6 DESCRIPTION OF SOCIO-ECONOMIC ENVIRONMENT

This section presents a description of the socioeconomic characteristics of the project area, and where available utilizes national and regional level data for providing a more cogent understanding of the context. This social baseline analysis is based on:

- primary data collected by conducting a systematic settlement survey targeting the project area in the Kotli District AJK to supplement the available surveys and studies; and
- secondary data collated from previously published literature as well as national and regional data.

The settlement survey was carried out over a period of ten days by two teams comprising a total of four members. The methodology for the collection of primary data consisted of focus group discussions and structured interviews in the villages listed below, geared to provide detailed qualitative socio-economic data. The villages included in **Table 6.1** are seen as those villages that will be directly affected by the proposed project activities.

Focus group discussions and structured interviews were chosen as the methodology in order to, provide detailed information rapidly; to provide information on the many non-measurable issues (for example, access to natural resources or the structure of social institutions); and to ensure a more inclusive, participatory approach than what would have been possible with individual questionnaires.

The secondary data pertaining to the project area was drawn chiefly from the following sources:

- Environmental Statistics AJK, AJK-EPA 2008
- Data available from Population Census Organization - Islamabad
- Data available from Planning & Development Department - AJK
- Economic survey of Pakistan 2010-2011

Table 6.1: Villages/Settlements in the Project Area

Village Name	*Village Name*
1. Aghar	5. Hill Kalan
2. Barali	6. Hill Khurd
3. Dharang	7. Jamal Pur
4. Gulhar	8. Mandi

6.1 Social Setting

Traditionally, the social set up of Kotli was largely based on kinship. The overall social arrangement was based around different clans (baraderi). The composition of society remained intact for centuries until the mid of last century when geo-political changes in the region brought about changes in political set up, economy and society. In the decades of 1960-70s migration of people to abroad for earning shifted the basis of economy. Forced from lack of economic activities in the past, the people of the area started migrating abroad for search of opportunities. With increasing exposure to market forces and exogenous lifestyle the pattern of interface between different communities also witnessed drastic changes. Despite modernization people still rely on pre-modernization social structure and social interaction and politics is largely shaped by social dynamics and power relationships. However, access of opportunities in the country and abroad enabled people to find increasing role in the society.

6.2 Demography

The district Kotli is the second largest in terms of population in Azad Jammu and Kashmir. The population of the district was 365,000 in 1981 and an increase of 54.37 percent was recorded over the last seventeen (17) years i.e 1981-1998. According to 1998 census its total population of the district is 0.563 million with a growth rate of 2.59%. The projected population is 0.69 million in 2006. The average annual growth rate of population is 2.59% in the district during inter censual period 1981-1998. The population density is 370 persons per sq. km. The average household size is 7.3 persons, which is slightly lower than national which is 8.5, but slightly higher than AJK -7.2. The demographic details are given in the table below:

Table 6.2: Demography of AJK

District	*Area (Sq. Kms)*	*Population (Millions)*		*Density In (2006) (Persons/ Sq. Km)*	*Growth Rate*	*House-Hold Size*
		1998	*2006*			
Muzaffarabad	2496	0.62	0.77	307	2.80%	7.1
Neelum	3621	0.126	0.159	42	2.80%	7.1
Mirpur	1010	0.334	0.395	391	2.09%	6.8
Bhimber	1516	0.302	0.37	244	2.60%	6.7
Kotli	1862	0.563	0.69	370	2.59%	7.3
Poonch	855	0.411	0.49	573	2.24%	7.6
Bagh	1368	0.393	0.46	336	2.00%	7.4
Sudhnuti	569	0.224	0.262	460	1.99%	7.3
Total	**13297**	**2.973**	**3.596***	**270**	**2.41%**	**7.2**

The human habitation in district Kotli is predominantly determined by its topography as the hilly mountainous terrain limits options for human habitation. Hence, most of the human habitation in the project area is scattered. The field survey about the settlement pattern of the surveyed communities shows that majority of the population (91.84 percent) resides in rural areas with some urban pockets in few settlements.

According to survey findings 99% households are headed by men. 57% of the households are living in a joint family system. In the project area average household comprises of 9.2 persons, which is higher as compared to the average national household size of 7.3 persons per household in the district.

Table 6.3: Population Data

Village/Settlement	*Number of Households*	*Population*	*Persons per Household*	*% Male Population*	*% Female Population*
Aghar	28	280	10.00	51.07	48.93
Barali	15	138	9.20	50.72	49.28
Dharang	33	288	8.73	50.69	49.31

Village/Settlement	*Number of Households*	*Population*	*Persons per Household*	*% Male Population*	*% Female Population*
Gulhar	14	136	9.71	45.59	54.41
Hill Kalan	14	103	7.36	48.54	51.46
Hill Khurd	12	117	9.75	50.43	49.57
Jamal Pur	35	332	9.49	53.31	46.69
Mandi	22	209	9.50	48.33	51.67
Survey Area Total/Average	**173**	**1,603**	**9.27**	**50.41**	**49.59**
Kotli District Total/Average	**94,521**	**690,000**	**7.30**	**50.62**	**49.38**
AJK Total/Average	**499,444**	**3,596,000**	**7.20**	**50.62**	**49.38**

As per the results of this survey female and male is 49.38 and 50.62 respectively.

Table 6.4: Age Distribution in the Project Area

Village/Settlement	*Total Population*	*Children below 9yrs (%)*	*Youth 10-17yrs (%)*	*Active population 18-65yrs (%)*	*Aged population above 65 (%)*
Aghar	280	24.29	13.57	58.93	3.21
Barali	138	29.71	12.32	54.35	3.62
Dharang	288	19.44	17.36	58.68	4.51
Gulhar	136	13.97	19.85	61.76	4.41
Hill Kalan	103	27.18	18.45	51.46	2.91
Hill Khurd	117	20.51	24.79	50.43	4.27
Jamal Pur	332	25.00	18.67	53.92	2.41
Mandi	209	27.27	23.44	45.93	3.35
Total	**1,603**	**23.46**	**18.15**	**54.90**	**3.49**

The findings of survey show that 54.9% of the sampled population was between 18 and 65 years of age, followed by 23.46% children. The percentage of those falling between 10 and 18 years is 18.15% whereas 3.49 % of the population falls in the age slot of more than 65 years and above.

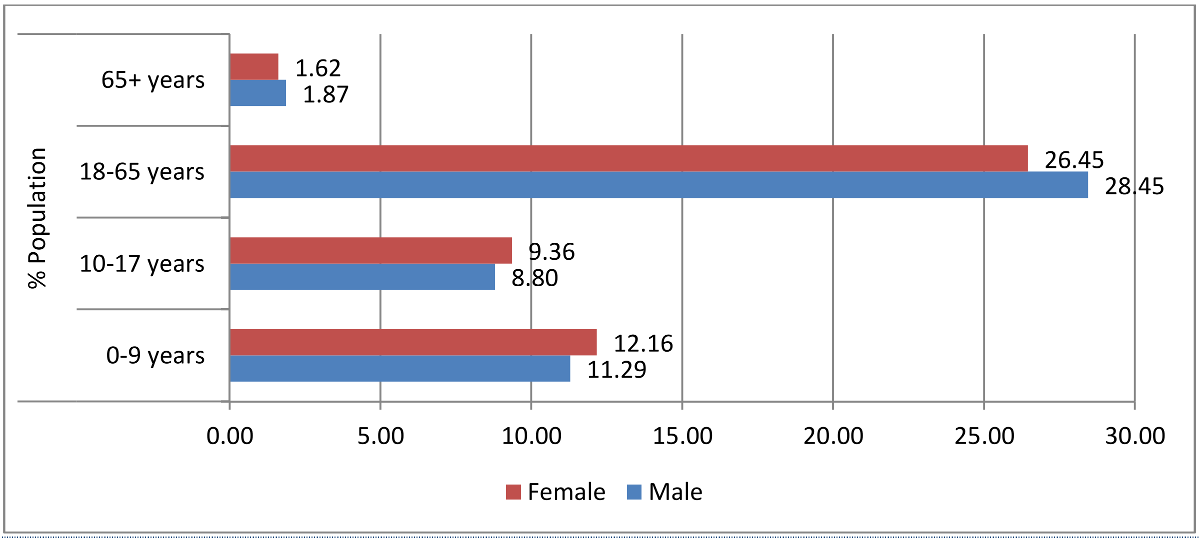

Figure 6.1: Age Distribution based on Gender in the Project Area

6.3 Social Composition

Despite rapid modernization and urbanization in AJK including district Kotli the kinship system has remained intact and exert great influence over the economy, politics and cultural ethos. The major tribes residing in the district are Syed, Gujar, Jat, Rajput, Awan and Sudhan. Hindko, Gojri and Pahari are the indigenous languages of the district. Other than vernacular languages, Urdu and Punjabi are also spoken. The majority of population of the district is Muslim, constituting 99.24 percent of the total population. Christians, Hindus, Qadiani/Ahmedi and Scheduled Castes form minority.

6.4 Political and Administrative Set-up

The state of AJK is constituted of an area of 3,297sq.km and is administratively divided into two divisions, seven districts, and nineteen sub-divisions. The area falls under the jurisdiction of State of Azad Jammu and Kashmir (AJK). The State of AJK is administratively controlled by Government of Pakistan under United Nation’s Commission on India and Pakistan 1948. The laws government of Pakistan extends to the entire state with the approval of the Azad Jammu and Kashmir Legislative Assembly (AJKLA).

Politically, the state of AJK is governed by Parliamentary form of Government. The president is the head of the state and the elected Prime Minister along with his cabinet of ministers is the head of the government. The State of AJK has its elected President, Prime Minster with Cabinet and AJK Legislative Assembly along with AJK Council represented by elected members from AJK Legislative Assembly and nominated members from Pakistan. Currently, the AJK government does not have local bodies system which is expected to be in place after the ruling of Supreme Court of Pakistan.

Table 6.5: Administrative Setup (2006)

Divisions	2
Districts	8
Sub-Divisions	22
Union Councils	182
Villages	1646
Town Committees	13
Development Authorities	5
Municipal Committees	10
District Councils	8
Municipal Corporations	2
Police Stations	42

The Project is located in Kotli district with a total area of 161,608 hectares. This district is divided into four sub-divisions/tehsils i.e. Kotli, Fatehpur Thakiala, Charhoi and Sehnsa. Deputy Commissioner along with three Assistant Commissioners in sub-divisions is the administrative and revenue head of the district. His major duty is the maintenance of law and order and to look after the land record of the district.

On the revenue side, Deputy Commissioner is assisted by the Revenue Officer/Extra Assistant Commissioner, Assistant Commissioner (sub-division), Tehsildar and Naib Tehsildar in each Tehsil.

The district is further divided into qanoongo, halqas and patwar circles. The qanoongos supervise the work of patwaries of their respective patwar circles.

Table 6.6: Divisions, Districts & Sub-Divisions of AJK

Division	*District*	*Sub-division*
Muzaffarabad	Muzaffarabad	Muzaffarabad
		Hattian
	Neelum	Athmaqum
		Sharda
	Poonch	Rawalakot
		Hajira
		Thorar
		Abbaspur
	Bagh	Bagh
		Haveli
		Dhirkot
	Sudhnuti	Pallandri
Mirpur	Mirpur	Mirpur
		Dudyal
		Chakswari
	Bhimber	Bhimber
		Barnala
		Samahni
	Kotli	Kotli
		Fatehpur Thakiala
		Sehnsa
		Charhoi

6.5 Conflict and Social Tension

Generally the area is peaceful as there are no chronic social and communal conflicts among the communities living in the project area. Owing to social diversity and culture of tolerance in the society, people hailing from different denominations and clans lives in harmony. The state laws are fully enforced in the project area. If a conflict arises within the community, the elders resolve the issues amicably or settled through courts of law. Though the role of clerics (ulema) was traditionally limited to marriage, burial and religious guidance, they are increasingly play their role in resolution of conflict among community members.

6.6 Land Ownership and Tenure

Area under cultivation in the state of AJK is around 166,432 hectares, which is almost 13% of the total Geographical area out of which 92% of the cultivable area is rain-fed. About 84% households have very small land-holdings between one to two acres per family. Major crops are maize, wheat & rice whereas minor crops include vegetables, grams, pulses (red lobia) and oil-seeds. Major fruits are apple, pears, apricot and walnuts. Agriculture and livestock income ranges between 30-40% of household earnings. The remaining share comes from other sources including employment and business etc.

In the project area the private landholding is 1,840 kanals which comprises agricultural 1,044 kanals (56%), commercial 110 kanals (6%), barren land 230 kanals (13%). Privately own forest land comprises 456 kanals (25%). The average cultivable landholding in Barali, Mandi, Hill Kalan, Hill Khurd and Dharang villages is larger as compared to Gulhar and Aghar. The average landholding of forest, barren and commercial categories is biggest in Jamalpur, followed by Dharang and Hill Khurd. The ownership of land in terms of category is given in the **Table 6.7** and **6.8.**

Table 6.7: Cultivable Land Holding

Village/ Settlement	*Households*	*Total Population*	*Household Size*	*Households with Farm Land (%)*	*Total Farm Area (kanals)*	*Farm Area Per Family (kanals)*	*Farm Area per Capita (kanals)*
Aghar	28	280	10.00	7.14	16	0.57	0.06
Barali	15	138	9.20	80.00	171	11.40	1.24
Dharang	33	288	8.73	54.55	234	7.09	0.81
Gulhar	14	136	9.71	7.14	2	0.14	0.01
Hill Kalan	14	103	7.36	100.00	132	9.43	1.28
Hill Khurd	12	117	9.75	91.67	117	9.71	1.00
Jamal Pur	35	332	9.49	54.29	194	5.54	0.58
Mandi	22	209	9.50	54.55	179	8.14	0.86
Survey Area Total/Average	**173**	**1,603**	**9.27**	**51.45**	**1,045**	**6.04**	**0.65**
Kotli District Figures	**94,521**	**690,000**	**7.30**	**65.00**	**460,622**	**4.87**	**0.67**
AJK Figures	**499,444**	**3,596,000**	**7.20**	**89.00**	**3,290,160**	**6.59**	**0.91**

Source: Survey Results

Table 6.8: Land by Types in Sample Villages

Village/Settlement	*Households*	*Average Farm Area per HH (kanals)*	*Average Forest Area per HH (kanals)*	*Average Barren Land per HH (kanals)*	*Average Commercial Land per HH (kanals)*
Aghar	28	0.57	0.50	0.04	0.00
Barali	15	11.40	2.00	4.00	3.33
Dharang	33	7.09	0.12	0.76	0.03
Gulhar	14	0.14	0.00	0.00	0.36
Hill Kalan	14	9.43	2.79	2.07	1.43
Hill Khurd	12	9.71	18.58	3.67	2.50
Jamal Pur	35	5.54	1.11	1.89	0.11
Mandi	22	8.14	4.86	0.23	0.00
Total	**173**	**6.04**	**2.64**	**1.33**	**0.64**

Source: Survey Results

6.6.1 Landholding by size and category

Most of the people (88%) own less than a kanal commercial land whereas only 4 people among the samples' population own more than 20 kanals of commercial land. The landholding size of cultivated land is also small as 56% people own less than 10 kanals of land and 15% among them own even less than a kanal of cultivated land. Only 8 people claimed to own more than 30 kanals of agricultural land. One among them claimed to own more than 50 kanals, and 3 respondents said they had more than 40 kanals. Only four respondents had 30-40 kanals.

Table 6.9: Average Landholdings by Area

Land in Kanals	*Farm Land (%)*	*Forest Land (%)*	*Barren Land (%)*	*Commercial Land (%)*
<1	15.00	79.00	75.00	88.00
1-9	41.00	5.00	12.00	7.00
10-19	24.00	8.00	8.00	0.00
20-29	13.00	3.00	4.00	2.00
30-39	4.00	1.00	1.00	2.00
40-49	3.00	1.00	0.00	0.00
50-60	1.00	3.00	0.00	0.00
Total	**100.00**	**100.00**	**100.00**	**100.00**

Source: Survey Results

The ownership of landholding in other categories of forest and barren land is not much different from the agricultural land which indicates subsistence farming in the area and no commercial level forming is viable in the mountainous valleys to export the agricultural produce to other cities or main market

6.7 Economic Profile

The main economic activity in area remains in agriculture, livestock and service sectors. Of the total land area of about 414,019 acres of Kotli District, 20% is available for cultivation while 80% of the land bears forest, settlements, infrastructures or lie in the form of uncultivable waste land. Wheat, maize and rice are cultivated on about 63,200 acres, 53,400 acres and 12,000 acres of land, respectively. Rice is not a common crop of Tehsil Kotli and it is cultivated in Nakyal sector. Average production of wheat and maize is 22 and 24 mounds/acre, respectively. Wheat is cultivated for the individual family needs and average land per family is about 5 acres. Vegetable and fruit trees are spread over the area of 99 and 222 acres respectively in Kotli District. In plain areas citrus fruit trees are present. Apple trees are also in the area but its fruit is not of good quality. The area is rural is characterized with subsistence farming and cattle rearing livelihoods.

The survey identity the professions of those falling in the age bracket of 19 to 65. According to survey finding 82% of the female workforce are housewives and 17% of the working males work abroad. In addition, 20% of the male workforce is skilled, whereas no female was reported to be a skilled worker. The following table depicts people associated with different profession and vocations.

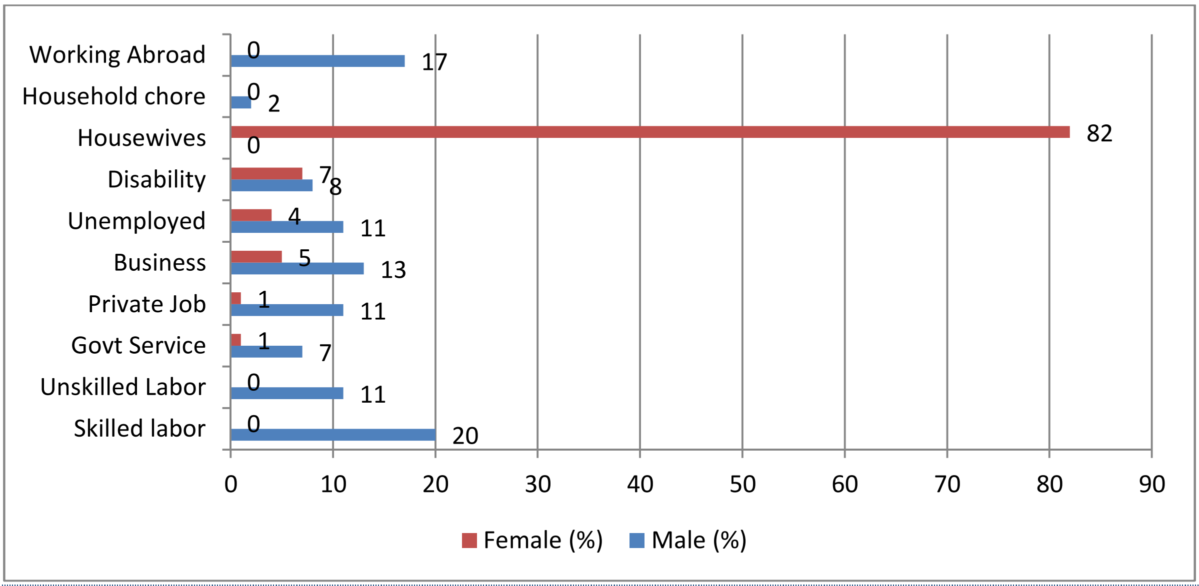

Figure 6.2: Occupation of Household Members (Above 19 years)

The survey results show that 11% of the male workforce is comprised of unskilled laborers, whereas no female works as a laborer. Male population working in the government sector makes 7% of the total workforce. Private jobs accommodate 11% males and 1% females. 8% of the total workforce is engaged in business sector. The unemployment rate is 11%.

Table 6.10: Economic Situation of Project Area Population

Villages	*Households*	*Total Sample Population*	*Per Household Monthly Income (PKR)*	*Per Household Monthly Spending (PKR)*	*Per Capita Annual Income (US$)*	*Per Capita Annual Consumption (US$)*
Aghar	28	280	36,696	36,939	**423.42**	426.22
Barali	15	138	49,087	43,487	**615.64**	545.40
Dharang	33	288	65,458	37,364	**865.42**	493.99
Gulhar	14	136	36,786	34,321	**436.93**	407.66
Hill Kalan	14	103	34,886	26,043	**547.12**	408.44
Hill Khurd	12	117	87,433	60,317	**1,034.71**	713.81
Jamal Pur	35	332	44,876	41,707	**545.87**	507.33
Mandi	22	209	28,591	26,845	**347.26**	326.06
Total	**173**	**1603**	**47,261**	**37,797**	**588.52**	**470.67**

Source: Survey Results

Per capita income in project area is US$ 589 with Hill Khurd being the highest and lowest Mandi. This is below the national per capita income which is US$ 1,256. Overall there is not a huge variance between the per capita income of the villages except Hill Khurd and Dharang.

Table 6.11: Earning and Spending Characteristics of Project Area Population

Sources of Income		*Expense Heads*	
Source	*Contribution (%)*	*Head*	*Consumption (%)*
Service/Job	19.87	Food	50.41
Business	23.73	Cooking and Heating	8.58
Skilled Labor	13.83	Housing Repair	3.40

Sources of Income		*Expense Heads*	
Source	*Contribution (%)*	*Head*	*Consumption (%)*
Unskilled Labor	7.24	Health Care	8.79
Pension	2.20	Education	9.84
Rental Income	1.31	Transport	5.65
Remittances	26.42	Utilities	4.63
Zakat/Bait-ul-Mal	0.04	Religious, Social Events	6.34
BISP	0.07	Other	2.37
Crops, Fruit, Vegetable	4.76		
Land, Forest	0.07		
Livestock, Poultry	0.24		
Other	0.22		
Total	**100.00**	**Total**	**100.00**

Source: Survey Results

Majority of the rural population still relies on agriculture for its livelihood. However, there is discrepancy between source of income between rural and urban areas because 84% of income generation is derived from profession which are urban base, such as service/jobs, skilled labor, business and remittances. With the increasing inflow of remittances the project area has witnessed mushrooming of construction. However, its contribution to overall income generation is minimal at 1%. Typical agricultural and rural income generating sources like livestock, poultry, land, forests, crops, fruits and vegetables make only 5.3% of total income generation. A salient feature of remittance economy is that it does not lead to investment in enterprises or small scale industry; rather it led to consumer culture. Thereby, siphoning off the hard earned income to outside areas.

The highest expenditure is 50.41% on food followed by education 10%. 9% of the total income is spending on health care. Heating consumes 8% of the income. Rest of the expenditures is made on house repair, transport, religious activities, festivals and utilities. It is important to highlight that the expenditure on food is symptomatic of food insecurity as evident in the **Table 6.10** that agriculture and livestock 5.3% of the total income generation. In addition, food commodities are being imported from main land in Pakistan. When people are faced with food insecurity, they tend to spend less on health and education as a counter coping mechanism. Therefore, it can be said that increase in expenses of one head has deteriorating impact on others.

Table 6.12: Income Ranges

Income Brackets (in Pak Rs.)	*Percent*
< 5,000	0
5,000-15,000	13
15,001-25,000	21
25,001-35,000	16
35,001-45,000	14
45,001-55,000	15
55,001&above	21

Source: Survey Results

The concentration of the poorest people (13%) falls in the bracket of Rs. 5,000-15,000 per month. Ordinary concentration of households (21%) is in the bracket of Rs 15,001-25,000. 16% fall in the bracket of 25,001-35,000. In the income of 35,001-45,000 per month falls 14% of the project population. Those above 45,001 but below 55,000 make 15% of the population, whereas richest concentration (21%) falls in the income bracket of Rs. 55,000 and above.

If different slots of income are divided between upper and lower incomes by attributing income 35,000 below and above respectively, then the ratio of people with lower and upper income remains equal. Division of income slots into three categories of lower, middle and higher income provides another perspective. If people with income of less than 25,000 per month are categorized as poor, than they make 34% of the total, whereas people with middle income (above 25,000 and below 45,000) form 30% of the total. The remaining with income above 45,000 per month make majority with 36% of the total. Cumulatively, both categories of middle and highest income make the bulk of the population which is 66%.

6.8 Education

According to the information received from Department of Education AJK, apart from a campus of University of Azad Jammu and Kashmir there is one post graduate college for men and 12 degree colleges for men and women in the district. Total number of colleges in the district are given in **Table 6.13**.

Table 6.13: Educational Institutions in Kotli

Post Graduate		*Degree*		*Inter*		*Total*
M	*F*	*M*	*F*	*M*	*F*	
1	0	6	6	8	11	32

Source: Survey Results and P&D AJK

The number of schools is 1028 according to Directorate of Schools AJK. The highest number of Primary schools 478, followed by 279 mosque schools and 157 middle schools. Apart from the government schools there are a number of private schools in the district.

Table 6.14: Schools and Education Facilities in Kotli

Mosque	*Primary*	*Middle*	*High*	*Higher Secondary*	*Indus School*	*Village Work Shop*	*Total*
276	478	157	108	6	2	1	1028

Source: Survey Results and P&D AJK

In the project area each settlement has primary level government schools for boys and girls within an average distance of 2 km. However, the students after passing their middle class and matriculation have to travel an average of 5 km to reach high schools or colleges in nearby town of Kotli. For rural settlements the average distance to high schools is 5 to 10 km. The overall literacy in the project area is as under:

Table 6.15: Literacy Level of Project Area Population

Level	*Male*	*Female*	*Total*
Illiterate	20%	36%	27%
Basic Literacy	7%	2%	5%
Primary	17%	15%	16%
Middle	18%	20%	19%
Metric	21%	18%	19%
Intermediate	12%	7%	10%

Level	Male	Female	Total
Degree	4%	1%	3%
Masters	2%	0%	1%
Diploma	1%	0%	1%

Source: Survey Results

Overall 27% of the population falling above the eligible age of 10 years population is illiterate (20% men and 36% women). Among the literate, 5% have basic literacy, 16% have attended primary school, 21% and 12% have done metric and intermediate respectively. Although there is a campus of the University of AJK in Kotli district, only 3% have attained a university degree followed by 1% master's degree holders. In addition, 14% children of school going age did not attend school at all. Overall there are more males than females in education school with the exception of middle level where female are 20% as compare to 18% men.

6.9 Population Health Profile

There is one District Headquarter (DHQ) Hospital in District Kotli, three Rural Health centers, 20 First Aid Posts (FAPs) and 16 Mother Child Health Care (MCH) Centers along with other health facilities at grassroots level.

Table 6.16: Health Facilities in Kotli

DHQ Hospitals	RH Cs	BH Us	Dispensaries	FA Ps	MCH Centres	TB Leprosy Centres	Dental Centres	EPI Centres	Malaria Sub Centres
1	3	25	13	20	16	6	4	30	25

Source: Planning and Development Department Govt of AJK

Access and preference of the people in the project area was ascertained through a question and almost all of the population (97.5%) said to have access to medical consultations and check-ups. Being in the vicinity of District Headquarters the majority (76%) of population goes to DHQ as their first option. 50% showed their dissatisfaction with the services being provided in the hospital and 45% showed satisfaction.

Table 6.17: Health Status

Facility	DHQ	Private Doctor	Dispensary/ BHU/ RHC
Access by people	76%	15%	5%

Source: Survey Results

There are private clinics and hospitals operating in the main town of Kotli which are approached by 15% respondents in the project area. Only 5% respondents said to approach a lower level government facility for checkups and treatment.

6.10 Housing

The housing pattern is lavish in terms of size and construction as more than 88% of the structures are pukka, made of cement and bricks with RCC structures. Only 5% houses and structures are kacha, made of mud and stone, whereas 6% structures are a combination of kacha and pakka.

Table 6.18: Housing Characteristics in the Area

Village/Se	Househo	Family Structure	Type of housing structure	Ownership	Number of

ttlement	lds	Joint (%)	Nuclear (%)	Pakka (%)	Kacha (%)	Mix (%)	of Residence (%)	Rooms per House
Aghar	28	57.14	42.86	82.14	10.71	7.14	100.00	5.50
Barali	15	60.00	40.00	86.67	6.67	6.67	100.00	5.87
Dharang	33	63.64	36.36	96.97	3.03	0.00	100.00	5.70
Gulhar	14	50.00	50.00	78.57	21.43	0.00	100.00	4.79
Hill Kalan	14	50.00	50.00	92.86	7.14	0.00	92.86	6.07
Hill Khurd	12	66.67	33.33	100.00	0.00	0.00	100.00	6.00
Jamal Pur	35	60.00	40.00	85.71	0.00	14.29	97.14	6.54
Mandi	22	45.45	54.55	86.36	0.00	13.64	95.45	4.23
Total	**173**	**57.23**	**42.77**	**88.44**	**5.20**	**6.36**	**98.27**	**5.64**

Source: Survey Results

The average rooms in a single housing unit are 2-5 in 55% houses, whereas 41% of households have 5-10 rooms and 3% houses are with 10-20 rooms. The entire surveyed population owned their houses, as no one reported to have rented residential accommodation.

6.10.1 Water Supply and Sanitation

According to Government of AJK, currently 80% of the urban population and 66% of rural population has been provided with a piped water supply through house connections and public stands. The entire population (95%) in the project area has access to drinking water in their houses. 23% use water from wells and 50% use water from both wells and pipeline. 32% have facility of sewerage system, and 57% use septic tank. 7% percent use a pit latrine and 4% use open fields. The majority of households do not have drainage facility (68%).

Table 6.19: Water Supply and Sanitation

Village/Settlement	House holds	HH Size	Source of Household Water			Latrine Type			Availability of Drainage (%)
			Pipe (%)	Well (%)	Both (%)	Pit latrine	Septic Tank	Open	
Aghar	28	10.00	28.57	17.86	53.57	71.43	25.00	3.57	25.00
Barali	15	9.20	13.33	26.67	60.00	33.33	66.67	0.00	33.33
Dharang	33	8.73	36.36	21.21	42.42	48.48	51.52	0.00	48.48
Gulhar	14	9.71	14.29	28.57	57.14	21.43	64.29	14.29	21.43
Hill Kalan	14	7.36	28.57	28.57	42.86	28.57	71.43	0.00	42.86
Hill Khurd	12	9.75	0.00	50.00	50.00	25.00	75.00	0.00	33.33
Jamal Pur	35	9.49	37.14	11.43	51.43	25.71	65.71	8.57	34.29
Mandi	22	9.50	4.55	31.82	63.64	31.82	63.64	4.55	13.64
Total	**173**	**9.27**	**24.28**	**23.70**	**52.02**	**38.73**	**57.23**	**4.05**	**32.37**

Source: Survey Results

6.10.2 Source of Energy

At present the total installed grid capacity in AJK is 403 MVA. About 20,242 km transmission lines provided to 1,629 villages. Out of these villages about 390,671 consumers have been provided with power connections.

Electricity connection is available to all the households (100%) in the project area. The electricity is used for lighting, washing, cooling and heating etc. For cooking and heating purposes 55% percent of the households use Liquid Petroleum Gas (LPG) and 7 % use wood. 34% rely on LPG and wood as fuel.

Table 6.20: Sources of energy for cooking and heating

Energy Source	*LPG*	*Wood*	*Both*
%age	55%	7%	34%

Source: Survey Results

6.11 Gender Issues

The women have no formal role in the authority structure of the nearby villages. They are about 48% of the population in these villages; the literacy rate for above 10 years of female population is 67% (80% for males). Apart from schools there are 6 degree colleges and 11 Intermediate colleges in the whole district for female population. The traditional attitude of not sending the girls to school is changing now, because the parents understand that the basic education is necessary for each individual regardless of sex. Most of the women stay at home and only travel outside the village in case of visiting to shrines, relatives, and going to weddings and hospitals in nearby towns.

- Local women pointed out the following major issues relating to this project activities;
- Working women (school teachers, lady health visitors & others) of the area will feel uncomfortable for traveling/ mobility during the construction activities;
- The timing of construction activities and local population especially women and children should be adjusted in view of their routine mobility/ schools timing and working/ jobs timing;
- Local women mobility will be restricted because of construction activities along the road.
- Construction should be done as fast as can be because in some emergencies women and children will have to go hospitals for health care purposes;
- Waiting sheds may be constructed, including provision of drinking water, toilet facilities, partition in waiting shed for females and males.

6.12 Vulnerable Groups

There is none falling under the category of ultra-poor as all the households have a monthly income which is above PKR 5,000/- and expenditure accordingly. The high monthly income is because of the remittance from abroad as every household has a family member or a closed relative working abroad who support the families and their spouses living in the country.

No household was found to be headed by women or elderly as well as people with disabilities and handicaps. Every household in the project area owns its own house for residence and there was no household living in a rented home. All the households have access to basic social infrastructures like schools, health facilities and roads in the area.

The project will have an overall positive impact on the living conditions of the local people as the employment opportunities as well as business opportunities would be increased which will be offered to local people as a priority. Moreover, the project Affected People will be compensated for loss of their land and non-land assets according to a Land Acquisition and Resettlement Framework which has been agreed by MPL and local communities. Under this LARF provisions the vulnerable have clearly been defined. The vulnerable including families headed by women, elderly people with limited abilities and those who lose more than 10% of their productive assets will adequately be compensated and supported with additional allowances and job to improve their livelihoods or maintain at least pre project conditions.

6.13 Cultural Heritage

Kotli has the official status of 'city of the mosques' or "Madina –tul- Masajid. There are some shrines of saints. One of them is in Gulhar, situated in south of the city, has the tombs of two Islamic Scholars; Qazi Fateh-ulla Siddiqui and Khawaja Muhammad Sadiq whose son Muhammad Zahid Sultani is also a great Islamic scholar. The tombs of some of the greatest Islamic Scholars Syed Noor Hussain Shah, Syed Aftab Hussain Shah and Syed Mushtaq Husssain Shah are in Mandi in the north of city on Poonch river bank.

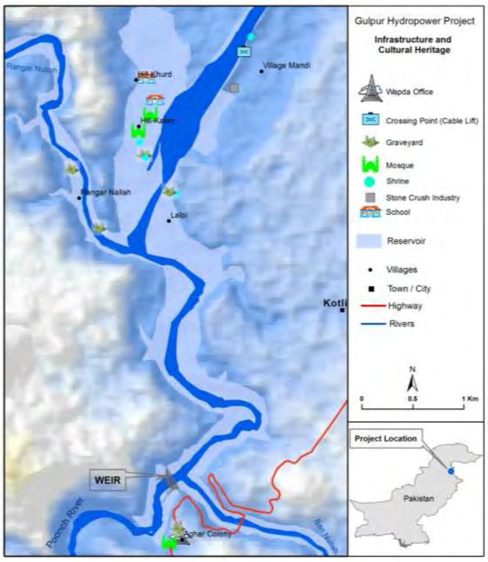

Figure 6.3: Infrastructure and Cultural Heritage

6.14 Community Health, Safety and Security

A separate community health, safety and security plan is to be developed by EPC Contractor and implemented to avoid health, safety and security issues emerging as result of implementation of the project.

7 ANALYSIS OF ALTERNATIVES

Alternatives are essentially, different ways through which the proponent can feasibly achieve sustainable development by carrying out a different type of actions, choosing design alternatives or adopting a different technology or design for the Project to create win-win scenario for all stakeholders. At the more detailed level, alternatives merge into mitigating measure where specific changes are made to the project design or to methods of construction or operation to avoid, reduce or remedy environmental effects. All ESIA systems also require developers to consider mitigation (i.e. measures to avoid, reduce and remedy significant adverse effects).

Alternatives and mitigation, therefore, cover a spectrum ranging from a high level to very detailed aspects of project design. As an example they might range from:

- different strategies e.g. to manage demand or reduce losses rather than develop a new resource;
- different sites or routes for all or part of the project;
- different technologies and raw materials e.g. construction of a thermal power plant rather than a hydro power plant;
- altered layouts or designs e.g. locating noisy activities away from sensitive receptors;
- environmental measures incorporated into the project design e.g. construction of an ecoduct to ensure safe passage of wildlife across a motorway rather than establishment of compensatory habitat.

The "No Project" scenario must also be considered as the baseline against which the environmental effects of the project should be considered. This may include changes from the present day situation as a result of other developments taking place in the vicinity and changes in environmental conditions. This section of the report presents the analysis of the alternatives considered for the proposed project. The following scenarios have been considered:

- No Project Scenario;
- Alternate Methods of Power Generation;
- Alternate Location of the Project;
- Design Alternatives
- Selection of Access Roads & Alignment;

7.1 No Project Scenario

The "No Project" option is least considered option for Pakistan. The country is currently going through the worse power crisis of the history. Energy crisis is considered as major development hurdle in Pakistan and has resulted in formulation of the national energy policy in the recent past. The energy crisis is being given utmost priority at the government level. The acute power shortage in Pakistan has resulted in massive load shedding in the country hugely deteriorating the economic development and growth.

An analysis of electricity data for year 2012-13 reveal that the minimum shortfall was 1,141 MW, while it touched the figured of 6,390 MW at one point in period under consideration. The average shortfall over the year remained 3,886 MW which is around 26% of the average demand of electricity during year.

The maximum generation during the year was 14,756 MW which is only 78% of the maximum demand of electricity. Whereas the minimum generation during the year was 7,345 MW which is 65% of the minimum demand in the same period.

The total generation was 95,364 GWh during year 2011-12, however 2,382 GWh were consumed as auxiliary load by power plants. As discussed above, this generation represents only 47% capacity utilization. The extraordinary transmission and distribution losses (around 22%) have added to catastrophe.

The No Project scenario is considered or adopted it would mean that the already power deficient economy would suffer even more and at current rate if no power is added to the national grid Currently, power outages are in the range of 12-14 hours daily for the rural areas and 8-10 hours for the urban areas, while at the same time the industrial sector is also suffering huge financial losses due to the power outages. Given the gravity of energy crisis and its repercussion on the economy, Pakistan cannot afford to deprive itself of a major project of cheap source of electricity.

7.2 Alternate Methods of Power Generation

7.2.1 Electricity Generation Options

There are different options available to generate electricity which include but are not limited to production using furnace oil, natural gas, coal, solar and hydel.

The root of all the devastation in power industry, other than crowning transmission and distribution losses, is the unsolicited expensive energy mix. Out of total 22,797 MW installed capacity, only 6,556 MW is Hydel power. The rest of capacity is mostly thermal projects with little contribution of 3% from nuclear production. Out of total 95,364 GWh produced during year 2011-12, only 30% has been generated by Hydel resources, 29% has been produced using natural gas while the 35% generation was dependable on expensive furnace oil. The nuclear energy contributed 5.5%, whereas a minor part of energy also came through diesel and coal (see **Table 7.1**).

Average cost of the energy delivered to Discos was PKR 7.11 per kilowatt hour. The average cost of delivery from furnace oil was PKR. 15.94. While the cost from coal generation came around PKR 3.18, the Hydel generation cost only PKR 0.16 per kilowatt hour (as most of the hydro plants have already paid their debts and incurring nominal O&M cost).

The government plans to replace the expensive furnace oil projects with coal technology to reduce the overall cost of production. On the other hand the power policy 2013 is focusing on the control of inefficiencies in transmission and distribution infrastructure.

Non-renewable options such as solar and wind are not brought into the national grid at any of the location in Pakistan, however, few wind projects are at different stages of implementation/construction.

Table 7.1: Electricity generation by Source 2012-13

Source	*% Share in Power Mix*
Hydel	30.0
Oil	35.0
Coal	0.5
Gas	229.0
Nuclear and Imported	5.5

Pakistan imports oil from other countries to meet domestic needs whilst the gas reserves of the country are fast depleting and hence cannot be presently considered as reliable sources of power generation. In the last few years the cost of furnace oil has sky rocketed. The only coal used in Pakistan is imported from Indonesia and South Africa. The Thar Coal resources are still in early stages of exploration and are yet to be further evaluated for potential to generate electricity.

Wind power is currently in the experimental stage and few projects are under implementation and having lower efficiency and power potential cannot be considered as a replacement or full time substitute of other sources of power generation.

Numerous perennial and seasonal rivers are flowing in the north south direction in Pakistan. Hence Hydel power is considered a viable option for a country rich in surface water resources. For a developing country like Pakistan minimum O&M cost makes the hydel power as a viable option.

7.2.2 Cost for Electricity Generation

Hydropower is the cheapest source of electricity in terms of per unit cost and maintenance of the generation system when compared with other alternatives, such as the furnace oil or gas run power plants. Hydropower requires significant initial investment compared with thermal options, however, once the debts are paid back the cost of electricity generation reduces significantly resulting in long term energy security of the country. A typical hydropower project in private sector has a levelized cost around 8-9 US cents/KWh with a generation cost of about 3 US cents/KWh after debt repayments are complete. In comparison the thermal projects (furnace oil based) currently have the levelized cost of around 16.0 US cents/KWh and keep on increasing with time due to continuous increase in oil prices.

7.2.3 Reliability of Power Generation

For assessing the reliability of power generation, the plant load factor can be used as an indicator. The load factor of an energy technology is the ratio (expressed as a percentage) of the net amount of electricity generated by a power plant to the net amount which it could have generated if it were operating at its net output capacity. The plant load factors for different power generation sources are presented in **Table 7.2**.

Table 7.2: Plant Load Factors

Technology	*Plant Load Factor*
Combined Cycle Gas Turbine (CCGT)	70-85%
Waste to Energy	60-90%
Coal	65-85%
Nuclear Power	65-85%
Hydro	30-50%
Wind Energy	25-40%
Wave Power	25%

Source: Renewable UK

The hydro power plants have a plant load factor in the tune of 30-50 %, which is lesser than that for conventional power generation sources with higher load factor of 60% - 80%. However, it is higher than those of other renewable energy options such as wind and wave energy.

7.2.4 Green House Gas Emissions

Greenhouse gases are one of the main causes of the rising global temperatures and climate change or climates shifts. Options are assessed all over the world for going towards technologies to reduce or eliminate the emissions of the greenhouse gases into the atmosphere. The main source of power generation in Pakistan is the thermal power which is based on fuel oil and / or natural gas. These options have greenhouse gas emissions and create a significant carbon foot print on the deteriorating natural environment of the country and in the wider context of the regional environment.

According to the Intergovernmental Panel on Climate Change (IPCC), the world emits approximately 27 gigatonnes of CO_2e from multiple sources, with electrical production emitting 10 gigatonnes, or approximately 37% of global emissions. In addition, electricity demand is expected to increase by 43% over the next 20 years.

Table 7.3: Lifecycle Greenhouse Gas Emissions by Electricity Source

Technology	*Description*	*50th Percentile (g CO2/kWhe)*
Coal	various generator types without scrubbing	1001
Natural Gas	various combined cycle turbines without scrubbing	469
Solar PV	polycrystalline silicon	46
Geothermal	hot dry rock	45
Solar Thermal	parabolic trough	22
Biomass	Various	18
Nuclear	Various generation II reactor types	16
Wind	Onshore	12
Hydroelectric	Reservoir	4

Source: Moomaw, W., P. Burgherr, G. Heath, M. Lenzen, J. Nyboer, A. Verbruggen, 2011: Annex II: Methodology. In IPCC: Special Report on Renewable Energy Sources and Climate Change Mitigation

Coal fired power plants have the highest Green House Gas (GHG) emission intensities on a lifecycle basis. Although natural gas and to some degree oil, have noticeably lower GHG emissions; biomass, nuclear, hydroelectric, wind, and solar photovoltaic all have lifecycle GHG emission intensities that are significantly lower than fossil fuel based generation (**Figure 7.1**).

