Northern (Gilgit-Baltistan) Areas Strategy for Sustainable Development. IUCN Pakistan Programme Governance
2. Fowler and Archer, “Conflicting Signals of Climatic Change in the Upper Indus Basin”, Journal of Climate, Vol. 19, 2006
3. Ghazi Barotha - Resettlement Action Plan, Islamabad 2002
4. Gleick, Peter H. (Ed.) 1996, Basic water requirement for human activities, Meeting basic needs. Water International, 24 (2) 83-92
5. Hewitt, “The Karakoram Anomaly? Glacier Expansion and the “Elevation Effect”, Mountain Research Development, 1998, 25, pp 332-340
6. IPCC Report “Climate Change 2001: The Scientific Basis“, Cambridge 2001
7. IPCC Report “Climate Change 2001: Asia“, Cambridge 2001
8. IUCN (2004) Draft working plan for Sustainable Management of the Coastal Ecosystem Karachi Coastal, Korangi/Phitti Creeks System – 95 p, unpublished
9. Jackson, Donald, The influence of dams on river fisheries, FAO Corporate Document Repository, 2000
10. Larinier, Michel, Environmental Issues, Dams and Fish Migration, FAO Corporate Document Repository, 2000
11. Mangla Raising - Resettlement Action Plan, Islamabad 2003
12. Miranda, Leandro, A review of guidance and criteria for managing reservoirs and associated riverine environments to benefit fish and fisheries, FAO Corporate Document Repository, 2000
13. National Environmental Quality Standards (Certification of Environmental Laboratories) Regulations, 2000, Government of Pakistan, Islamabad, in: Ameer, B. U, Manual of Environmental Laws in Pakistan, Khyber Law Publishers, Lahore, 2005, p 47-62
14. Northern (Gilgit-Baltistan) Areas Strategy for Sustainable Development, IUCN Pakistan Programme
15. Pakistan Environmental Assessment Procedures, Pakistan Environmental Protection Agency, Islamabad, 1997
16. Pakistan Environmental Protection Act, 1997, in: Ameer, B. U, (2005), Manual of Environmental Laws in Pakistan, Khyber Law Publishers, Lahore, pages 1-36
17. Pakistan National Conservation Strategy, Government of Pakistan and IUCN, Islamabad, 1992
18. Pakistan Water Sector Strategy, Ministry of Water and Power, Islamabad 2002.
19. Population Census Organisation, Statistics Division, 1951-1998 Population of Administrative Units (1st March, 1998), Government of Pakistan, Census Publication No. 161, Islamabad. January 2002.
20. Review of IEE and EIA Regulations, 2000, in: Ameer, B. U, Manual of Environmental Laws in Pakistan, Khyber Law Publishers, Lahore, 2005, p 64-84
21. Seckler David, Upali Amarasinghe, David Molden, Redhike de Silva and Randolph Barker 1998, World Water Demand and Supply, 1990 to 2025: Scenarios and Issues, International Water Management Institute, Sri Lanka (Research Report 19).
22. Shafiullah, Ali Asghar Hashmi, Agriculture and Food Security
23. Shahid, Ahmed, and Muhammad Faiz Joyia, Water Background Paper

24. Singh and Bengtsson, “Impact of Warmer Climate on Melt and Evaporation for the Rain-fed, Snow-fed and Glacier-fed Basins in the Himalaya Region”, Journal of Hydrology, pp 140-154)
25. Statutory Notifications (S.R.O.) from October 28, 1998, on “Delegation of power and function to the provincial EPA’s”
26. Study on Water Escapages Downstream of the Kotri Barrage to address Environmental Concerns (Study-II), Kotri Barrage Study-II Consultants Group under lead of Lahmeyer International GmbH Germany, Pakistan 2005
27. World Commission on Dams (WCD) Report, 2000
28. World Commission on Dams, Contributing Paper, Capacity and Information base Requirements for Effective Management of Fish Diversity, Fish Stocks and Fisheries Threatened of Affected by Dams During Project Cycle, Garry Bernacsek, Australia 2000
29. World Commission on Dams, Contributing Paper, Dams and Fish Migration, Michael Larinier, France 2000