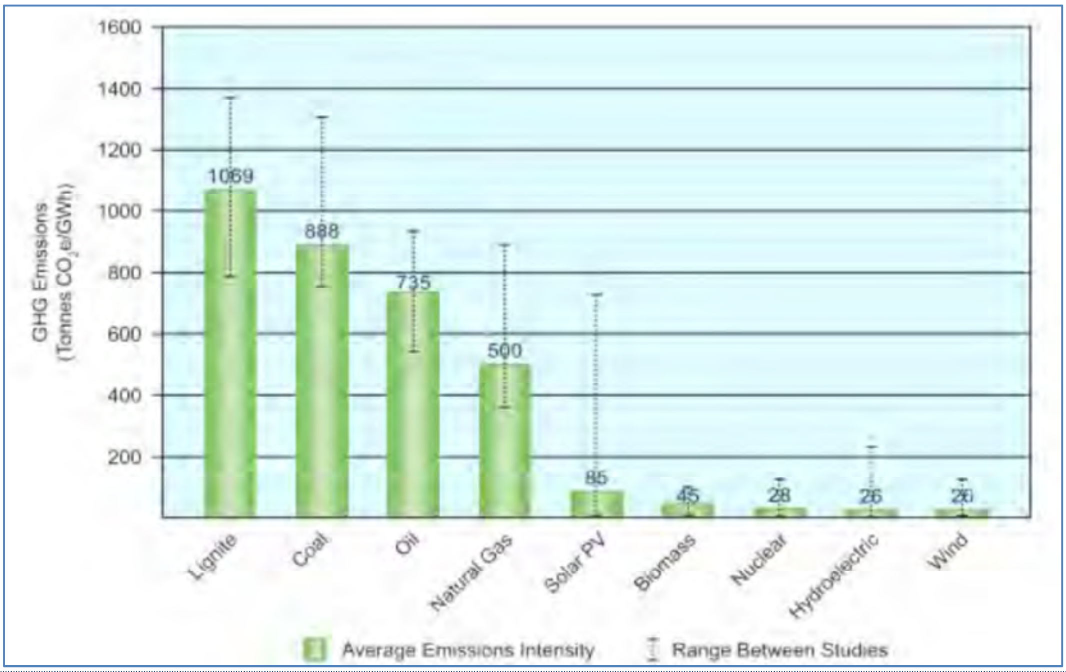

Figure 7.1: Lifecycle GHG Emissions Intensity of Electricity Generation Methods[17]

World Nuclear Association (WNA)'s report places wind energy's 26 tonnes CO2e/GWh emission intensity at 7% of the emission intensity of natural gas and only 3% of the emission intensity of coal fired power plants. In addition, the lifecycle GHG emission intensity of hydropower generation is consistent with renewable energy sources including biomass, hydroelectric and nuclear.

The proposed project is located in a greener area where installation of a combustion based power plant would only deteriorate the environment, while installation of hydro power station would not have any greenhouse emissions from plant operations and the positive economic impact would help reduce the pressure on the local natural resources. It is obvious from the above table the hydro power plants are the lowest ranked in terms of greenhouse emissions into the environment while the much publicized coal power plants are the most notorious when it comes to greenhouse gas emissions.

7.2.5 Rationale for Selection of Hydro Power Generation Option

As discussed in the above sections, the hydro power generation option is most feasible in Pakistan, as the country has significant potential to fulfill its energy requirements. It is the second largest source of power generation. The economics of power generation from hydro power is favorable and almost comparable to natural gas option. The hydro power generation is also one of the cleanest energy generation options and has a suitable plant load factor as well. Additionally, hydropower projects help in grid stabilization.

[17] World Nuclear Association Report

7.3 Alternate Location for the Project

The Gulpur Hydropower Project (GHPP) was first identified by GTZ/HEPO-WAPDA and presented in their report "Comprehensive Planning of Hydropower Resources in Jhelum River Basin – Medium Hydropower Projects in Poonch River Catchment", Lahore – July 1992.

The study by GTZ/HEPO-WAPDA had identified following five locations for developing hydropower potential in the Poonch River catchment:

1. Rajdhani Dam (10 Km from the end of Mangla Reservoir)
2. Gulpur Dam (28 Km from the end of Mangla Reservoir)
3. Barali Dam (37 Km from the end of Mangla Reservoir)
4. Kotli Dam (47 Km from the end of Mangla Reservoir)
5. Sehra Dam (67 Km from the end of Mangla Reservoir)

The possible Poonch River development, as suggested by GTZ-WAPDA, was to be carried out in two main combinations. Combination-A comprised four sites, which include Sehra, Kotli, Barali and Rajdhani dam sites whereas Combination-B consisted of three sites namely Sehra, Kotli and Gulpur dam sites. GTZ proposed a 90 m high concrete gravity dam at Gulpur with an installed capacity of 116 MW; annual energy of project was estimated about 702 GWh.

AJK Hydroelectric Board in 1996 decided to get the previous studies reviewed and confirmed and thus hired the services of the Korean consultants who made a field reconnaissance of the four sites identified in the above-mentioned GTZ/HEPO-WAPDA report. After studying these sites, Koreans identified a new site, which is located near Gulpur Village approximately 7 Km downstream of the Barali dam site identified by GTZ/HEPO-WAPDA and at 18 Km downstream of Kotli city. Considering its location, the Koreans have given this site the name of "Gulpur Hydroelectric Project" which is obviously different from the Gulpur site identified by GTZ/HEPO-WAPDA. At this site, Korean suggested a 57 m high concrete gravity dam with an installed capacity of 60 MW; annual energy of project was estimated about 348 GWh. This site was assigned to the Consultants for the Feasibility Study.

During the initial stages of the feasibility study, it was noticed that the reservoir level (El 475 m) of proposed Rajdhani Hydropower Project would submerge the Gulpur site identified by the Korean. After detailed survey of the river and discussion with AJK HEB, the site was shifted to an upstream location above the reservoir level of Rajdhani Hydropower Project.

During Conceptual Stage, several locations were examined to find a suitable site where a high storage dam could be built to maximize the power potential. The finally recommended site was designated as Axis F-F. Project was conceived as of 120 MW installed capacity. The annual energy of the Project was estimated at about 640 GWh, which was to be produced with the help of an 80 m high Roller Compacted Concrete dam through an underground powerhouse to be located in the right bank.

After considering various design alternatives (as explained below in Section 1.4) the final site location will ensure that the Kotli and Rajdhani Dam can also be constructed along with the Gulpur Dam. To ensure the natural and social environment are not disturbed numerous tweak in the design are included.

7.4 Design Alternatives

It is a general practice all over the world for dam engineering that reservoir rim periphery has to be closed either through natural contours at dam crest elevation or by constructing a man-made structures to avoid resettlement areas. Man-made structure can be earthen dyke, Roller Compacted Concrete Embankment, Concrete retaining walls etc.

During the finalization of the feasibility study of the Project Consultants initially recommended the normal operating level (NOL) of reservoir at El. 550 m. The Project layout involved submergence of about 646 houses and 1800 acres of inhabited area affecting nearly 5,000 people.

However, in an effort to reduce the environmental and social impacts through limiting the submergence of populated area by reservoir waters were further explored by the consultants upon the requirement of proponent. It was concluded that dislocating and rehabilitation of the inhabitants of the area would be problematic and require heavy expenditure with associated social issues. It was found that submergence can be avoided, if the normal operating level (NOL) of reservoir is lowered from El. 550 m to El. 540 m. The lowering of NOL does not affect the technical viability of the Project.

Following three options described below were studied in the aforesaid context:

- **Option 1**: It is based on the earlier concept where a 75m high dam with NOL at El. 550 m and an underground powerhouse was proposed.
- **Option 2**: This is essentially Option-1 but with a reduced dam height of 60 m and NOL at El. 535 m. In this option, submergence of villages will be avoided.
- **Option 3**: This option is based on the concept wherein the head is partly created by a weir and partly by a tunnel utilizing the steep gradient of the river. The Project works consist: a 30 m high weir-cum-spillway to maintain the reservoir level at El. 540 m, an intake structure in the Nullah to divert river flows through a 3.04 km long power tunnel, a surge shaft, steel penstock and a surface powerhouse at the end of the tunnel.

Following the selection of Option 3 as the most viable option, further design optimization and studies were based on such option under which maximum reservoir level was fixed at El. 540.0 m to avoid submergence of surrounding villages and Project was conceived as run-of river with small storage.

Option 3 has advantageous in respect of the following crucial aspects:

Significant reduction is resettlement which is further reduced by exercising the option of construction earthen dyke is the resettled areas;

- Significant saving in rehabilitation cost

- Diversion tunnels are not required.
- Overall cost of the Project will be reduced.
- Reduction in construction time
- Reduction in construction difficulties due to a surface powerhouse
- Longer life of Project due to effective sluicing of incoming sediments

In an effort to further curtail the resettlement and minimizing environmental impacts for selected Option 3 (as explained above) different options were further studied keeping in view the following considerations:

- Height of water retaining structure should be minimum for stability and cost point of view
- Availability of construction material in the vicinity of the project
- Minimum risk for the downstream populated areas
- Minimum health and environmental risk
- Stability and reliability of water retaining structures
- Adequate free board to cater flood volume
- Minimum disturbance of the local residents
- Arrangement for collection and disposal of rain water for the downstream areas

The further options studied were as follows:

- Option-1: Earthen Protection dyke + Collection Drain + Dewatering Arrangement
- Option-2: Retaining Wall + Collection Drain + Dewatering Arrangement
- Option-3: Earth filling up to EL. 540 m + Earthen Dyke

Screening of three selected options will also be applicable for left banks resettlement areas (Laloi and Mandi).

Table 7.4: Screening of Available Options for Right bank

Relevant Aspect	*Option-1*	*Option-2*	*Option-3*
Topography	Favorable	Favorable	Favorable
Geological and Geotechnical Conditions	Favorable	Favorable	Favorable
Availability of Construction Material	Favorable	Acceptable	Favorable
Dewatering Arrangement	Required	Required	Nil
Ease of Construction	Favorable	Marginally Favorable	Favorable
Houses to be Inundated	Nil	Nil	27 houses can be rebuild with raised elevation
Graveyard to be Inundated	Nil	Nil	Can be Raised
Religious Bodies (Shrines and Mosques etc)	Nil	Nil	01 Shrine
Social Impact	Low	Low	Medium
Cost	Low	High	Moderately High
Suitability	Most suitable	Less Suitable	Suitable
Technical Rating	First	Third	Second

Note: Same screening results will be applicable for left bank areas

Conclusions drawn from the above comparison are as follows:

1. Option-1 is considered most suitable to the site specific conditions and thus is technically rated as the first choice.
2. Option-2 is considered also suitable to the site specific conditions and is technically rated as the third choice.
3. Option-3 is considered marginally suitable to the site specific conditions and thus is technically rated as the second choice.

7.4.1 Option-1: Earthen Dyke with Collection Drain and Dewatering

7.4.1.1 For Right Bank Area

Further optimization of Option-1 has been carried out to arrive at most optimum solution with respect to cost of land acquisition, resettlement and compensation. Main criteria for this optimization were kept to reduce the cost of earthen dyke by reducing the length and height of earthen dyke, which should be compared with the cost of resettlement to arrive at the most optimum solution. Six scenarios of option-1 were plotted as conceptual layouts **Figure 7.2**.

Table 7.5 shows that with the reduction of dyke length by shifting it towards the uphill, cost for dyke and other arrangement reduces. However, cost for resettlement, land acquisition and compensation will increase.

7.4.1.2 For Left Bank Laloi Area

In Laloi area, total 10.48 acre land at EL. 542 m and 20 houses will be inundated, if no engineering solution is provided for resettlement curtailment. With earthen protection dyke and associated arrangement, land and houses can be saved for resettlement and compensation. Conceptual layout and cross section of proposed engineering solution of earthen dyke and collection drain is shown in **Figure 7.2** along with tabular details.

7.4.1.3 For Left Bank Mani Area

In Mandi area, total 17.70 acre land at EL. 542 m, one shrine, one mosque, few rooms and private crusher plant will need to be displaced or relocated, if no engineering solution is provided for resettlement curtailment. With earthen protection dyke and collection drain, these structures can be saved for resettlement and compensation. In this area most important structure is shrine. Actual shrine has already been submerged in the river. Therefore, keeping in view the emotional and religious affiliation of locals with the symbolic Shrine, it can be relocated at some higher elevation of same area.

Conceptual layout for proposed engineering solution of earthen dyke and collection drain is shown in **Figure 7.2** along with **Table 7.5**.

Table 7.5: Optimization of Option 1

Relevant Aspect	*Embankment Alignment Options*					
	R 1	*R 2*	*R 3*	*R 4*	*R 5*	*R 6*
Length of Dyke or Retaining Wall (m)	1237	1150	1021	918	777	300
*Avg. Height (m)	7.3	6.8	6.4	5.8	5.4	5.6
Area to be Inundated (Acre)	31.7	32.79	42.65	50.22	58.77	94.09 (KDA)
Houses to be Inundated	Nil	3	5	11	24	78
Area of graveyard to be inundated (Acre) Total 4.12	Nil	Nil	1.2	3	4	4.12
Other Structures (Rooms/Shrines/School)	Nil	Nil	Nil	0/1/0	0/1/0	1/3/2001
Social Impact	Low	>	>	>	>	High
Cost	High	>	>	>	>	Low
Suitability	Most Suitable	Suitable				Less Suitable
Technical Rating	First	Second	Third	Fourth	Fifth	Sixth

*Crest of dykes (earthen embankment) is kept at EL. 545 m in accordance with main dam crest of EL. 545 m given in the basic design report of the Gulpur Hydropower Project

7.4.2 Option-2: Concrete Retaining Wall with Collection Drain and

Very high cost was anticipated for dewatering arrangement in this option, therefore further working and development of conceptual layouts and cross-sections have not been developed. However, conceptual layout will generally be the same as of Option-1.

7.4.3 Option-3: Earthen Filling with Earthen Dyke and Collection Drain

In this option, area of about 54.44 acres up to EL 540.25 m has to be filled with common material along with construction of earthen dyke up to EL. 545 m and collection drain. Run-off water will be discharged into the lake at Normal Operation Level (NOL) of EL. 540 m through concrete outlet structures and flap valves. During detailed studies, if reveals, one collection drain at EL. 542 m will be provided to drain the catchment run-off into the lake. Pros and cons of this option are as follow:

- Pros:
    - No pumping is required for dewatering
    - No land acquisition is required, same land after raising to higher elevation of 545.25 m (average thickness of filling =1.5 to 2 m) will be used for cultivation.
    - Only 16 houses will need to be either shifted or re-build at the same location
    - Operation and maintenance cost is negligible
- Cons:
    - High Cost
    - Shifting of 16 houses

In this option, collection drain may be required, if hydrological studies confirm this. Conceptual layout of Option-3 for the left and right bank resettlement curtailment is shown as **Figure 7.3**.

7.4.3.1 For Left Bank Laloi Area

In Laloi area, total 5.70 acre land at EL. 540.25 m will need to be filled with common material, for which 27 houses will be either displaced to save location or re-build at same location at higher elevation. Apparently, it seems that cost for earth filling along with cost of resettlement and compensation will be much higher than Option-1 as described above.

7.4.3.2 For Left Bank Mani Area

In Mandi area, total 12.82 acre land at EL. 540.25 m will need to be filled with common material, for which one shrine, one mosque, one private crusher plant and few rooms will be either displaced to save location or re-build at same location at higher elevation. Apparently, it seems that cost for earth filling along with cost of resettlement and compensation will be much higher than Option-1 as describe above.

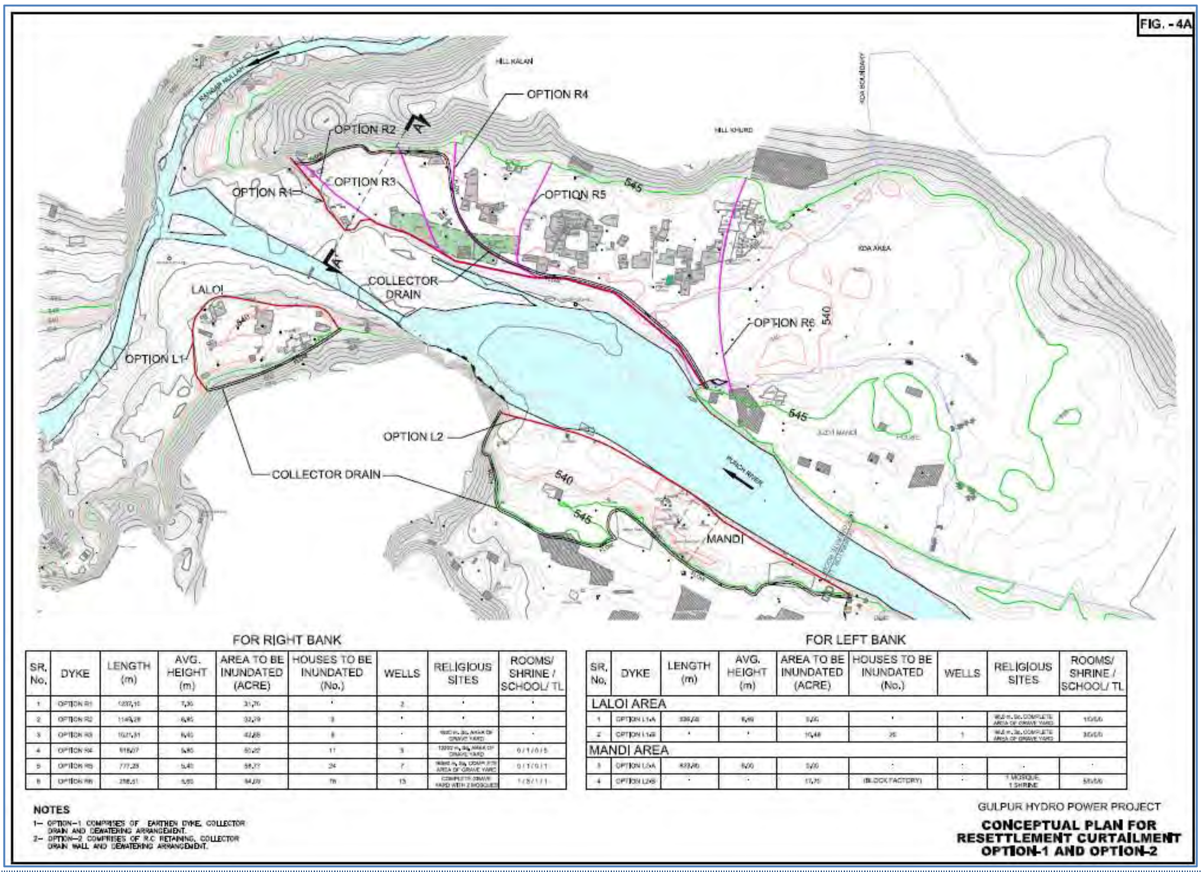

Figure 7.2: Conceptual Plan for Resettlement Curtailment Option 1 and 2

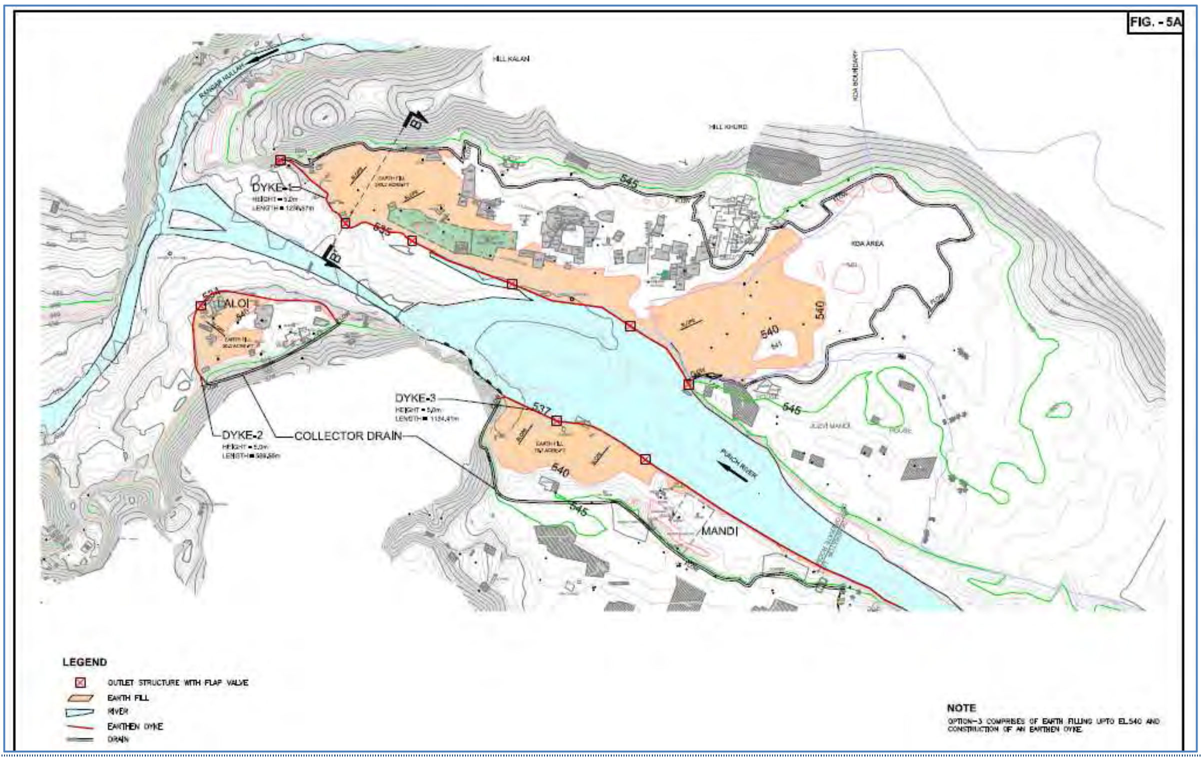

Figure 7.3: Conceptual Plan for Resettlement Curtailment Option 3

7.4.4 No Dyke Option

If the no dyke option is considered than it would have significant social, environmental and economic implications. These would be hard to address and take time which would not be favorable for the project and the general public interest. Therefore, it can safely be concluded in the light of previous dyke options discussion that dyke option should be used so that the social and environmental issues associated with the project would be minimized and set precedent for other similar projects.

8 STAKEHOLDER CONSULTATIONS

8.1 General

This section describes the outcomes of the stakeholder consultation process as part of the ESIA. This ensures that feedback from communities and other stakeholders directly or indirectly affected by the project is collected so that it may be used to adjust and improve the project's design, planning, implementation and help structure ensuring that the project is both environmentally and socially sound. The consultation process was carried out in accordance with the requirements of the ADB and IFC and Government of AJK on public consultation.

The objectives of this process were:

- To disseminate information on the project and its expected impact, long-term as well as short-term, among primary and secondary stakeholders,
- To gather information on relevant issues so that the feedback received could be used to address these issues at an early stage,
- To determine the extent of the negative impacts of different project activities and suggest appropriate mitigation measures.

8.2 Identification of Stakeholders

There are two types of stakeholders, i.e.

8.2.1 Primary stakeholders.

The primary stakeholders are the initial stakeholders, such as affected persons, general public and women residing in the project area. Accordingly, the consultations/ focus group discussions were made with all above primary stakeholders for sharing of information about the proposed project and expected impacts and understanding about the concerns by category of stakeholders.

8.2.2 Secondary stakeholders

The secondary stakeholders are the representatives of Government Departments/Agencies involved in the planning, design, implementation and operation of the project, including various government departments such as District Administration, Revenue Department, WAPDA, Agriculture including the Horticulture wing, Irrigation, Forest, PWD and other relevant departments.

8.3 Stakeholder Consultation Process

The overall strategy for stakeholder's consultation is as follows:

Table 8.1: Process of stakeholder's consultations

Stakeholders	*Purpose of consultations*	*Methodology*	*Stage*
Primary Stakeholders	• Information gathering and data collection. • Information sharing about the project (disclosure)	• FGDs • Household surveys • Formal and informal Community meetings	• Base line study • Impact assessment

Stakeholders	*Purpose of consultations*	*Methodology*	*Stage*
	• Opinion seeking (concerns and expectations) • Grievance redress • Involvement of PAPs		• Inventory of Losses • Price fixation Discloser
Secondary Stakeholders	• Participation in the process • Information gathering • Authentication and validation of the processes verification of the record	• One on one meetings • In-depth interviews • Group meetings	• On need basis

Stakeholder consultation for this project was planned in two stages. The first stage was scoping, which has already taken place, consisted of meetings with individuals, groups, relevant organizations and government departments, which are in some way linked to the project and therefore considered stakeholders. The meetings were conducted to inform stakeholders about the project and how it may affect their lives/activities, and to record their concerns, whether real or perceived. Through the use of various tools the study team tried to involve the stakeholders in active decision-making. The results of this exercise are described below, where mitigation measures have been developed addressing the pertinent stakeholder concerns.

The second stage of the stakeholders' consultation was part of the separate study conducted for the preparation land acquisition and resettlement framework of the project. The results of this study and the proposed mitigation measures for potential social impacts will be documented separately and will be included in the overall framework of the proposed project.

8.4 Primary Stakeholders Consultation

Apart from gathering of quantitative data through household survey of the area of influence of the project and 100% survey of project affected people a total of 16 consultations (qualitative) were conducted with the affected persons and other local community to share the information about the project and record their concerns/ feedback associated with this project. In this context, APs shared their view point regarding the assessment especially price assessment, method of payment of compensation and procedure for entering their concerns/ grievances. A list of public consultations is presented in the below table:

Table 8.2: List of Primary Stakeholder's Consultations in the Project Area

No	*Date*	*Location/Venue*	*Name of Main Participants*
1	21-06-2013	Hill Khurd	- Mr. Zulfiqar Hussain Shan - Mr. Adil Shah - Mr. Khalid Mehmood - Mr. Muhammad Hussain
2	22-06-2013	Hill Khurd	- Mr. Muhammad Dad - Mr. Talib Shah - Mr. Sadar Sharif - Mr. Mushtaq Shan - Mr. Yaqoob Shan - Mr. Sardar Azeem

No	Date	Location/Venue	Name of Main Participants
3	24-06-2013	Hill Khurd	- Mr. Sobidar Javed - Mr. Ahmed Shah - Mr. Abid Shah - Mr. Rehmat Shah - Mr. Sardar Shah - Mr. Anwar Shah
4	25-06-2013	Hill Kalan	- Mr. Mohammad Khan - Mr. Mohammad Shafiq - Mr. Mohammad Shakeel - Mr. Talib Hussain - Mr. Khadim Hussain - Chaudhray Azam
5	26-06-2013	Hill Kalan	- Mr. Mohammad Hussain - Chaudhry Fazal - Mr. Abdul Rehman - Mr. Khadim Hussain Shah - Chaudhry Talib - Mr. Shafiq & others
6	27-06-2013	Hill Kalan	- Mr. Wazir Batt - Mr. Akram Batt - Mirza Bashrat - Mr. Rehmatullah Batt - Mr. Farqan Batt - Mr. Mohammad Idress Batt
7	30-06-2013	Laloi	- Chaudhry Lal - Mr. Abdul Majeed - Mr. Abdul Haneef - Mr. Abdul Hafeez - Mr. Abdul Azeem
8	1-07-2013	Laloi	- Mr. Abdurashid - Mr. M Riasat - Mr. Abdul Qayyum - Mr. Abdul Latif
9	2-07-2013	Laloi	- Mr. Aurangzeb - Mr. M Azam - Mr. M Mushtaq
10	4-07-2013	Laloi	- Mr. Atif Mushtaq - Mr. M Azam - Mr. M Ashi
11	5-07-2013	Banar	- Mr. Sadiq Mehmood
12	7-07-2013	Rehmani Muhallah	- Mr. Mehboob Ali - Mr. Abid Ali - Mr. Sajid Ali - Mr. M Younis
13	9-07-2013	Noshki	- Mian Abdul Rehman - Mr. Ghulam
14	30-06- 2013	Hill Kalan /Hill Khurd	- Gultraz Bukhari - Khadim Hussain - Syed Zahoor - Syed Kazim Hussain - Syed Zulfiqar - M. Atif

No	Date	Location/Venue	Name of Main Participants
15	29-06-2013	Dharang/Jamal Pur	- Akarak Ali - Raja Maqsood - Shahid Javed - Shehryaar Sabir - Sahid Javed - Rashid
16	28-06-2013	Barali	- Abdul Rehman - Qamar Zaman - M. Saleem - Syed Naseem Hussain - Muhammad Akarm - Khalid Rashid - Qurashi - Iftikhar Ahmed - M. Khalid

8.4.1 Topics for Discussion

The topics discussed in the consultations were

- Land acquisition and resettlement issues.
- Employment and livelihoods of communities.
- Gender and women issues
- Contractor's camp and access
- Environmental issues

8.4.2 Outcomes of Consultations

- All actions associated with the project should be taken through proper consultations
- There should be a continuous community consultation program throughout the project implementation period.
- There should be employment opportunities for skilled and unskilled local people, preference should be given to the project affected persons.
- Vocation training/ educations needs to be provided to local women, so that they could be able to support their families by supplementing their household income.
- Electricity and irrigation water and electric tube wells are needed for the increased productions of crops.
- To include local people wherever possible in jobs during the construction of project. Thus, income generating activity of the area will be enhanced.
- Chances of some environmental effects like noise/ vibration and dust emissions to the nearby community.
- A large number of women are involved in working in agriculture fields, so that their routine activities should not be disturbed.
- No major effect on land or crop will occur if the project is implemented after crop harvest.
- Overall the project is good for the villagers and the country.
- No serious concerns with the project because this project will increase the employment and will reduce the load shedding issue of the country.

8.4.3 Consultation Teams

There were 8 members team including two female enumerators for household surveys. A PRA Specialist conducted the Focused Group Discussions (FGDs) with stakeholders, whereas an EIA specialist supported by a field assistant conducted interviews and meetings with government functionaries.

8.4.4 Future Consultations

The consultations will be continued with all stakeholders and especially with government regulatory agencies like EPA, AJK and Deputy Commissioner, Kotli. A mechanism for consultations with local communities is part of the LARP.

8.5 Land Acquisition and Resettlement–Related Concerns

The following issues and concerns were showed by the stakeholders regarding land acquisition and resettlement.

- Compensation for loss due to the project should be provided based on market rates.
- Crops compensation should also be given in addition to land compensation
- Compensation of trees should also be given.
- There should be transparent and fair compensation methods/ procedures, so that the entitled person could receive his payment.
- The most affected people in Hill Kalan and Hillahurd demanded that compensation of their land/houses be provided on good market price and as the construction material transportation cost for these villages is too high. The access is only through boat or lift system and there is no any access road that can be used for material transportation in bulk.
- Moreover, the people in these areas are demanding that they must be provided same basic facilities on alternate site where they may be shifted or settled.
- The market price of land in Banar village was very high. Therefore, APs demanded compensation according to the current market rates.

8.6 Addressing Stakeholders Concerns

To address the issues and concerns raised by the stakeholders a mitigation plan has been developed and made part of the ESIA.

8.7 Meetings with Secondary Stakeholders

The following stakeholders were consulted on different occasions to seek their inputs, feedback and opinion on the design and scope of the project. The offices and Individuals who were consulted are as follows:

i. Office of Deputy Commissioner Kotli
ii. Environment Protection Agency, AJK
iii. Chief Conservator Forests AJK
iv. Director Wildlife and Fisheries
v. Deputy director Wildlife and Fisheries AJK

vi. AJK Rural Support Programme Kotli.
vii. World Wildlife Fund Pakistan (WWF-P)
viii. Leadership for Environment and Development Pakistan
ix. Pakistan Museum of Nature History
x. Snow Leopard Foundation Pakistan

The stakeholders supported the Gulpur Hydro Power project provided that environmental and issues are addressed through mitigation measures. To address the issues an ESIA and Land Acquisition and Resettlement Plan (LARP) are developed and shared with stakeholders for their feedback and suggestions.

9 IMPACT ASSESSMENT AND MITIGATION

This chapter discusses in detail any of the potential environmental and social impacts that may be resultant of the project activities (**Section 3**) in the surrounding environment (**Section 4 to 6**) of the project area.

An overview of the general approach for the impact assessment is discussed below so that it is not repeated in each environmental component. In case, where specific mitigation measures have been provided for an environmental component these are presented in the relevant section with supplementary information.

9.1 Impact Assessment Methodology

9.1.1 Project Area

The project area is the site of the proposed project and the area of probable impact as the extent of the area outside the project area that is likely to be directly or indirectly impacted by the proposed project is been considered see **Section 7**.

9.1.2 Establishment of the Existing Environment

The baseline condition is the environmental conditions that would lie in the absence of the construction and operation of the Project, and against which the potential environmental impacts of the Project would be assessed. For the majority of the technical studies the baseline is the conditions at the present time. Baseline information for the ESIA has been collected from published literatures, desk studies, consultations with relevant stakeholders and data collected for this study during field surveys.

9.1.3 Prediction / Evaluation of Impacts

The prediction and evaluation of impacts of the Project has been considered against the baseline in the ESIA. The following impacts have been considered:

- Direct impacts – a primary impact of the Project.
- Indirect impacts – impacts that arise from activities not explicitly forming part of the Project.
- Permanent impacts – impacts that arise from an irreversible change to the baseline environment or which persist for the foreseeable future.
- Temporary impacts – impacts that persist for a limited period only or can be reversible. Where possible these will be classified as temporary, short-term, medium-term or long-term.

Each of the environmental impact will be categorized in to the:

- Beneficial impacts – impacts that have a beneficial influence on environmental receptors and resources.
- Adverse impacts – impacts that have an adverse influence on environmental receptors and resources

The impacts that will be evaluated to be beneficial will be further enhanced to benefit the environment while those having adverse impact will be mitigated by proposing the required mitigation measures.

9.1.3.1 Impact Evaluation and Description

Environmental impacts have been and will continue to be considered, eliminated or reduced throughout the lifecycle of the Project. For the ESIA process Impact evaluation has been carried out in compliance with the national and international legal requirements and guidelines. These documents use various types of tools in an attempt to define a comprehensive and consistent method to capture all potential impacts of a proposed Project.

A uniform system of impact description is used to enable the reviewers to understand how impacts have been interpreted. The description of each impact will have the following features:

- A definition of the impact using an impact statement;
- The impact statement clearly identifying the project activity or activities that causes the impact, the pathway or the environmental parameter that is changed by the activity, and the potential receptors of the impact;
- Establishing the sensitivity of the receiving environment or receptors;
- Based on the stakeholder consultations undertaken, outlining of the level of public concern regarding the specific impact;
- Rating of the significance of the impact;
- Description of the mitigation and management measures and the effectiveness of proposed measures; and
- Characterization of the level of uncertainty in the impact assessment.

The significance of an impact is determined based on the product of the consequence of the impact and the probability of its occurrence. The consequence of an impact, in turn, is a function primarily of three impact characteristics: magnitude; spatial scale; and duration.

Magnitude is determined from quantitative or qualitative evaluation of a number of criteria discussed further below. Where relevant, this includes comparison with standards or thresholds. Examples of thresholds include:

- legal thresholds—established by law or regulation;
- functional thresholds—if exceeded, the impacts will disrupt the functioning of an ecosystem sufficiently to destroy resources important to the nation or biosphere irreversibly and/or irretrievably;
- normative thresholds—established by social norms, usually at the local or regional level and often tied to social or economic concerns;
- preference thresholds—preferences for individuals, groups or organizations only, as distinct from society at large; and
- reputational thresholds—the level of risk a company is willing to take when approaching or exceeding the above thresholds.

After the evaluation of the impacts resulting from project, the probability of impact occurrence is considered to further evaluate overall impact significance. The probability in this case relates to the likelihood of the impact occurring.

The resulting significance rating may be further qualified by explaining the effectiveness of proposed management measures designed to mitigate or enhance the impact, and by characterizing the level of confidence or uncertainty in the assessment.

9.1.3.2 Impact Significance Rating

The impact significance rating process serves two purposes: firstly, it helps to highlight the critical impacts requiring consideration in the approval process; secondly, it serves to show the primary impact characteristics, as defined above, used to evaluate impact significance. The impact significance rating system is presented in **Table 9.1**.

- Part A: Define impact consequence using the three primary impact characteristics of magnitude, spatial scale and duration;
- Part B: Use the matrix to determine a rating for impact consequence based on the definitions identified in Part A; and
- Part C: Use the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from Part B) and the probability of occurrence.

Using the matrix, the significance of each described impact is rated.

9.1.3.3 Mitigation and Good Practice Measures

Wherever, the Project is likely to result in unacceptable impact on the environment, mitigation measures are proposed. In addition, in certain cases good practice measures are proposed.

Table 9.1: Method for Rating the Significance of Impacts

PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE			
Impact characteristics	Definition	Criteria	
MAGNITUDE	Major	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded	
	Moderate	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded	
	Minor	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded	
	Minor+	Minor improvement; change not measurable; or threshold never exceeded	
	Moderate+	Moderate improvement; within or better than the threshold; or no observed reaction	
	Major+	Substantial improvement; within or better than the threshold; or favorable publicity	
DURATION/ FREQUENCY		Continuous aspects	Intermittent aspects
	Short term/ low frequency	Less than 4 years	Occurs less than once a year
	Medium	More than 4 years up to end	Occurs less than 10 times a year but

		of life of project (approximately 56 years)	more than once a year
	Long term/ high frequency	Beyond the life of the project (greater than 30 years)	Occurs more than 10 times a year
SPATIAL SCALE		Biophysical	Socio-economic
	Small	Within 200 meters (m) of the Project footprint	Within the Study Area
	Intermediate	Within 3 kilometer (km) of the Project footprint	10 km from the Project facilities
	Extensive	Beyond 3 km of the Project footprint	Beyond 10 km from the Project facilities

PART B: DETERMINING CONSEQUENCE RATING
Rate consequence based on definition of magnitude, spatial extent and duration

			SPATIAL SCALE		
			Small	Inter-mediate	Extensive
MAGNITUDE					
Minor	DURATION/ FREQUENCY	Long / high	Medium	Medium	Medium
		Medium	Low	Low	Medium
		Short / low	Low	Low	Medium
Moderate	DURATION/ FREQUENCY	Long / high	Medium	High	High
		Medium	Medium	Medium	High
		Short / low	Low	Medium	Medium
Major	DURATION/ FREQUENCY	Long / high	High	High	High
		Medium	Medium	Medium	High
		Short / low	Medium	Medium	High

PART C: DETERMINING SIGNIFICANCE RATING
Rate significance based on consequence and probability

		CONSEQUENCE		
		Low	Medium	High
PROBABILITY (of exposure to impacts)	Definite	Low	Medium	High
	Possible	Low	Medium	High
	Unlikely	Low	Low	Medium

+ denotes a positive impact.

9.2 Impacts on Physical Environmental

The physical environmental aspects that may be affected by the project activities are following

- Noise and dust associated with construction and operations
- Use of water for Project activities
- Generation of waste by the Project activities during construction and operations
- Construction of an earthen dyke for flood protection and minimization of inundation area

Following are the potential impacts that may arise from the execution of the project activities:

- Impact PE1: Soil Contamination
- Impact PE2: Soil Erosion
- Impact PE3: Water Contamination
- Impact PE4: Change in Drainage Pattern due to Weir Construction
- Impact PE5: Water Resource Depletion
- Impact PE6: Fugitive Dust Emissions
- Impact PE7: Vehicular and Generator Exhaust Emissions
- Impact PE8: Damage to Infrastructure due to Blasting
- Impact PE9: Noise Nuisance due to Blasting, Drilling and Batching Plant
- Impact PE 10: Construction of Earthen Dyke

9.2.1 Soil Quality

Improper handling of oils, lubricants and other such substances may result in spills which would lead to soil contamination. Other than this accidental releases and leakages are another grey area in this regard. Storage in areas with no lining and containing walls and low quality storage containers pose another threat of soil contamination.

Impact PE1: Discharge related to Project construction and Operation particularly operation of generator and wastewater system can potentially result in the contamination of soil and consequent deterioration of groundwater and surface water quality								
Applicable Project Phase								
Construction					*Operational*			
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Long	Intermediate	High	Possible	High	-	High
Mitigation Measures: • MM01: The generator will be placed on impervious layer. Sufficient area around the generator will be made impervious to contain any spill during maintenance • MM02: Fuel tanks will be appropriately marked by content and will be stored in dyked areas with an extra 10% of the storage capacity of the fuel tank. The area will be lined with an impervious base • MM03: Grease traps will be installed on the site, wherever needed, to prevent flow of oily water. • MM04: Spill control kit (shovels, plastic bags and absorbent materials) will be available near fuel and oil storage areas. • MM05: Emergency plan for spill management will be prepared and inducted to the staff for any incident of spill. • MM06: The bottom of any soak pit or septic tank will be at least 10 m above the groundwater table. The distance can be reduced, if based on the soil properties, it is established that the lesser distance will not result in contamination of groundwater								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Long	Intermediate	Medium	Unlikely	Low	-	High
Good Practice Measures:								
Monitoring: • MN01: Daily monitoring for any of the spills and leakages in the generator room and other construction area • MN02: Quarterly monitoring of level of wastewater in soak pits and septic tanks.								

9.2.2 Soil Erosion

Any excavation work during the construction activities, whether permanent or temporary, would lead to loss of soil. Erosion of soil can also occur from removal of vegetation cover, runoff from unprotected excavated areas, muck disposal sites, quarry sites etc. Excavations on slopes would also decrease its stability. Given the topography of the area, unprotected excavations on sloping grounds may lead to landslide, especially during the rainy season.

Impact PE2: Land clearing and blasting and drilling activities may loosen the top soil in the project area resulting in possible acceleration of soil erosion, especially in the wet season								
Applicable Project Phase								
Construction					*Operational*			
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Short	Small	Low	Definite	Low	-	High
Mitigation Measures: • MM1: Vegetation loss shall be minimized to the extent possible which would help soil bonding • MM2: The nearby area will be sprinkled before blasting and drilling to minimize erosion • MM3: Controlled blasting shall be done to minimize environmental impacts • MM4: Areas such as muck disposal area, batching plant, labor camp, quarry sites, etc. after the closure shall be covered with grass and shrubs • MM5: Slopes in the drilling and blasting areas should be protected against sliding • MM6: All trace cutting works for road construction, adequate retaining wall or breast wall to be provided in case the geology is not self-supporting. • MM7: Slope stabilization measures will be adopted such as adequate vertical and horizontal drains, drainage along road sides, cross drainage etc.								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short	Small	Low	Unlikely	Low	-	High
Good Practice Measures: Local species for plantation shall be selected to restore the biodiversity of the area in consultation with forest department after completion of respective activities								
Monitoring: • MN01: HSE officer visit before the above mentioned activities on regular basis								

9.2.3 Water Contamination

Impact PE3: Water contamination due to releases from the construction camp, vehicles washing area and in the project phase sewage from the power plant facilities and possible oil spills/leakages								
Applicable Project Phase								
Construction				*Operational*				
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Major	Medium	Extensive	High	Possible	High	-	High
Mitigation Measures: • MM1: Soak pits for kitchen waste water will be installed • MM2: Septic tanks for sewage waste will be put in place • MM3: Prohibit release of camp effluents to the water channels or land • MM4: Lining of all effluent channels at all working areas with cement will be done to prevent seepage • MM5: All the garbage shall be collected and disposed off adequately to the disposal site or to an incinerator, if feasible • MM6: Leakage of oil wastes from oil storage and vehicles should be avoided in order to prevent potential contamination of streams or ground water • MM7: Surface runoff from oil handling areas/devices should be treated for oil separation before being discharged into the river.								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short	Small	Low	Possible	Low	-	High
Good Practice Measures:								
Monitoring: • MN01: HSE officer visit before the above mentioned activities on regular basis								

9.2.4 Change in Drainage Pattern

Construction of weir and creation of dam will change the flow regime of the existing river, which may pose impacts on downstream and upstream ecology. Keeping in view the sensitivity of the issue and project setting, a biodiversity assessment exercise will be carried out separately and made part of the ESIA. Biodiversity study would aim at determining the ecological flow and the requirements of releases to maintain that flow after the proposed development. Further options will be assessed to incorporate positive impacts of the project in that area and specifically in the Poonch River. The creation of dam will certainly enhance the aesthetic value of the locality and also provide opportunities for eco-tourism. Another advantage would be the increased productivity of fish harvest with the increase of water availability due to dam creation in that area.

The construction of access road for intake and quarrying of construction material may also alter the drainage pattern of the area.

Impact PE4: Construction of weir may alter the drainage patterns of the area								
Applicable Project Phase								
Construction				*Operational*				
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Medium	Intermediate	Medium	Possible	Medium	-	High
Mitigation Measures: • MM1: Results of the biodiversity assessment (ecological flow) be incorporated in implementation plans. • MM2: Surface runoff from oil handling areas/devices should be treated for oil separation before being discharged into the river. • MM3: The sand and gravel quarrying sites shall be selected keeping in view the impacts and magnitude of change in surface water drainage patterns. Major changes in the landscape shall be avoided. • MM4: At the completion of activities the natural pattern shall be restored, to the extent possible.								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Major	Medium	Intermediate	Extensive	Possible	High	-	High
Good Practice Measures:								
Monitoring: • MN01: HSE officer visit before the above mentioned activities on regular basis								

9.2.5 Water Resource Depletion

There are several project activities that may affect the water availability in the area. Especially the area above tunneling location have some households where tunneling under these households may disturb the groundwater table of that location specifically. Keeping in mind the terrain of the area and findings of the feasibility studies there would be no groundwater reservoirs/aquifers. There would be safe distance maintained from the possible reservoirs and in this way no major impact is envisaged. Still if there is an issue of groundwater depletion then after establishing that the residents would be provided an alternate source of water in the source of water supply scheme or regular supplies in containers to be managed by the project proponent in consultation with the local community and the local authorities. Other activities that may deplete the water resources include use for cleaning supplies, drinking water supplies and for other construction activities. While quarrying and drilling the natural water ways and springs may be disrupted or damaged and in this way limiting the availability of water to the local communities. Special care needs to be taken while conducting such activities to avoid damage or blockage of natural water ways and channels.

Impact PE5: Use of local water resources for construction activities may reduce the water availability to the local communities								
Applicable Project Phase								
Construction					*Operational*			
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Major	Short	Small	Medium	Possible	Medium	-	High
Mitigation Measures: • MM1: Water for different construction activities will not be drained of the local wells or fountains instead will be arranged form the river or via a water contractor from an approved source by the local authorities • MM3: Water conservation techniques will be developed and implement by the EPC contractor • MM4: Records of water usage would be maintained • MM5: Shallow or perched aquifers shall not be tapped for any project activity • MM6: Access to community wells shall be kept clear so that the community's ability to meet its water requirements are not compromised								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short	Intermediate	Medium	Unlikely	Low	-	High
Good Practice Measures:								
Monitoring: • MN01: Third party audit of the water levels in the impact area every six months								

9.2.6 Fugitive Dust Emissions

The project is spread around an area of around 6km^2 in a hilly terrain acts as a natural barrier to movement of heavy traffic and humans. Therefore there would be more than one camping site for the proposed project. This would require of road driving, furthermore the roads are two lane and therefore the shoulders of the road would be used and cut more often generating more dust emissions. Defensive driving and regular water sprinkling are few steps that would significantly reduce the emissions and their likely impacts.

<table>
<tr><td colspan="9">Impact PE6: Vehicular movement and drilling will create fugitive dust emissions specially while off road driving</td></tr>
<tr><td colspan="9">Applicable Project Phase</td></tr>
<tr><td colspan="4">Construction</td><td colspan="5">Operational</td></tr>
<tr><td colspan="4"></td><td colspan="5"></td></tr>
<tr><td colspan="9">Impact Rating</td></tr>
<tr><td></td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>Significance</td><td>+/-</td><td>Confidence</td></tr>
<tr><td>Initial Impact</td><td>Moderate</td><td>Short</td><td>Intermediate</td><td>Medium</td><td>Definite</td><td>Medium</td><td>-</td><td>High</td></tr>
<tr><td colspan="9">Mitigation Measures:
• MM1: For fugitive dust control, sprinkling of water on the project roads will be done
• MM2: Grading operation to be suspended when the wind speed exceeds 20 km /hr.
• MM3: All storage piles shall be adequately wetted or covered with plastic to ensure protection of ambient air from fugitive emission during wind storm
• MM4: Batching plants and associated machinery installed for project activities will be installed with suitable pollution control arrangements
• MM5: Speed limits and defensive driving policies will be strictly implemented
• MM6: Road damage caused by project activities will be promptly attended to with proper road repair and maintenance work</td></tr>
<tr><td></td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>Significance</td><td>+/-</td><td>Confidence</td></tr>
<tr><td>Residual Impact</td><td>Minor</td><td>Short</td><td>Small</td><td>Low</td><td>Unlikely</td><td>Low</td><td>-</td><td>High</td></tr>
<tr><td colspan="9">Good Practice Measures:</td></tr>
<tr><td colspan="9">Monitoring:
• MN01: Early morning and afternoon in the inspection by the site EHS officer and if required the frequency can be increased</td></tr>
</table>

9.2.7 Vehicular and Generator Exhaust Emissions

Emissions from the exhaust of vehicles, batching plant and generators etc. would release emissions which would certainly add to the ambient air levels of the immediate vicinity. Especially the movements of heavy machinery and vehicles of old make and poor engine condition tends to release more than new well-tuned vehicles. Use of low grade fuels and lubricants also increases the emission levels.

Impact PE7: Exhaust emissions from generators, project traffic and batching plant may deteriorate the local ambient air quality								
Applicable Project Phase								
Construction				*Operational*				
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Short	Small	Low	Possible	Low	-	High

Mitigation Measures:

- MM1: New and low emission equipment and vehicles shall be used
- MM2: Best quality fuel and lubes shall be purchased where possible lead free oil and lubes should be used
- MM3: Batching plant shall be set up considering the wind direction so that the nearby communities are not affected by the emissions from batching plant
- MM4: Batching plant should be kept as near to natural sinks to minimize emissions to ambient environment
- MM5: Regular maintenance of vehicles and equipment will be conducted to keep emissions in check
- MM6: Filters will be installed wherever available in vehicles and equipment
- MM7: All stacks will be at least 8ft high to safeguard the labor and passersby from the emissions

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short	Small	Low	Unlikely	Low	-	High

Good Practice Measures:

Monitoring:

- MN01: Biannual monitoring of the emissions against NEQS and other applicable emission standards by third part auditors

9.2.8 Damage to Infrastructure due to Blasting

Blasting and drilling near any civil structures like houses, schools, mosques, shrines, commercial buildings etc. may cause damage or destruction of the structure in the worst case or if safe distances are not maintained. Apart from that noise and vibrations produced from these activities would also create nuisance to the surrounding communities and wildlife. Therefore, special care is needed in view of these sensitivities. Special plans and safe distances need to be calculated according to the best industrial practices to avoid all such mishaps to the extent feasible.

Impact PE8: Blasting for tunneling may cause damage to nearby infrastructure								
Applicable Project Phase								
Construction				*Operational*				
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Short	Small	Low	Definite	Low	-	High

Mitigation Measures:

- MM1: Safe distances acceptable worldwide will be calculated and maintained
- MM2: Where safe distances cannot be maintained the structures will be evacuated of the occupants to avoid human loss
- MM3: Controlled blasting techniques will be adopted at all times
- MM4: Public infrastructure and cultural heritage sites if any near the blasting area will be reinforced in terms of civil works
- MM5: Muffled blasting techniques be adopted where required.

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Long	Intermediate	Medium	Possible	Medium	-	High

Good Practice Measures:

Monitoring:

- MN01: Cracks on ground surface to be monitored for the stabilization of slops and landsliding.
- MN02: Noise level to be monitored at receptor levels to recommend, if a muffled blast is needed.
- MN03: Dispersion of explosion produced debris shall be monitor to ensure personnel and public safety on regular basis.
- MN04: Sources of ground water, including springs and hand pumps shall be monitored for change in water availability and quality.

9.2.9 Noise Nuisance

Impact PE9: Noise produced from blasting, drilling and batching plant may cause nuisance in the vicinity of the respective activity								
Applicable Project Phase								
Construction				*Operational*				
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Short	Small	Low	Definite	Low	-	High

Mitigation Measures:

- MM1: The construction equipment generating high noise must be designed to have an adequate muffler system.
- MM2: All stationary noise generating equipments such as air compressors and power generators should be used away from the residential area.
- MM3: A proper routine and preventive maintenance procedure for project vehicles and equipment should be set and followed in consultation with the respective manufacturer which would help prevent noise levels from deteriorating with use.
- MM4: Provision of proper Personal Protective Equipment (PPEs), i.e., ear muffs and plugs, will reduce noise impact on personnel.
- MM5: Movement of vehicles should be restricted to project area only.
- MM6: Restriction on pressure horns.
- MM7: The nearest community will be informed three siren in advance for the case of blasting activities
- MM8: Blasting will be done only in day hours
- MM9: unscheduled blasting will be strictly prohibited in any case

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Long	Intermediate	Medium	Possible	Medium	-	High

Good Practice Measures:

Monitoring:

- MN01: Regular monitoring of the noise levels in the nearest communities against the baseline noise conditions and if the threshold values are exceeded then re calculating the safe distances on the basis of monitoring report

9.2.10 Construction of Earthen Dyke

The proposed flood protection dyke would provide some engineering challenges and some environmental and social issues as well. According to the suggested option there would be earthen dyke at elevation which is designed at twice the PMF water level which would eliminate any potential risks. Furthermore there is proposed water gathering and disposal drain which would cater for the adjacent catchment's waters which would be collected at elevation 542 m in the drain coming directly from the adjoining catchment area and subsequently dispose off all the water into the river protecting the houses along the proposed dyke from any potential flash floods and water logging threats. The issue of water logging or pond formation for these houses is not an issues because the sewage from these households are collected in soak pits and septic tanks built inside the house hence this issue would be eliminated as well.

The only issue that can arise from this dyke option would be of standing water in case the water levels rise in the locality. Keeping in view the rock formation and soil nature of the area it is distinct possibility but cannot be overlooked at the same time. Therefore, along with the dyke there is a proposal for installation of water pumps (Section 7and 3) of industrial capacity to take care of this issue as well. The cost of which would be paid by the project proponent.

Impact PE10: Impacts of earthen dyke on physical environment.								
Applicable Project Phase								
Construction				*Operational*				
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	High	Long Term	Intermediate	High	Definite	High	-	High
Mitigation Measures: • MM1: The dimensions of dyke to be identified after detailed assessment of floods and surface hydrology of the area. • MM2: The drainage system of surface water during rains and excess water for irrigations shall not be blocked and the diversion of the same shall be in a manner that it has no impacts to the community and agricultural lands. • MM3: Water logging and salinity of the area shall be assessed and pumps be installed, if required. • MM4: Material for the construction of the dyke to be sourced considering environmental aspects including drainage pattern, stability, vegetation and public infrastructure.								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Long	Intermediate	Medium	Definite	Low	-	High
Good Practice Measures:								
Monitoring: • MN01: Water logging and salinity of the area shall be monitored on bi-annual basis.								

9.3 Impacts on Ecology and Biodiversity

The project area represents a human dominated landscape, and the vegetation has been subject to human influence over a long period of time. The people depend entirely upon the forests for grazing, fodder, timber and fuel. The heavily grazed areas near the town of Kotli show signs of extreme denudation, with consequential adverse effects on the fertility of the soil. The southern and southeastern slopes above thickly populated stretches are also suffering from similar damage. Majority of the species recorded in the area were of the tropical origin or fall in introduced/cultivated category, which signifies that the flora of the project area is much disturbed and altered. In the adjacent forests, nineteen Himalayan endemic species were recorded. However, none of them is narrow endemic and all have relatively wider distribution. There are no threatened plant species found in the area. The dominant land use at the project facilities is agriculture/settlements, and areas devoid of forest make about 25% of the land area.

Since the majority land impacted by the project will be either cultivated land or sparse broad leaf forest which already have poor ground cover, impacts of the project on vegetation are anticipated to be minor. Although one rare species (*Fraxinus raiboearpa*) exists in the area, its wide distribution was recorded in dense forest areas, and it is not expected to occur in disturbed habitats in vicinity of the project facilities. In conclusion, no loss of forest of conservation importance is anticipated either upstream (reservoir) or downstream of the dam site near the power station and along access roads. Vegetation clearing during the construction phase may lead to soil erosion. Erosion does not only result in loss of valuable topsoil but also in leaching of soil nutrients and loss of organic matter.

Seventeen species of mammals were recorded in the study area, and most of them are common and wide spread. The Eurasian Otter *Lutra lutra* is a rare but widely distributed carnivore species. It was reported to be present in the area, however the survey team could not find any reliable evidence. The Indian Grey Mongoose *Herpestes edwardsi* and the Small Asian Mongoose *Herpestes javanicus* are included in the CITES APPENDIX III. These species have a trade pressure for their skins which are exported to different countries. None of the small mammals found in the area are listed as Threatened under IUCN Red List. Concerning large mammals, the project area and its surroundings are dominated by adaptable species like fox and jackal, while the species which either pose danger (eg, common leopard) or have economic value (ungulates) seems to be locally extirpated. The species of large home ranges like common leopard gets killed if a vagrant individual enters into to the area.

All the 21 species of reptiles recorded during the survey were commonly found at all the study sites, and majority of them are either Not Evaluated species (52%) or have Least Concern status (42%), according to IUCN 2013 Red List. Only one species, Brown Cobra (*Naja oxiana*) was found Data Deficient with unknown population trend. None of the recorded species is protected under the AJK Wildlife Act 1975 or AJK Wildlife Ordinance 2013. Six are CITES Species with one (*Varanus bengalensis*) listed in Appendix I, four species (*Hoplobatrachus tigerinus*, *Lissemys punctata*, *Eryx johnii, Naja oxiana*) are listed in Appendix II while one species (*Xenochrophis piscator*) is listed in Appendix III of the CITES 2013.

Most of the avifauna of the Project is very common. The endangered species, the White Rumped Vulture (*Gyps bengalensis*) and endangered EGYPTIAN VULTURE (*Neophron percnopterus*) were also recorded from the study area.

Out of 29 fish species found in Poonch River, 12 species viz., *Barilius pakistanicus, Schistura punjabensis, Cirrhinus reba, Labeo dero, Labeo dyocheilus, Tor putitora, Cyprinus carpio, Botia rostrata, Clupisoma garua, Ompok bimaculatus, Mastacembelus armatus* are species of special importance. The species, *Barilius pakistanicus* and *Schistura punjabensis* are endemic in Pakistan including AJK. Four species, *Tor putitora* (Endangered), *Cyprinus carpio* (Vulnerable), *Botia rostrata* (Vulnerable), *Ompok bimaculatus* (Vulnerable) and *Ompok bimaculatus* (Near Threatened) have special IUCN status. Out of these, *Tor putitora, Cyprinus carpio* and *Ompok bimaculatus* are commercially important. The other commercially important species are *Clupisoma garua*, and *Mastacembelus armatus*.

Based on the factors described above, following potential impacts were identified:

- Impact EC1: Land disturbance due to construction and operation of project facilities resulting in disturbance, fragmentation, displacement and direct loss of animal, plants, reptiles, amphibians and birds.
- Impact EC2: Deterioration of area's water resources river if pollutants such as domestic waste (sanitary and kitchen discharge) or oil and grease, and fuel from project related machinery or equipment are mixed with surface runoff during rain, or if pollutants leach into the ground or are carried to river.
- Impact EC3: Reduction in water flow beyond weir, which can alter ecology of the area and lead to decline in abundance of fish, especially of Mahasher, results in habitat fragmentation, or affects connectivity of Mangla Reservoirs fishes to Poonch River.

9.3.1 Land Disturbance

Impact EC1: Land disturbance due to construction and operation of project facilities resulting in disturbance, fragmentation, displacement and direct loss of animal, plants, reptiles, amphibians and birds

Applicable Project Phase

Construction	*Operational*

Impact Rating

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	High	Long Term	Large	Low	Definite	High	-	High

Mitigation Measures:

- MM1: Cutting of trees if any will be minimized and damage will be compensated by re-plantation.
- MM2: Off-road driving will be prohibited outside the project area.
- MM3: Discharging firearms will be explicitly prohibited
- MM4: The project staff will be educated and instructed to avoid killing or chasing wildlife.
- MM5: The staff will be educated and monitored to ensure that they do not get engage in animal related trade
- MM6: Periodic trainings of the project staff will be conducted on biodiversity conservation issues to sensitize them about the biodiversity and protected area
- MM7: All restrictions imposed under wildlife legislation of AJK, particularly relevant to national park, will be strictly observed.

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short Term	Small	Low	Definite	Low	-	Moderate

Good Practice Measures:

The Mahasher National Park has been notified recently to protect biodiversity of the Poonch River, particularly the Mahasher fish. The national park through relevant legislation restricts various forms of species exploitation to ensure that the habitat remains protected and congenial for the indigenous species. In fact many mitigation measures given above are specified in the legislation. However, implementation of such measures and management of park resources require a park infrastructure and dedication of the park staff. As the matter stands now, there is limited park staff and other infrastructure which means park notification does not carry any meaning for the public, particularly for the culprits engaged in non-sustainable exploitation of the park resources. Many components of the local biodiversity are already degraded and rest are under severe ongoing assault, due to grazing, timber extraction, hunting, fishing, poisoning, electrification, and exactions in the river bed, etc.

The measures listed above will not only help mitigate project related impacts, but will halt ongoing biodiversity degradation in the project area. The project staff will cooperate with the Fisheries and Wildlife Department in implementing park restrictions and the project will contribute to maintenance and rehabilitation of natural habitat and species in the area.

Monitoring:

- MN01: Annual visits of the Fisheries and Wildlife Department to ensure that mitigation measures are implemented.

9.3.2 Deterioration of Area's Water Resources and River

Impact EC2: Deterioration of area's water resources river if pollutants such as domestic waste (sanitary and kitchen discharge) or oil and grease, and fuel from project related machinery or equipment are mixed with surface runoff during rain, or if pollutants leach into the ground or are carried to river.

Applicable Project Phase

Construction	*Operational*

Impact Rating

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Minor	Long	Small	Medium	Possible	Medium	-	High

Mitigation Measures:

- MM1: No waste will be discharged in open areas.
- MM2: No contaminated effluents will be released to the River
- MM3: Water from washing areas and kitchen will be released in sumps
- MM4: Sumps will remain covered all the time and measures will be taken to prevent entry of rainwater into them and at safe distance from runoff
- MM5: Fuels and lubricants will be stored in areas with impervious floors and dykes that can contain spills, and at safe distance from water resources
- MM6: Fuels and lubricants will be handled in areas with impervious floors.
- MM7: The produced water will be discharged into the waste pit.
- MM8: Entry of runoff from surrounding areas to the land farming site will be restricted by the construction of bunds or diversion of runoff
- MM9: All septic tanks will be lined with concrete and at safe distance from runoff
- MM10: Waste mud and cuttings will be released into the imperviously lined waste pit
- MM11: Septic tanks and wastewater pits will be designed so that runoff does not flow into them or at and at safe distance from runoff.
- MM12: Maximum spill tray will be provided to all project vehicles to control fuel or oil leakage

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short Term	Small	Low	Definite	Low	-	Moderate

Good Practice Measures:

Project activities will result in waste generation (effluent and solid) that may be hazardous and if not disposed of adequately. Fish in the river and animals that are exposed to this waste, particularly scavenger species, may become infected with disease and suffer ill effects, including death. Mammal scavenger species reported from the area such as, Asiatic Jackal and Red Fox as well as bird species such as, vulture species are susceptible to this impact. Infected animals may spread the disease among other animals they come in contact with.

However, this impact is not likely to be of consequence if the mitigation measures for adequate disposal of waste material from the project facility are implemented.

Monitoring:

- MN01: Regular inspections and reporting by project environmental staff during construction and operation.

9.3.3 Reduction in Water Flow beyond Weir

The project area enjoys following ecological significances, and ecological integrity of the system can be compromised, if project is implemented without relevant mitigation measures.

- **Important refugium for Mahasher Fish:** Mahasher has been a widely distributed fish in Pakistan during sixties and seventies. It was flourishing in the five rivers of Punjab and breeding in the Himalayan foothill areas. Due to damming of the water bodies, ecological fragmentation of the water bodies, pollution, water diversion, habitat destruction and indiscriminate hunting, its population has been continuously declining. Its distribution range in the country, therefore, continued squeezing and presently it is almost non-existent in the rivers of Punjab. Recently, IUCN (2010) has declared it as an endangered species. The Poonch River, however, still has a reasonably good population. It is successfully breeding in Poonch River's upper and middle reaches. The main centers of Mahasher breeding within the project area are Bann Nullah, Rangar Nullah, Nail Nullah, Hajira Nullah, Meander Nullah and the Titri Note area where river is wide to its maximum extant. It is the Poonch River where anglers can still catch a fish of 100 cm weighing 10 Kgs. Efforts are required to save this natural resource for our future generation. In case of a catastrophe for the Mahaseer population in Poonch, this valuable species will be lost from the country. If the species sustains, it can support poverty alleviation and promotion of eco-tourism.
- **Breeding ground for the fish fauna of Mangla Reservoir:** Poonch River serves as a breeding ground for many of the fish fauna of the Mangla Reservoir which usually breed in flowing water conditions. Most of the commercially important cyprinid species usually breed in backwaters of the reservoir in the Poonch River. The side nullahs meeting to Poonch River are the major breeding grounds for these fishes. These Nullahs may also serve as nursery grounds for the breeding fishes.
- **Natural reserve for twin-banded loach, *Botia rostrata*:** Twin banded loach is a beautiful aquarium fish. The fish has been quite common in the Himalayan foothill areas but presently its population in the foothill areas is almost depleted or non-existent. The Poonch River has a very good population of this loach and is a hot spot area for it.
- **Supporting healthy population of *Labeo dyocheilus*:** Poonch River holds a good population of *Labeo dyocheilus* as compared to any other river in the country. This fish has maximum size in this river and a fish weighing 3-4 kg is commonly caught in the nets.
- **Supporting healthy population of *Garra gotyla*:** The fish *Garra gotyla* is also a fish of submountanous areas but it is also found in plains. Its population in plain areas has decreased over the last 20 years and hardly one comes across any fish while sampling. In past, it was very common in Potowar areas but it is no more seen in any of these areas except a few localized places. Poonch River has very healthy population of this fish throughout its length in AJK.
- **Supporting high fish diversity as compared to its size:** Poonch is the smallest river in AJK as compared to other two rivers, the Jhelum and the Neelum. It, however, has a very good fish diversity of 29 species as compared to 32 species in Jhelum and 12 species in Neelum. This is mainly due to optimum water temperature, pristine breeding grounds, wide river valley, and network of side nullahs with suitable physic-chemical environment.

The lake developed after project completion will change the lotic ecosystem (running water) in to lentic (standing water). This will cause a shift in benthic macro invertebrate fauna and it is likely to be replaced by pollution tolerant taxa, similar to species observed at S_3 (**Table 5.3**). If flow is not available during the dry season, it may generate intermittent ponds in area downstream of weir. This will also replace lotic ecosystem benthic macro-invertebrates with lentic benthic macro-invertebrates. A regular flow would require for maintaining lotic ecosystem to the downstream of weir.

Impact EC3: Reduction in water flow beyond weir, which can alter ecology of the area and lead to decline in abundance of fish, especially of Mahasher, results in habitat fragmentation, or affects connectivity of Mangla Reservoirs fishes to Poonch River.

Applicable Project Phase

Construction	*Operational*

Impact Rating

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Large	Long	Large	High	Definite	High	-	High

Mitigation Measures:

- MM1: Species become more vulnerable due to the barrier of dam, therefore a management plan will be developed for ensuring long-term survival of the species.
- MM2: Determination of Environmental/Ecological Flows: The rivers all over the world are increasingly being altered through the construction of dams, diversions, and levees. More than half of the world's large rivers are dammed and the number continues to increase. Dams and other river structures change the downstream flow patterns and consequently affect water quality, temperature, sediment movement and deposition, fish and wildlife, and the livelihoods of people who depend on healthy river ecosystems. Environmental flows seek to maintain these river functions while at the same time providing for traditional off stream benefits. Environmental flows describe the quantity, timing, and quality of water flows required to sustain freshwater ecosystems and the human livelihoods and wellbeing that depend on these ecosystems. Through implementation of environmental flows, water managers strive to achieve a flow regime, or pattern, that maintains the essential processes required to support healthy river ecosystems. Environmental flows do not necessarily require restoring the natural, pristine flow patterns, instead, are intended to produce a broader set of values and benefits from rivers rather than strictly focusing on water supply, energy, recreation, etc. Determination of ecological flows is an essential measure that will be undertaken for maintaining healthy population of the fauna and flora of the river in the downstream area of the Weir.
- MM3: Intensification of watch and ward services: The Poonch River and its tributaries provide a breeding ground for many ecologically and commercially important fish species. The commercially important fish fauna is being poached through illegal netting, use of illegal mesh size, fishing in breeding season, fishing of migrating species, blasting, electro-fishing etc. A fleet of active guards need to be appointed by the government to intensively protect the fish resources of the river. The guards need to be provided with motorcycles, fuel, uniforms and torches for an effective patrolling of the area to check any illegal fishing. These guards may be given special training for performing their duties in a proper manner.
- MM4: Declaration of Weir to Power House Area as closed area for fishing: The area from Weir to Power House will be the most vulnerable area for the fish species as it will have low water especially during winter season. The area needs to be protected from overfishing. Declaration of this area as no fishing zone will allow survival of the fish species in ecological flows determined for the river.
- MM5: Involvement of Community in Conservation: Communities living along the project area will be involved in various eco-tourism activities to provide them an incentive for conservation of fish resources of the area. They will be helpful in self-watch and ward activities and in control of activities that are damaging to the fish fauna.

- MM6: Involvement of Local Administration in Conservation Process: Involvement of local administration and law enforcement agencies in the fisheries conservation process is important as nothing happens without their will and commitment. Regular meetings with local deputy commissioners, police officers and senior bureaucrats will be held to take them on board for implementation and enforcement of law.
- MM7: Establishment of Mahasher Hatcheries: Two Mahasher hatcheries need to be established, one upstream of the weir and the other downstream of the weir for recruiting the river and dam site for compensation of any loss of Mahasher fish being caused by the project activities.

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short Term	Small	Low	Definite	Low	-	Moderate

Good Practice Measures:

Through the mitigation measures described above, a multi-prong approach has been adapted, which will ensure a net gain in habitat and biodiversity. While maintaining ecological flow and recruiting Mahasher from hatcheries, decline in Mahasher and other fish populations will be minimized. Intensive watch and ward, strict protection, and engagement with the communities and administration will halt ongoing deterioration of the ecosystem. In view of greater protection of the park for 30 years and availability of a vast habitat in the form of water reservoir, following benefits for the park and biodiversity are anticipated:

- Enhanced habitat availability, habitat diversification and depth in the form of reservoir will help in maintaining the species diversity. For example the Mangla Reservoir supports sixty fish species as compared to about thirty in entire stretch of the Poonch River.
- The reservoir with vertical and seasonal variations in temperatures will provide wintering habitat to fish species, and some species of cold water may also get established here.
- Fishes of commercial importance will get established, and fisheries will get developed in the area. Fisheries market will grow, creating new jobs and valuable support for the local economy.
- Overall bird diversity and population will be enhanced, owing to diverse habitat.
- The area will serve as staging ground for migratory bird species.
- Ecotourism could be promoted, which is an important tool for environmental education and helpful in developing responsible attitudes towards nature
- With intensive watch and ward, poaching of terrestrial wildlife will be controlled, and species historically occurring in the area will have a chance to re-establish.

In view of above discussion, it is concluded that with strict mitigation measures in place, anticipated benefits to biodiversity will more than balance the expected loss, and the area may serve as an important hub for biodiversity in the province.

Monitoring:

- MN01: Regular monitoring of fish populations will be carried out to determine the changes in abundance and diversity of the fish species.

9.4 Impacts on Socio-Economic Environment

Environmental and social impacts attributable to the project can broadly be classified into those taking place during construction and those occurring during the operational phase. Some of these impacts can be anticipated and avoided through appropriate adjustments / provisions in the project design. Some can be mitigated by careful implementation of the project while some other can be adjusted with by appropriately following the operational manual and an effective collaboration with communities.

- Construction related impacts are heavily dependent on:
- The contractor's work practices, especially those related to storage of construction materials and cleanliness of work site;
- Cooperation between local communities and local authorities and the contractor and use of public space and utilities;
- Project management's enforcement of correct construction practices and standards;
- The incorporation of mitigation measures identified in the ESIA into the overall work practices;
- An effective collaboration with local communities in evolving a workable project implementation; and
- The quality of Monitoring and Reporting of ESMP implementation.

Operational impacts of the proposed project are associated with the movement of vehicular traffic on it and allied activities. These include air and noise pollution, safety hazards and other similar impacts.

Following are the potential socio-economic impacts that may arise from the execution of the project activities:

- Impact SE1: The project will provide job opportunities for the local people in construction and operation phases.
- Impact SE2: The local communities access to the health facilities.
- Impact SE3: Permanent acquisition of land and non-land assets for the project
- Impact SE4: Lose of livelihood.
- Impact SE5: Diseases incidences due to pollution and interaction with labor
- Impact SE6: The blockade of access of local community due construction activities
- Impact SE7: Privacy of local people to be disturbed because of contractor's camp and construction work.
- Impact SE8: Conflict between workers and local community to increase

9.4.1 Economic Opportunities

The impact of the project on the economic opportunities is positive as the area has no significant industries and other economic opportunities to be affected by the project operations. The project would provide job opportunities for skilled and unskilled laborers during the construction phase. The job opportunities for local people can be increased through skilled development of people in operating machinery required for construction phase. Also the project will prove instrumental in injecting money into the local economy and thereby providing new opportunities and opening up avenues for new professions and services.

Impact SE1: The project will provide job opportunities for the local people in construction and operation phases.								
Applicable Project Phase								
Construction				*Operational*				
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Long	Intermediate	High	Possible	High	+	High
Mitigation Measures: • MM01: The local people will be offered project related jobs on priority basis. • MM02: The project will arrange skills development and training programmes to local unskilled labour in handing equipment and machinery required for the project. • MM03: The project will boost local economy by injecting money and enacting instrumental role in emergence of new vocations and professions.								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short Term	Small	Low	Definite	Low	-	Moderate
Good Practice Measures:								
Monitoring: • MN01: Quarterly monitoring reports about number of people employed and trained.								

9.4.2 Improved Healthcare

The impact of the project on existing healthcare is minimal as no health care facilities are being affected by the project operations. The communities will have access to the first aide health care provided by the EPC Contractor to labor during construction phase.

Impact SE2: The local communities access to the health facilities.								
Applicable Project Phase								
Construction				*Operational*				
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Long	Intermediate	High	Possible	High	+	High
Mitigation Measures: • MM01: The contractor to establish health facilities in the camp during construction phase.								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Moderate	Long	Intermediate	High	Possible	High	+	High
Good Practice Measures:								
Monitoring: • MN01: Quarterly monitoring of facilities and level of patients visiting the facilities.								

9.4.3 Acquisition of Land and non-Land Assets for the Project

This impact is directly related to the consideration of design alternative to construct the earthen dyke. The proponent has carried out detailed analysis of land requirements and resettlement requirement under following two options:

- Option 1: Earthen Dyke with Collection Drain and Dewatering
- Option 2: No Dyke

9.4.3.1 Option 1 – Earthen Dyke with Collection Drain and Dewatering

Land Use

Under this Option the project will consume 16% (116 Acres) of the total area for building structures, reservoir, colony, and camp and approach roads. About 84 percent (614 Acres) of the land required for the proposed project will be utilized for the reservoir. In total the proposed project will required 730 Acres of land; major portion (80 percent) of this land is owned by the Government while only 20 percent land in privately owned

S. No.	*Structure/ Item*	*Total Area (Acres)*	*Private Land*		*Government Land*			
			Ownership	*Shamilat*	*Auqaf*	*KDA*	*Forest*	*Wasteland*
1	Power Complex	2	-	-	-	-	-	2
2	Weir	10	-	-	-	-	-	10
3	Intake	1	-	-	-	-	-	1
4	Reservoir	613.61	32.64	84.80	26	-	8.81	461.36
5	Spoil Dumping Areas	36	3	1	-	-	14	18
6	Colonies/ Camps/ Stores/ Workshops	54	24	2	-	-	2	26
7	Access Roads for Power House	13	-	-	-	-	-	13
	Total	**729.61**	**59.64**	**87.80**	**26**	**-**	**24.81**	**531.36**
	Percentages	**100%**	**8.2%**	**12.0%**	**3.6%**	**-**	**3.4%**	**72.8%**

Non-Land Assets

Under Dyke Option the details impacted of Non-Land Assets is as follows:

S. No.	*Structure/ Item*	*Weir*	*Submerged Areas*					*Temporary Structures*			*Total*
			Laloi	*Rangar Nullah*	*Hill Kalan*	*Hill Khurd*	*Mandi*	*Weir*	*Power-house*	*M&E Yard*	
1.	Houses (Up to 542)	-	-	06	-	-	-	01	04	-	**11**
2.	Graveyard		-	02	-	-	-	-	-	-	**02**
3.	Water Mill		01	01	01	-	-	-	-	-	**03**
4.	Crushers	01	-	-	-	-	-	-	-	-	**01**
5.	Electric Poles		-	02	-	-	-	03	04	05	**14**
6.	Suspension Bridge	01	-	-	-	-	-	-	-	-	**01**
7.	WAPDA Gauge	01	-	-	-	-	-	-	-	-	**01**
8.	Telephone Poles	-	-	-	-	-	-	03	-	05	**08**

9.4.3.2 Option 2 – Without Earthen Dyke

Land Use

Under “No Dyke” option the project will consume 13% (113 Acres) of the total area for building structures, reservoir, colony, and camp and approach roads. About 87 percent (804 Acres) of the land required for the proposed project will be utilized for the reservoir. In total the proposed project will required 920 Acres of land; major portion (74 percent) of this land is owned by the Government while only 26 percent land in privately owned

S. No.	*Structure/ Item*	*Total Area (Acres)*	*Private Land*		*Government Land*			
			Owner-ship	*Shamilat*	*Auqaf*	*KDA*	*Forest*	*Waste-land*
1	Power Complex	2	-	-	-	-	-	2
2	Weir	10	-	-	-	-	-	10
3	Intake	1	-	-	-	-	-	1
4	Reservoir	803.85	127.64	84.80	39	57.25	8.81	486.36
5	Spoil Dumping Areas	36	3	1	-	-	14	18
6	Colonies/Camps/Stores/Workshops	54	24	2	-	-	2	26
7	Access Roads for Power House	13	-	-	-	-	-	13
	Total	**919.85**	**154.64**	**87.80**	**39**	**57.25**	**24.81**	**556.36**
	Percentages	**100%**	**16.8%**	**9.5%**	**4.2%**	**6.2%**	**2.7%**	**60.5%**

Non-Land Assets

Under “No Dyke” Option the details impacted of Non-Land Assets is as follows:

S. No.	*Structure/ Item*	*Weir*	*Submerged Areas*					*Temporary Structures*			***Total***
			Laloi	*Rangar Nullah*	*Hill Kalan*	*Hill Khurd*	*Mandi*	*Weir*	*Power-house*	*M&E Yard*	
1.	Houses (Up to 542)	-	18	06	56	18	-	01	04	-	**103**
2.	Shrines		-	-	02	-	01	-	-	-	**03**
3.	Graveyard		01	02	01	01	-	-	-	-	**05**
4.	Water Mill		01	01	01	-	-	-	-	-	**03**
5.	Crushers	01	-	-	-	-	02				**03**
7.	Transformers		01	-	02	02	02				**07**
8.	Electric Poles		06	02	25	13	05	03	04	05	**61**
9.	Suspension Bridge	01	-	-	-	-	-				**01**
10.	Well		02	-	11	03	-	-	-	-	**16**
11.	WAPDA Gauge	01									**01**
12.	Mosques	-	-	-	02	-	02	-	-	-	**04**
13	Schools	-	-	-	-	02	-	-	-	-	**02**
14.	Telephone Poles	-	-	-	-	-	-	06	-	02	**08**

From the aforesaid analysis that obvious choice of the Proponents to go for “Dyke Option” which has the minimal environmental and social impacts with least cost.

9.4.3.3 Assessment framework for Permanent Acquisition of Land and Other Assets

For permanent acquisition/ loss of land and non-land assets the following framework will be followed:

i. Loss of Agricultural Land

Agricultural land shall be directly acquired by the Government of AJK and shall be leased to the Company for the term of the Project. For the legal title holders, customary or usufruct rights holders, cash compensation of affected land would be paid on the basis of willing seller-willing buyer at the mutually agreed market value of the acquired land. The tenants and sharecroppers (if any) will be compensated for the un-expired duration of the lease. The vulnerable encroachers or squatters (if any) will be compensated for affected structure at the replacement cost.

ii. Loss of Residential, Commercial or Institutional Land

The compensation entitlement in case of loss of residential, commercial or institutional land will essentially be similar to the one for the loss of agricultural land, described above. The PAPs with legal title holders, customary or usufruct rights will be compensated on the basis of willing seller-willing buyer at the mutually agreed market value of the acquired land. The tenants will be compensated for the un-expired duration of the lease. The vulnerable encroachers or squatters will be compensated for affected structure at the replacement cost.

iii. Loss of Residential, Commercial or Institutional Structure

The owners of the affected structure, with or without legal title, will be entitled to cash compensation at the replacement value (salvage value of the structure will not be deducted). In addition, an allowance will also be paid to the owner for the repairs of the remaining structure, if any.

iv. Loss of Common Resources and Facilities

In case of the loss of any common resources or facilities, the project will replace or restore the affected facility or resource, in consultation with the affected community.

v. Loss of standing crops

The affected cultivators will be entitled to cash compensation for the damaged crops calculated on the basis of market prices.

vi. Loss of Trees

The owners of the affected trees, with or without land title, will be paid cash compensation, on the basis of market value of the trees according to the type, age, size and productivity of trees.

vii. Loss of Public Infrastructure

The project will pay cash compensation to the relevant agency based upon the replacement value of the affected infrastructure. Alternatively, the project will replace or restore the damaged infrastructure in the pre-project condition or better, in consultation with the concerned agency.

viii. Loss of or Damage to Religious Sites

The project will pay cash compensation for the replacement cost of the religious sites, such as mosques/ shrines. Alternatively, the project will construct the religious sites, in consultation with the affected community. Project will also pay cash compensation for the relocation of graves/shrines.

Impact SE3: Permanent acquisition of land and non-land assets for the project								
Applicable Project Phase								
Construction				*Operational*				
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	High	Long	Intermediate	High	Possible	High	-	High
Mitigation Measures: • MM01: land and non-land assets to be acquired at replacement value/market value following the Land Acquisition and Resettlement Framework. • MM02: clear delineation and dissemination of laws both customary and positive laws related to land issues.								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Moderate	Long	Intermediate	Medium	Unlikely	Low	-	High
Good Practice Measures: Unforeseen impacts on land and non-land assets to be addressed as per the spirit of LARF.								
Monitoring: • MN01: Quarterly Internal and External Monitoring as per Land Acquisition and Resettlement Plan.								

9.4.4 Loss of Livelihoods

The project has no significant direct impacts on the livelihoods of the local people. The only impact on the income from on farm and off farm income from the acquired land will adequately be compensated at replacement cost. Moreover, the skilled and local people will be provided with job opportunities on priority basis in the construction and operational phases. The project will also arrange training skills development opportunities to unskilled people enable them to qualify for the skill and semi skill jobs in the project. Though, the project may cause minimal loss of agriculture land, it will also provide local people with new opportunities as reservoir will become habitat for varieties of fish that survive in the streams and Punch river. Availability of fish at large scale in the reservoir might provide people with another source of income.

<table>
<tr><td colspan="9">Impact SE4: Temporary land to be acquired for contractor’s camp and roads.</td></tr>
<tr><td colspan="9">Applicable Project Phase</td></tr>
<tr><td colspan="5">Construction</td><td colspan="4">Operational</td></tr>
<tr><td colspan="5"></td><td colspan="4"></td></tr>
<tr><td colspan="9">Impact Rating</td></tr>
<tr><td></td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>Significance</td><td>+/-</td><td>Confidence</td></tr>
<tr><td>Initial Impact</td><td>Moderate</td><td>Long</td><td>Intermediate</td><td>High</td><td>Possible</td><td>High</td><td>-</td><td>High</td></tr>
<tr><td colspan="9">Mitigation Measures:
• MM01: People losing more than 10% of their productive assets to be provided with livelihood allowances as per LARF.
• MM02: People losing their assets to be offered project related jobs
• MM03: Skills development training to local people</td></tr>
<tr><td></td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>Significance</td><td>+/-</td><td>Confidence</td></tr>
<tr><td>Residual Impact</td><td>Moderate</td><td>Short</td><td>Intermediate</td><td>Medium</td><td>Unlikely</td><td>Low</td><td>-</td><td>High</td></tr>
<tr><td colspan="9">Good Practice Measures:</td></tr>
<tr><td colspan="9">Monitoring:
• MN01: Quarterly monitoring of number people provided with livelihood allowances, jobs and trainings.</td></tr>
</table>

9.4.5 Disease Incidence

The chances of disease incidences is minimal, however, the project will assure minimal incidences through isolation of contractor's camps from local communities, regular follow ups for vaccination of workers and camp followers.

Impact SE5: Diseases incidences due to pollution and interaction with labor								
Applicable Project Phase								
Construction					*Operational*			
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Short	Intermediate	High	Possible	High	-	High
Mitigation Measures: • MM01: A comprehensive Health and safety plan to be implemented • MM02: Creation of grievance redressed mechanism to protect rights and livelihood of community								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Moderate	Short	Intermediate	Medium	Unlikely	Low	-	High
Good Practice Measures:								
Monitoring: • MN01: Daily monitoring of incidences through grievance redressal mechanism.								

9.4.6 Access blockade

The probability of blockade of access for the local community is high due to construction work on the ware, dyke and power houses. The contractor will assure the access by scheduling the work and alternate access in consultation with local community during construction period. Road blockade for construction may cause trouble in case of emergency. To avoid any untoward event in emergency, the contractor ought to make alternate arrangements.

Impact SE6: The blockade of access of local community due construction activities								
Applicable Project Phase								
Construction					*Operational*			
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Long	Intermediate	High	Possible	High	-	High
Mitigation Measures: • MM01: Alternate access to local communities during construction work, • MM02: Scheduling for road blockade • MM03: Alternate options for patients in emergencies								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Long	Intermediate	Medium	Unlikely	Low	-	High
Good Practice Measures:								
Monitoring: • MN01: Daily monitoring of access and registration and reporting of complaints through redressal mechanism.								

9.4.7 Privacy

The local communities are living in settlements mostly in family groups where the community members especially women freely move around without hesitation. The probably of disturbance in the privacy of local people near contractor's camp is moderate due to non-local labor in camps. The local people especially the women will not feel comfortable in the presence of non-local labors in the camp. The contractor will assure the privacy of local people by establishing camp at a reasonable distance from local settlements and restrict the mobility of labor in the community.

Impact SE7: Privacy of local people to be disturbed because of contractor's camp and construction work.								
Applicable Project Phase								
Construction				*Operational*				
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Long	Intermediate	High	Possible	High	-	High
Mitigation Measures: • MM01: Contractor's camps to maintain a reasonable distance from local population • MM02: Restriction on mobility of workers in local community								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Long	Intermediate	Medium	Unlikely	Low	-	High
Good Practice Measures:								
Monitoring: • MN01: Daily monitoring for any of the incidences and complaints.								

9.4.8 Conflicts with local population

The chances of conflict between labor and local community are high as the local people would not like the mobility of the labor in the community. The contractor will make sure a harmony between labor and local community through a permanent liaison with community elders and by maintaining a reasonable distance of the camp site from the local population.

Impact SE8: Conflict between workers and local community to increase								
Applicable Project Phase								
Construction				*Operational*				
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Long	Intermediate	High	Likely	High	-	Low
Mitigation Measures: • MM01: Contractor's camps to maintain a reasonable distance from local population • MM02: Restriction on mobility of workers in local community • MM03: Priority in jobs for the local people with expertise required by the project								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Long	Intermediate	Medium	Unlikely	Low	-	High
Good Practice Measures:								
Monitoring: • MN01: Daily monitoring for any of the incidences and complaints								

10 TRAFFIC ASSESSMENT STUDY

10.1 Introduction

The proposed Gulpur Hydropower Project is located about 5km downstream of Kotli. The proposed project can be approached by an all-weather road from Islamabad and on grand trunk (GT) road via Mirpur. Currently the road(s) can cater for the needs of the traffic that is using these approach roads but with the anticipated increase in heavy and light traffic there are likely to be impacts on the existing road infrastructure. This study will mainly focus on the routes that may be used for project related traffic and the likely impacts that may be caused due to the proposed project.

For this purpose the road was studied from satellite imagery and by travelling on the road. Traffic count surveys were also conducted to assess the traffic load baseline before onset of the proposed project.

10.2 Objectives

The main objectives of this study are as follows:

- to review the existing traffic conditions of the road network
- to appraise the potential traffic impact of the proposed development on the surrounding road network
- to propose a feasible special traffic arrangement plan in peak erection and construction activities.

10.3 Access Route Options

The site is located about 167 Km from Islamabad and 285 km from Lahore, it is directly approachable from Islamabad and Lahore by a two-lane, all-weather paved road. Access to the Project site from Islamabad is via Kahuta –Kotli to Gulpur. The other route is from Lahore via GT Road to Dina and then to Gulpur via Mirpur. During rainy season, traffic is susceptible to occasional disruptions due to landslides. Another option that may be considered to access the proposed site via Kalar Sayedan and reach Kotli via Dodyal that would take car ride around 2.5 to 3 hours from Islamabad. All these three options are shown in **Figure 10.1**.

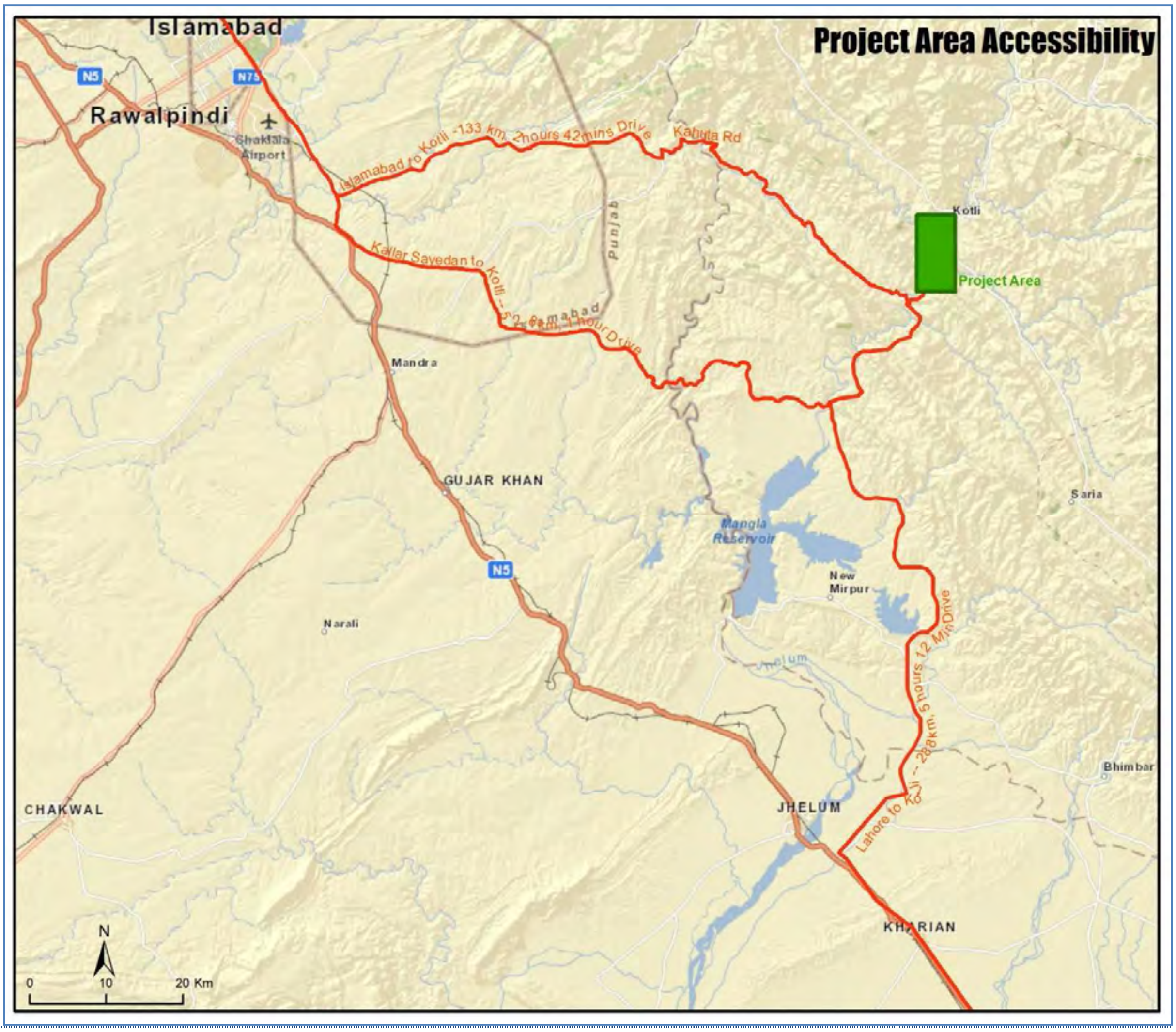

Figure 10.1: Access Route Options for Gulpur Site

GT road is the main access route for all heavy transport vehicles for domestic needs and also for transit trade with Afghanistan also is a main trade route for India and Indian held Kashmir via AJK. Considering that most of the machinery and manpower would come from the southern regions of the country and it would be easier for them to approach the project site via Dina-Mangla-Mirpur-Kotli route. Machines for the proposed power plant would be imported via sea and then transported by road from Karachi.

Rail a rather cheapest and more beneficial mode of transport on land with much safety compared to option could not be explored as is no rail access to the p the project site. The provision of the railway line is not even considered by the government of Pakistan and AJK in its near future for the area. Hence it is not considered at all.

It would not be advisable to take the long route by diverting from Jhelum to Islamabad and then go to Kotli via Dodyal or Kahuta which would add another 300 km (approx.). Furthermore the Kahuta option may not be feasible as the road passes near some strategic installations and access to that route can be made limited due to a number of reasons without a prior notification which would then hamper project activities.

The nearest international airport is located in Islamabad that is around 150km (approx.) so the Kahuta or the Kalar Sayedan options can perhaps be explored for people reaching the project site by air or from Islamabad.

10.4 Traffic Survey

Traffic count surveys were conducted at three different locations in and around Kotli which are listed as follows:

- Location 1: Gulpur Junction
- Location 2: Palak Junction
- Location 3: Near Proposed Project Site

Separate counts were conducted for both traffic attracted towards a point and traffic leaving that area so that the complete baseline could be established. There were separate counts for all different sorts of vehicles that are using the road in order to assess the load in terms of the type of traffic that is currently using these roads and then would the project related traffic bring as an impact to the project area.

10.4.1 Location 1: Gulpur Junction

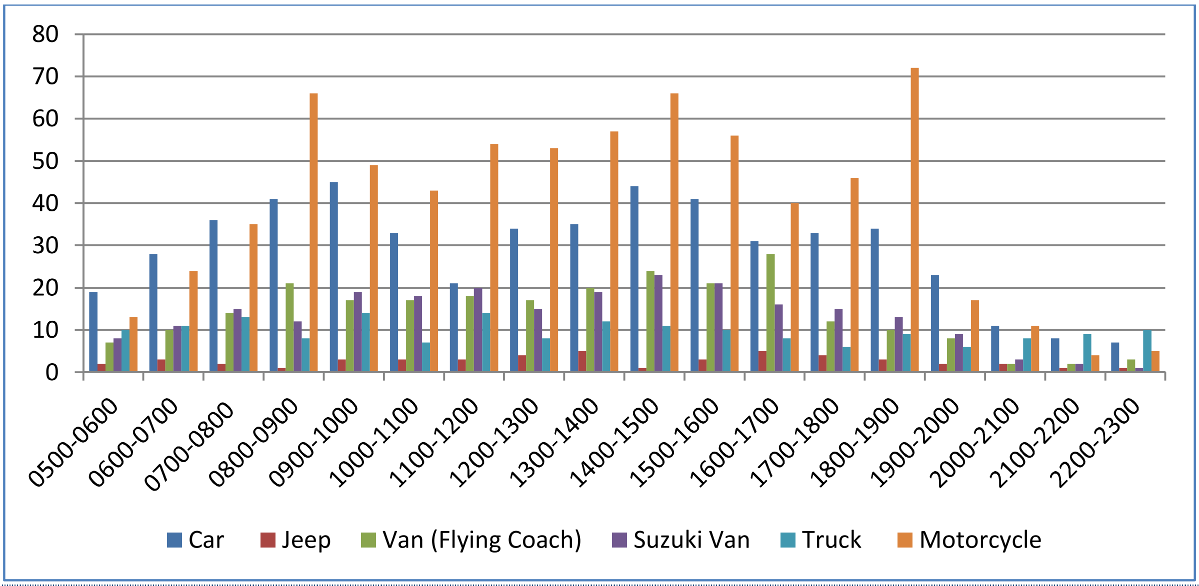

Figure 10.2: Out at Gulpur Junction (Towards Mirpur-Rawalpindi Traffic)

It is obvious from the **Figure 10.2** that the traffic activity varies with the different times of the day starting from lower number of vehicle in early morning to gradually increasing towards the mid-day and then there is a dip in the afternoon and then another rise in traffic count in the evening and finally a drop towards the later of the evening and still lower in the late night of the hours.

In terms of the traffic activity there are three main peaks first is around the 0900 hours which is normally the time when people have to reach to the offices and business. Next surge is in the afternoon lunch time around 1400 hours as that is lunch time in the offices and off time for educational institutions and hence the greater activity. The last peak in the traffic activity is observed in the evening around the 1700 hours time mark because this is the time when people leave their work places and rush towards their homes.

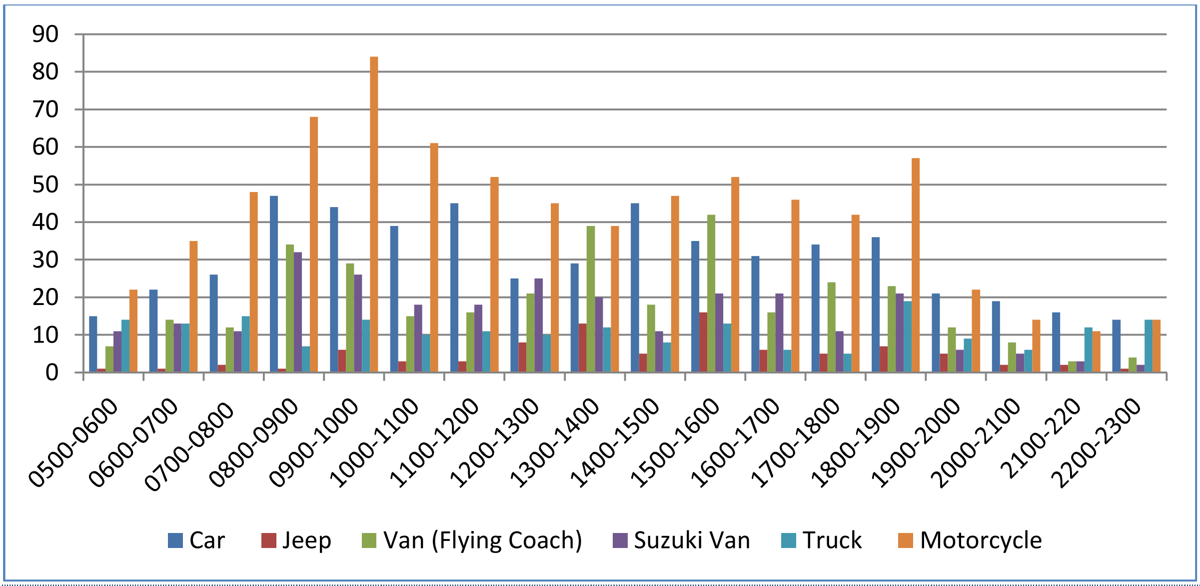

Figure 10.3: In at Gulpur Junction (From Mirpur-Rawalpindi to Kotli Traffic)

The traffic pattern in the opposite direction at the Gulpur Junction follows a slightly different pattern in terms of the number of traffic peaks in which away traffic were three and here there are two clear surges, one at the same time in the morning around the 1000 hours while the next one is observed at around the 1600 hours (**Figure 10.3**).

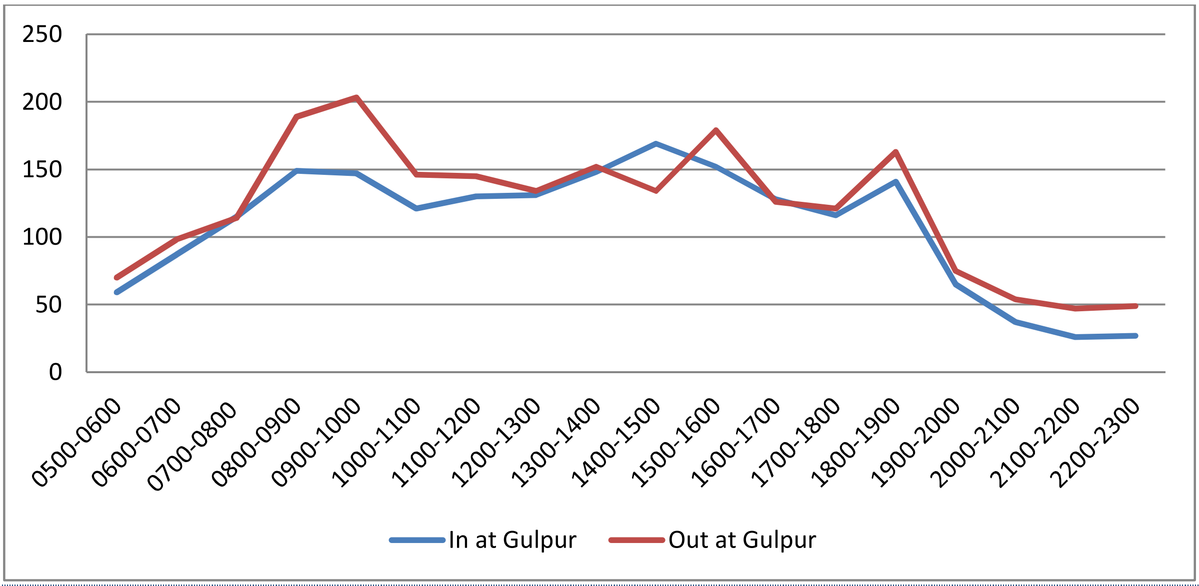

Figure 10.4: Traffic in/out at Gulpur Junction

If we compare the two traffic patterns simultaneously (**Figure 10.4)** it can be seen that the volume of traffic attracted towards Gulpur and then traffic away from the Gulpur area is more or less the same but the slight change is observed only in the timings of peak traffic hours. This is due to the reason that people from the adjoining areas come to for business to Gulpur in the morning and then go back and hence the greater activity in that direction.

10.4.2 Location 2: Palak Junction

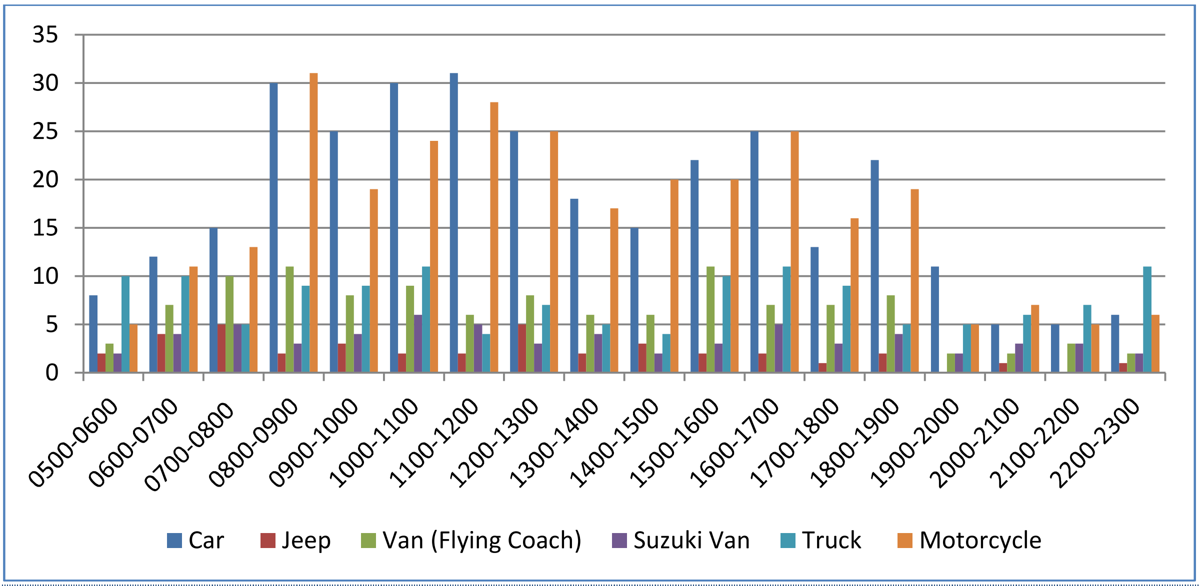

Figure 10.5: Out at Palak Junction (From Kotli to Dadyal-Mirpur Traffic)

At this location the traffic follows a different pattern with no hourly surges or peak hours to be specific but starting to rise in the early hours of the morning around the 0800 hours the traffic volume remains constant well in the afternoon and even towards the evening (**Figure 10.5**). The early morning hours and then later at night there is a considerable dip in the traffic count in the area owing to the rural setting of the locality. If we observe carefully there is sudden lull in traffic around the 1900 hours.

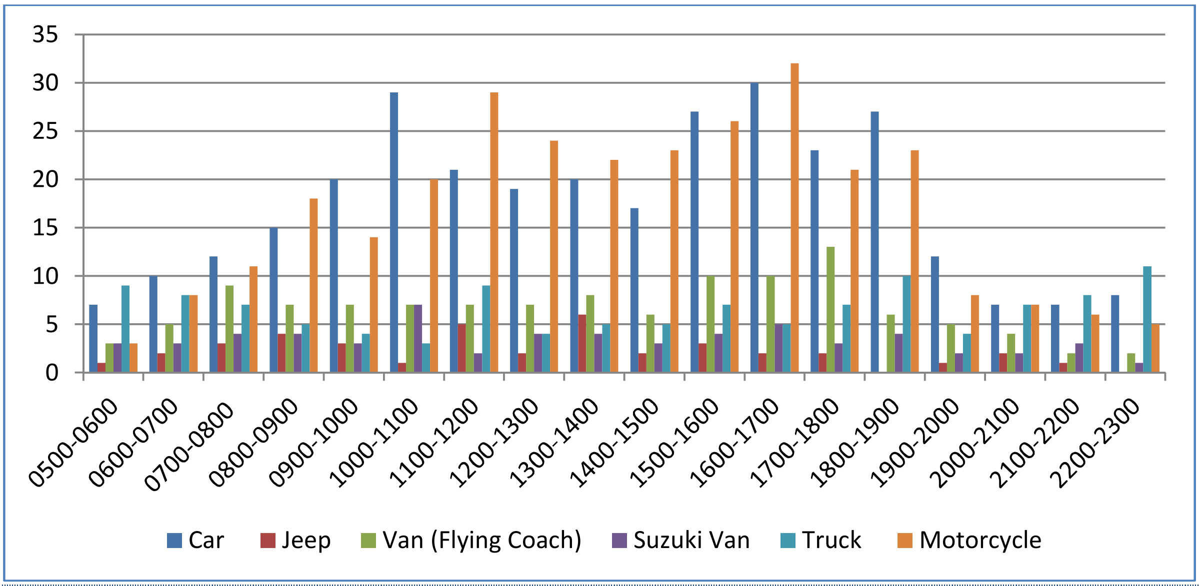

Figure 10.6: In at Palak Junction (From Dadyal-Mirpur on Kotli Road Traffic)

Unlike the traffic going away from the traffic survey point there change in the volumes. From the early mornings of the day there is a constant build up towards the 1000 hours when there is a distinct peak in traffic volume and then again in the evening around the 1700 to 1800 hours. Towards the late evening, just like the early hours of the morning the traffic volumes are significantly reduced (**Figure 10.6**).

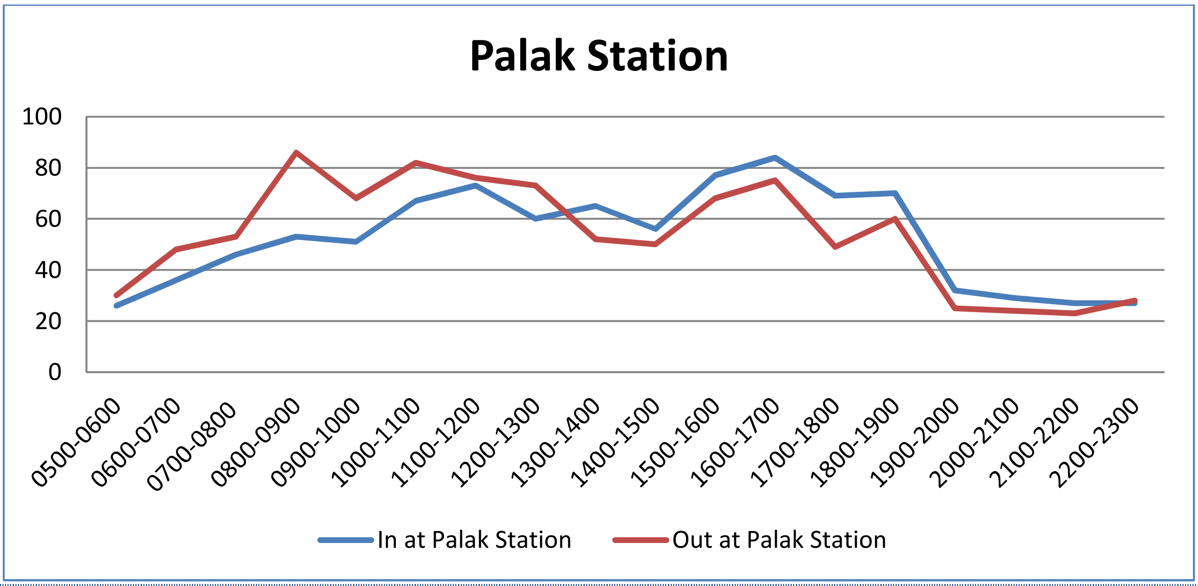

Figure 10.7: Traffic In/Out at Palak Station

If we compare the two traffic volumes the patterns and volumes are more or less the same except for a deviation around the 0800 to 1000 hours where the traffic away from the traffic survey point is higher than the traffic attracted towards this location (**Figure 10.7**).

10.4.3 Location 3: Near Proposed Project Site

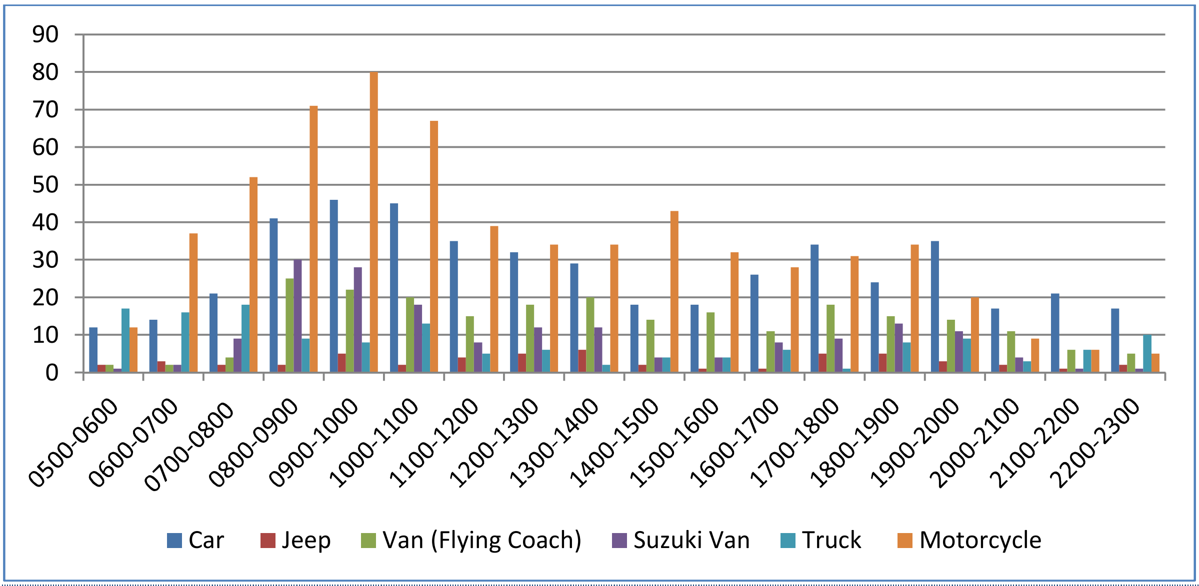

Figure 10.8: In at Project Site (Towards Kotli City Traffic)

This was the last of the traffic survey locations that was selected for this round of traffic count survey. For the project attracted towards this location there is only one high volume activity zone which is from 0800 to 1100 hours. Apart from that the traffic volume is significantly lower than the three hours when there is maximum activity recorded in terms of traffic attracted towards the project site (**Figure 10.8**).

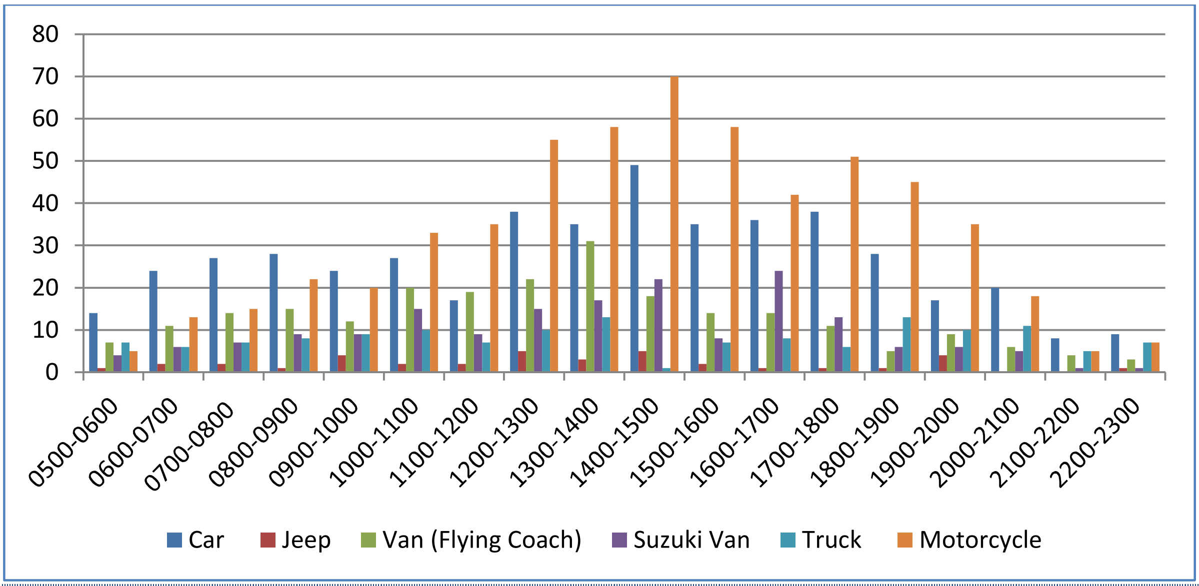

Figure 10.9: Out At Project site (Away from Kotli on Rawalpindi-Mirpur Road Traffic)

The traffic pattern at this point is totally different and the busiest part of the day is around 1400 hours in the afternoon with the least activity in the early hours of the morning and the late hours of the evening (**Figure 10.9**).

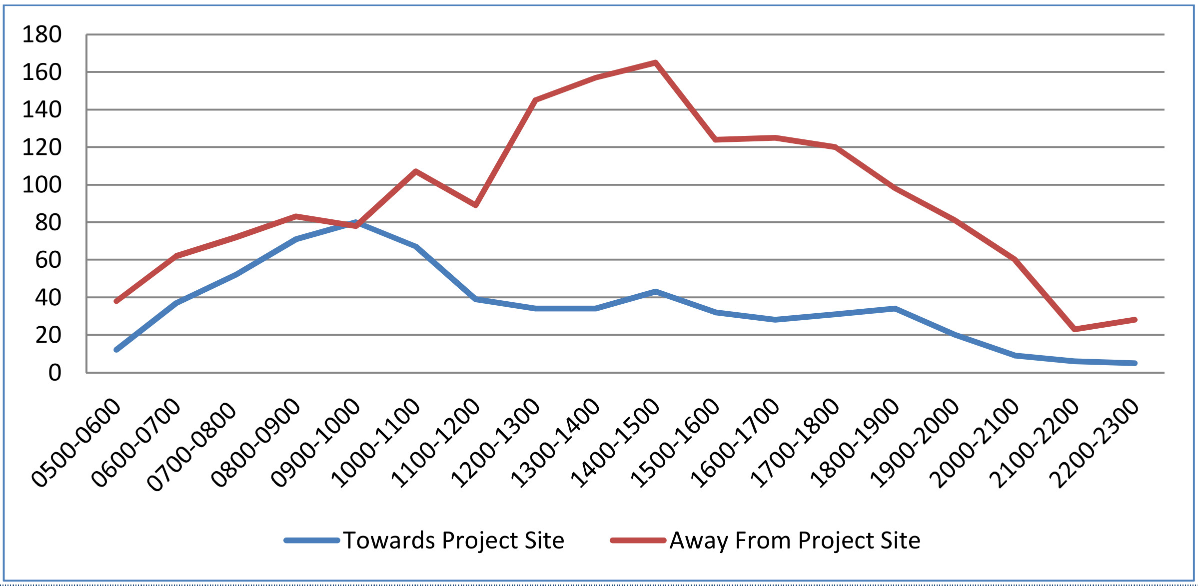

Figure 10.10: Traffic Towards and Away from the Proposed Project Site

If we plot the traffic data for both directions for this point there is a wide gap emerging in the traffic volumes in the afternoon. Overall the traffic coming towards the project site is significantly lesser that the traffic going away from the project site (**Figure 10.10**).

As seen in **Figure 10.11**, if we compare the traffic count data from all the three survey locations we can see that majority of the vehicles are motor cars and motor bikes, followed by public transport vehicles and trucks. Keeping in mind the proposed project this indicates that the volume of heavy vehicles would definitely increase and may cause traffic impacts that are listed and assessed in the following sections.

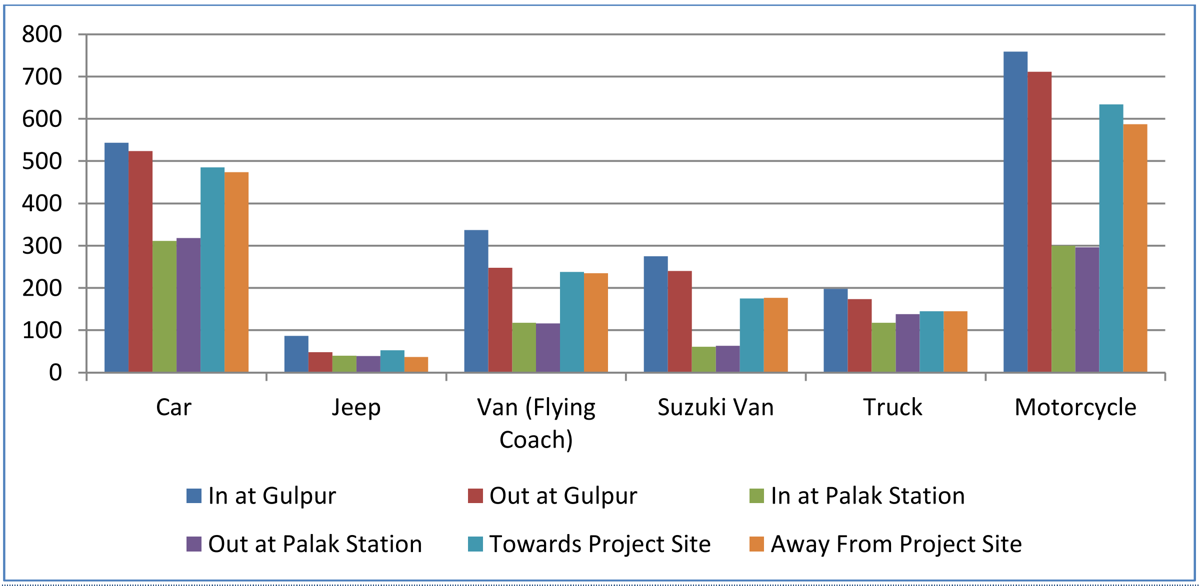

Figure 10.11: Traffic Flow by Vehicle Type

The traffic counts may be higher for a hilly area but majority of the count accounts for motor bikes which would, in the project scenario, be less of an issue with reference to the expected rise in traffic volumes.

Another important observation is that daily around 200 trucks are moving along the roads which would be used for project activities, which means that the risks associated with the movements of these vehicles are known to the people. Furthermore these roads are frequently used by trucks so there would not be a need for roads improvement at least in the initial phases of the project, in time if the requirement arises, different options can be assessed as per the demand of the situation then.

Passenger Car Equivalent (PCE) is a metric used in Transportation Engineering, to assess traffic-flow rate on a highway. A Passenger Car Equivalent is essentially the impact that a mode of transport has on traffic variables (such as headway, speed, density) compared to a single car. For example, typical values of PCE (or PCU) are:

- private car (including taxis or pick-up) 1
- motorcycle 0.5
- bicycle 0.2
- horse-drawn vehicle 4

- bus, tractor, truck 3.5

In our case the PCE or PCU values are as low as 1,724 and 1,776 for traffic leaving and entering the project site.

While if it is considered as Class 1 Highway the PC/ hour for combined flow is only 195 while according to HCM 2000 the recommended capacity of the two lane highway is 3200 PC/hour so the traffic flow is very low and with addition of at maximum 200 trucks per day the value will rise insignificantly.

10.5 Potential Impacts

i. In view of the above discussion following are the potential impacts envisaged due the proposed project activities:
ii. Traffic congestions at the entry and exit points of Kotli and especially near the different quarrying sites
iii. Road damage to the main road shoulders at the proposed quarrying sites, camping sites and near the batching plant (s)
iv. Noise due to the movement of heavy traffic and their pressure horns especially while loading and offloading near communities
v. Fugitive dust emission I general due to movement of heavy traffic on roads and especially the dust emissions from the trucks that would be carrying the quarried material to and away from the quarrying site as well when carrying the spoil load for disposal away from site
vi. Increased risk of road side accidents as the traffic would have to pass through several small and large settlements where the shops, schools, mosques and other such types of places are almost on the road shoulder
vii. In case a heavy vehicle carrying equipment or construction material is met with an accident that would block the road entirely creating a major problem as the roads enter the hilly terrain of the AJK region which would cause serious issues as there would be no alternative route available in the immediate vicinity to shift the traffic
viii. As the road passes through so many villages and there are cattle that frequently cross the road would also be exposed to increased risk
ix. Exhaust emissions from these vehicles would impact the ambient air quality as well and in case of traffic blockages or traffic congestion it may be a hazard for the nearby people

10.6 Mitigation Measures

Following are the general mitigation measures to be followed during the construction activities. Detail traffic management plan is to be developed for the construction phase (see ESMMP).

i. Contractor's vehicle will follow strict speed limits within city and all applicable local traffic rules and regulations especially near sensitive receptors (Schools, hospital, mosques etc.)
ii. In no case horn will be used during the day timings near the sensitive receptors
iii. Over speeding will be subject to disciplinary actions.
iv. Local traffic will be allowed to overtake and drivers will be encouraged to make way for the local commuters, ambulances, army and special persons conveys in all cases.

v. Contractor's personnel will only use access routes assigned to them for project activities which will be finalized during the kickoff meeting with representatives of client, subcontractor and social receptors
vi. Trucks and vehicle will not be overload.
vii. Movement of contractor's vehicles for transportation of material and wastes from and to the site will be restricted to low traffic timings.
viii. A monitoring protocol will be implemented to track the vehicles
ix. Heavy traffic will only travel in the night time or a special permission from the district administration be obtained.
x. Contractor's vehicles and equipment will be parked at identified designated area.
xi. Vehicles and machinery should be appropriately parked/ placed to provide ample access to local commuters/pedestrians
xii. Diversion plans will be developed to minimize disturbance to local population during occasional high activity timings / days. These plans will be communicated to residents well in advance and proper diversion signs will be placed to inform locals.
xiii. Prior communication to residents and safety signs will be installed well before the commencement of any activity at site
xiv. The vehicles will be encouraged to leave the city area as quickly as possible after the delivery of material to the project site.

10.7 Conclusions

The traffic baseline surveys and traffic assessment clearly suggest that the current road conditions are appropriate for the project related traffic during the construction and operation. The traffic load is also as calculated PCE values are very low in comparison to HCM 2000.

The social receptors are already experiencing the traffic flow on the current road so it is not expected that they will be susceptible to project related traffic. With implementation of the proposed mitigation measure and development and implementation of the project traffic management plan the impact will be minimized.

MIRA POWER LIMITED

Environmental and Social Management and Monitoring Plan (ESMMP)

Volume 2

100MW Gulpur Hydropower Project

Kotli, Azad Jammu and Kashmir - Pakistan

GLOBAL POWER LEADER KOSEP | SAMBU | LOTTE | DAELIM

Environmental and Social Management and Monitoring Plan (ESMMP)

of

100MW Gulpur Hydropower Project
Kotli, Azad Jammu and Kashmir, Pakistan

Volume 2

September, 2013

11 ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN

This section comprises the Environmental and Social Management and Monitoring Plan (ESMMP) for the ESIA for this Project. It summarizes the organizational requirements, management and monitoring plans to ensure that the necessary measures are taken by MPL to avoid potentially adverse effects and maximize potential benefits of the Project as identified in preceding section of the ESIA and to operate in conformance with applicable laws and regulations of AJK, as well as the policies of international financial organizations such as ADB and IFC.

The environmental and social management and monitoring plan (ESMMP) presented in this section is a component of the overall environmental management that is particularly important with respect to this ESIA report as it presents MPL's commitments to address the impacts identified by the impact assessment process.

The ESMMP is based on the baseline conditions and the impact assessment described in previous chapters, plus the results of discussions with stakeholders. ESMMP is prepared for all the identified environmental impacts during design, construction, and operation of various Project activities. The methodology followed for preparing the ESMMP consists of the following steps:

- Deriving mitigation/protection measures for identified impacts using impact evaluation methodology;
- Rationalize and combine series of mitigation, compensation and enhancement measures from each identified impacts and risks to prepare overall measures;
- Developing a mechanism for monitoring the proposed mitigation measures;
- Estimating budget requirements for implementation mitigation and monitoring measures; and
- Identifying responsibilities of various agencies involved in the Project for implementation and monitoring of mitigation measures

The ESMP may be considered as a separate, stand-alone section within the suite of documents that are being prepared as part of the ESIA process for this Project. This ESMMP due to its nature and applicability will be further use for contractual purposes and will be included as a part of the bid document for EPC contractor who have to coerce to it along with the regulatory requirement. The strict implementation of the ESMMP and project management's strict enforcement of the adequate construction practices and standards will greatly reduce the negative impacts of the Project.

11.1 Institutional Implementation of ESMMP

Effective implementation and functioning of the ESMMP depends on adequate human and financial resources, clearly defined responsibilities for environmental and social management, appropriate training and good communication. An outline of how these features will be managed for the Project is presented below

11.1.1 Management Commitment

To be effective, this ESMMP must be viewed as a tool reflecting to the contractors and sub-contractors overall commitment to environmental protection. This must start at the most senior levels in the organisation. Contractor management must provide strong and visible leadership to promote a culture in which all employees share a commitment to environmental awareness and protection. The following are commitments to be achieved by the highest position in Pakistan from the MPL:

- Putting environmental and social matters high on the agenda of meetings;
- Highlighting the importance of environmental and social issues in relation to the HSE considerations in business decisions and communication with stakeholders;
- Evaluating environmental and social aspects, before final decisions are reached;
- Being fully aware of the main environmental and social hazards associated with the Contractor and Sub Contractor activities and the systems, procedures and field practices in place to manage these hazards;
- Immediately and visibly responding and being involved in investigating incidents or other abnormal events related to environmental and social and HS issues;
- Seeking internal and external views on environmental and social issues; and recognizing their achievement.

The organization setup of MPL is provided in **Figure 11.1**.

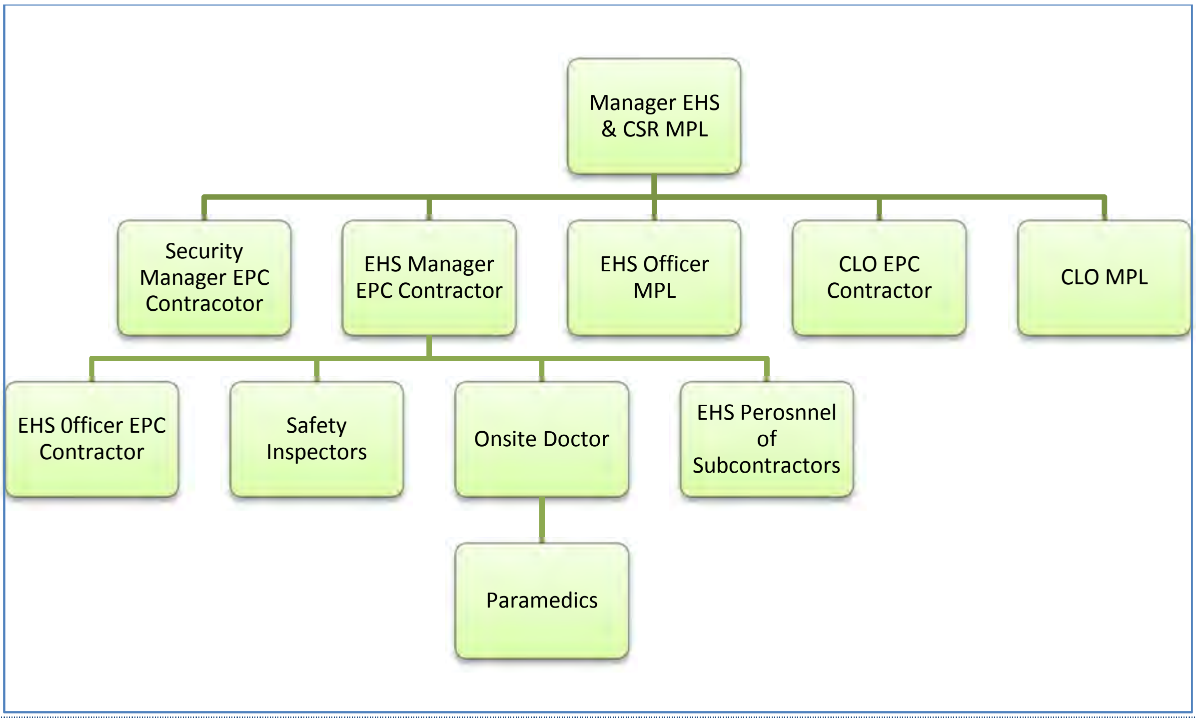

Figure 11.1: Organization Setup of MPL

11.1.2 Roles and Responsibilities

11.1.2.1 Client

With overall responsibility for the Project, MPL will:

- Minimize any impact the Project may have on the environment through preparation of this ESIA (as being carried out in the design stage)
- Appoint responsible contractors who will comply with this ESIA.
- Approve environmental safe materials for use on site in accordance with the ESIA.
- Ensure all relevant parties receive a copy of the approved ESIA and that it is incorporated into all contractual documentation
- Obtain the relevant environmental permits, consents and authorizations prior to commencing site works.
- Comply with all requirements of AJK EPA and obtain NOCs related to the Project.

11.1.2.2 Contractor

The Contractor's general responsibilities will be to:

- Ensure the implementation of the ESIA/ESMMP throughout construction works by all contractor personnel and subcontractors.
- Ensure that adequate resources are available to implement the requirements of this ESMMP.
- Undertake quarterly environmental audits and report to MPL on regular basis.
- To coordinate with MPL for all correspondence to AJK EPA.
- Prepare a comprehensive legislation list and ensure compliance to these legislations.

11.1.2.3 Sub-Contractors

Any Sub Contractor hired directly or indirectly by the Contractor to carry out Project related tasks is designated as a subcontractor. It is the responsibility of those sub-contractors, whose activities have at least one interface with identified key environmental aspects, to comply with the ESIA at all times. They must also designate sufficient competent resources to ensure all Sub-Contractor personnel receive the required training. Sub-Contractors directly in charge of activities shall be registered and approved. Registration documentation should be provided to the Client prior to commencement of any activities. Sub-Contractors are expected to demonstrate a proactive behavior towards environmental concerns. It is their responsibility to provide information requested by the Client with regard to their scope of activities and to demonstrate compliance with the applicable environmental requirements.

11.1.2.4 Personnel

Chief Executive Officer

The Chief Executive Officer (CEO) manages and superintends all head office and site activities for the implementation of the Project. In relation to the ESIA and implementation of ESMMP, the CEO's responsibilities will include:

- Overall responsibility for ensuring implementation of the ESMMP in compliance of all legal matters regarding the Project.
- The development and establishment of adequate Environmental, Safety and Quality Management teams, who will ensure the development, communication and implementation of this ESIA across the entire project, including all activities being undertaken by subcontractors and suppliers working on the site, and all personnel visiting the site.
- Ensure that an environmental representative is available on the Subcontractor part to address environmental requirements in accordance with the ESIA.
- To develop and establish an organization structure adequate to oversee the whole of the works, including overseeing the appointment of an appropriate qualified HSE Manager and Environmental Manager.
- Ensure that adequate resources are available to implement the requirements of this ESIA.
- Ensure the ESIA is reviewed regularly to correspond with on-going construction activities.
- Coordinate with government agencies and bodies regularly to discuss the Project's construction environmental issues and requirements.
- Attend regular meetings with the Head Hydro Project, Construction Manager, HSE Manager and Environmental Manager in order to discuss the site's environmental issues and requirements.

Chief Technical Officer

Responsibilities include:

- Taking primary responsibility for all activities on site, including those undertaken by direct or indirectly employed personnel or agencies.
- Ensuring the issue of suitable procedures for the definition of working methods and site regulations that take into consideration the requirements within the ESIA.
- Ensuring that construction and erection works are performed in respect of the ESIA requirements.
- Attending regular meetings in order to discuss the site's environmental issues and requirements.

Manager EHS & CSR

The Manager EHS & CSR manages and supervises the Project activities relating to health, safety and environment. The HSE Manager will be responsible for:

- The overall responsibility for the development and implementation of the Project HSE policy / philosophy.
- Coordinating weekly HSE meetings, during which any environmental issues will be discussed and minuted.
- Reviewing and ensuring the implementation of Contingency and Emergency Response Procedure.
- Providing specialized HSE input into engineering, construction and contracts, ensuring requirements are properly integrated into project planning, design criteria, construction plans and specifications and contracts

- Supporting / leading incident investigations as per project procedure and report to all concerned. Follow up and review the corrective and preventive action taken, and close-out the incidences.
- Conducting HSE inspections of project construction activities and monitoring compliance with requirements including contractual commitments, permits and projects HSE plan and other applicable HSE requirements and ensure that the Project HSE inspection plan is implemented.
- Ensuring that all internal as well as external incidents and complaints are appropriately resolved with all applicable forms and records duly filled and maintained.
- Coordinating and organizing regular meetings with the Project Director, Construction Manager and Environmental Manager in order to discuss the site's HSE issues and requirements.
- Coordinating the environmental activities with the higher management time to time.
- Coordinating with the AJK EPA, other regulatory authorities and stakeholders on environmental issues related to construction of the Project.
- Monitoring construction activities and performance to ensure compliance with the ESIA and effectiveness of control measures adopted.
- Ensuring that no works are carried out outside the construction corridor as defined in the ESIA, especially within the protected areas (e.g. forests).
- Ensuring the issue and updating of the project's environmental plans.
- Coordinating Project document review activities from an environmental standpoint, assuring that the execution of these activities is compatible with development of the Project and reporting any discrepancies between the environmental requirements and other Project objectives to the Head Hydro Power and CEO.
- Supplying essential information for the preparation of the environmental control plan for construction.
- Updating AJK EPA regularly on construction information.
- Coordinate the development of environmental monitoring data relevant to construction activities.
- Performing environmental checks and monthly internal audits of onsite activities, in coordination with the HSE Manager.
- Supporting the higher management in relations with the governmental agencies and with the AJK EPA on environmental matters.
- Implementing the environmental requirements of the project management system including inspection and reporting.
- Monitoring construction activities and performance to ensure compliance with the CEMP and effectiveness of control measures adopted.
- Developing and implementing of the environmental training programme.
- Conducting staff environmental training, inductions and Tool Box Talks (TBT).
- Advise the Project Manager, or in his absence the relevant Construction Manager, to stop work which could, or is, causing unacceptable environmental impacts.
- Communicate with internal and external parties as required.

- Coordinating daily and weekly site inspections and approving the associated environmental inspection report.
- Reviewing daily and weekly checklists to ensure that appropriate recording of site activities and observations.
- Preparing of the monthly environmental reports, quarterly performance reports and incident reports.
- Reporting of any environmental incidents to the higher management.
- Ensuring that major environmental incidents are reported to AJK EPA within a maximum of 3 days.
- Participating in environmental management reviews.
- Reviewing environmental monitoring data.
- Raise non-conformance and issue CAPs reports in coordination with the HSE Manager / coordinator(s).
- Ascertaining that effective measures and relevant actions are undertaken to avoid or minimize adverse environmental impacts.
- Attending regular meetings with the CEO, Head Hydro Power, PM, Construction Manager and HSE Manager in order to discuss the site's environmental issues and requirements.
- Ensuring that all internal as well as external environmental incidents, emergencies and complaints are appropriately resolved with all applicable forms and records duly filled and maintained.
- Regular reviewing of environmental plans and procedures to assess compliance and recommend revisions, where required.
- Review quarterly audit reports and submit to AJK EPA with the quarterly performance reports.

11.2 Mitigation and Management Plan

The plan prepared in accordance with the above framework is given below. The key components of the plan are discussed in the following sections.

The environmental and social management plan includes the following:

- Impact reference – this specifies the impact/s which according to impact assessment methodology followed for the project has potential influence either negative or positive and needs to be mitigated by the proposed management measure influences as discussed in earlier sections.
- Description of the impact – this briefly describe the potential impact which may arise from the project activities and need a management measures
- Mitigation / Management measure – a description of the action, which will be clear, concise and specific enough to enable execution of the action. Where relevant, targets, indicators, trigger points and/or threshold levels will be incorporated into the management measure. If a set of management actions is required to meet the objective, the ESMP will be simplified by making a commitment to develop an appropriate supporting document in which the detail will be provided.
- Project phase – Indicating the project phase/s when the management measure is applicable

- Institutional Responsibilities –an indication of the roles and responsibilities for the concise implementation of proposed management measures
- Targeted residual impact– an indication of how achievement of the management measure will be assessed, which will be used to develop the monitoring, inspection or audit program

In addition to the above, specific management plans are developed which includes:

- Construction management Plan
- Air Pollution Control Plan
- Waste Management Plan
- Muck Disposal Plan
- Spill Contingency Plan
- Biodiversity Conservation and Management Plan
- Construction Labour Management Plan
- Traffic Management Plan
- Health and Safety Plan
- Emergency Preparedness Plan

Table 11.1: Environmental and Social Management Plan

Impact Ref	Description	Mitigation / Management Measures	Project Phase	Institutional Responsibilities		Targeted Residual Impact
				Implementation	Supervision	
PE1	Discharge related to Project construction and operation can potentially result in the contamination of soil	1. The generator will be placed on impervious layer. Sufficient area around the generator will be made impervious to contain any spill during maintenance 2. Fuel tanks will be appropriately marked by content and will be stored in dyked areas with an extra 10% of the storage capacity of the fuel tank. The area will be lined with an impervious base 3. Grease traps will be installed on the site, wherever needed, to prevent flow of oily water. 4. Spill control kit (shovels, plastic bags and absorbent materials) will be available near fuel and oil storage areas. 5. Emergency plan for spill management will be prepared and inducted to the staff for any incident of spill. 6. The bottom of any soak pit or septic tank will be at least 10 m above the groundwater table. The distance can be reduced, if based on the soil properties, it is established that the lesser distance will not result in contamination of groundwater	Construction Operation	Constructional and operational Contractor	MPL	There are no major oil releases (more than 200 litres) during the construction and all the minor releases (less than 5 litres) are reported
PE2	Land clearing and blasting and drilling activities may loosen the top soil in the project area especially during the wet season	7. Vegetation loss shall be minimized to the extent possible which would help soil bonding 8. The nearby area will be sprinkled before blasting and drilling to minimize erosion 9. Controlled blasting shall be done to minimize environmental impacts 10. Areas such as muck disposal area, batching plant, labor camp, quarry sites, etc. after the closure shall be covered with grass and shrubs	Construction	Construction contractor	MPL	There are no major landslides due to project

Impact Ref	Description	Mitigation / Management Measures	Project Phase	Institutional Responsibilities		Targeted Residual Impact
				Implementation	Supervision	
		11. Slopes in the drilling and blasting areas should be protected against sliding 12. All trace cutting works for road construction, adequate retaining wall or breast wall to be provided in case the geology is not self-supporting. 13. Slope stabilization measures will be adopted such as adequate vertical and horizontal drains, drainage along road sides, cross drainage etc.				
PE3	Uncontrolled wastewater releases from the construction camp, vehicles washing area	14. Soak pits for kitchen waste water will be installed 15. Septic tanks for sewage waste will be put in place 16. Prohibit release of camp effluents to the water channels or land 17. Lining of all effluent channels at all working areas with cement will be done to prevent seepage 18. All the garbage shall be collected and disposed off adequately to the disposal site or to an incinerator, if feasible 19. Leakage of oil wastes from oil storage and vehicles should be avoided in order to prevent potential contamination of streams or ground water 20. Surface runoff from oil handling areas/devices should be treated for oil separation before being discharged into the river.	Construction and Operations	Construction and operation contractor	MPL	The river water quality is not affected by the project
PE4	Construction of weir may alter the drainage patterns of the area	21. Results of the biodiversity assessment (ecological flow) be incorporated in implementation plans. 22. Surface runoff from oil handling areas/devices should be treated for oil separation before	Detailed Design and Construction	Design consultant and contractor	MPL	Little to no impact on the ecological biodiversity downstream

Impact Ref	Description	Mitigation / Management Measures	Project Phase	Institutional Responsibilities		Targeted Residual Impact
				Implementation	Supervision	
		being discharged into the river. 23. The sand and gravel quarrying sites shall be selected keeping in view the impacts and magnitude of change in surface water drainage patterns. Major changes in the landscape shall be avoided. 24. At the completion of activities the natural pattern shall be restored, to the extent possible.				
PE5	The water availability to the local communities may be affected due to influx of project	25. Water for different construction activities will not be drained of the local wells or fountains instead will be arranged form the river or via a water contractor from an approved source by the local authorities 26. Water conservation techniques will be developed and implement by the EPC contractor 27. Records of water usage would be maintained 28. Shallow or perched aquifers shall not be tapped for any project activity 29. Access to community wells shall be kept clear so that the community's ability to meet its water requirements are not compromised	Detailed Design and Construction	Design consultant and Contractor	MPL	No complaints from the locals on water availability
PE6	Construction activities will create fugitive dust emissions	30. For fugitive dust control, sprinkling of water on the project roads will be done 31. Grading operation to be suspended when the wind speed exceeds 20 km /hr. 32. All storage piles shall be adequately wetted or covered with plastic to ensure protection of ambient air from fugitive emission during wind storm 33. Batching plants and associated machinery installed for project activities will be installed	Construction	Construction contractor	MPL	Ambient PM values are within permissible limits

Impact Ref	Description	Mitigation / Management Measures	Project Phase	Institutional Responsibilities		Targeted Residual Impact
				Implementation	Supervision	
		with suitable pollution control arrangements 34. Speed limits and defensive driving policies will be strictly implemented 35. Road damage caused by project activities will be promptly attended to with proper road repair and maintenance work				
PE7	Exhaust emissions from generators, project traffic and batching plant may deteriorate the local ambient air quality	36. New and low emission equipment and vehicles shall be used 37. Best quality fuel and lubes shall be purchased where possible lead free oil and lubes should be used 38. Batching plant shall be set up considering the wind direction so that the nearby communities are not affected by the emissions from batching plant 39. Batching plant should be kept as near to natural sinks to minimize emissions to ambient environment 40. Regular maintenance of vehicles and equipment will be conducted to keep emissions in check 41. Filters will be installed wherever available in vehicles and equipment 42. All stacks will be at least 8ft high to safeguard the labor and passersby from the emissions	Construction	Contractor	MPL	No complaints received regarding noise pollution
PE8	Blasting for tunneling may cause damage to nearby infrastructure	43. Safe distances acceptable worldwide will be calculated and maintained 44. Where safe distances cannot be maintained the structures will be evacuated of the occupants to avoid human loss 45. Controlled blasting techniques will be adopted at all times 46. Public infrastructure and cultural heritage sites	Construction	Contractor	MPL	No complaints received regarding noise pollution

Impact Ref	Description	Mitigation / Management Measures	Project Phase	Institutional Responsibilities		Targeted Residual Impact
				Implementation	Supervision	
		if any near the blasting area will be reinforced in terms of civil works 47. Muffled blasting techniques be adopted where required.				
PE9	Constructional may cause nuisance in the vicinity	48. The construction equipment generating high noise must be designed to have an adequate muffler system. 49. All stationary noise generating equipments such as air compressors and power generators should be used away from the residential area. 50. A proper routine and preventive maintenance procedure for project vehicles and equipment should be set and followed in consultation with the respective manufacturer which would help prevent noise levels from deteriorating with use. 51. Provision of proper Personal Protective Equipment (PPEs), i.e., ear muffs and plugs, will reduce noise impact on personnel. 52. Movement of vehicles should be restricted to project area only. 53. Restriction on pressure horns. 54. The nearest community will be informed three siren in advance for the case of blasting activities 55. Blasting will be done only in day hours 56. unscheduled blasting will be strictly prohibited in any case	Constructional	Contractor	MPL	No complaints received regarding noise pollution
PE10	Impacts of earthen dyke on physical environment	57. The dimensions of dyke to be identified after detailed assessment of floods and surface hydrology of the area. 58. The drainage system of surface water during rains and excess water for irrigations shall not	Constructional and Operational	Contractor	MPL	No complaints received regarding noise pollution

Impact Ref	Description	Mitigation / Management Measures	Project Phase	Institutional Responsibilities		Targeted Residual Impact
				Implementation	Supervision	
		be blocked and the diversion of the same shall be in a manner that it has no impacts to the community and agricultural lands. 59. Water logging and salinity of the area shall be assessed and pumps be installed, if required. 60. Material for the construction of the dyke to be sourced considering environmental aspects including drainage pattern, stability, vegetation and public infrastructure.				
EC1	Land disturbance due to construction and operation of project facilities resulting in disturbance, fragmentation, displacement and direct loss of animal, plants, reptiles, amphibians and birds.	61. Cutting of trees if any will be minimized and damage will be compensated by re-plantation. Off-road driving will be prohibited 62. Discharging firearms will be explicitly prohibited 63. The project staff will be educated and instructed to avoid killing or chasing wildlife. 64. The staff will be educated and monitored to ensure that they do not get engage in animal related trade 65. Periodic trainings of the project staff will be conducted on biodiversity conservation issues to sensitize them about the biodiversity and protected area 66. All restrictions imposed under wildlife legislation of AJK, particularly relevant to national park, will be strictly observed.	Construction	Construction Contractor	MPL	The trees are replanted in case of cutting. BAP implemented on site
EC2	Deterioration of area's water resources river if pollutants such as domestic waste (sanitary and kitchen discharge) or oil and	67. No waste will be discharged in open areas. 68. No contaminated effluents will be released to the River 69. Water from washing areas and kitchen will be released in sumps 70. Sumps will remain covered all the time and	Construction	Construction contractor	MPL	Waste management is implemented

Impact Ref	Description	Mitigation / Management Measures	Project Phase	Institutional Responsibilities		Targeted Residual Impact
				Implementation	Supervision	
	grease, and fuel from project related machinery or equipment are mixed with surface runoff during rain, or if pollutants leach into the ground or are carried to river	measures will be taken to prevent entry of rainwater into them and at safe distance from runoff 71. Fuels and lubricants will be stored in areas with impervious floors and dykes that can contain spills, and at safe distance from water resources 72. Fuels and lubricants will be handled in areas with impervious floors. 73. The produced water will be discharged into the waste pit. 74. Entry of runoff from surrounding areas to the land farming site will be restricted by the construction of bunds or diversion of runoff 75. All septic tanks will be lined with concrete and at safe distance from runoff 76. Waste mud and cuttings will be released into the imperviously lined waste pit 77. Septic tanks and wastewater pits will be designed so that runoff does not flow into them or at and at safe distance from runoff. 78. Maximum spill tray will be provided to all project vehicles to control fuel or oil leakage				
EC3	Deterioration of area's water resources river if pollutants such as domestic waste (sanitary and kitchen discharge) or oil and grease, and fuel from project related machinery or equipment are mixed	79. A management plan will be developed for ensuring long-term survival of the species. 80. Determination of ecological flows to be undertaken for maintaining healthy population of the fauna and flora of the river in the downstream area of the Weir. 81. A fleet of active guards need to be appointed by the government to intensively watch and ward of the fisheries resources of the river. The guards need to be provided with the	Operation	Contractor	MPL	Implementation of BAP

Impact Ref	Description	Mitigation / Management Measures	Project Phase	Institutional Responsibilities		Targeted Residual Impact
				Implementation	Supervision	
	with surface runoff during rain, or if pollutants leach into the ground or are carried to river	motorcycles, petrol, uniforms and torches for an effective patrolling of the area to check any illegal fishing. These guards may be given special training for performing their duties in a befitting manner. 82. Declaration of Weir to Power House Area as closed area for fishing. 83. Communities living along the project area may be involved in various eco-tourism activities for conservation of fisheries resources of the area. 84. Involvement of local administration and law enforcement agencies in the fisheries conservation process is important as nothing happens without their will and commitment. Regular meetings with local deputy commissioners, police officers and even with top bureaucrats need to be held to take them on board for implementation and enforcement of law. 85. Two Mahasher hatcheries need to be established, one upstream the weir and the other downstream the weir for recruiting the river and dam site for compensation of any loss of Mahasher fish being caused by the project activities.				
SE1	Potential for local opportunities	86. The local people be offered project related jobs on priority basis 87. The project will arrange skills development and training program to local people in handing equipment and machinery required for the project 88. The project to boost local economy by injecting money and enacting instrumental role in	Construction and Operation	Constructional contractor and operational contractor	MPL	100 % unskilled jobs are provided to the locals

Impact Ref	Description	Mitigation / Management Measures	Project Phase	Institutional Responsibilities		Targeted Residual Impact
				Implementation	Supervision	
		emergence of new vocations and professions				
SE2	Local communities access to the health facilities	89. The contractor to establish health facilities in the camp during construction phase.	Operation	Operational contractor	MPL	Health facilities developed in area
SE3	Permanent acquisition of land and non-land assets for the project	90. Land and non-land assets to be acquired at replacement value/market value following the Land Acquisition and Resettlement Framework. 91. Clear delineation and dissemination of laws both customary and positive laws related to land issues.	Detailed Designed	Resettlement specialist	MPL	RAP is developed and implemented. No local communities complaints regarding the compensation and its mechanism
SE4	People lose their productive assets to the project	92. People losing more than 10% of their productive assets to be provided with livelihood allowances as per LARF. 93. People losing their assets to be offered project related jobs 94. Skills development training to local people	Detailed Design and Construction	Resettlement specialist Construction contractor	MPL	No local communities complaints regarding the compensation and its mechanism
SE5	Diseases incidences due to pollution and interaction with labor	95. A comprehensive Health and safety plan to be implemented 96. Creation of grievance redressed mechanism to protect rights and livelihood of community	Construction	Construction contractor	MPL	No local communities complaints regarding the compensation and its mechanism
SE6	Blockage of roads during the construction	97. Alternate access to local communities during construction work, 98. Scheduling for road blockade 99. Alternate options for patients in emergencies	Construction	Construction contractor	MPL	No local communities complaints Diversion plan implemented Drivers trained on the traffic issues
SE7	Privacy of local people to be disturbed because	100. Contractor's camps to maintain a reasonable distance from local population	Construction	Construction contractor	MPL	No local communities

Impact Ref	Description	Mitigation / Management Measures	Project Phase	Institutional Responsibilities		Targeted Residual Impact
				Implementation	Supervision	
	of contractor's camp and construction work.	101. Restriction on mobility of workers in local community				complaints Diversion plan implemented Drivers trained on the traffic issues
SE8	Conflict between workers and local community to increase	102. Contractor's camps to maintain a reasonable distance from local population 103. Restriction on mobility of workers in local community 104. Priority in jobs for the local people with expertise required by the project	Construction	Construction contractor	MPL	No local communities complaints Diversion plan implemented Drivers trained on the traffic issues

11.3 Monitoring Plan

Monitoring of environmental components and mitigation measures during implementation and operation stages is a key component of the ESMMP to safeguard the protection of environment. The objectives of the monitoring are to

i. manage environmental issues arising from construction works through closely monitoring the environmental compliances
ii. monitor changes in the environment during various stages of the project life cycle with respect to baseline conditions;

Monitoring program will includes regular monitoring of construction and commissioning activities for their compliance with the environmental requirements as per relevant standards, specifications and ESMMP. The purpose of such monitoring is to assess the performance of the undertaken mitigation measures and to immediately formulate additional mitigation measures and/or modify the existing ones aimed at meeting the environmental compliance as appropriate during construction.

The monitoring programme will be coupled with a series of supporting procedures, yet to be developed, covering:

- sample or data collection;
- sample handling, sample storage and preservation;
- sample or data documentation;
- quality control;
- data reliability (calibration of instruments, test equipment, and software and hardware sampling);
- data storage and backup, and data protection;
- interpretation and reporting of results; and
- verification of monitoring information by qualified and experienced external experts.

Skeleton Environmental Monitoring Plan is provided in Table below. Data will be documented and interpreted. Temporal and spatial trends in the data will be discerned and compliance with relevant thresholds will be evaluated. Monitoring reports will be produced to meet internal and external reporting requirements. If monitoring results indicate non-conformance with stipulated thresholds or if a significant deteriorating trend is observed, it will be recorded as a non-conformance and handled by the non-conformance and incident procedure.

11.3.1 Site inspections

Site inspections will be undertaken regularly in relevant areas of the Project. The inspections will focus on compliance with the ESMMP. The inspections will play an important role in increasing awareness of ESMMP.

Minor non-conformances will be discussed during the inspection and recorded as a finding in the inspection report. Major non-conformances will be reported as incidents. Inspection results will be disclosed at management meetings.

11.3.2 Formal audits

Formal audits will be undertaken at planned intervals in accordance with the requirements of client and regulatory authorities. Procedures for audits will be established, implemented and maintained. These will cover the audit criteria, scope, frequency and methods, and will address the responsibilities and requirements for planning and conducting audits, reporting results and retaining associated records.

Any negative findings arising from an audit will be treated an incident and dealt with in accordance with the non-conformance and incident procedure. Results from audits and evaluations of compliance with legal requirements will be reported to site and senior management and subject to management reviews. Usually environmental regulatory authorities require a quarterly audit report for large scale projects.

11.3.3 Non-conformances and incidents

Non-conformances include the following:

- exceedances of relevant thresholds as identified during routine monitoring;
- non-conformances with the requirements of the ESMP or supporting documentation identified during an internal inspection;
- non-conformances identified during an audit or by regulatory authorities;
- events, such as spills, resulting in potential or actual environmental harm;
- events that did or could result in injury to staff, visitors to site or surrounding communities; and
- significant complaints or grievances received from any source.

Corrective and preventive actions will be identified and implemented in response to these non-conformances. These actions will address the root cause of the non-conformance and will reduce or prevent repeated non-conformances.

A process will be established for the identification, investigation and tracking of non-conformances, including:

- prioritizing and classifying non-conformances based on the type and severity of the non-conformance;
- recording of non-conformances and the results of corrective and/or preventive actions, including the actions necessary to mitigate or remedy any associated impacts;
- defining results expected from the corrective and/or preventative actions;
- confirming the corrective and/or preventive actions taken to eliminate the causes of the non-conformance are appropriate to the magnitude of problem and commensurate with the impacts encountered;
- reviewing the effectiveness of the corrective and/or preventive actions taken; and
- implementing and recording required changes in the ESMP or monitoring programme resulting from corrective and preventive action.

Serious non-conformances will be classified as incidents. Incidents will be promptly reported to appropriate management. A guideline will be prepared on:

- the types of incidents reportable to internal management at the site, Project and corporate levels, as well as to regulatory authorities and other external stakeholders; and
- standards to be observed when reporting incidents.

During construction, environmental monitoring will ensure the protection of air and noise pollution, community relations, and safety provisions. Post monitoring evaluation will be carried to evaluate the impacts of the Project during first 3 years of operation of the Project. During operation, emissions, air, noise, and waste water quality monitoring and greenbelt development around the plant will be important parameter of the monitoring program.

The monitoring requirement can only be fulfilled by maintaining the proper documentation records of the findings. Daily checklists, weekly reports and monthly audit will be taken in accordance with construction management plan. Based on the ESIA approval a scheduled audit will be conducted by the MPL and reports will be shared with the regulatory authority and funding agency if required.

11.3.4 Documentation and Record Keeping

Monitoring elements of the ESMMP will be documented and controlled in accordance with a document control system. Records demonstrating compliance with legal requirements and conformance with the ESMMP will also be maintained. Client will supervised, establish, implement and maintain procedures:

Documentation and record keeping controls will include:

- measures to enable relevant documents and records to be readily available and identifiable (labeled, dated and properly filed), legible and protected from damage;
- review, revision and approval of documents for adequacy by authorized personnel at least once a year;
- establishment of the electronic document control version as the 'authorized version';
- making current versions of relevant documents available at locations where operations essential to the effective functioning;
- suitably identifying obsolete documents retained for legal and knowledge preservation purposes; and
- identification and segregation of confidential and privileged information.

11.3.5 Preliminary monitoring programmes

Preliminary monitoring program have been prepared in response to the ESMP (**Table 11.1**). These provide a framework of monitoring to evaluate performance and assist in predicting and managing impacts.

The frequencies and locations may need to be adjusted depending on final Project design and ongoing review of results obtained by the monitoring programmes.

Table 11.2: Preliminary Environmental Monitoring Program

Aspect	*Impact reference*	*Type of monitoring*	*Units*	*Frequency*	*Location/s*	*Records*	*Reporting*
Land disturbance	PE1, PE2, PE3, EC1	Footprint area disturbed and/or rehabilitated	m^2	Monthly during construction and then as needed when land disturbed or rehabilitated	Alongside the weir and power house area	Log	Monthly report during construction Annual report during operation
	PE1, PE2, PE3, EC1	Soil quality for at least the following parameters: Al, Sb, As, Ba, Be, Bi, Bo, Cd, Ca, Cr^{III}, Cr^{iv}, Co, Cu, Fe, Pb, Li, Mg, Hg, Mo, Ni, P, K, Se, Si, Ag, Sr, S, Tl, Sn, U, V, Zn, TPH, NH-3, Cl, EC, F, nitrate, nitrite, pH, phosphate, sulphate, TOC	ug/L, mg/L or other units as appropriate	Annually	ESIA baseline monitoring points	Database	Annual report on results and long term trends
	PE1, EC1	Visual inspections for signs of erosion or wind deposition	None	Quarterly or on receipt of grievance	Construction sites, rehabilitated areas and water release points	Log	Annual report with non-conformances handled
	PE2, SE7	Visual inspection of road condition	None	Quarterly or on receipt of grievance	Bypass roads around fenced Project facilities	Log	Annual report with non-conformances handled
Water	PE1, PE3, PE4, PE5, EC2, EC3, SE3, SE4	Measure of the flow	m^3	Weekly	Before and after the projects at selected monitoring points	Log	Monthly Reports

Aspect	*Impact reference*	*Type of monitoring*	*Units*	*Frequency*	*Location/s*	*Records*	*Reporting*
	PE1, PE3, PE4, EC2, EC3	Quality of water supply in accordance with the WHO and National regulation	Mg/l or other units as appropriate	Quarterly	ESIA baseline monitoring points	Database	Quarterly report
	PE1	Volume of water used for dust control	m^3/d	When water trucks filled	Truck filling points	Database	Monthly report of volume
Air	PE1, EC1, SE7	Dust deposition and horizontal dust flux	$mg/d/m^2$	Quarterly	ESIA baseline monitoring points	Database	Quarterly report of results and long term trends
	PE6	Ambient air concentrations	$\mu g/m^3$	Quarterly	ESIA baseline monitoring points	Database	Quarterly report of results and long term trends
	PE6	Stack testing of generators and other equipment	$\mu g/m^3$	During induction to site and quarterly	For each equipment including but not limited to generator, batching plant	Database	Quarterly report of results and long term trends
Vehicle and Equipment	PE1, EC1, PE6, PE9, SE7, SE8	Random speed checks	km/hr.	Once a week and different location and different time	Access and haul roads	Log	Monthly report
	PE1, EC1, PE6, PE9, SE7, SE8	Records of vehicle and equipment maintenance	None	As per manufacturers instructions	Mine truck shop and equipment workshop	Log	Annual report

Aspect	*Impact reference*	*Type of monitoring*	*Units*	*Frequency*	*Location/s*	*Records*	*Reporting*
	PE9, SE2	Baseline noise emissions of new equipment	dB	On commissioning of new equipment	Within 100m of equipment	Log	None
Ecological	EC1	Visual inspections by ecologist to verify presence or absence of species of conservation importance	None	As per BAP	Areas to be utilised for construction or waste deposition	Log	Monthly report
	EC1, EC2	Visual inspections of presence of weeds or invasive species	None	As per BAP	Disturbed and rehabilitated areas, and adjacent areas	Log	Annual report on findings and remedial measures
	EC2, EC3	Records of animal kills	None	On occurrence	Within Project areas	Log	Annual report on fatalities and remedial measures
	EC2	Records of major wildlife sightings	None	On occurrence	Within or near the Project area	Log	Annual report on observations

11.4 Cost Estimates

Cost estimates are prepared for all the mitigation and monitoring measures proposed in the ESMMP. The cost represented **Table 11.3** is indicative only. This budget has been calculated for a duration of 45 months of the construction phase. The costs for implementation of environmental and social mitigations during the operational phase are not included. The operational cost shall be calculated before the completion of construction phase after consultation with stakeholders and regulatory authorities. The cost for land acquisition and resettlement related activities are not included. This cost shall be calculated on actual basis after detailed and specific surveys and completion of land acquisition and resettlement plan (LARP).

Estimates are based on the current market rates for similar activities and items, which are implemented in similar projects. Estimations of quantities are based on previous experiences. The cost estimates and the budget during design and construction phase for the mitigation and monitoring measures is estimated to be around one and half million united states dollars.

The cost estimates for control measures and some of the mitigation measures that were already part of Engineers estimate are not included in the ESMMP. The cost estimates also includes the budget for environmental monitoring, implementation, institutional strengthening and capacity building of project staff and environmental enhancement/compensation measures.

Table 11.3: Indicative Budget and Breakdown

Sr. No.	*Activity*	*Estimated Cost (USD)*
1	Facility for generators (PE1-1)	2,830
2	Oil and grease collection system (PE1-3, EC2-79)	420
3	Spill control kit (shovels, plastic bags and absorbent materials) (PE1-4)	2,360
4	Sprinkling of water on the project roads, blasting/drilling areas and material piles (PE2-8, PE6-30, PE6-32)	21,220
5	Plantation and re-vegetation (PE2-10, EC1-61)	94,340
6	Soakage pits for wastewater (PE3-14, EC2-70, EC2-71, EC2-73, EC2-74)	1,320
7	Septic tanks for sewage waste (PE3-15, EC2-76, EC2-78)	1,690
8	Lining for effluent collection system (PE3-17, EC2-77)	850
9	Solid waste management (PE3-18)	8,490
10	Plastic covering of all material storage piles (PE6-32)	3,770
11	Personal Protective Equipment (PPEs) (PE9-51)	24,340
12	Installation of pumps for water logging and salinity (PE10-59)	28,300
13	EHS trainings (EC1-65, EC1-66, SE1-88, SE3-95)	14,150
14	Facility for fuels and lubricants storage (EC2-72)	990
15	Biodiversity Action Plan (EC3-80)	141,500
16	Ecological Flow Assessment (EC3-81)	141,500
17	Environmental monitoring activities (EC3-84)	9,430
18	Activities for involvement of local administration and law enforcing agencies (EC3-85)	18,860
19	Establishment of two Mahasher hatcheries on the upstream and downstream of the weir (EC3-86)	188,670
20	Construction of a basic health facility, with necessary equipment and operation cost for 45 months (SE2-90)	116,000
21	Implementation of health and safety plan (SE5-96)	212,260
22	Salaries for EHS staff	500,900
	Total Cost	**1,534,190**

11.5 Environmental Training

Personnel, including contractors' personnel, working for or on behalf of the Project will be informed of potential significant environmental and social impacts and risks associated with the Project by means of awareness training. Visitors to Project sites will also receive awareness training as part of site induction training.

Personnel, including contractors' personnel, will be made aware of their specific environmental and social management responsibilities. Training needs analyses will be undertaken and personnel will be given adequate training to meet these responsibilities.

The training programme comprises the following elements:

- identification of training needs for all employees specific to their varying responsibilities;
- development of a training plan and schedule to address defined needs;
- verification of training programmes to confirm consistency with organizational requirements;
- training of employees and documentation of training received;
- evaluation of training effectiveness; and
- review and modification of training programmes, as required.

Personnel with direct responsibility for implementation of the ESMMP and functioning of the will have additional training to:

- provide them with the knowledge and skills necessary to perform their work;
- maintain their knowledge of relevant environmental and social obligations; and
- enable them to implement specific measures required under the ESMP in a competent and efficient manner

11.6 Construction Management Plan

The construction contractor will develop a specific construction management plan (CMP) based on the conceptual CMP included below. The CMP will be submitted to the client for approval.

The CMP will clearly identify all areas that will be utilized during construction for various purposes. For example, on a plot plan of the construction site the following will be shown:

- Areas used for camp
- Storage areas for raw material and equipment
- Waste yard
- Location of any potentially hazardous material such as oil
- Parking area
- Loading and unloading of material
- Septic tanks

Every contractor should submit the CMP and get a prior approval from the client before the commencement of any activity on the site.

The plan should:

- Be in line with the client requirement
- Adhere to the rules and regulation
- Identify clear roles and responsibilities
- Identify monitoring plan for management

Table 11.4: Aspects and Objectives of Construction Management Plan

Aspect	*Objective*	*Mitigation and Management Measure*
Vegetation clearance	• Minimize vegetation clearance and felling of trees	• Removal of trees should be restricted to the development footprint. • Construction activities shall minimize the loss or disturbance of vegetation • Use clear areas to avoid felling of trees • A procedure shall be prepared to manage • vegetation removal, clearance and reuse • Inform the plant management before clearing trees • Cleared areas will be re-vegetated
Poaching	• Avoid illegal poaching	• Contractual obligation to avoid illegal poaching • Provide adequate knowledge to the workers relevant government regulations and punishments for illegal poaching
Discharge from construction sites	• Minimize surface and ground water contamination • Reduce contaminant and sediment load discharged into water bodies affecting humans and aquatic life	• Install temporary drainage works (channels and bunds) in areas required for sediment and erosion control and around storage areas for construction materials • Prevent all solid and liquid wastes entering waterways by collecting waste where possible and transport to approved waste disposal site or recycling depot • Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean •
Soil Erosion and siltation	• Avoid sediment and contaminant loading of surface water bodies and agricultural lands.	• Minimize the length of time an area is left disturbed or exposed. • Reduce length of slope of runoff • Construct temporary cutoff drains across excavated area • Setup check dams along catch drains in order to slow flow and capture sediment • Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust • Increase the watering frequency during periods of high risk (e.g. high winds) • All the work sites (except permanently occupied by the plant and supporting facilities) should be reinstated to its initial conditions (relief, topsoil, vegetation cover).
Excavation, earth works, and construction yards	• Proper drainage of rainwater and wastewater to avoid water and soil contamination	• Prepare a program for prevent/avoid standing waters, which Construction Supervision Contractor (CSC) will verify in advance and confirm during implementation • Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater

Aspect	*Objective*	*Mitigation and Management Measure*
		connecting to the existing established drainage lines already there
Construction vehicular traffic	• Control vehicle exhaust emissions and combustion of fuels	• Use vehicles with appropriate exhaust systems and emission control devices. • Establish and enforce vehicle speed limits to minimize dust generation • Cover haul vehicles carrying dusty materials (cement, borrow and quarry) moving outside the construction site • Level loads of haul trucks travelling to and from the site to avoid spillage • Use of defined haulage routes and reduce vehicle speed where required. • Transport materials to site in off peak hours. • Regular maintenance of all vehicles • All vehicle exit points from the construction site shall have a wash-down area where mud and • earth can be removed from a vehicle before it enters the public road system.
	• Minimize nuisance due to noise	• Maintain all vehicles in good working order • Make sure all drivers comply with the traffic codes concerning maximum speed limit, driving hours, etc.
	• Avoid impact on existing traffic conditions	• Prepare and submit a traffic management plan • Restrict the transport of oversize loads • Operate transport vehicles, if possible, in non– peak periods to minimize traffic disruptions.
	• Prevent accidents and spillage of fuels and chemicals	• Restrict the transport of oversize loads • Operate transport vehicles, if possible, in non– peak periods to minimize traffic disruptions • Design and implement safety measures and an emergency response plan to contain damages from accidental spills • Designate special routes for hazardous materials transport.
Construction machinery	• Prevent impact on air quality from emissions	• Use machinery with appropriate exhaust systems and emission control devices. • Regular maintenance of all construction machinery • Provide filtering systems, duct collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all stages
	• Reduce impact of noise and vibration on the surrounding	• Appropriately site all noise generating activities to avoid noise pollution to local residents. • Ensure all equipment is in good repair and operated in correct manner. • Install high efficiency mufflers to construction equipment. • Operators of noisy equipment or any other workers in the vicinity of excessively noisy equipment are to be provided with ear protection equipment • The project shall include reasonable actions to ensure that construction works do not result in vibration that could damage property adjacent to the works

Aspect	*Objective*	*Mitigation and Management Measure*
Construction activities	• Minimize dust generation	• Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust • Increase the watering frequency during periods of high risk (e.g. high winds). • Stored materials such as gravel and sand should be covered and confined • Locate stockpiles away from sensitive receptors
	• Reduce impact of noise and vibration on the surrounding • Avoid driving hazard where construction interferes with pre–existing roads	• Notify adjacent landholders or residents prior to noise events during night hours • Install temporary noise control barriers where appropriate • Avoid working during 21:00 to 06:00 within 500m from residences.
	• Minimizing impact on water quality	• Stockpiles of potential water pollutants (i.e. bitumen, oils, construction materials, fuel, etc.) shall be locate so as to minimize the potential of contaminants to enter local watercourses or storm-water drainage • Storm-water runoff from all fuel and oil storage areas, workshop, and vehicle parking areas is to be directed into an oil and water separator before being discharged to any watercourse. • An Emergency Spills Contingency Plan shall be prepared.
Siting and location of construction camps	• Minimize impact from construction footprint	• Arrange accommodation in local towns for small workforce • Locate the construction camps at areas which are acceptable from environmental, cultural or social point of view
Construction Camp Facilities	• Minimize pressure on local services	• Adequate housing for all workers • Safe and reliable water supply. • Hygienic sanitary facilities and sewerage system. • Treatment facilities for sewerage of toilet and domestic wastes • Storm water drainage facilities. • In–house community entertainment facilities
Disposal of waste	• Minimize impacts on the environment	• Ensure that all on-site wastes are suitably contained and prevented from escaping into neighboring fields, properties, and waterways, • and the waste contained does not contaminate soil, surface or groundwater or create unpleasant odors for neighbors and workers • Prepare detailed waste management and muck disposal plan incorporating safe disposal of the expected waste from the construction activities
Water and sanitation facilities at the construction sites	• Improve workers personal hygiene	• Provide portable toilets at the construction sites and drinking water facilities. • Portable toilets should be cleaned once a day. • All the sewerage should be pumped from the collection tank once a day into the common septic tank for further treatment.

11.7 Spill Contingency Plan

The plan should be read in correspondence to the other plans of ESMMP which includes:

- Construction management Plan
- Air Pollution Control Plan
- Waste Management Plan
- Muck Disposal Plan
- Biodiversity Conservation and Management Plan
- Construction Labour Management Plan
- Traffic Management Plan
- Health and Safety Plan
- Emergency Preparedness Plan

The construction contractor will develop a specific plan (SCP) for the project and get a prior approval from the client before the commencement of any activity on the site.

The plan should:

- Be in line with the client SCP
- Adhere to the local rules and regulation
- Identify clear roles and responsibilities
- Identify monitoring plan for management

Spill Contingency Plan (SCP) scope is to provide the basis and the guidelines for the management of spills which could happen during the execution of the Project.

The Plan is dedicated to the management of oil/ chemical incident (both accident and near misses): for other kind of environmental incident refer to Emergency Management Plan.

During the course of the Project, every effort shall be made to ensure that all operations are conducted in order to avoid the risk of a spill situation or, whenever an accident occurs, to implement measures and actions to prevent its escalation.

Starting from the identification of the main situations in which a spill of pollutants may occur, the plan outlines strategies for spill prevention relevant to the site activities and describes procedures for the control and limitation of the releases, in order to avoid or minimize the impact on the environment.

Moreover this plan details the overall response coordination in order to organize the control, alert and intervention, so as to avoid or reduce any potential pollution.

The Spill Contingency Plan will include the following:

- identification of the relevant types of spill and the scenarios which could possibly lead to pollution;
- identification of the prevention strategies and the actions adopted during and immediately after the release of pollutants;

- description of the project site organization, both during the prevention and emergency intervention phases;

In pursuing this aim, the following actions shall be considered as priorities:

- carrying out all the necessary operations for the protection of the health and safety of all people present where the spill occurs, both employees and others;
- minimization of the spill dimensions and protection of the main structures;
- minimization of environmental impact due to spill.

11.7.1 Identification of Potentially Polluting Substances and Pollution Scenarios

This section provides an inventory of polluting substances present on site, indicates a possible classification of spills by degree of severity, and identifies the various pollution scenarios.

11.7.1.1 Inventory of Potentially Polluting Substances

Potentially polluting substances have been identified by analyzing the main critical activities performed during the Project. The detailed list of construction activities is provided in ESIA, **Section 3**.

An analysis of the above-mentioned activities shows that the most critical substances that may be involved in spills are:

- diesel fuels;
- brake fluids;
- lubricants, such as engine and transmission fluids;
- solvents and chemicals;
- cement additives and residues;
- paints;
- battery acid;
- hazardous liquid wastes (e.g. used oil, spent paints and solvents, wastewater from washing equipment facilities).

However, during the execution of the Project, only small quantities are typically involved in incidents, with the possible exceptions of fuel transportation operations, breakdown of storage tanks or of existing pipelines.

The following subsections outlines descriptions of the main identified hazardous substances that will be possibly used throughout the PROJECT, and gives preliminary indications about their use and storage.

11.7.1.2 Polluting Substances and Management Options

The following subsections outlines descriptions of the main identified hazardous substances that will be possibly used throughout the project, and gives preliminary indications about their use and storage.

Diesel fuels

- The most of diesel fuels will be used for vehicles and equipment throughout the project area.
- Designated refueling areas are classified for mobile machinery and equipment and semi-permanent equipment installations. Vehicles and equipment that are difficult to move due to their size or whose movement to the designated refueling areas may cause further damage to the environment and create a road safety hazard shall be refueled by means of mobile refueling vehicles.
- Diesel fuel will be stored in dedicated facilities protected by concrete retention bounds or lined with plastic sheeting for spill containment.

Brake fluids

- Brake fluid is a specially formulated liquid used in the brake hydraulic system.
- Brake fluids will be stored in sealed containers within a designed and bounded area. The storage in non-designated areas is forbidden. In addition, drip trays will be used during maintenance activities.

Oil and Lubricants

- Oil and lubricants will be used for the maintenance of all vehicles, vessels and equipment, usually during planned maintenance processes at the site maintenance facilities. However, it is possible that machinery and equipment will have to be serviced or repaired outside of the maintenance area: oil and lubricants may be de-canted from their storage drums and transported for use to other areas of operation.
- Oil and lubricants shall be stored in sealed drums (150 – 200 L) within a designed secondary containment area at the main camp facility designated maintenance and storage areas. The storage in non-designated areas is forbidden.

Paints and Solvents/Chemicals

- Paints (used during painting activities) shall be stored in sealed drums in properly designated areas with appropriate environmental and safety controls.
- Solvents and other chemicals shall be stored in sealed drums in properly designated areas with appropriate environmental and safety controls.
- All solvents and chemicals shall be segregated as per their MSDS and stored separately depending on their chemical reactivity and compatibility criteria.
- Chemicals shall be used, in any significant quantity, for maintenance in camp areas.

Cement Additives and Residues

- Cement additives will be used during the Construction activities and will be stored within the cement production area in designated compounds.
- Cement residues may be arisen during cleaning operations involving cement trucks and mixing facilities, when they are performed in-site. The residue shall be mixed with copious amounts of water. An area for the cleaning of cement-contaminated equipment shall be

designated within the cement production area. This kind of wastewater shall be properly collected and disposed of in an environmental responsible manner.

Battery Acid

- Battery acids will be used for maintenance requirements. They shall be stored separately from any other substance in a designated area within the hazardous substance storage area. It shall be stored in a supplier's container and shall not be de-canted into any other container.

Hazardous liquid wastes

- The provisions of this Plan may be applied also to respond to potential spills of liquid wastes. Recommendations about hazardous liquid wastes management is reported in the Waste Management Plan

In addition, it shall be remarked that wastewater for large concrete-mixing equipment, if any, shall not be discharged on the ground. It shall be collected and disposed of properly. All washing equipment operation shall be carried out in identified locations where produced wastewater may be collected and disposed of in a proper manner.

11.7.1.3 Classification of Spills

As it may be detected from the above inventory, the pollutants most likely to be spilled are hydrocarbons and there would be essentially no difference in the impact of any one of these substances on the environment.

Therefore the spill contingencies are usually classified into three levels, or "Tier" approach and the classification is based on the entity of the spill and on the response resources required to deal with it, as follows:

Table 11.5: Classification of Spill Contingencies

Tier	*Definition*	*Example*	*Responsibility*
Tier A	**Minor Incident** One that is easily brought under control and prevented from re-occurring by the Contractor	• Small, containable spills within the site boundary • Minor nuisance but controllable and preventable from re-occurrence • Minimal environmental damage but controllable and preventable from re-occurrence	Following the incident response the HSE Coordinator will be responsible for notifying the Environmental Manager / Construction Manager.
Tier B	**Medium Incident** One that will need to be brought under control and prevented from re-occurrences in consultation with the HSE Coordinator	• Un-containable or uncontrollable spills within the site boundary • Excessive uncontrollable incidents which are likely to re-occur to cause nuisance or when a complaint is received • Un-rectifiable environmental damage and likely to re-occur	Following incident response the Environmental Manager / Construction Manager will be responsible for notifying the local authorities and detailing actions to prevent re-occurrence.
Tier C	**Major Incident** (Emergency) One which cannot be controlled by the Project	• Un-containable or uncontrollable spills outside the site boundary or which affect authorities supply networks	Following incident response the Environmental Manager / Construction Manager will,

Tier	*Definition*	*Example*	*Responsibility*
	or that effects local authorities or independent parties	• Excessive uncontrollable incidents which will re-occur to cause danger, nuisance, numerous complaints or significant impact to proponents reputation and / or principles • Massive environmental damage at the site which will re-occur to cause long term major impacts.	in agreement with proponent, be responsible for implementing the relevant authority's response plans.

The classification is to be considered only as a general guideline: who is responsible for dealing with the emergency shall decide, case by case, which actions are the most appropriate for the specific spill occurred.

The potential severity of a spill may be reduced by the following actions:

- Ensure that in site there are appointed personnel with appropriate and sufficient skills and information in order to mobilize promptly suitable resources;
- Allow rapid and orderly expansion of spill response by each Project areas as needed during a declared emergency;
- Optimize use of project resources, and facilitates the interface among contractor, Subcontractors, Government and their Agencies and others that could become involved in an escalating spill response;
- Provide flexibility to address local, regional, countrywide emergencies, with a clear understanding and devolution of responsibilities.
- As a spill evolves, its severity is continuously re-evaluated, and the level of response is adjusted as appropriate.

For the Project activities, the most probably spills are of Tier A: in order to deal with them the procedure explained in this plan will be applied.

11.7.1.4 Pollution Scenarios/Potential Incidents

Spills are usually related either to operator errors or to incidental events due to equipment failures.

Equipment failures include corrosion and leaking of pipes and tanks, valves failure, and sewer and drain leaks. Many of these failures may be avoided through proper inspection and maintenance procedures.

Operator errors include overfilling tanks and improper alignment of valves and piping. These and other operator errors can properly be corrected through developing operating procedures, regular training and testing of personnel, and systematic follow-up to assure that procedures are followed.

It is assumed that all personnel performing or supervising the various phases of work are familiar with international and local standards and have gained sufficient operational experience to be able to take preventive measures in all types of high-risk situations.

Furthermore, those responsible for the various phases of the Project Execution shall ensure that all vessels, vehicles, and equipment are kept in perfect working order and functioning efficiently. This will reduce drastically the likelihood of spill due to both human errors and malfunction/breakdown.

In addition, it will be their responsibility to ensure that all controls and necessary maintenance work are carried out correctly, so that the equipment in use is always in a perfect state.

Possible common incidents that may occur during site activities and may cause the release of hazardous materials include the following:

- **Spills during vehicle maintenance** such as oil leaks while changing the oil, engine coolant leaks while changing or adding coolant, and fuel leaks while refueling the vehicles. If these spills occur, the quantities should be minimal;
- **Oil/diesel spills** due to improper handling of drums and improper storage of them (Tier A expected – 200, 250 liters);
- **Paint spills** from painting and labeling equipment, oil and hydraulic fluid leaks from machinery, and gas leaks from welding equipment. The severity of these spills will vary depend upon spill detention and response (Mostly it is expected to be Tier A);
- In case of a **vehicle overturning**, the fuel tank may be damaged and a fuel spill occurs. Furthermore, depending upon what the vehicle was transporting, other spills may occur in conjunction with the fuel spill. The severity of these spill events is highly dependent upon several factors such as the hazard degree of the substances transported, where the spill occurred, and what, environmentally sensitive areas were affected, if any.
- **Breakdown of storage tanks**. The severity of these spills will vary depending upon the quantity involved, expected to be quite high (it shall be noticed that if the release occurs in the retention basin it is not to be considered as environmental accident, but a near miss).
- In case of spills as a result of a **vehicle accident / collision** the severity will vary depending upon the quantity of vehicles involved and the severity of the incident.

11.7.2 Spill Prevention Strategies and General Response Action

Potential incidents are usually related either to operational/human errors or to unexpected events/breakdown.

All personnel performing or supervising the various phases of work shall be familiar with international and local standards and have gained sufficient operational experience to be able to take preventive measures in all types of high-risk situations.

The purpose of this section is to describe the preventive and planning measures and the responding procedures for dealing with spills of pollutant substances during the execution of the Project.

Specific responsibilities and procedures to be followed during prevention, planning, and spill response activities are detailed in the following.

The review of the procedures of this Plan will be carried out by contractor on as-needed basis.

The main objective of the emergency procedures review is:

- to determine if the procedures should be modified to prevent reoccurrence of similar accidents;
- to improve preventive and response measures;
- to investigate the causes that led to the spill;
- to keep records of spills and actions undertaken to deal with the emergency.

11.7.2.1 Spill Prevention

The main objective of the prevention and planning phase is the implementation of all possible measures to prevent any potential spill of polluting substances.

Prevention of spills shall be the prime objective and shall include operating practices (maintenance to the construction equipment and tools), inspections and monitoring of facilities.

Personnel responsible for handling and storage of liquids which may be involved in spills shall receive training on the best practices to be adopted in site.

In this phase, the resources appointed to manage the emergency arisen by the spill of pollutant substances, has the following tasks:

- to identify all the hazardous materials, related to Project activities, that may produce a health and safety risk for project employees and subcontractors and that may produce an environmental impact;
- to make all personnel working on the project informed about environmental protection concerned and to ensure that all workers are familiar with response procedures when a spill occurs;
- to ensure that the activities carried out comply with the procedures, especially those regarding prevention of spills into the environment of pollutant substances;
- to provide continuous training to enable workers to perform their work in a safe and healthy manner.

For the particular activities potential source of incident, the general strategies described in the following subsections shall be adopted in order to prevent the most critical spills.

The activities are:

- Chemicals and Hazardous materials handling and storage
- Oil changes
- Chemicals/fuel transfer
- Construction equipment operation

Chemicals and hazardous material handling and storage

Properly label containers;

- Keep an updated inventory of all chemicals and hazardous materials stored on site;
- Keep Material Safety Data Sheets (MSDSs) at storage areas: handling and storage shall respect the recommendations defined in;

- Use appropriate chemical segregation practices where any potentially toxic or hazardous material will be stored;
- Manual handling of hazardous materials shall be minimized and the use of forklifts or cranes with pallet loads shall be preferred;
- Storage areas of hazardous materials/chemicals shall be sheltered from the sun, provided with a means to restrict access, located away from occupied buildings and work areas, and properly sign posted (**Figure 11.3**) - eg. "no smoking", "hazardous material storage area", etc".
- All hazardous chemicals and materials will be stored in contained bounded areas with impervious flooring, or according to the most conservative of relevant government regulations and guidelines regarding safe handling, storage and transport;
- All chemicals storage tanks and drums shall be located on paved area or contained within a suitably sized concrete retention bound. In this case the bound shall be provided with a lockable valve. All drainage valves shall be kept closed. They shall be opened only after checking the absence of chemicals in water to be discharged.
- Waste oils and other liquid wastes shall be stored in sealed drums within a designated secondary containment area or in a temporary storage area consisting of an earth bound lined with plastic sheeting;
- All fixed fuel storage tanks will be contained within a suitably sized concrete retention bund (**Figure 11.2**);

Figure 11.2: Hazardous Storage Area and Diesel Tanks Containment Basin

- Stationary fuel storage tanks and dispensing areas will have a containment membrane underneath and a bund around;
- In the event of a significant leakage from the fuel tanks in the bund retained fuel will be pumped back into another tank or the repaired tank. Residual fuel on the bottom of the bund will be soaked up using appropriate spill kits or sand and disposed of in compliance with Waste Management Plan. This episode has to be considered a "near miss";
- For transferring of fuel from a delivery tanker to a stationary storage tank:
  - The hose coupling must be compatible,
  - The use of improvised connections shall not be permitted,

- o Shut off valves shall be available and easily closable in the event of hose or connection failure,
- o The operation must be supervised at all times.

- According to ESIA, daily and weekly checks will be undertaken of the construction area including chemical and hazardous materials / waste storage area: these will be recorded in the daily and weekly site inspection reports.
- The access to potentially hazardous materials shall be granted only to qualified personnel: Hazardous materials will only be handled by trained personal.

Furthermore, environmental warning signboards shall be displayed at critical pollution point, in order to address the workers to adopt good environmental behavior and promote environmental awareness.

Figure 11.3: Environmental Awareness Signboards

Maintenance and Refueling

The maintenance and refueling activities shall be carried out on a dedicated area, properly demarcated and with signboard (preferably an area for each activity). The Area shall be:

- Located safe in terms of position;
- Not close to site traffic access routes;
- Not place within 30 m of any hot work activity;
- Not on environmentally sensitive surface.

The area shall be paved; only if there is not availability of any paved area, a non-paved area can be used.

The maintenance vehicles shall perform the activity only in the Maintenance area and every vehicle shall be provided with:

- MSDS;
- Drip tray;
- Spill Response Kit;
- PPE;

- Fire extinguisher.

During Maintenance and Refueling, the following measures shall be strictly put in place in order to avoid any kind of contamination of the ground and ground water.

- Place retention tanks or drip trays below drum taps and fuel hoses to collect every drips and leaks and provide spill response kit
- Use portable tanks placed under engine drain points to prevent any spilling of oils during oil changes. The contents of these tanks will be transferred immediately to sealed drums within the designated waste oil storage areas;
- Place retention tanks or drip trays below all terminals and in-line connections (e.g. drum taps, fuel hoses, etc.) to collect drips and leaks. Couplings will be appropriate, shut off valves easily accessible;
- Check tanker delivery hose for residual fuel from last fuelling operation. If there is residual fuel, handle the delivery hose accordingly;
- Properly connect delivery pipes. Ensure the integrity of all terminal and in-line connections;
- Operator must control the dispenser at all times.

If there is some oil that spills inside the drip tray, it shall be put again in the tank or dispose as indicated in Waste management plan. This episode has to be considered a near miss.

Figure 11.4: Drip Trays under Fuel Hoses and Drums Stored Temporarily

Construction equipment operation

- All welding machine, compressor units, water pumps, power generators (on wheels or not) - diesel and petrol operating construction equipment shall have drip trays placed under them during operation (any eventual spillage – that in this case has to be considered near miss- will be collected and disposed of as hazardous waste);
- Trucks transporting oils, greases and fuels for the earthmoving machinery shall be equipped with anti-spilling devices on distribution nozzles and pistols.
- Heavy vehicles and cranes shall be assisted during maneuvering to avoid incidents;

- All plants and vessels shall be maintained in an efficient state, efficient working order and in good repair;
- Vehicle maintenance and Routine inspections of components and systems shall be carried out as per the manufactures maintenance manual;
- Vehicles and equipment will be kept in designated areas away from sensitive environments.
- Pre start checkup and visual checks to be carried out to ensure the integrity of the plants/equipment.


Figure 11.5: Equipment Washed in a Dedicated Area inside Drip Tray

11.7.2.2 General Response Action

This section provides a general overview of response options to deal with possible oil and chemical spills during site activities. These may include more significant spills arising from accidents, or spills resulting from leaking fuel tanks, chemical drums, etc., that can lead to large releases of material.

Any incidents where pollutant spills are involved require immediate response to stop the source of the discharge, to limit the spread of material and to ensure the safety of personnel and the sensitivity in the area where spill occurred.

During response operations, priority shall be given to the protection of health and safety of the personnel involved. Therefore, appropriate PPE shall be worn during the response activities.

The main objective of the response phase is to minimize the effects of any spill and, if necessary, to clean-up the site concerned.

In this phase, the organization assigned to manage the emergency has the following tasks:

- to guarantee the immediate identification of the spill;
- to take action to handle the emergency phases after the spill of polluting substances, and specifically to stop and contain the spill, taking the necessary steps to protect personnel and the environment, thus minimizing the negative effects of such an occurrence;
- to take action to clean-up the impacted area.

Spill identification

The first step after the occurrence of a spillage is the identification of its source. Once the spill has been assessed, response measures shall be immediately selected and undertaken in order to mitigate its effects. Any response action may depend on the spill severity.

Incident Evaluation

After spill identification, the severity of the spill shall be evaluated in order to select the proper response strategies.

In addition, the situation shall be assessed to determine whether evacuation is required. If necessary, traffic will also be re-routed.

Once these factors have been determined, the proper level of response will be determined. In any case, after stopping the release of material to the environment, containment shall likely be the next step of response process.

Spill Response Equipment

As rapid containment of any spill is desirable, the equipment for the clean – up shall be suitable for adequately respond to the type of substance spilled.

In particular, according to CEMP, spill kits shall be provided in the construction site in the area where a possible scenario of spill, as described, can occur.

Commercially are available different types of spill kit (**Figure 11.6**), fit for the purpose (i.e. volume of spill, liquid involved, outdoor / indoor spill, etc). In the common spill kit the following items are provided:

- Absorbent pillows and granulate;
- Polypropylene adsorbent pad;
- Containment drip pans;
- Shovels;
- Protective gloves;
- Goggles / safety glasses;
- Heavy duty oil resistant storage bags;
- Duct tape.

Figure 11.6: Spill Response Kit

The pollutant materials, arisen by clean-up actions, shall be disposed of in compliance with Waste Management Plan

All response and clean up material will be replaced as soon as practicable after it has been used.

After an incident, the effectiveness of the present Plan shall be assessed and, if necessary, the spill response procedure shall be properly improved and updated.

It is contractor and subcontractor duty to verify that their workers are equipped (and trained to use) with all PPE prescript on specific MSDS concerning each chemical substance used.

It is Contractor and subcontractor duty to include type of PPE to be used specifically to individual chemicals, as prescript on MSDS, on their HSE Plans. This information will be available before to the site activities and will be transmitted by HSE Manager.

Containment methods

Selection of appropriate control and containment techniques is dependent on site-specific conditions, such as:

- the nature of the substrate;
- the slope of the terrain;
- the amount of product;
- the time available to implement response action.

The following subsections describe **general containment** and **clean-up techniques** to treat pollutant spills that have impacted impermeable and permeable land surfaces.

The objective of surface containment is to prevent the spread of spilled material on soil surface and to intercept the horizontal movements in the subsoil. The most important containment techniques are:

- **surface containment**: to prevent spread of substances on soil surface or substrate surface and to prepare it for the recovery;
- **sorbent barriers**: to form a continuous barrier to limit spreading and collect the pollutant to allow recovering by physical removal of spent sorbents or by pumping.

Surface Containment

The method for surface containment of fuels, solvents, chemicals, and other dangerous or hazardous toxic materials on impermeable ground may consist of:

- block inlets/outlets to drains, pipes, sewage systems, and cable ducts to prevent explosion risk or contamination of sewage treatment plants or water courses (if any in the area);
- use sorbents to limit spreading;
- concentrate the material by brushing it in to a collecting area, or by creating an absorbent barrier that can be tightened around the pool, so that it can be transferred to a container.

In case of a spill directly to permeable ground or if spilled material escapes a bermed area, one of the following approaches will be employed:

- for smaller spills, increase sorption capacity of surface layers by spreading absorbent material;
- use absorbent barriers to contain the spill;
- for larger spills or where movement is an issue, construct barriers, such as berms, dams, and trenches, to contain or divert the flow. These barriers can be constructed with readily available tools and equipment, such as shovels, earth-moving equipment, and sorbents;
- block all inlets, except the oily water drains, and let the pollutant flow enter an oil interceptor via the water drainage system and retain it there;
- in presence of oil spill, bulldoze or otherwise move any free oil and oil-saturated soil to the nearest natural or artificial impermeable surface.

The confinement operations should be started immediately to limit the amount of penetration of spilled material into the soil surface, thus containing the spill impacts.

The advantage of the containment methods is that confinement and damming can be achieved using easily available materials and are suggested if the pollutant is to be pumped and/or sucked up.

Sorbent Barriers

Sorbent materials may be stacked or piled to form a continuous barrier across the entire leading edge of the advancing pollutant mass to contain minor flow and recover a portion of the hazardous substance. Collected pollutant is recovered by physical removal of spent sorbents or by vacuuming or pumping when quantity exceeds absorption capabilities of the sorbents.

The application depends on the form of the sorbent; generally they are spread or applied over the slick and, after absorption, they are collected by various methods.

Clean-up, Recovery and Removal Methods

The appropriate clean-up technique to be used depends on the location of the incident, volume and type of the pollutant involved, and the amount of soil that has to be removed. For smaller spills, storage containers, such as lined drums or lined hauling trucks, will typically be sufficient for collection and transport of the recovered and waste materials. For larger spills or if insufficient storage containers are available, the removed material may be held, prior to disposal or treatment, in a lined excavated ditch prepared using a bulldozer.

Depending on the specific circumstances of the spill, the choice on how to conduct recovery depends on:

- the material spilled;
- the quantity spilled;
- the location of the spill and terrain of the surrounding area;
- potentially endangered resources;
- manpower and equipment resources available.

These factors define the possible impact of the spill and the options for cleanup. The expected benefits from using a particular technique must be weighed against the potential impact to the environment from the suitable clean-up techniques.

Possible recovery and removal strategies include:

- excavation;
- recovery pump system.

Excavation

It is used to remove impacted unsaturated soil and prevent contamination of the ground water.

Contaminated soil may be removed by mechanical excavation, using various types of earth-moving equipment, to prevent the contamination of the groundwater.

The method should not be used:

- if excavation will disturb or penetrate an impermeable natural layer;
- if there is a risk of damaging underground utilities such as pipes and electric cables;
- for large spills, because there is a danger of causing more damage and costs also rise steeply with increased depth: recovered material may cause disposal problems.

The advantage of the method is that early and successful excavation can save long-term recovery operations and it may be the most economic method of recovering high viscosity substances (heavy fuel oils, some crudes, etc), even though it may increase the volume of impacted materials for disposal.

At the end of clean-up operations the stored material will be disposed in accordance with the Waste Management Plan. Recovered waste materials will be collected and transported as specified in the above mentioned specification.

Recovery pump system

It is used to remove pollutant from the water table. This strategy is generally applied to a site when the depth of the groundwater table is not significant.

11.8 Biodiversity Conservation and Management Plan

The biodiversity conservation and management Plan or which may refer to biodiversity action plan / framework will be integral part of the ESMMP and ESIA. As part of the ESIA completion an ecology survey of the project area has been conducted as discussed in baseline section which included:

- Qualitative and quantitative assessment of flora, mammals, reptiles and birds
- Identification of key species, their population and their conservation status in the area.
- Reports of wildlife sightings and fish captured in the area by the resident communities.

Data analysis to determine baseline biodiversity and to evaluate whether any potential critical habitat and ecosystem services were present in the area

In the course of ESIA based on the literature review and detailed surveys in the environmental setting of the project area (as discussed in baseline section) the need of consequent survey(s) spanning to different seasons was observed.

The survey as have to spread to upcoming seasons the biodiversity conservation and management plan is still in the process of finalization. The biodiversity conservation and management plan will be included as part of the ESIA after its completion before commencement of activities on site.

It is the client commitment to implement the findings and proposed mitigation measures of the biodiversity conservation and management plan. All the contractor and subcontractor will also be obliged to follow it.

11.9 Air Pollution Control Plan

This Plan aims to reduce the sources and amounts of pollutants responsible for the loss of any air quality, acidification and global warming and to improve the quality of life, protecting their health risks from air pollution. This Plan has also been the initial commitment of client to reduce dust, greenhouse gases (GHGs) emissions in a context of sustainable development with economic growth, social cohesion and environmental protection at the project level. The plan should be considered in accordance with the other plans which include:

- Construction management plan
- Water pollution control plan
- Waste management plan
- Muck disposal plan
- Biodiversity conservation and management plan
- Construction labour management plan
- Traffic management plan
- Health and safety plan

- Emergency preparedness plan

The Contractor will devise the specific plan identifying the monitoring points and detail of the monitoring location in accordance with the clients and regulatory requirements.

The strategic lines on which contractor should submit his detail plan is as follows:

Air quality:

- Having an optimal system of assessment and forecasting of air quality for monitoring PM_{10}, $PM_{2,5}$, SO_2, NO_x, CO
- Water will be sprinkled regularly to suppress dust emissions
- Stock piles from leveling will be appropriately located and dampened to avoid dust emissions
- All the equipment and machinery will be inspected regularly for any maintenance
- Contractor's equipment and machinery will be properly maintained and provided with necessary noise reduction and control equipments such as silencers and mufflers
- Regulate speed of construction vehicles
- Reduce the sources and amounts of pollutants responsible for the loss of urban ambient air quality
- Achieve a level of air quality where concentrations of air pollutants do not pose a risk to human health and the environment.
- Improving awareness and promote a change in consumption and mobility habits.
- Improve coordination, exchange information and implement joint work with other public and private agencies related to air quality.
- Increasing transparency and keep the public informed about air quality.

Climate Change

- Maximize savings, energy efficiency and participation of renewables in the energy structure at local and regional level.
- Reduce the sources and amounts of pollutants responsible for global warming with "Best Available Technologies", cleaner fuels and more sustainable mobility.

Specific Objectives

- Implementation of the mitigation measures related to the air pollution control as identified in the ESIA.
- Reducing emissions of nitrogen oxides and volatile organic compounds during construction.
- Incorporation of energy efficiency and renewable energy measures
- Incorporation of Vapor Recovery Systems in Fuel Stations.

In addition the contractor need to identify the roles and responsibilities of the personnel(s) involved for the proper management and implementation of the plans.

11.10 Waste Management Plan

This is a project level plan for the waste management. The plan has been prepared to meet the Local regulatory requirement, equator principle and EHS guideline of The World Bank. The contractor will be asked to adhere to the plan and prepare and submit the more specific plan related to the assigned activities to them.

The purpose of the present Plan is to provide effective guidance for the management of all the Waste generated during Project execution.

The Plan lays down measures to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing the overall impacts of resource use and improving the efficiency of such use. This Plan introduces an approach that takes into account the whole life-cycle of products and processes and not only their waste phase.

The scope of the present Plan is to:

- Describe the main principles of Waste Management strategy;
- Describe how client wishes to deals with wastes generated by its activities, products and services (collection, handling, transportation, storage, treatment, disposal, records keeping, auditing);
- Provide guidance to personnel and contractor for managing waste effectively and within the requirements of the applicable waste Laws and Regulations.

11.10.1.1 Waste Management Strategy

Waste management includes the collection, temporary storage, transportation, recovery/recycle, treatment and disposal of waste produced by activities in an effort to reduce their effects on human health and environment throughout the entire cycle of life of their products or processes.

Contractor and its Subcontractor shall take the necessary measures to ensure that waste management is carried out with the duty of care and without endangering human health, and harming the environment. In particular risks to water, air, soil, plants and animals, and nuisance through noise or odors shall be avoided.

The basic principles of waste management in activities are summarized as follow:

- Reduce
- Reuse
- Recycle
- Recovery (e.g. energy recovery)
- Responsible Disposal

This shall be considered as a hierarchy, which shall apply in a priority order in waste prevention activities and management taking into account the Best Environmental Practicable Option (BPEO) and Best Available Control Technology (BACT).

At all levels everyone shall take measures, as appropriate, to promote the application of this hierarchy in all activities.

11.10.1.2 Waste Minimization Strategy

Waste minimization (source reduction and reuse) helps to conserve resources and reduce pollution, including greenhouse gases that contribute to global warming. Moreover, it reduces waste disposal and handling costs, because it avoids the costs of recycling, municipal composting, landfilling, and combustion.

Source reduction is the practice of designing, manufacturing, purchasing, or using materials (such as products and packaging) in ways that reduce the amount and/or the toxicity of waste created. This process include, e.g.:

- material elimination
- inventory control and management
- material substitution
- reduction in the consumption of natural resources.
- process modification
- improved housekeeping

Reuse (without any treatment) is the way to stop waste at the source because it delays or avoids items entry in the waste collection and disposal system.

Client and contractor will dedicate all efforts dedicated towards minimizing waste generation at the source, by preventing the generation of waste and by selecting product and raw material alternatives of lesser damage to the environment.

Following some minimization actions that will be implemented:

- reduce the water consumption (and consequently the wastewater production) from accommodation camps through personnel awareness campaign and with the use of taps aerator and two-way flushing system
- reduce equipment and machinery wash water through awareness campaign of the involved personnel
- reduce packaging and packing material buying in bulk. Packaging and packing material will be reused for other purposes (shipping, etc.)
- used wooden planks will be reused for concrete formworks and scaffolds
- timber will be used for project sign boards, etc.
- empty drums will be used as waste bins
- metal scrap will be used for other purpose, as metal drip trays, etc.
- paper from office will be reduced with proper awareness campaign of the personnel (i.e. avoid printing, two-side printing, etc.)
- the use of small water bottles will be limited and use of water dispenser and reusable glasses will be enhanced, especially in offices. Water bottles may be refilled several times at the water dispenser

- soil cut material will be reused as filling material, if technically possible, or for unpaved road maintenance.

Opportunity for minimization will be identified and consequently prioritized during the entire execution of the project.

11.10.1.3 Waste Treatment

Substances or object that cannot be reused (waste) shall be properly treated before disposal where possible. Waste treatment refers to the activities required to ensure that waste has the least practicable impact on the environment.

According to waste hierarchy recycling/recovery is the first option of waste treatment. Recycling/recovery is the conversion of wastes into usable materials and/or extraction of energy or materials from wastes.

11.10.1.4 Waste Disposal

Responsible disposal is the depositing of waste on land (e.g. landfilling) trying to mitigate any negative impact to the environment. Disposal is the least desirable waste management option and shall be discouraged, and considered only for unused waste.

11.10.2 Waste Management Activities

Client is committed in the application of the strategy described above and in particular to ensure that efforts will be dedicated toward waste production minimization. Where feasible, the waste will be managed according to the described hierarchy.

The waste generator (Contractor and Subcontractors) is the owner of the waste and in thus responsible for the correct handling in accordance with applicable legislation until it reaches the approved waste management facilities.

11.10.2.1 Target and Objective

The objectives for the first year related to Waste Management are described in the following table (the objectives for the following years will be contained in other relevant document):

Table 11.6: SMART Objectives

	Specific		*Measurable*	*Achievable*	*Responsibility*	*Timely*
Subject	*Description of objective*	*Activity*	*Indicator*	*Target*	*Responsible Department*	*Time Frame*
Waste	Waste Segregation	Implement segregation on project sites	No of sites where segregation is done vs. total No of sites	100%	Construction	End
Waste water	Wastewater	Minimization of wastewater from camps	Wastewater discharged per person per day / 160 liters	1,00	Camp Boss / HSE	End
Solid Waste	Mixed solid waste	Minimization of mixed solid waste from camps	Mixed solid waste produced per person per day / 2 kg	0,90	Camp Boss / HSE	End

11.10.2.2 Waste Identification and Classification

The first step of a proper and effective waste management is the identification of waste streams arising from project activities and temporary offices/accommodation camps.

The waste shall be properly classified in order to select the best available management technique. According to applicable laws and regulations wastes are classified as follow:

Table 11.7: Waste Identification and Classification

Classification	*Examples*
Solid Waste	Like domestic, industrial, agricultural, medical, construction and demolition wastes
Liquid waste	Effluents from residential, commercial and industrial premises and others
Gas, Fume, Vapor and Dust Wastes	Produced by crushers houses, bakeries, incinerators, factories, quarries, power stations, oil works, and transportation and commuting various means
Hazardous Wastes	The residual or ash of the various activities and operation having hazardous contents.
Non-Hazardous Waste	Other wastes that may not be classified as hazardous
Medical Wastes	Any wastes made in whole or part of human tissue, animal tissue, blood or other body liquids, secretions, drugs or other pharmaceutical products, bandages, syringes, needles or other medical sharp objects, or any other wastes whether contagious chemical or radioactive produced by medical activities, nursing, treatment, medical care, dental, veterinary or pharmaceutical or processed activities or others, tests, research works or study materials or sampling or storage of the same.

Should the classification of a waste is unknown (whether hazardous or non-hazardous), the Project HSE Site Coordinator and HSE Site Inspectors shall conduct initial field screening using portable testing equipment or monitors (e.g. LEL meter, PID monitors, pH testing equipment, etc.) on wastes to determine if they exhibit any hazardous characteristics. If an unknown waste is identified as hazardous or potentially hazardous, the material should be subjected to laboratory testing to guarantee its proper classification.

11.10.2.3 Waste Segregation and Collection

The segregation of different waste streams is a pre-requisite for implementing a good waste management system.

Wastes sorting shall be promoted at all level for a more efficient handling before treatment or disposal. Segregation shall be done in compliance with local requirements and in accordance with final destinations available options. To facilitate and improve recycling/recovery, waste shall be collected separately if technically, environmentally and economically practicable and appropriate to meet the necessary quality standards for the relevant recycling sectors, where available.

Waste shall not be mixed with other waste or other material with different properties. In any case hazardous waste shall not be mixed (or diluted), either with other categories of hazardous waste or with other waste, substances or material.

Wastes shall be collected in adequate containers (bins, skips, etc.) as they accumulate. A color code system shall be implemented in order to facilitate the segregation process. In all areas good housekeeping shall be maintained at all times. The number of categories of bins/skips shall be consistent with waste generated in the relevant areas. Clear signboards/placards shall be put on the skips/bins in all the collection points, in order to help identifying appropriate waste type and promote segregation.

11.10.2.4 Waste Storage

Specific areas for waste temporary storage shall be foreseen on construction sites and temporary yards. Waste temporary storage areas will be located at main and satellite Construction Camps

Temporary waste storage shall be conducted in a way to prevent risks to the environment (water, air, and soil) and public health, and without causing a nuisance through dust or odors. These locations shall meet the most stringent safety and environmental conditions.

Temporary waste storage areas shall be well identified by clear signboards and properly fenced. Waste removed from the various generation areas shall be collected, transferred and temporally stored in this main collection points for a definite period, before being sent off site. A dedicated competent person will be appointed to supervise the area in order to:

- Receiving wastes and ensuring they are placed in the correct area
- Ensuring all containers are properly marked with the relevant information
- Ensuring all wastes are properly packed/contained with adequate isle spacing between containers for inspection and emergency exit
- Regular inspection of the area to ensure integrity of all waste storage containers
- Control over the removal of wastes from the area by contractors or others
- Ensuring all containers are securely covered except when waste is being added or removed
- Receiving and issuing waste transfer consignment notes
- Maintenance of waste transfer records
- Security and cleanliness of the storage area.

An up-to-date inventory of all wastes temporarily store on site must be maintained, together with relevant health and safety information. Other kind of form, containing the same information may be proposed by subcontractor.

Particular attention shall be given to hazardous waste storage area and collection. Hazardous waste should be removed from sites/facilities as soon as practically possible and shall be handled by competent persons. Bins/skips provided for hazardous waste collection shall be identified by labels indicating the type of waste contained and shall be located in a paved area cover by a roof, if necessary. The Hazardous wastes shall be collected and stored in compliance with applicable legal requirements and recommendations of the relevant Material Safety Data Sheets (MSDSs), which shall be available on site. Fire-fighting and spill response provision shall also be available on site.

Liquid contaminated/hazardous waste shall be stored in secure fenced areas, with impermeable bounded base (covered by a roof). These areas shall have a suitable drainage control. Containers and storage tanks shall be designed of suitable/compatible material to contain the waste. Fire-fighting provision and spill response material shall be available on site.

The following practical criteria shall be kept into consideration, particularly while handling Hazardous Waste:

- Hazardous waste shall be stored in dedicated leak-proof containers provided with tight caps and seals with appropriate capacity;
- Clear marks shall be placed on hazardous waste storage containers stating the contents and indicating the hazards associated with handling and storage;
- Flammable substances must be kept separate from sources of ignition or oxidizing agents;
- Acids must be kept away from substances with which they may react, producing dangerous compounds e.g. cyanide;
- Strong corrosive agents must be kept away from gas cylinders or other containers;
- Volatile liquid waste should be safely stored in closed drums in a dedicated open area;
- Pressurized aerosol cans must be collected separately in a single, suitably marked container;
- Hazardous waste containers shall not be located in public areas at any times.

Applicable local legislation does not indicate any time/quantity limit related to hazardous/non-hazardous waste temporary storage area, anyway the maximum retention time for storage in site may not exceed 3 months and 10 m3, according to the best practice. In any case, putrescible waste shall be removed daily from the storage area.

11.10.2.5 Waste Transportation

Wastes produced during activities shall be treated or disposed to offsite facilities and areas.

No waste shall be given to a Third Party.

Competent appointed personnel shall check if subcontractor complies with the following requirements:

- Any vehicle used to transport waste shall be constructed and maintained so as to prevent spillage of waste and equipped with all safety equipment
- Any container used to transport the waste shall be secured safely on the vehicle used to transport the waste
- Any vehicles used to transport waste shall be covered when loaded
- Any vehicles shall not overloaded
- Incompatible wastes shall not be mixed or transported together
- Any material segregated for recycling shall not be mixed with different waste during transportation
- Any vehicles shall be driven by trained licensed drivers
- Any vehicles shall display clear marks indicating the extend of danger of their loads (if any), and the best course of action in emergency cases.

To assure waste traceability, each shipment shall be documented as per local laws and regulations Waste traceability shall be assured for all waste typology by Contractor and Subcontractors, even if not specifically required by applicable law (log and register shall be used for all type of waste, the use of WTN also for non-hazardous waste will be assessed, if feasible).

11.10.2.6 Final Destination

In order to assure the proper management of waste treatment/disposal throughout all the waste cycle all waste shall have proper authorization by Competent Authority and, as a minimum, comply with applicable legislation for disposal site. Evidence of the NOC / permit shall be available to the Environmental Manager prior of the waste transportation.

11.10.2.7 Medical Waste Management

Medical waste shall be properly segregated into the categories and disposed of only in proper containers prepared to this purpose under the directions of the Ministry of Health.

11.10.3 Duty of Care

Everyone who produced, handles, stores, transports or disposes of waste has a duty of care to ensure that:

- All reasonable steps are taken to ensure the waste is kept in a safe and secure state
- The waste does not cause pollution of the environment
- The waste does not harm people.

Duty of care process and parties responsibilities are summarized in **Figure 11.7**.

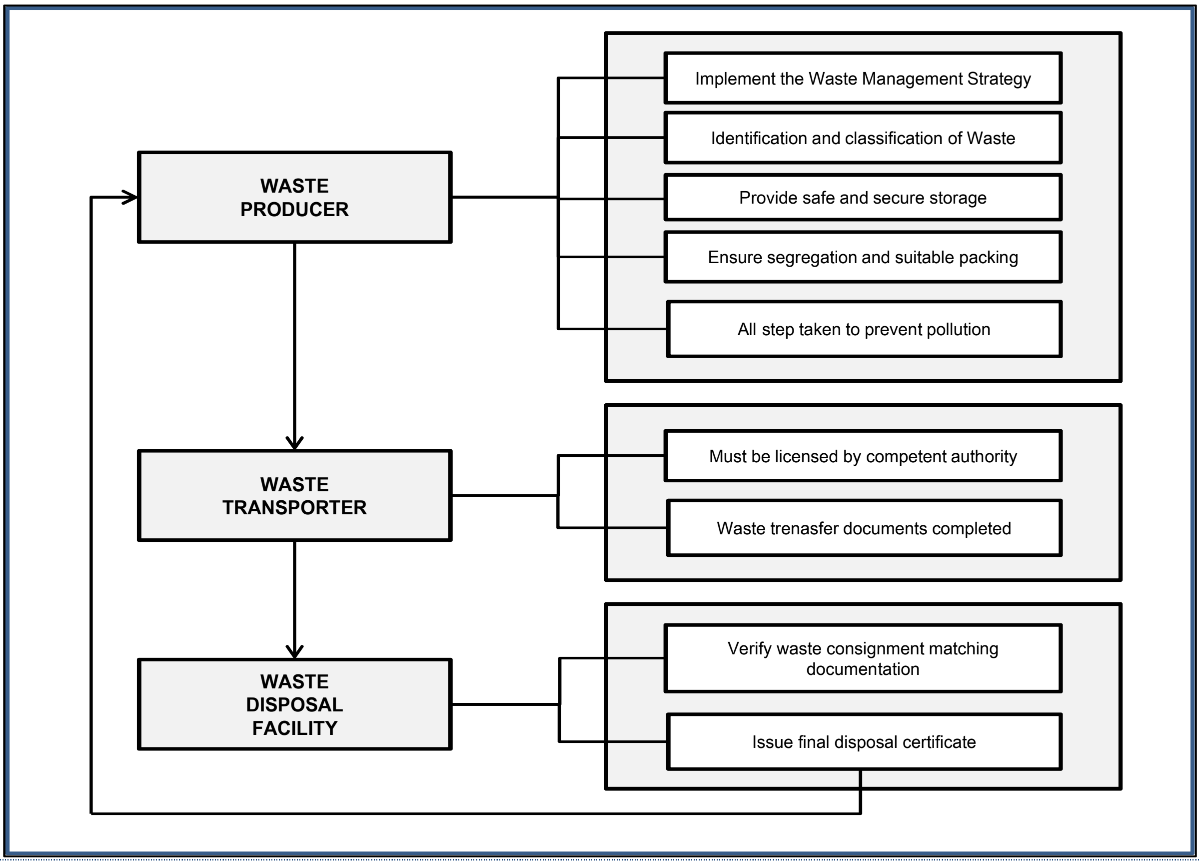

Figure 11.7: Process and Parties Responsibilities for Waste Management

11.10.4 Training

At all level personnel shall receive proper information about waste management requirements, in particular regarding waste prevention strategy and proper segregation.

Personnel involved with waste handling shall be provided with basic and/or specific information about most significant issues related to waste management. Workers engaged in the handling and management of the hazardous waste shall be properly trained (hazardous material handling) and competency assurance shall be guaranteed.

11.10.5 Inspection and Audit

Environment Department will undertake periodic waste management site inspections. All sites shall be duly inspected with reference to the generation, storage, transportation and disposal of all waste types.

An Inspection schedule (Daily, Weekly and Monthly) will be implemented and proper check lists will be prepared. Weekly inspection shall be undertaken on Temporary Waste Storage Areas.

Periodic Audit will be undertaken, and proper schedule will be prepared before commencement of construction activities. Internal Audit will be performed monthly while annual corporate audit will be also scheduled.

11.10.6 Reporting

Contactor and its subcontractors shall keep records or logs of waste produced, generation process and amounts generated and transported to the waste treatment/storage facility. The records shall include:

Full description of wastes showing their dangers and their physical and chemical characteristics

- Quantities
- Sources
- Collection rates and periods
- Transport means
- Treatment method
- The name of the contractor to which these wastes are delivered

The Environment department shall prepare a weekly waste management report and send it to the Projects' Corporate function, as required in the Contract. The report should include the following:

- Total quantities/volumes of hazardous and non-hazardous wastes sent to each disposal facility;
- Total quantities/volumes of separated/recycled wastes;
- Sewage liquid quantity sent for disposal;
- Complaints received from the nearby sensitive receptors on odor or other nuisances as a result of generated wastes; and
- A summary of any waste incidents/spills reported during the year.

Contractor and its subcontractors shall prepare the monthly report

11.11 Muck Disposal Plan

This plan provides the disposal plan for the Muck which will be generated from the project activities. It is expected that 1 million cubic meter of muck will be excavated for the project activities. The details of the Muck excavation are provided in the **Section 3**. The plan should be considered in accordance with the other plans which include:

- Construction management plan
- Water pollution control plan
- Air pollution control plan
- Waste management plan
- Biodiversity conservation and management plan
- Construction labour management plan
- Traffic management plan
- Health and safety plan
- Emergency preparedness plan

Key issues related to the muck disposal plan to be submitted by the contractor should include

- According to the waste management plan the producer has the responsibility of safe disposal of any waste which makes the contractor responsible for the disposal of Muck.
- The muck disposal should be carried out in accordance with the client's environmental policy and legal requirement.
- The extent of possible reuse as fill material of the muck for the construction activity
- The location of the disposal point. The disposal point should be downwind to the habituation and water bodies
- All the relevant permits and documentary proof be obtained from the relevant authorities
- Clear route for transportation of muck to the identified and approved sites be identified and discussed in the plan
- Dust control measure identified in air pollution control plan be implemented and documented
- Proper roles and responsibilities of the concerned be identified

11.12 Traffic Management Plan

Construction related traffic may pose a threat for the social receptors alongside the project area. **Section 3** has discussed in detail the proposed project activities which will result in in the increase of the traffic on the existing road. A new access road is also included as the scope of the project to overcome the local stress on the roads.

This traffic management plan should be considered in accordance with the other plans which include:

- Construction management plan
- Water pollution control plan
- Waste management plan
- Muck disposal plan
- Biodiversity conservation and management plan
- Construction labour management plan
- Health and safety plan
- Emergency preparedness plan

Every contractor should submit the traffic management plan and get a prior approval from the client before the commencement of any activity on the site.

The traffic management plan should:

- Be in line with the client requirement on the traffic management
- Adhere to the local rules and regulation
- Identify clear roles and responsibilities
- Identify monitoring plan for management

The plan at minimum should include the following mitigation measures

- Contractor’s vehicle will follow strict speed limits within city and all applicable local traffic rules and regulations
- Contractor’s personnel will only use access routes assigned to them for project activities which will be finalized during the kickoff meeting with representatives of client, subcontractor and social receptors
- Movement of contractor’s vehicles for transportation of material and wastes from and to the site will be restricted to low traffic timings.
- Contractor’s vehicles and equipment will be parked at identified designated area. Vehicles and machinery should be appropriately parked/ placed to provide ample access to local commuters/pedestrians
- Diversion plans will be developed to minimize disturbance to local population during occasional high activity timings / days. These plans will be communicated to residents well in advance and proper diversion signs will be placed to inform locals.
- Prior communication to residents and safety signs will be installed well before the commencement of any activity at site

11.13 Health and Safety Plan

Contractor will submit a detailed Health and Safety Plan. The plan is to be prepared in accordance with client’s requirement, IFC Performance Standard 4 Community Health and Safety (Section 2.3), which require that a plan is in place to effectively respond to emergencies associated with project hazards and that local communities are involved in the planning process and World Bank Group General EHS Guidelines, Volume 3 and other relevant of the EHS Guidelines relevant to the Project.

11.14 Emergency Preparedness and Response Plan

The contractor will prepare and submit an Emergency Preparedness, Response and Recovery Plan (EPRRP). The EPRRP will be prepared in accordance with IFC Performance Standard 4 Community Health and Safety (Section 2.3), which require that a plan is in place to effectively respond to emergencies associated with project hazards and that local communities are involved in the planning process and World Bank Group General EHS Guidelines, Volume 3 and other relevant of the EHS Guidelines relevant to the Project.

The EPRRP will at minimum contain the following elements:

- Planning and management commitment (Scope, Policy and regular update);
- Roles and Responsibilities;
- Internal Communication Protocol;
- Resources;
- Monitoring;
- Contingency Plan (in addition to shared SCP);
- Emergency response procedures for each emergency scenario;
- Mock emergency scenarios and drills schedule; and
- Review (to identify missing or weak elements, consistency with any regional and national disasters plans and compliance with relevant legislation and codes).

References and Annexures

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ANNEXURES

Annexure 1: Seismic Hazard Study

General

The proposed Project site is located on the foothill of Himalayan range. It lies close to the Riasi thrust which is a branch of Main Boundary Thrust (MBT). Numerous large earthquakes with magnitude greater than VIII are believed to be associated with MBT in Himalayan range East of the Project site. As the Project site is located in active seismic region, evaluation of realistic seismic design parameters is therefore necessary to design the Project structures so that these can withstand the expected ground motions due to earthquakes.

Methodology

The methodology adopted for the seismic hazard evaluation of Gulpur Hydropower Project is as follows:

- Collection and review of the regional geology and tectonic setting in an area of 150 km radius from the site. For this, the data available with WAPDA, Geological Survey of Pakistan, Oil and Gas Development Corporation and various universities were collected and analyzed.
- Study of all available historical and instrumental earthquake data including data from regional network as well as Mangla local network and development of comprehensive earthquake catalogue.
- Study of existing faults of the area through satellite images and available geologic literature and maps.
- On the basis of synthesis of tectonic and siesmological data obtained from the above mentioned studies, development of a siesmotectonic map and evaluation of the active faults for their capability to generate earthquakes.
- Carry on seismic hazard analysis by using probabilistic and deterministic approaches. EZ-FRISK software was used for the probabilistic hazard analysis. For the deterministic analysis, several faults and attenuation relationship were used to calculate the maximum horizontal ground acceleration.
- Evaluation of OBE and MCE accelerations and selection of appropriate seismic design parameters for the design of the Project structures.

Tectonic Setting

Regional Tectonic Setting

The geodynamic of Pakistan is characterized by the collision and coalescence of Eurasian and Indian Continental Plates (**Figure 1**), which were once separated by oceanic domains. This process started in the late Eocene to early Oligocene with formation of the Himalayan ranges[18]. It is however, also

[18] Farah, A., De Jong, K.A; Geodynamics of Pakistan: An introduction; Geodynamics of Pakistan, Geological Survey of Pakistan (1979).

understood that the recent collision of Indo-Pakistan subcontinent has succeeded a similar collision immediately north of Pakistan[19] or throughout southern Asia[20] that took place in Paleozoic era.

The Himalayas are believed to form a sharp frontal thrust belt as the southern edge of a wide collision zone extending north to include Hindukush, Pamir, Tien Shan, Tibetan Plateau, and other collisional features of Central Asia.

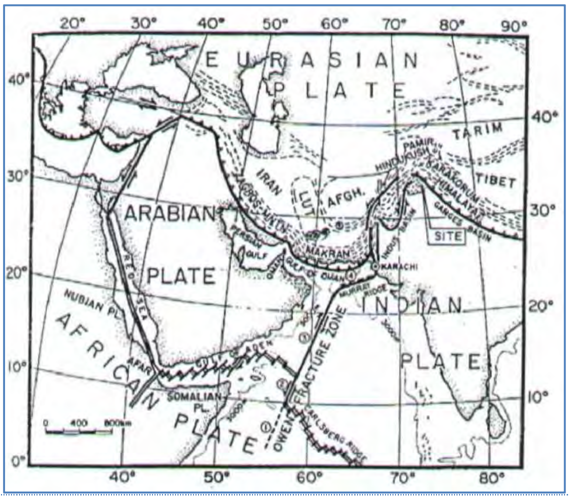

Figure 1: Regional Plate Tectonic Setting

Relative to Eurasia, the Indian Plate is still moving northwards at a rate of about 3.7 cm/yr near 73 degree longitude east[21]. Indus suture line that coincides with upper Tsengpo river valley represents the original site of the continental collision along which linear and well-developed ophiolite suites are found. These ophiolites are interpreted as the remnants of the oceanic crust of the Tethys ocean trapped during the collision between Indian and Eurasian continental blocks. The major portion of this convergence was taken up by deformation along the northern collision boundary involving folding and thrusting of the upper crustal layers[22] in the shape of MKT (Main Karakorum Thrust), MMT (Main Mantle Thrust), MBT (Main Boundary Thrust) and SRT (Salt Range Thrust), as shown in **Figure 2.**

[19] Kravchenko, K.N.; Tectonic evolution of the Tien Shan, Pamia and Karakorum; Geodynamics of Pakistan, Geological Survey of Pakistan (1979)
[20] Talent, J.A.; Mawson, R.; Paleozoic – Mesozoic biostratigraphy of Pakistan in relation to biogeography and the coalescence of Asia; Geodynamics of Pakistan, Geological Survey of Pakistan (1979)
[21] Minster, J.B., et el..; Numerical modeling of instantaneous plate tectonics, Royal Astron. Soc. Geophys. Jour. Vol.36 (1974).
[22] Seeber, L., Jacob K.H.; Micro earthquake survey of northern Pakistan, Preliminary results and tectonic implications; Proc. Symp. on Himalayan Geology, CNRS, Paris (1976).

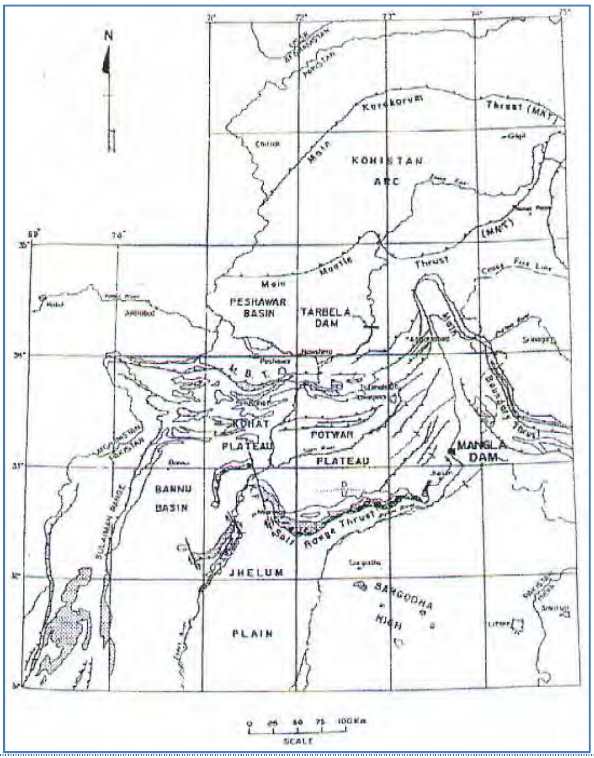

Figure 2: Generalized Tectonic Map Northern Pakistan

The MKT separates rocks of Asian landmass from Kohistan island arc complex. The Kohistan island arc is separated from the Indian plate by MMT. The MBT separates pre-collisional Paleozoic and Mesozoic sedimentary rocks of the Indian plate from the younger post-collisional Himalayan molasse sediments. A single detachment surface is believed to exist beneath the entire rocks south of MMT. This surface extends southwards till it emerges out in the shape of Salt Range Thrust[23].

Local Tectonic Setting

Project site is located close to Riasi thrust, which runs more than 200 km along the Himalayan range and is considered as a main branch of the MBT. Towards East it joins MBT and towards West it merges again into MBT at the axis of Hazara-Kashmir Syntaxial Bend, which is quite sharp near Muzaffarabad towards North and becomes less sharp towards South. On the East of the Hazara-Kashmir Syntaxial Axis, the geological features show predominantly northwest trend while their trend change to northeast towards the West of the axis. The main tectonic features West of Syntaxial Axis are Salt Range Thrust, Dil Jabba Thrust, Kahuta Fault and Riwat Fault (Fig-4.8). The Syntaxial Axis itself is believed to run along a north-south running strike-slip fault called Jhelum Fault. As many active tectonic features are present close to the Project site, therefore it is located within highly active geotectonic environment.

[23] Seeber L. et al; Seismicity and continental subduction in the Himalayan arc, in Zagros – Hindukush Himalayas; Geodynamics Evolution, A.G.U. Geodynamics Services, Vol.3 (1981).

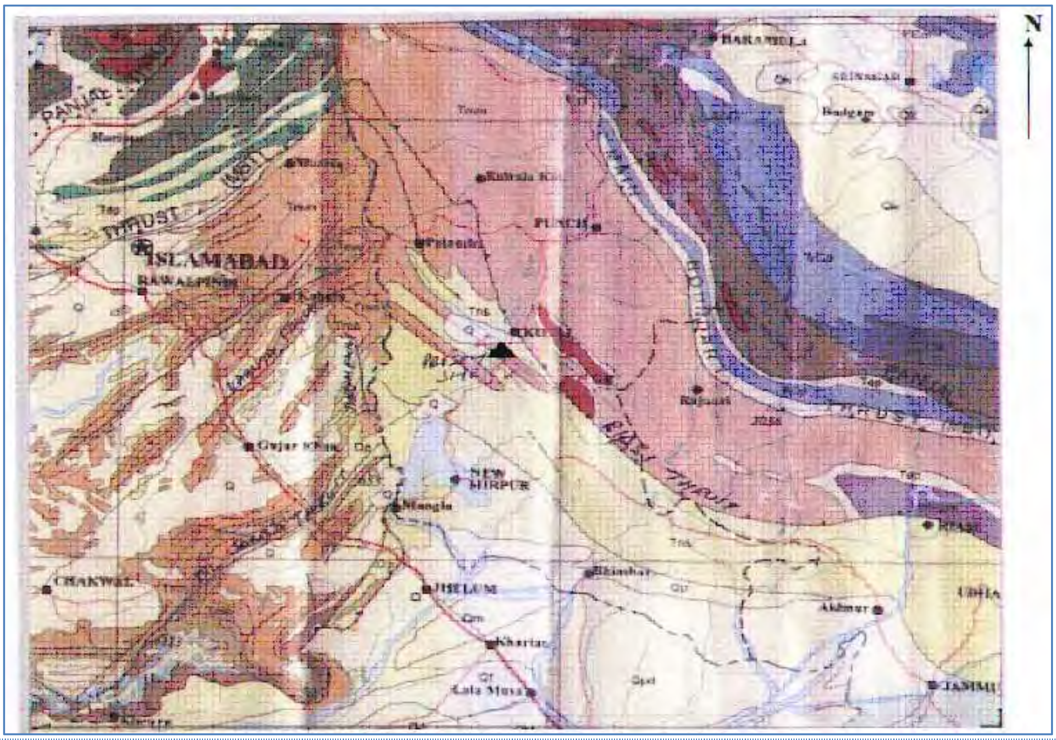

Figure 3: Regional Geological Map

Quittmeyer et al.[24] have classified whole of the area of Pakistan into fifteen seismotectonic provinces (**Figure 4**). Gulpur Hydropower project is located near the following four distinct provinces being discussed below:

a. Himalayas Province
b. Hazara Region Province
c. Salt Range Province and
d. Indus Basin Province

a) Himalayas Province

The Himalayas represent one of the primary compressional features that have resulted from the collision of the Indo-Pakistan Continental Plate with Eurasian Plate. This zone of deformation is the result of folding and thrusting associated with the development of large nappe structures and deep crustal shortening[25]. The Himalayas trends in a southeasterly direction just east of the Hazara-Kashmir syntaxis (Fig-4.7) where the project site is located.

Seismicity within this seismotectonic province is characterized as moderate to high level. Most events are associated with the frontal zone of deformation. They are located parallel to and northeast of the surface trace of the Main Frontal Thrust. One great earthquake, the 1905 Kangra event with Ms=8.0 occurred within this zone, probably rupturing a 300 km portion along the Main

[24] Quittmeyer, R.C., et al; Seismicity of Pakistan and its relation to surface faults; Geodynamics of Pakistan (1979).
[25] Ganser, A.; Geology of the Himalayas: New York, Inter Science Publications (1964).

Frontal Thrust[26]. Riasi thrust is a branch of MBT and runs almost parallel to MBT upto the syntaxial bend.

In the vicinity of the Hazara-Kashmir syntaxis, the mapped surface trace of the frontal thrust bends around from a southeast trend to a southwest orientation. The seismically defined fault zone, however, does not follow the mapped surface faults; it continues for an additional 100 km to the northwest of the Hazara-Kashmir syntaxis[27].

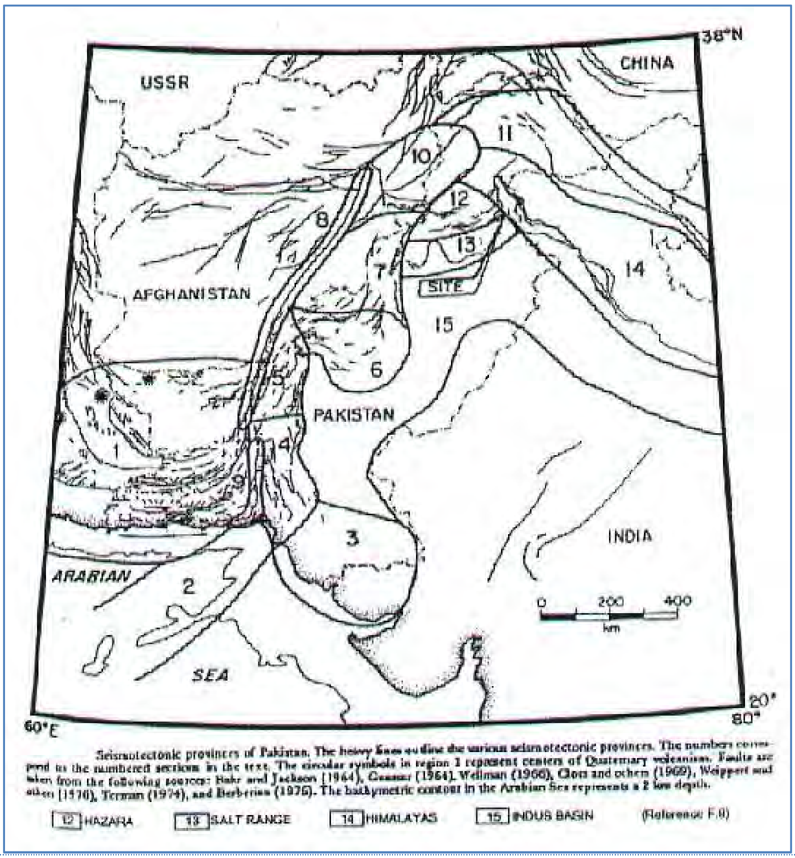

Figure 4: Seismotectonic Provinces of P[Pakistan

b) Hazara Region Province

The Hazara seismotectonic province encompasses mostly eastward trending folds and faults of the Hazara region in Northern Pakistan. The deformation within this zone is primarily the result of thrusting and a deep crustal decollement process associated with the collision between the Indian and Eurasian plates[28].

[26] Quittmeyer, R.C., et al; Seismicity of Pakistan and its relation to surface faults; Geodynamics of Pakistan (1979).
[27] Armbruster, J., et al.; Tectonics of the lower Himalayas in north Pakistan based on micro earthquake observations, Jour. Geophys. Res., Vol.83 (1978).
[28] Ganser, A.; Geology of the Himalayas: New York, Inter Science Publications (1964).

Seismic activity within this province has occurred at a low level[29]. Historical data however do indicate moderate events causing significant damage in this region.

Shallow seismicity within the Hazara region occurs on perpendicular, steeply dipping faults characterized by reverse and strike-slip faulting. The microseismicity data suggest that the Hazara Thrust Fault may be related to a decollement surface identified at depth[30]. However, as the mapped faults are dominantly of thrust nature, a narrow alignment of epicenters along these faults is not to be expected. Furthermore, some activity is also associated with faults that are located below the decollement surface, which do not have any surface expression. The broad band of activity following the dominant structural trend, however, suggests that at least some of these earthquakes may be related to the major mapped structures[31].

c) Salt Range Province

The Salt Range is situated south of the Hazara seismotectonic province and extends from the Sulaiman Range on the West to the Himalayas in the East (Fig-4.9). General orientation of this range is east northeast, but prominent southeast trending transverse features offset parts of it (Fig-4.7). It is composed of folded and faulted thrust sheets and represents thin-skinned internal deformation within the Indian Plate resulting from its collision with Eurasia.

Although it is the frontal zone of deformation in this region, the Salt Range is characterized by a low level seismic activity, in contrast to other parts of the frontal zone in Pakistan. It has limited known history of moderate or large magnitude earthquake. Micro-earthquake studies, however, indicate that at low magnitude levels ($m<4$), the entire Salt Range is active, especially along transverse faults at points where it is offset. Cambrian salt deposits may provide an explanation for this aseismic character of the Salt range. Deformation may result from aseismic slip along a decollement surface mechanically detached by the salt[32]. The micro seismic activity may represent small readjustments within the decollement sheets.

d) Indus Basin Province

The Indus Basin is located within the Indo-Pakistan Plate South and Southwest of the Himalayas and Salt Range, and East of the predominantly northward trending mountain ranges of Pakistan (Fig-4.8). This feature is a foredeep basin. The seismicity occurring within this zone is generally of low level. Although infrequent, some events have caused considerable damage. Southwest of the Himalayas, the events occur along a discontinuous, but nevertheless, linear trend about 200 km from the Main Frontal Thrust[33]. This same trend parallels the Salt Range, but not at as great a distance. This activity

[29] Seeber, L., Jacob K.H.; Micro earthquake survey of northern Pakistan, Preliminary results and tectonic implications; Proc. Symp. on Himalayan Geology, CNRS, Paris (1976).
[30] Seeber L. et al; Seismicity and continental subduction in the Himalayan arc, in Zagros – Hindukush Himalayas; Geodynamics Evolution, A.G.U. Geodynamics Services, Vol.3 (1981).
[31] Quittmeyer, R.C., et al; Seismicity of Pakistan and its relation to surface faults; Geodynamics of Pakistan (1979).
[32] Seeber, L., et al; Seismicity of the Hazara arc in northern Pakistan; Decollement vs. basement faulting; Geodynamics of Pakistan (1979).
[33] Menke, W., and Jacob, K.H.; Seismicity Patterns in Pakistan and north western India associated with continental Collision: Seismol. Soc. America Bull; Vol.66 (1976).

within the Indus Basin may be related to bending of the lithosphere[34], active basement faults transverse to the fold and thrust belts[35], and/or development of a new frontal thrust[36]. A focal mechanism for one event near New Delhi showed normal faulting on one of two nodal planes parallel to the Himalayas[37].

Surface faults have not been mapped in the Indus Basin; the extensive alluvial cover has buried any structural evidence of faulting on the surface. Inferences based on gravity data, however, indicate basement faults may exist in some portions of the Indus Basin[38].

Seismicity

General

Earthquakes pose a multitude of hazard to dams, either by direct loading of the structures or by initiating a sequence of events that may lead to dam failure. For example, strong ground shaking or fault offset at the dam foundation is a direct load on the structure while an upstream failure, seiche or landslide into the reservoir are earthquake generated events that can lead to overtopping and failure. Effects of ground shaking by earthquakes are also documented in terms of loss of free board due to differential tectonic ground movements, slope failure, piping failure through cracks induced by ground shaking, failure of spillway and outlet works[39].

Earthquakes are generated by tectonic process in the upper part of the earth called lithosphere that is divided into several rigid parts called as “Plates”. Due to movements along these plates, stress build up takes place and results in the deformation of the crystal mass. This energy accumulation gives birth to seismic events. The contact zones between adjacent plates are, therefore, considered as most vulnerable parts from the seismic hazard point of view.

The project site is located near one of these contacts between Indian plate and Eurasian plate. This contact represented by the Himalayas has always been generating moderate to large earthquakes including Kangra (1905), Bihar-Nepal (1934) and Assam (1897) earthquakes that caused widespread destruction and huge loss of life.

[34] Molnar, P., et al; Fault plane solutions of shallow earthquakes and contemporary tectonics in Asia, Earth and Planetary Science Letters, Vol.19 (1973).
[35] Valdiya, K.S.; Himalayan Transverse faults and folds and their parallelism with subsurface structures of north Indian plains, Tectonophysics, Vol.32 (1976).
[36] Le Fort, P., Himalayas: The collided range. Present knowledge of the continental Arc: A.M. Jour Sci., Vol.275-A (1975).
[37] Molnar, P., et al; Fault plane solutions of shallow earthquakes and contemporary tectonics in Asia, Earth and Planetary Science Letters, Vol.19 (1973).
[38] Farah, A., et .el; Gravity field of the buried shield in the Punjab plain, Pakistan: Geol. Soc. America Bull., Vol.88 (1977).
[39] Seed, H.B. “Earthquake resistant design of earth dams:, International Conference on Recent Advances in Geotechnical Earthquake, Engineering and Soil Dynamics, Missouri, (1981).

Historical Seismicity

The earthquakes originated before the advent of seismic recording instruments that have been mentioned in the literature and were located within the Project region give mainly information about the level of damage that this region has undergone historically. Though this information does not give a conclusive account of their epicentral location, these do give an understanding about the extent of structural damages and probable life loss in return. This non-instrumental data is solely dependent upon human observation. In order to perform a quantitative analysis of the effects of an earthquake, it is convenient to reduce the raw data to a more manageable form. For this purpose intensity scales have been established which categorize the effects experienced by human being into well defined level ranging from minimum sensations to catastrophic extremes. The historical / pre-instrumental earthquake data was collected from Oldham[40], Heuckroth et al.[41], Ambraseys et al.[42] and Quittmeyer et al.[43] catalogues as the same source of information has been used in the seismotectonic studies of other large projects in Pakistan (Tarbela dam, Mangla dam, etc.).

A brief description of the main historic events in the region under study is given below:

a) 4th Century B.C

The first known historical account of seismicity in this region was described in 4th Century B.C by Aristobulus of Cassanderia. He accompanied Alexander on his expedition to India and pointed out that the country above river Jhelum was subjected to earthquakes which caused the ground to open up so much that even the river bed was changed.

b) Year 25 A.D

Another historical record of a destructive earthquake is available of Taxila event. This event was located in the Hazara area and occurred in 25 A.D. Seismic intensity at Taxila was about X and felt throughout the country. The damage effects are still witnessed in the remains of Jandial, Sirkap and Dharmarajika around Taxila. After the earthquake, building methods had to be changed and height of the buildings was reduced. It was also started to ensure that foundations of the new buildings are more secure.

c) June 23, 1669

An earthquake with as much intensity as IX was felt at the city of Attock.

d) September 24, 1827

A destructive earthquake was felt in Lahore Region. The Fort Kolitaran near the city was destroyed. About 1000 lives were lost. A hill was shaken down which fell into the River Ravi. Its maximum intensity was estimated as VIII-IX.

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40 Oldham, T.; A catalogue of Indian earthquakes, Mem. Geol. Survey India, Vol. 19 (1893)

41 Heuckroth, L. and Karim, R.: Earthquake history, seismicity and tectonics of the regions of Afghanistan, Seism. Centre, Kabul University (1970).

42 Ambraseys A. Lensen G., and Monifer A.; The Pattan earthquake of 28 December 1974, UNESCO Publication (1975)

43 Quittmeyer R.C and Jacob K.H; Historical and modern seismicity of Pakistan, Afghanistan, northwestern India and southeastern Iran ; Bull. Siesm. Soc. Am. Vol. 69, No.3 (1979)

e) May 30, 1885

A destructive earthquake in Kashmir, which inflicted heavy destruction in Sopor, Gulmarg and Srinagar area, 3,000 people were killed. Radius of perceptibility was about 650 km. Many aftershocks were recorded. The maximum intensity in the epicentral region was VIII.

The intensities of the felt earthquakes recorded in this region are shown in **Figure 5**.

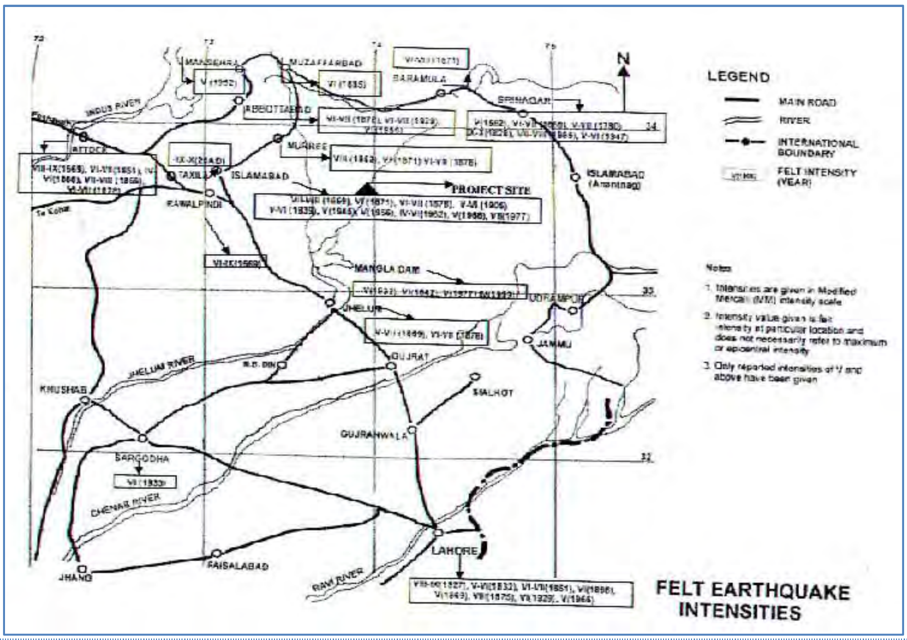

Figure 5: Felt Earthquake Intensities

A chronological list of available intensity data of the earthquakes occurred in the Project region before the present instrumental recordings started in 1904 is given in **Table 1**.

Table 1: Historical Earthquakes in the Project Region

Sr. No.	*Year*	*Date*	*Description*	*Estimated Intensity MM*	*Source*
1	4^{th} Century BC		Aristobulus of Cassandreia, who accompanied Alexander on his expedition to India, points out that the country above the river Hydaspes (Jhelum) is subjected to earthquakes which cause the ground to open up so that even the beds of river are changed.	IX-X	Ambraseys
2	25 AD		A destructive earthquake in north-western Pakistan laid Taxila in ruins and caused wide spread havoc throughout the country side. The effects of this earthquake can still be seen among the excavated remains at Jandial, Sirkap and Dharmarajika. As result of the earthquake new methods of buildings were introduced and the height of buildings was reduced from four to two storeys with special precautions to make the	IX-X	Q&J

Sr. No.	Year	Date	Description	Estimated Intensity MM	Source
			foundation secure.		
3	1669	4-Jun	Strongly felt in Mandra	VI-X	Q&J
4	1669	23-Jun	An earthquake at Attock, a fissure 50 yards long was formed in the ground.	VIII-IX	Q&J
5	1827	24-Sep	Destructive in Lahore region. Fort Kolitaran near city destroyed, about 1000 perished in ruins. A hill shaken down, which fell into river Rowee (Ravi) produced an inundation of 100 coss of land.	VIII-IX	Q&J
6	1831		Peshawar & valley of Indus – Severe, extended from Peshawar to Dera Ghazi Khan, felt most at Dera bank (Darban); men and camels unable to stand, rocks fell in many places, water forced from crevices in the plains.	Daraban VIII-IX Peshawar & D.G. Khan IV-VI	Q&J
7	1832	22-Jan	Near Lahore-violent, people all rushed out of houses.	V-VI	
8	1832	21-Feb	Lahore, valley of Badakhshan, N.W. India huge masses of rock was thrown from the cliffs at many places chocking up valleys. Great part of population destroyed.	Lahore V-VI Mangla V	
9	1842	19-Feb	Kabul, Peshawar. At Kabul said to have lasted for 3 minutes, several shocks, rocked the fouth in a frightful manner. At Peshawar very destructive, "earth-trembled like aspen leaf" several killed. At Ferozpur severe. At Ludhiyana north south, the hot springs of South (temp. 140 deg-110 deg) become as cold as the ordinary wells, water diminished greatly and at times the springs were completely dry. These appearances continued for 25 days.	Kabul	Q&J
				VI-VII Peshawar VI Ferozpur VI	
10	1851	4-Feb	Lahore, appears to have extended all over Punjab.	Lahore V-VI	
11	1851	6-Feb	Lahore, appears to have extended all over Punjab.	Lahore V-VI	
12	1851	17-Feb	Strongly felt in Lahore, Multan	Lahore V-VI	
13	1853	Nov.	Strongly felt in Attock	VI	Q&J
14	1858	29-Aug	Lahore-sharp shocks	Lahore IV-V	
15	1865	22-Jan	Slight damage and great panic in Peshawar, long duration.	V-VII	
16	1865	4-Dec	Lahore – tow smart shocks	III-V	
17	1867	10-Nov	Damaging in Bannu	VII-VIII	Q&J
18	1868	11-Aug	Damaging in Peshawar, a portion of the fort was shaken down (official record).	VII-VIII	Q&J
19	1868	12-Nov	Violent shock felt in Lahore, Dera Ismail Khan and Attock, followed by many aftershocks which were felt throughout the Punjab.	Attock IV-VI & D.I. Khan IV-VI	Q&J
20	1869	24-	Severe shock in the upper reaches of Jhelum	V-VII	Q&J

Sr. No.	Year	Date	Description	Estimated Intensity MM	Source
		Mar			
21	1869	25-Mar	A large earthquake in the Hindukush, strongly felt at Kohat, Lahore, Peshawar and at Khojend and Tashkent; shocking lasting 20 seconds.	Kohat, Lahore & Peshawar V	NESPAK
22	1869	April	Peshawar – Part of fort shaken down (official record).	VII-VIII	Q&J
23	1869	20-Dec	Rawalpindi – Shock said to have lasted for 1/2 a minute; cracked walls and caused all people to run out of houses. Attock – A series of shocks at intervals of about 20 sec. Lawrencepur – Ist shocks 15 sec others at 5 sec. interval. Campbellpur – For half an hour; building much damaged. Talagang – Not felt	VII-VIII	Q&J
24	1871	April	Severe at Rawalpindi and Murree; originating from Kashmir	Rawalpindi & Murree VI	Q&J
25	1875	12-Dec	Damaging in villages between Lahore and Peshawar where a number of people were killed.	VII-VIII	Q&J
26	1878	2-Mar	Damaging earthquake in the Punjab. At Kohat several houses, public buildings and portion of the wall of the fort fell. At Peshawar, it caused damage to houses and city walls. Damaging at Attock, Abbottabad, Rawalpindi, Jhelum, Murree. Strongly felt at Bannu, Nowshera, Mardan, Lahore and Simla. Many aftershocks.	Peshawar & Kohat VII-VIII, Attock VI-VII, Lahore VI	
27	1883	April	Damaging shock at Peshawar.	VI-VIII	Q&J
28	1885	30-May	Destructive shock in Kashmir, Sopor, Gulmarg and Srinagar about totally ruined and 3,000 people killed. Heavy damage at Gurias and Punch: Muzaffarabad heavily damaged. Felt in Peshawar, Lahore, Simla, Leh, Kanpalu, and Gilgit. Radius of perceptibility about 650 km. Many aftershocks.	Kashmir VIII, Muzaffarabad VI-VII, Peshawar IV	Q&J
29	1893	3-Nov	Slight damage at Peshawar, Nowshera, felt throughout the Punjab	VI-VII	Q&J
30	1905	4-Apr	Kangra earthquake, in Rawalpindi few lofty buildings cracked, some damage in Lahore.	Kangra VIII Rawalpindi V-VI	Q&J
31	1929	1-Feb	Destructive earthquake, perhaps shallower than calculated, ruin Skorzor and Drosh. Damage was equally heavy in the USSR at Kulyab. It caused substantial damage in Abbottabad, Peshawar, Cherat, Gurez, Chitral and Dushambe. It was felt within a radius area of 1,000 km.	Abbottabad & Peshawar VI-VII	NESPAK
32	1939	21-Nov	Destructive in the Badakhshan area, the damage extending to Srinagar, Rawalpindi and Kargil. Drosh was seriously damaged. Felt within a radius of 600 km.	Rawalpindi V-VI	NESPAK
33	1945	27-Jun	Felt in Peshawar	IV	NESPAK
34	1945	22-Jun	Destructive at Chamba and parts of Kahsmir. Strongly felt at Rawalpindi, Peshawar, Lahore and Simla.	Rawalpindi V	NESPAK
35	1953	1-Mar	Slight damage in Cambellpur	VI-VII	Q&J
36	1956	16-	Destructive in the Ghazi district in Afghanistan	Rawalpindi V	NESPAK

Sr. No.	*Year*	*Date*	*Description*	*Estimated Intensity MM*	*Source*
		Sep	where many villages were destroyed and animals lost. The damage was equally serious at Said Karem. Cause panic at Kohat. Strongly felt at Parachinar, Parwan, Loger, Ghaiz, Nazerajat, Beshud, Makur, Rawalpindi and Rawalpindi Srinagar. Radius of perceptibility about 450 km.		
37	1962	2-Aug	Felt at Rawalpindi	IV-VI	Q&J
38	1966	11-Jan	Felt at Risalpur	IV	NESPAK
39	1966	2-Feb	Strongly felt around Abbottabad where it caused minor damage at Havelian. Felt at Rawalpindi, Islamabad, Abbottabad, Taxila. The shock was felt at Muzaffarabad and Gujar Khan.	Abbottabad VI Islamabad V Taxila VI	Q&J
40	1977	14-Feb	About 7 km northeast of Rawalpindi caused damage in 20 villages. In villages Kuri, Malot and Pindi Begwal around Nilour most of the "Katcha" houses either collapsed or damaged. A few houses built with dressed blocks of sandstone and sand-cement mortar also developed extensive cracks.	VII	NESPAK
41	1978	7-May	Felt widely at Punjab and NWFP Provinces. Some damage at Peshawar and Chitral.	Mangla IV Tarbela VI	WAPDA
42	1980	12-Feb	Felt widely in the areas of Punjab and NWFP.	Mangla IV Tarbela V	WAPDA
43	1983	31-Dec	Felt widely in the areas of Punjab and NWFP. Damages at Peshawar, Chitral and many northern areas. Some damage near Tarbela also. Felt in parts of Afghanistan also.	Chitral VII Peshawar VI Rawalpindi V Tarbela V Mangla III	WAPDA
44	1996	4-Apr	Felt widely in the areas of Punjab and NWFP. Some damages at Peshawar, Chitral and Northern Areas. Some damage near Tarbela also. Felt also in parts of Afghanistan.	Chitral VI Peshawar V Rawalpindi IV Mangla III Lahore & Jhelum III	WAPDA
45	1999	17-Feb	Epicenter near Mangla. Felt also in the adjoining areas.	Mangla IV	WAPDA

Instrumental Seismicity

The instrumental recording of earthquakes started in 1904 but the number of seismic stations remained small in South Asian Region until 1960 when the installation of high quality seismographs under World Wide Standard Seismograph Network (WWSSN) increased the quality of earthquake recording. In addition, local microseismic networks were also established at important dams and other projects in Pakistan. In the present seismic studies, two classes of instrumental earthquake data have been used. The first one is based upon earthquakes recorded by local seismic networks and the other is compiled from regional data catalogues.

Seismicity Recorded by Local Networks

Near the Project site, an independent telemetry microseismic network belonging to Mangla Dam Project is functioning. Initially, it comprised of three stand-alone stations since 1966. However, in 1993, it was replaced with a more modern microseismic network having thirteen field seismic stations out of which seven have been put to operation. The Central Recording Station (CRS) is installed near the left abutment of the main embankment of Mangla dam. The microseismicity recorded by Mangla Dam network is shown in **Figure 6**.

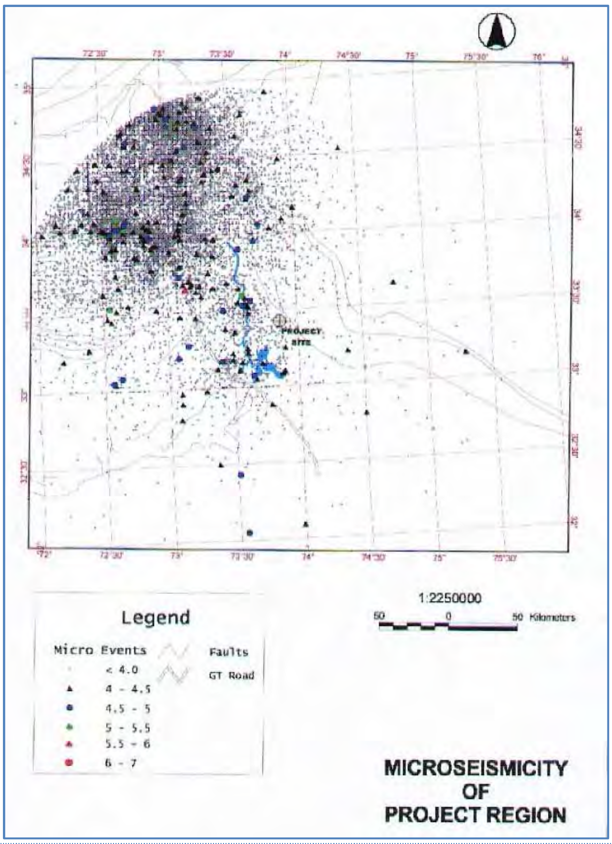

Figure 6: Microseismicity of the Project Region

Seismicity Recorded by Regional Networks

The regional seismic data catalogue being used in the study is compiled on the basis of seismic events listed since 1904 by various agencies like British Association for the Advancement of Science (BAAS), International Seismological Centre (ISC), International seismological summary (ISS), United States Geological Survey (USGS) and others. It consists of a list of 594 earthquakes among which 331 earthquakes have magnitude more than or equal to 4 within a radius of about 200 km from project site.

Composite Earthquake Catalogue

A composite list of earthquakes recorded within about 200 km of the Project site was prepared from the data collected from regional as well as microseismic networks mentioned above. This list contains all the earthquakes recorded in area between latitude 32.0o-35.0oN and longitude 72.0o-76.0oE. This list is presented in **Table 2**. The epicenters of these earthquakes are plotted in **Figure 7**.

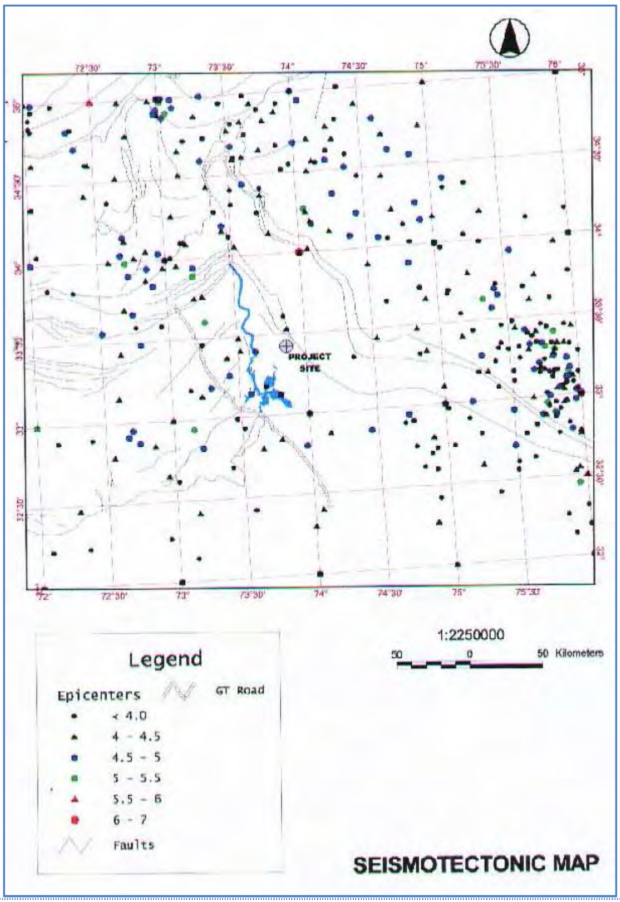

Figure 7: Seismotectonic Map of the Project Region

Table 2: Composite List of Recorded Earthquake Data

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
1	1905	4	4	00:50:00.00	33.0000	76.0000	35	6.8	8.0		PAS
2	1928	11	14	04:33:09.00	35.0000	72.5000	110	5.6	6.0		PAS
3	1937	11	7	19:07:40.00	35.0000	73.0000	100	5.5	5.8		PAS
4	1945	6	22	18:00:57.00	32.5000	76.0000	60	5.9	6.5		PAS
5	1964	2	13	05:10:47.20	34.9900	72.7000	68	4.5			ISC
6	1964	7	3	14:10:27.80	34.1500	74.9100	33	4.9			ISC
7	1964	12	31	08:21:11.00	34.9000	73.0000	131	4.4			ISC
8	1965	10	9	04:34:22.00	32.3000	74.0000	79	4.5			USCGS
9	1965	11	8	21:23:09.40	34.6000	73.3000	65	4.6			USCGS
10	1966	2	2	09:20:09.30	33.8900	73.2000	37	5.1			ISC
11	1966	3	16	00:08:17.30	33.2300	75.9100	33	4.7			ISC
12	1966	4	6	01:51:53.20	34.9100	73.0600	54	5.1			ISC
13	1967	2	10	05:46:29.00	33.2800	75.2900	21	4.8			ISC
14	1967	2	20	14:23:48.70	33.6900	75.4200	38	4.8			ISC
15	1967	2	20	15:18:39.00	33.6300	75.3300	20	5.5			ISC
16	1967	2	20	15:39:54.40	33.4800	74.8300	96	4.0			ISC
17	1967	2	21	12:37:43.00	33.6500	75.4400	20	4.9			ISC
18	1967	2	24	00:17:38.80	33.5700	75.3900	32	4.6			ISC
19	1967	7	2	08:32:39.70	33.2100	75.7100	42	4.8			ISC
20	1968	3	3	09:31:21.60	34.7100	72.3600	43	5.0			ISC
21	1968	7	3	19:46:55.00	34.8000	74.6000	88	4.6			ISC
22	1969	1	23	20:01:21.00	32.1900	76.0000	64	3.9			ISC
23	1970	1	2	20:01:02.00	32.5000	76.0000	96	4.1			ISC

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
24	1970	4	28	14:12:32.00	32.8000	74.9000	116	4.5			ISC
25	1970	4	28	15:11:47.70	32.9000	74.7000	126	3.5			ISC
26	1970	4	30	03:24:54.30	33.2600	73.4300	33	4.8			ISC
27	1970	6	11	10:30:39.90	33.1100	75.0000	72	4.5			ISC
28	1970	9	7	21:19:09.00	33.0000	75.2000	54	4.6			ISC
29	1970	12	5	17:51:54.00	33.9000	74.5000	75	4.3			ISC
30	1971	4	28	15:12:42.62	34.4449	73.5973	43	4.8			ISC
31	1971	12	27	20:59:39.26	34.9776	73.0234	55	5.2			ISC
32	1972	1	8	01:30:35.00	34.7000	74.1000	96	4.0			ISC
33	1972	3	10	14:36:16.95	33.9073	72.7158	40	4.9			ISC
34	1972	4	17	02:24:50.14	33.9487	72.8622	52	4.8			ISC
35	1972	9	27	02:03:39.00	33.9910	72.6996	41	5.1			ISC
36	1973	1	16	21:31:25.86	33.2922	75.8320	39	5.1			ISC
37	1973	4	10	00:10:02.88	33.1703	75.7460	61	4.4			ISC
38	1973	7	13	22:03:38.06	33.1732	75.6747	48	4.8			ISC
39	1973	7	13	22:54:27.85	33.1819	75.7057	55	4.4			ISC
40	1973	10	24	05:23:51.34	33.1479	75.9166	37	5.3			ISC
41	1973	10	24	19:57:17.09	33.1167	75.9269	48	4.9			ISC
42	1973	12	16	19:09:46.94	34.2686	74.0466	40	5.1			ISC
43	1974	3	25	13:44:05.79	33.7003	72.6774	39	4.4			ISC
44	1974	3	26	04:45:54.73	33.8805	72.8457	72	4.1			ISC
45	1974	4	12	10:32:48.23	33.5311	73.8677	50	4.4			ISC
46	1974	5	20	17:39:19.59	34.5632	74.2327	49	4.8			ISC
47	1974	8	1	19:54:11.76	33.4410	74.5294	0	4.5			ISC
48	1974	8	11	17:21:00.02	34.8828	73.2713	33	4.1			ISC
49	1974	12	28	22:38:53.24	34.9946	73.1013	68	4.8			ISC
50	1975	1	20	09:28:00.68	34.9363	73.1054	63	4.6			ISC
51	1975	4	7	06:41:02.95	34.9085	72.9663	53	5.0			ISC
52	1975	10	17	10:46:09.30	34.2535	74.0640	77	4.1			ISC
53	1975	10	30	14:20:54.36	32.8923	75.7092	75	4.7			ISC
54	1975	10	30	14:36:44.40	32.9700	75.9583	45	4.8			ISC
55	1975	12	10	05:03:47.30	32.7871	75.9180	76	4.7			ISC
56	1976	1	9	23:50:16.49	32.7799	75.9813	96	4.5			ISC
57	1976	2	25	07:45:23.79	33.3444	74.8921	51	4.5			ISC
58	1976	5	22	18:32:53.58	33.0491	75.8290	71	4.4			ISC
59	1977	1	21	14:57:46.38	32.7601	75.9826	51	4.5			ISC
60	1977	2	14	00:22:37.80	33.5967	73.2669	27	5.2			ISC
61	1978	4	12	02:10:16.20	33.7184	75.4263	33	3.8			ISC
62	1978	4	27	18:12:24.79	35.0022	73.0280	58	4.9			ISC
63	1978	5	7	10:32:25.57	33.3964	73.6306	25	5.0	4.4		ISC
64	1978	5	16	06:31:57.14	33.1817	75.3309	96	4.1			ISC
65	1978	5	17	08:39:15.29	32.8934	75.7301	96	4.0			ISC
66	1978	11	18	01:35:00.00	32.8740	72.7513	39	4.6			ISC
67	1979	3	4	02:51:47.95	33.9436	73.1959	42	4.7			ISC
68	1979	7	2	16:27:04.29	34.7364	74.9361	74	4.4			ISC
69	1979	7	2	16:30:47.22	34.5062	74.3684	89	4.6			ISC
70	1979	12	4	04:05:42.07	34.1725	74.0963	33	4.7			ISC
71	1979	12	22	22:28:44.99	33.1078	75.8963	18	4.8	4.1		ISC
72	1980	2	5	20:17:56.85	33.2496	75.8083	33	4.2			ISC
73	1980	2	9	18:23:01.17	32.7900	72.5576	27	4.1			ISC
74	1980	3	29	02:02:53.68	32.7961	73.9736	18	4.7			ISC
75	1980	3	29	07:12:56.39	33.1427	73.2231	30	4.5			ISC
76	1980	5	1	05:43:10.65	33.0264	75.9745	18	4.9	3.8		ISC
77	1980	7	27	11:24:00.24	34.6240	72.0444	53	4.0			ISC
78	1980	8	23	21:36:49.04	32.9637	75.7509	3	5.2	4.9		ISC
79	1980	8	23	21:50:01.20	32.9023	75.7974	13	5.2	4.9		ISC
80	1980	10	5	10:47:18.67	34.6882	74.2892	33	4.1			ISC

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
81	1981	2	6	09:54:01.40	34.3459	72.0258	263	3.8			ISC
82	1981	6	23	19:54:02.10	34.2608	74.8815	33	4.8			ISC
83	1981	7	4	03:49:25.77	34.3555	75.2542	209	3.7			ISC
84	1981	8	17	09:11:15.75	33.4165	75.6202	6	4.9	3.8		ISC
85	1981	9	27	11:10:42.48	33.2954	75.6352	33	4.5			ISC
86	1981	11	9	19:31:02.47	33.3267	75.8524	33	4.5			ISC
87	1981	12	14	18:25:39.23	33.1881	75.7226	21	4.5			ISC
88	1982	1	17	12:17:37.86	34.5236	73.9030	33	3.9			ISC
89	1982	4	3	22:39:21.98	33.3664	73.4204	3	4.1			ISC
90	1982	9	8	17:53:18.54	32.9277	75.4959	33	4.8			ISC
91	1982	10	25	08:16:27.39	34.0589	73.5200	83	4.3			ISC
92	1983	1	18	13:45:30.03	34.3461	74.2660	33	4.8			ISC
93	1983	5	30	08:39:49.37	32.7136	75.4850	41	4.6			ISC
94	1983	10	12	02:44:42.23	33.7596	75.7209	33	4.5			ISC
95	1984	2	18	07:08:56.67	34.3491	72.0208	33	4.1			ISC
96	1984	4	21	20:34:20.58	34.9902	73.6360	10	3.8			ISC
97	1984	5	23	03:14:17.66	33.1703	75.9302	14	4.8			ISC
98	1984	6	4	05:03:50.16	34.8752	73.0254	52	4.6			ISC
99	1984	8	15	05:31:04.62	34.9020	74.4680	53	4.5			ISC
100	1984	12	20	07:32:07.23	32.9495	72.6961	37	4.6			ISC
101	1984	12	27	20:22:05.91	32.9062	72.6691	22	4.6			ISC
102	1984	12	28	16:28:01.63	34.6108	73.6090	47	4.5			ISC
103	1985	2	25	18:56:07.72	34.2191	74.4430	44	4.6			ISC
104	1985	4	23	12:23:56.07	32.8225	73.2092	64	4.6			ISC
105	1985	8	10	12:56:13.90	33.8905	74.8008	41	4.6			ISC
106	1986	4	25	06:30:50.46	34.8207	73.5379	33	3.9			ISC
107	1986	5	16	05:16:13.70	34.0000	72.5800	15	4.3		4.0	ISC
108	1986	7	10	07:56:12.00	34.1500	72.6900	2	4.7		4.5	ISC
109	1986	7	30	04:03:27.18	33.0499	75.8544	61	4.6			ISC
110	1986	9	19	11:15:38.56	34.2749	73.0635	64	4.4			ISC
111	1987	3	16	06:09:36.61	34.8302	72.3380	212	3.7			ISC
112	1987	7	12	12:19:18.59	33.4897	73.5054	22	4.4	3.3		ISC
113	1988	1	9	01:16:12.48	34.4401	73.3257	95	4.4			ISC
114	1988	1	20	11:48:33.40	34.6956	74.6575	33	4.3			ISC
115	1988	1	21	10:26:48.69	34.7349	73.1783	33	3.4			ISC
116	1988	11	25	00:07:07.45	32.8931	75.8088	80	4.8			ISC
117	1988	12	7	21:13:54.99	33.9486	72.9770	50	4.4			ISC
118	1989	4	7	05:43:24.49	33.7463	73.2029	43	4.3			ISC
119	1989	5	7	10:19:33.68	32.2303	72.3548	33	3.9			ISC
120	1989	5	10	20:05:28.01	33.3402	75.6956	33	3.9			ISC
121	1989	5	10	20:19:21.56	33.3270	75.6545	37	4.7	4.0		ISC
122	1989	9	7	07:42:36.94	34.7668	74.2484	147	4.4			ISC
123	1989	12	5	02:46:11.18	34.8303	73.7770	33	4.2			ISC
124	1990	3	3	05:53:37.96	32.8660	74.1490	10	4.3			ISC
125	1990	3	6	14:43:08.50	33.2381	75.3939	10	3.8			ISC
126	1990	3	15	17:33:27.92	34.5038	74.0883	33	4.5			ISC
127	1990	4	26	15:39:18.31	34.5983	73.5383	33	4.2			ISC
128	1990	9	7	01:57:55.58	34.1017	73.1395	33	4.0			ISC
129	1990	10	9	21:56:38.54	34.0921	73.1564	33	4.4			ISC
130	1990	11	12	15:45:19.76	33.2544	75.8220	67	4.8			ISC
131	1990	12	20	05:46:48.57	34.4392	74.6409	33	4.3			ISC
132	1990	12	25	03:56:46.06	33.3059	75.7558	51	5.3	4.5		ISC
133	1991	1	10	01:33:22.37	34.0152	74.8202	33	3.9			ISC
134	1991	3	16	03:57:42.41	34.5221	72.6623	33	4.5			ISC
135	1991	5	17	17:04:30.87	34.9251	73.8863	33	3.9			ISC
136	1991	5	24	15:38:03.11	34.9778	72.2006	210	3.4			ISC
137	1991	12	18	14:17:21.95	32.8030	73.6496	42	4.2			ISC

Sr No	*Date*			*Time*	*Latitude*	*Longitude*	*Depth*	*Magnitude*			*Source*
	Year	*Month*	*Day*	*GMT*	*N*	*E*	*Km*	*mb*	*MS*	*ML*	
138	1992	1	6	19:07:13.99	34.0237	74.0587	34	4.3			ISC
139	1992	2	6	18:47:03.05	34.7764	72.7539	33	4.0			ISC
140	1992	3	24	21:01:47.77	33.8365	72.9023	14	4.9	4.4		ISC
141	1992	4	17	12:42:58.71	34.1295	72.7016	13	4.2			ISC
142	1992	6	19	23:02:35.62	32.2247	72.0831	33	3.8			ISC
143	1993	2	17	16:06:07.62	33.5623	72.5114	26	4.9	4.3		ISC
144	1993	5	15	07:27:12.14	34.8269	72.0362	33	3.8			ISC
145	1993	5	15	08:14:04.96	34.9046	72.0295	33	3.8			ISC
146	1993	6	8	14:30:37.83	33.6669	72.7367	32	4.8			ISC
147	1993	7	2	21:03:59.63	34.1576	73.4272	19	4.3			ISC
148	1993	7	12	01:27:51.90	33.3303	75.9049	33	4.0			ISC
149	1993	9	15	15:08:14.79	33.3314	75.7436	44	5.0	4.3		ISC
150	1993	11	13	00:01:40.54	34.3166	73.5060	33	3.9			ISC
151	1994	4	15	09:44:21.37	34.5578	74.1278	58	4.5			ISC
152	1994	5	13	09:19:52.17	32.5496	75.9544	33	4.3			ISC
153	1994	8	4	22:43:10.32	33.8449	72.1197	28	3.8			ISC
154	1994	12	19	03:22:18.05	34.0508	72.0483	33	3.9			ISC
155	1995	9	26	20:31:54.64	32.2679	74.8940	0	4.2			ISC
156	1995	12	8	21:00:25.17	33.4263	72.6422	10	4.1			ISC
157	1995	12	30	23:40:16.95	34.8482	72.0314	33	3.8			ISC
158	1996	2	14	01:52:22.94	34.9863	73.0220	30	3.9			ISC
159	1996	2	20	02:55:52.66	34.0396	72.6740	46	4.7	4.2		ISC
160	1996	3	25	06:31:20.76	33.1437	73.5821	16	4.6	3.5		ISC
161	1996	4	21	01:09:48.70	34.7841	73.5142	34	4.0			ISC
162	1996	5	5	10:21:23.30	33.5900	72.7600	0	3.7			EIDC
163	1996	5	15	15:02:06.43	33.1462	75.8056	58	3.5			ISC
164	1996	5	24	16:23:44.70	34.4198	72.4188	55	4.1			ISC
165	1996	8	8	14:58:19.85	34.0425	72.9533	21	4.8	4.2		ISC
166	1996	8	17	15:48:02.76	33.4550	75.4542	78	3.2			ISC
167	1996	8	25	05:13:25.20	34.1200	75.6900	0	3.8			EIDC
168	1996	9	8	10:47:15.70	33.8220	72.3103	33	3.6			ISC
169	1996	9	23	11:13:11.52	33.3954	75.6388	33	3.5			ISC
170	1996	11	28	22:56:33.30	32.2700	72.9400	85	3.6			EIDC
171	1996	12	14	09:48:39.36	34.2335	74.7044	33	4.0			ISC
172	1996	12	16	17:59:35.16	33.1416	75.9892	46	3.4			ISC
173	1997	1	19	13:59:24.10	33.6811	75.0662	33	3.6			ISC
174	1997	4	12	05:35:24.18	33.4529	75.7405	33	3.4			ISC
175	1997	5	19	22:21:49.17	34.6110	72.4376	16	3.8			ISC
176	1997	5	31	19:20:21.03	34.8346	73.6131	57	4.4	3.9		ISC
177	1997	7	2	12:01:58.75	34.4141	73.7255	33	3.8			ISC
178	1997	7	21	17:24:49.30	32.9030	72.3950	0	3.8			EIDC
179	1997	7	29	09:43:35.67	32.8482	73.7897	7	4.0	3.1		ISC
180	1997	8	28	01:15:41.20	33.7600	73.2600	15	4.5		4.3	BJI
181	1997	9	5	15:41:52.39	33.9647	73.0764	24	4.0			ISC
182	1997	10	25	12:20:34.30	34.2825	73.3834	0	3.6			EIDC
183	1997	12	7	18:59:50.80	32.9700	75.0200	33	3.2		2.7	NDI
184	1997	12	23	04:15:04.96	33.8045	75.2336	33	4.0			ISC
185	1997	12	27	12:38:20.70	33.9600	75.8800	26	4.1		3.8	BJI
186	1998	3	18	13:35:22.56	35.0082	74.3500	102	3.7			ISC
187	1998	3	24	04:25:43.89	32.3976	74.0587	54	4.0	3.6		ISC
188	1998	5	10	09:42:23.20	34.3737	72.5867	0	3.8			EIDC
189	1998	5	18	12:29:31.78	33.1574	75.8387	65	3.5			ISC
190	1998	5	24	13:22:28.84	34.5864	74.3820	33	3.6			ISC
191	1998	5	29	19:11:05.14	34.1016	73.1230	33	3.9			ISC
192	1998	6	7	08:20:35.68	34.0109	73.0408	33	3.5			ISC
193	1998	6	8	12:22:07.70	34.5535	74.1551	0	3.6	3.3		EIDC
194	1998	7	6	22:50:49.32	33.0806	75.9018	23	3.7			ISC

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
195	1998	7	6	10:24:06.24	32.9384	75.7640	59	3.8			ISC
196	1998	7	12	05:45:02.41	34.0217	72.7723	66	4.5			ISC
197	1998	8	17	17:55:01.86	33.1524	75.7102	33	3.5			ISC
198	1998	8	21	01:58:36.26	34.3694	73.7272	64	4.0			ISC
199	1998	9	28	15:28:01.46	34.1280	74.7807	33	3.7			ISC
200	1998	9	28	18:10:55.53	34.0470	74.6599	33	3.5			ISC
201	1998	11	9	17:52:55.24	34.9465	72.0533	122	3.6			NDI
202	1999	1	5	03:06:05.90	33.1180	75.7970	10	2.7			NDI
203	1999	1	11	00:35:08.90	32.3080	75.9890	5	1.7			NDI
204	1999	1	13	15:01:36.90	34.6720	73.8730	272	3.4			NDI
205	1999	2	12	16:30:49.90	32.9333	73.5163	0	3.6			NDI
206	1999	2	17	03:02:13.22	33.1290	73.7990	3	4.0			ISC
207	1999	2	21	15:14:56.50	32.8330	75.8980	10	2.1			NDI
208	1999	2	23	06:56:13.89	34.0570	74.5920	25	4.8	3.9		ISC
209	1999	2	24	09:59:18.50	33.9850	75.3320	33	2.9			NDI
210	1999	2	28	00:38:02.90	32.6860	73.4220	10	2.7			NDI
211	1999	2	28	10:53:26.30	32.9550	75.8090	10	2.2			NDI
212	1999	2	28	23:28:09.60	32.8690	75.7980	10	2.1			NDI
213	1999	3	1	01:00:06.93	33.5470	75.1620	10	3.9			ISC
214	1999	4	2	10:48:07.90	33.1760	73.6940	81	3.0			NDI
215	1999	4	7	00:43:50.00	32.9220	75.8390	0	2.9			NDI
216	1999	4	9	17:59:22.40	33.1690	75.5170	5	2.7			NDI
217	1999	4	12	04:11:30.40	33.0150	75.7520	6	2.0			NDI
218	1999	4	21	06:32:17.50	32.8310	75.6600	15	3.8		3.4	NDI
219	1999	4	22	05:22:04.80	32.9960	75.7680	7	4.9			NDI
220	1999	4	22	07:19:30.40	33.1750	75.2610	6	3.7		3.3	NDI
221	1999	4	24	04:38:33.80	32.4710	72.2880	1	4.3			NDI
222	1999	4	28	13:00:43.80	33.4810	72.7930	15	5.0		5.2	NDI
223	1999	4	28	13:00:47.25	33.1900	73.2910	17	4.9	3.6		ISC
224	1999	5	8	20:59:17.40	33.4420	75.9120	15	2.7			NDI
225	1999	5	14	09:05:56.70	34.6520	73.7420	2	4.1			NDI
226	1999	5	14	09:06:00.60	33.1750	73.1360	33	3.7			ISC
227	1999	5	17	17:45:40.30	32.5590	75.5030	33	2.0			NDI
228	1999	7	12	17:43:53.30	34.4450	74.4590	33	3.0			NDI
229	1999	7	12	21:45:50.80	33.6120	75.6740	18	4.1		3.8	NDI
230	1999	7	12	21:45:58.71	33.1560	75.8170	66	3.7			ISC
231	1999	7	13	03:17:29.40	32.7760	75.5810	33	3.7			NDI
232	1999	7	15	04:29:33.45	32.6610	72.9510	36	4.2	3.5		ISC
233	1999	7	15	04:29:35.50	32.8460	72.8610	33	4.5		4.1	NDI
234	1999	7	30	19:55:08.90	33.1120	75.5240	38	2.0			NDI
235	1999	8	24	05:39:18.00	32.4200	73.5670	17	3.1			NDI
236	1999	9	18	16:30:02.50	32.9630	75.8670	9	4.1		3.8	NDI
237	1999	10	25	18:12:17.60	32.4340	75.3610	15	2.9			NDI
238	1999	10	29	01:23:03.60	33.4770	75.5290	10	3.1			NDI
239	1999	10	29	23:31:37.10	34.1880	74.0940	15	4.2		3.9	NDI
240	1999	10	31	19:03:05.90	34.9870	72.9250	33	4.2		3.8	NDI
241	1999	11	29	14:31:19.48	33.0040	75.6470	33	4.2			ISC
242	2000	1	16	12:00:57.95	33.2650	75.8240	39	4.0			ISC
243	2000	2	22	17:53:43.31	33.4280	75.7760	15	3.5			ISC
244	2000	2	25	22:23:37.70	33.2340	75.7450	33	2.2			NDI
245	2000	3	17	07:41:42.20	33.3520	75.4380	5	2.5			NDI
246	2000	4	8	12:47:00.30	33.7010	75.0800	6	2.9			NDI
247	2000	4	26	12:15:21.26	34.0390	75.2200	43	3.5			ISC
248	2000	5	28	14:52:01.31	33.7340	74.8650	58	3.7			ISC
249	2000	7	8	14:22:41.60	34.4050	73.5070	33	3.0			NDI
250	2000	7	10	23:32:27.40	33.3340	74.3460	15	2.7			NDI
251	2000	7	12	07:51:40.40	33.0640	75.8710	5	2.3			NDI

Sr No	*Date*			*Time*	*Latitude*	*Longitude*	*Depth*	*Magnitude*			*Source*
	Year	*Month*	*Day*	*GMT*	*N*	*E*	*Km*	*mb*	*MS*	*ML*	
252	2000	7	15	00:45:12.20	33.3180	75.5730	20	2.8			NDI
253	2000	7	17	05:26:11.45	34.9320	72.9900	52	4.8	3.8		ISC
254	2000	7	23	23:13:40.50	32.7990	75.2530	33	2.5			NDI
255	2000	7	24	12:53:30.20	32.1380	75.8910	18	2.4			NDI
256	2000	7	27	01:47:06.70	33.6090	73.8450	0	2.8			NDI
257	2000	8	11	03:46:44.40	32.6050	75.5110	48	2.9		2.3	NDI
258	2000	8	14	14:46:11.80	33.0770	75.4000	14	2.7			NDI
259	2000	8	23	14:32:44.70	34.0750	74.3830	33	4.7			NDI
260	2000	8	24	01:29:08.60	33.3190	75.4200	33	3.0			NDI
261	2000	8	28	00:32:11.20	33.4440	75.2430	7	2.7			NDI
262	2000	8	31	22:46:36.70	34.1240	73.4810	33	3.2			NDI
263	2000	9	5	14:04:28.90	33.9730	75.0360	33	2.9			NDI
264	2000	9	6	02:53:03.49	34.3400	75.0920	33	3.7			ISC
265	2000	9	7	21:58:41.80	33.3240	74.8350	26	3.4			NDI
266	2000	9	26	19:39:24.95	33.4090	75.6960	9	4.4			ISC
267	2000	10	2	05:41:54.00	35.0000	76.0000	0	5.1			NDI
268	2000	10	28	16:47:01.90	32.6010	74.9060	35	2.4			NAO
269	2000	10	28	23:53:13.10	32.9040	75.1710	33	2.6			NAO
270	2000	12	22	16:55:58.20	33.3190	75.9430	5	2.9			NAO
271	2000	12	27	00:40:16.40	33.2670	75.9950	0	2.7			NAO
272	2001	1	2	04:49:27.00	32.0000	75.0000		3.7			NAO
273	2001	1	3	21:35:23.00	32.0000	75.0000		4.1			NAO
274	2001	1	5	21:35:23.00	34.0000	76.0000		4.0			NAO
275	2001	1	8	09:01:51.60	33.6910	75.6250	33	3.9		3.5	NAO
276	2001	1	8	09:01:53.85	33.4260	75.9610	38	4.0			ISC
277	2001	1	8	09:06:19.40	33.2470	75.5730	15	2.9			NDI
278	2001	1	9	03:12:27.80	33.7670	75.9670	33	2.8			NDI
279	2001	1	9	07:19:37.00	32.0000	75.0000		3.8			NAO
280	2001	1	14	04:19:20.00	33.0000	76.0000		4.3			NAO
281	2001	1	16	10:36:58.00	33.0000	75.0000		4.3			NAO
282	2001	1	20	01:15:36.00	34.0000	72.0000		3.7			NAO
283	2001	1	21	01:24:50.00	33.0000	75.0000		4.0			NAO
284	2001	1	21	08:13:25.14	34.9500	73.4590	33	3.7			ISC
285	2001	1	23	12:01:07.00	33.0000	73.0000		4.2			NAO
286	2001	1	24	12:23:53.30	32.6310	75.6330	5	2.7			NDI
287	2001	1	24	19:49:44.50	32.7720	75.8240	33	2.7			NDI
288	2001	1	25	19:23:58.00	33.0000	74.0000		3.5			NAO
289	2001	1	31	04:18:05.00	34.0000	74.0000		2.7			NAO
290	2001	2	2	21:22:59.00	32.0000	72.0000		4.0			NAO
291	2001	2	4	10:14:08.44	33.2860	75.8310	19	4.3	3.6		NAO
292	2001	2	9	03:00:56.80	34.5520	73.9600	45	3.8			ISC
293	2001	2	9	18:17:51.00	33.0000	72.0000		3.9			NAO
294	2001	2	10	01:27:06.00	34.0000	76.0000		3.9			NAO
295	2001	2	10	03:46:16.00	32.0000	75.0000		4.5			NAO
296	2001	2	10	18:57:34.00	32.0000	75.0000		3.7			NAO
297	2001	2	12	10:20:37.00	32.0000	72.0000		4.5			NAO
298	2001	2	15	21:17:09.00	33.0000	72.0000		3.7			NAO
299	2001	2	18	07:42:25.00	32.0000	72.0000		3.8			NAO
300	2001	2	18	19:35:56.00	33.0000	74.0000		4.1			NAO
301	2001	2	20	17:33:33.50	33.1240	75.9510	40	4.5	3.8		ISC
302	2001	3	1	20:56:55.00	32.0000	72.0000		3.8			NAO
303	2001	3	1	21:29:52.10	32.4150	74.9170	33	2.6			NDI
304	2001	3	6	04:24:12.00	34.0000	72.0000		4.7			NAO
305	2001	3	6	17:59:39.60	32.9070	74.7640	28	2.8			NDI
306	2001	3	11	03:19:32.00	33.0000	75.0000		3.6			NAO
307	2001	3	11	19:09:52.00	32.0000	73.0000		3.5			NAO
308	2001	3	11	20:19:06.00	32.0000	74.0000		4.4			NAO

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
309	2001	3	12	09:35:22.00	32.0000	75.0000		3.8			NAO
310	2001	3	17	18:34:54.00	34.0000	75.0000		3.9			NAO
311	2001	3	17	19:37:03.00	35.0000	75.0000		3.6			NAO
312	2001	3	19	00:35:10.00	33.0000	73.0000		4.5			NAO
313	2001	3	22	04:03:28.00	33.0000	76.0000		3.8			NAO
314	2001	3	24	14:39:10.48	33.3790	75.6720	33	3.8			ISC
315	2001	3	28	12:33:32.00	35.0000	74.0000		4.6			NAO
316	2001	4	2	19:08:50.00	32.0000	76.0000		3.5			NAO
317	2001	4	8	18:33:54.00	34.0000	73.0000		3.9			NAO
318	2001	4	9	15:00:37.74	32.6205	73.0157	0	3.8			IDC
319	2001	4	9	15:19:07.00	35.0000	74.0000		4.3			NAO
320	2001	4	13	03:25:27.10	32.7360	75.0530	76	2.5			NDI
321	2001	4	18	23:32:26.50	32.6200	74.8150	33	2.6			NDI
322	2001	4	19	22:06:50.00	32.0000	72.0000		3.8			NAO
323	2001	4	22	20:29:28.00	32.0000	75.0000		3.7			NAO
324	2001	4	22	22:47:10.00	32.0000	75.0000		3.6			NAO
325	2001	4	29	13:52:46.00	34.0000	76.0000		3.6			NAO
326	2001	4	30	00:32:15.00	33.0000	75.0000		3.8			NAO
327	2001	4	30	15:37:12.20	33.1510	75.7770	8	2.6			NDI
328	2001	5	4	06:26:42.50	34.6210	74.2410	33	3.9			ISC
329	2001	5	7	22:08:00.00	35.0000	73.0000		3.6			NAO
330	2001	5	9	03:47:52.00	33.0000	75.0000		4.3			NAO
331	2001	5	11	14:59:21.00	32.0000	73.0000		4.3			NAO
332	2001	5	18	03:06:16.00	34.0000	72.0000		3.7			NAO
333	2001	5	21	22:16:00.00	34.0000	76.0000		4.5			NAO
334	2001	5	23	18:06:39.30	32.7290	74.9190	38	2.5			NDI
335	2001	6	2	04:39:00.70	34.1203	74.2258	200	4.3			DMN
336	2001	6	3	19:47:28.00	35.0000	72.0000		3.5			NAO
337	2001	6	5	22:50:34.00	32.0000	75.0000		3.8			NAO
338	2001	6	7	04:48:12.00	32.0000	72.0000		4.0			NAO
339	2001	6	8	22:10:31.90	34.9961	73.3194	10	4.8			DMN
340	2001	6	11	14:36:12.20	34.6762	73.5251	10	4.9			DMN
341	2001	6	13	07:33:45.00	32.0000	75.0000		4.1			NAO
342	2001	6	13	19:43:28.20	33.3090	75.4900	5	3.1			NDI
343	2001	6	13	19:49:18.80	32.6960	74.8840	11	2.5			NAO
344	2001	6	15	03:56:30.00	33.0000	75.0000		3.6			NDI
345	2001	6	15	11:13:13.60	32.8870	72.1500	33	3.6			NAO
346	2001	6	16	07:43:38.00	34.0000	73.0000		4.6			NAO
347	2001	6	17	17:18:43.00	34.0000	76.0000		3.8			NAO
348	2001	6	18	14:04:50.00	35.0000	73.0000		4.0			NAO
349	2001	6	20	04:36:56.00	34.0000	73.0000		3.8			LDG
350	2001	6	23	07:49:16.00	32.0000	73.0000		3.7			NDI
351	2001	6	27	03:50:32.00	35.0000	76.0000		3.5			NDI
352	2001	6	28	23:25:09.00	32.7520	74.7670	10	3.1			NAO
353	2001	7	1	00:12:51.00	33.0000	75.0000		3.5			IDC
354	2001	7	2	20:33:05.75	34.7376	73.3292	0	3.8			NAO
355	2001	7	4	05:35:45.00	35.0000	76.0000		4.3			NAO
356	2001	7	6	15:52:38.00	33.0000	75.0000		5.1			NAO
357	2001	7	7	21:24:36.00	33.0000	76.0000		4.6			NAO
358	2001	7	11	23:52:04.00	34.0000	72.0000		4.3			NAO
359	2001	7	14	01:54:56.00	32.0000	76.0000		3.8			NAO
360	2001	7	15	05:01:38.00	32.0000	73.0000		4.0			NAO
361	2001	7	16	16:07:16.20	32.9420	73.1480	33	5.2			MOS
362	2001	7	17	02:55:32.00	33.0000	75.0000		4.0			NAO
363	2001	7	17	14:10:33.00	32.0000	72.0000		3.9			NAO
364	2001	7	18	12:22:11.60	33.4074	75.1596	345	4.5			NAO
365	2001	7	20	05:21:24.00	33.0000	73.0000		4.3			NAO

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
366	2001	7	20	13:27:28.00	33.0000	75.0000		4.0			NAO
367	2001	7	21	00:17:17.00	33.0000	75.0000		4.7			NAO
368	2001	7	25	21:47:09.00	35.0000	73.0000		3.5			NAO
369	2001	8	7	08:31:39.00	34.0000	75.0000		3.9			NAO
370	2001	8	9	01:30:01.00	32.0000	74.0000		3.8			NAO
371	2001	8	9	19:32:32.80	33.4444	75.5545	336	4.2			DMN
372	2001	8	15	00:45:06.00	33.0000	72.0000		3.7			NAO
373	2001	8	24	18:57:02.00	33.0000	73.0000		4.0			NAO
374	2001	8	25	19:54:09.00	33.0000	75.0000		4.6			NAO
375	2001	8	26	17:05:28.00	33.0000	75.0000		4.2			NAO
376	2001	8	26	17:52:17.00	32.0000	75.0000		3.7			NAO
377	2001	8	27	01:57:26.20	33.6622	74.9070	200	4.1			DMN
378	2001	8	27	03:42:48.00	33.0000	75.0000		4.8			NAO
379	2001	8	28	11:33:44.00	33.0000	74.0000		4.7			NAO
380	2001	8	30	09:02:14.00	35.0000	76.0000		4.7			NAO
381	2001	8	31	15:36:21.00	35.0000	73.0000		2.8			NAO
382	2001	9	1	05:59:51.00	33.0000	72.0000		4.3			NAO
383	2001	9	6	00:40:49.00	33.0000	75.0000		4.8			NAO
384	2001	9	8	15:48:53.00	33.0000	75.0000		4.5			NAO
385	2001	9	9	01:04:37.00	33.0000	72.0000		3.7			NAO
386	2001	9	9	01:06:26.00	32.5326	75.9245	324	4.5			DMN
387	2001	9	9	23:39:35.50	34.5198	73.1259	133	4.4			DMN
388	2001	9	14	15:18:19.00	35.0000	73.0000		4.7			NAO
389	2001	9	14	15:39:10.80	34.5967	74.6998	300	4.7			DMN
390	2001	9	14	16:28:24.00	33.0000	73.0000		3.9			NAO
391	2001	9	14	18:29:53.00	33.0000	75.0000		3.7			NAO
392	2001	9	20	20:22:53.00	34.0000	76.0000		3.8			NAO
393	2001	9	24	05:30:53.00	34.0000	73.0000		3.6			NAO
394	2001	9	24	20:15:35.00	32.0000	76.0000		3.7			NAO
395	2001	9	26	15:29:57.00	33.0000	75.0000		3.8			NAO
396	2001	9	28	04:37:57.50	33.4010	75.8300	33	5.1			MOS
397	2001	9	30	00:54:15.90	34.6835	74.0036	133	4.7			DMN
398	2001	9	30	11:29:15.00	32.0000	74.0000		4.5			NAO
399	2001	9	30	11:31:02.80	34.5649	74.8615	320	4.8			DMN
400	2001	10	5	02:36:56.00	33.0000	75.0000		4.8			NAO
401	2001	10	6	19:21:07.30	34.1863	73.4330	10	4.9			IDC
402	2001	10	7	13:57:05.00	34.0000	74.0000		3.6			NAO
403	2001	10	11	06:01:41.72	34.6092	72.4553	0	4.0			IDC
404	2001	10	14	10:35:51.00	33.0000	73.0000		3.7			NAO
405	2001	10	15	20:18:09.00	33.0000	72.0000		3.8			NAO
406	2001	10	18	17:54:26.00	35.0000	76.0000		4.3			NAO
407	2001	10	18	17:55:59.00	34.3970	75.0860	268	5.0			DMN
408	2001	10	21	13:23:29.00	34.0000	76.0000		4.2			NAO
409	2001	10	21	14:29:12.00	34.0000	72.0000		3.7			NAO
410	2001	10	21	20:17:15.10	34.9918	72.0489	10	4.7			DMN
411	2001	10	27	03:53:51.00	32.0000	75.0000		3.9			NAO
412	2001	10	28	23:16:24.00	32.0000	72.0000		3.8			NAO
413	2001	11	3	04:50:45.71	33.1522	72.6066	0	4.2			IDC
414	2001	11	6	02:19:36.00	32.0000	72.0000		3.8			NAO
415	2001	11	6	10:50:06.00	32.0000	73.0000		4.1			NAO
416	2001	11	7	05:13:08.00	33.0000	76.0000		3.9			NAO
417	2001	11	12	22:21:40.00	32.0000	73.0000		4.2			NAO
418	2001	11	13	16:35:04.00	32.0000	72.0000		4.9			NAO
419	2001	11	13	19:29:13.00	33.0000	75.0000		3.9			NAO
420	2001	11	16	12:34:21.00	32.0000	75.0000		4.1			NAO
421	2001	11	19	17:58:08.00	32.0000	72.0000		3.8			NAO
422	2001	11	23	20:42:29.00	34.0000	74.0000		6.7			NAO

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
423	2001	11	24	14:43:57.00	33.0000	74.0000		3.7			NAO
424	2001	12	9	12:08:57.00	33.0000	75.0000		4.0			NAO
425	2001	12	9	16:01:32.00	35.0000	73.0000		4.0			NAO
426	2001	12	16	05:32:32.00	33.0000	75.0000		3.5			NAO
427	2001	12	16	05:34:02.50	34.1263	73.7819	147	4.3			DMN
428	2001	12	21	20:06:41.00	33.0000	75.0000		4.2			NAO
429	2001	12	21	21:56:41.50	32.8733	74.4470	33	5.0			DMN
430	2001	12	22	03:39:13.00	34.0000	75.0000		5.0			NAO
431	2001	12	22	11:26:25.90	34.8174	72.3052	10	4.8			DMN
432	2001	12	22	12:06:59.10	34.6710	73.1330	33	4.3			MOS
433	2001	12	24	09:42:50.40	32.6147	75.2520	305	4.0			NAO
434	2001	12	28	20:58:48.75	34.6099	73.5547	0	3.8		3.1	IDC
435	2001	12	30	18:39:14.00	33.0000	75.0000		4.2			NAO
436	2001	12	31	22:20:24.00	33.0000	75.0000		5.1			NAO
437	2002	1	6	14:34:22.00	33.0000	74.0000		3.8			NAO
438	2002	1	7	13:04:18.24	33.6575	74.6155	61	3.6			IDC
439	2002	1	7	20:32:47.00	33.0000	74.0000		4.4			NAO
440	2002	1	11	01:24:49.00	34.0000	76.0000		4.4			NAO
441	2002	1	13	12:08:10.60	32.4450	75.9370	33	5.1			NAO
442	2002	1	13	12:08:35.19	34.9422	74.0524	33	4.6			MDD
443	2002	1	13	13:39:30.82	33.9197	75.5453	33	4.6			MDD
444	2002	1	19	04:38:04.00	33.0000	75.0000		3.8			NAO
445	2002	1	24	15:34:32.00	35.0000	72.0000		4.3			NAO
446	2002	2	5	05:35:56.00	32.0000	73.0000		5.1			NAO
447	2002	2	7	03:29:20.00	34.0000	72.0000		4.2			NAO
448	2002	2	8	04:02:14.00	32.0000	76.0000		3.8			NAO
449	2002	2	9	18:10:03.00	33.0000	76.0000		3.8			NAO
450	2002	2	12	23:13:56.00	33.0819	75.9476	0	3.4		2.9	IDC
451	2002	2	12	23:14:22.36	33.6144	75.8236	0	3.9		3.7	IDC
452	2002	2	14	23:44:02.00	32.0000	72.0000		4.6			NAO
453	2002	2	17	05:22:59.70	33.0400	75.8800	31	4.3		4.1	BJI
454	2002	2	18	22:33:31.00	32.0000	74.0000		4.4			NAO
455	2002	2	19	07:22:47.00	33.0000	72.0000		4.1			NAO
456	2002	2	20	01:37:50.00	35.0000	74.0000		4.0			NAO
457	2002	2	22	10:01:31.00	33.0000	75.0000		4.5			NAO
458	2002	2	22	17:27:02.00	33.0000	73.0000		4.0			NAO
459	2002	2	26	14:04:26.00	34.0000	76.0000		4.6			NAO
460	2002	3	3	12:07:11.00	32.0000	74.0000		4.7			NAO
461	2002	3	3	13:04:48.00	33.0000	75.0000		5.0			NAO
462	2002	3	3	16:31:37.00	32.0000	73.0000		3.9			NAO
463	2002	3	3	21:03:38.00	32.0000	75.0000		4.3			NAO
464	2002	3	5	14:15:03.00	33.0000	74.0000		4.0			NAO
465	2002	3	6	19:56:13.00	33.0000	75.0000		4.7			NAO
466	2002	3	7	16:59:46.00	33.0000	73.0000		3.9			NAO
467	2002	3	9	20:58:43.00	32.0000	75.0000		3.9			NAO
468	2002	3	14	10:45:36.00	33.0000	75.0000		3.8			NAO
469	2002	3	14	18:44:03.80	34.1600	75.9800	48	3.9		3.8	BJI
470	2002	3	18	04:29:14.40	32.9700	75.8900	57	4.1		4.5	NAO
471	2002	3	21	21:57:31.00	33.0000	72.0000		4.9			NAO
472	2002	3	24	10:18:09.70	32.2564	75.8423	0	3.7		3.8	IDC
473	2002	3	29	01:58:18.00	33.0000	73.0000		4.2			NAO
474	2002	3	30	21:13:21.00	32.0000	74.0000		3.8			NAO
475	2002	3	31	17:09:17.00	33.0000	75.0000		3.5			NAO
476	2002	4	3	02:23:09.00	34.0000	72.0000		4.6			NAO
477	2002	4	5	20:30:42.00	33.0000	74.0000		4.7			NAO
478	2002	4	11	16:05:58.00	33.0000	75.0000		3.9			NAO
479	2002	4	13	23:13:57.00	32.0000	75.0000		3.8			NAO

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
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481	2002	4	16	08:14:07.00	32.0000	75.0000		3.5			NAO
482	2002	4	16	23:45:39.00	33.0000	73.0000		4.3			NAO
483	2002	4	17	06:32:53.00	32.0000	75.0000		3.5			NAO
484	2002	4	18	22:12:41.90	32.9470	74.7260	33	4.8			BER
485	2002	4	21	10:41:16.00	35.0000	76.0000		4.0			MDD
486	2002	4	30	23:01:19.00	33.0000	73.0000		4.0			NAO
487	2002	5	6	09:32:10.10	34.2600	73.7000	70	3.9			BJI
488	2002	5	6	16:27:25.00	33.0000	74.0000	0	3.6			NAO
489	2002	5	8	06:30:40.00	35.0000	73.0000		4.1			NAO
490	2002	5	9	08:11:38.00	32.0000	73.0000		3.6			NAO
491	2002	5	10	06:00:49.27	33.0359	75.9810	0	3.8		3.7	IDC
492	2002	5	13	18:41:11.00	32.0000	73.0000		4.0			NAO
493	2002	5	15	15:32:54.00	35.0000	74.0000		3.8			NAO
494	2002	5	18	22:47:22.30	32.1414	73.1310	0	3.8	4.2	3.2	IDC
495	2002	5	18	22:47:44.00	35.0000	74.0000		3.5			NAO
496	2002	5	19	03:56:51.81	34.1667	74.9971	0	4.0		3.1	IDC
497	2002	5	19	08:39:52.00	35.0000	76.0000		4.1			NAO
498	2002	5	21	05:48:26.00	34.0000	74.0000		3.8			NAO
499	2002	5	23	09:19:48.00	34.0000	72.0000		3.1			NAO
500	2002	5	27	00:05:01.00	32.0000	72.0000		3.8			NAO
501	2002	6	2	05:15:16.00	33.0000	75.0000		3.6			NAO
502	2002	6	4	00:12:04.00	33.0000	72.0000		4.0			NAO
503	2002	6	6	00:32:15.00	35.0000	73.0000		3.5			NAO
504	2002	6	9	02:51:14.00	33.0000	72.0000		3.5			NAO
505	2002	6	10	23:19:47.00	33.0000	72.0000		2.8			NAO
506	2002	6	10	23:26:00.00	32.0000	75.0000		4.1			NAO
507	2002	6	16	19:47:09.48	33.5874	72.9457	0	3.8		3.2	IDC
508	2002	6	24	20:41:39.00	34.0000	72.0000		3.8			NAO
509	2002	6	25	03:21:42.00	33.0000	75.0000		3.7			NAO
510	2002	7	1	07:35:09.00	33.0000	75.0000		3.9			NAO
511	2002	7	2	05:36:33.99	33.0653	75.8859	0	3.8		3.6	IDC
512	2002	7	2	07:01:11.00	32.0000	74.0000		3.8			NAO
513	2002	7	9	02:56:47.32	32.9866	73.4734	0	3.8		2.9	IDC
514	2002	7	11	03:32:11.00	33.0000	76.0000		4.5			NAO
515	2002	7	14	21:03:28.00	34.0000	73.0000		3.6			NAO
516	2002	7	18	20:29:19.00	34.0000	72.0000		4.1			NAO
517	2002	7	22	07:55:59.00	32.0000	73.0000		3.0			NAO
518	2002	7	22	09:57:23.00	32.0000	72.0000		3.8			NAO
519	2002	8	3	15:26:12.80	33.8840	72.8450	33	4.4			MOS
520	2002	8	4	05:02:28.00	35.0000	74.0000		3.5			NAO
521	2002	8	8	20:50:27.00	33.0000	75.0000		4.2			NAO
522	2002	8	8	22:45:11.00	33.0000	72.0000		4.0			NAO
523	2002	8	14	12:06:34.00	35.0000	73.0000		3.9			NAO
524	2002	8	14	16:15:17.00	33.0000	75.0000		3.8			NAO
525	2002	8	16	01:33:08.00	35.0000	74.0000		4.0			NAO
526	2002	8	17	23:23:28.00	33.0000	72.0000		3.6			NAO
527	2002	8	18	00:32:06.60	34.0550	72.8600	33	4.5			MOS
528	2002	8	20	14:53:38.00	34.0000	73.0000		4.1			NAO
529	2002	8	20	22:51:26.00	34.0000	76.0000		3.4			NAO
530	2002	9	3	17:26:14.00	33.0000	72.0000		5.5			NAO
531	2002	9	3	21:01:06.00	33.0000	76.0000		3.9			NAO
532	2002	9	4	11:37:46.00	33.0000	76.0000		4.4			NAO
533	2002	9	9	23:46:49.00	35.0000	74.0000		3.9			NAO
534	2002	9	11	06:39:20.00	33.0000	75.0000		3.8			NAO
535	2002	9	13	04:27:22.00	32.0000	74.0000		3.7			NAO
536	2002	9	13	18:20:12.00	33.0000	72.0000		4.0			NAO

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
537	2002	9	16	06:09:40.00	32.0000	73.0000		4.0			NAO
538	2002	9	18	04:46:38.00	32.0000	72.0000		3.9			NAO
539	2002	9	22	19:57:07.00	33.0000	74.0000		4.3			NAO
540	2002	10	1	02:50:51.00	33.0000	72.0000		5.3			NAO
541	2002	10	2	23:28:30.00	35.0000	75.0000		4.3			NAO
542	2002	10	4	14:59:54.00	33.0000	73.0000		3.9			NAO
543	2002	10	5	11:47:16.00	35.0000	73.0000		4.2			NAO
544	2002	10	10	15:27:00.00	32.0000	76.0000		4.6			NAO
545	2002	10	10	17:25:05.00	33.0000	73.0000		3.8			NAO
546	2002	10	17	04:29:45.00	32.0000	73.0000		4.4			NAO
547	2002	10	17	14:24:03.00	34.0000	72.0000		4.6			NAO
548	2002	10	21	13:49:10.00	33.0000	72.0000		3.7			NAO
549	2002	10	29	11:00:58.00	34.0000	76.0000		5.1			NAO
550	2002	10	30	03:12:30.00	35.0000	76.0000		3.6			NAO
551	2002	11	1	22:55:05.00	33.0000	76.0000		3.9			NAO
552	2002	11	1	22:55:18.56	34.7529	73.6430	0	3.8		2.9	IDC
553	2002	11	1	22:57:44.73	34.9448	73.6945	0	4.1		2.9	IDC
554	2002	11	2	04:55:07.00	35.0000	76.0000		4.0			NAO
555	2002	11	2	15:23:17.00	33.0000	76.0000		4.6			NAO
556	2002	11	3	04:47:17.00	33.0000	76.0000		4.0			NAO
557	2002	11	3	06:11:11.00	34.0000	76.0000		4.1			NAO
558	2002	11	3	14:48:07.00	33.0000	75.0000		3.8			NAO
559	2002	11	3	18:53:05.00	32.0000	72.0000		3.8			NAO
560	2002	11	4	05:18:47.00	35.0000	76.0000		4.1			NAO
561	2002	11	4	22:03:36.00	34.0000	76.0000		3.9			NAO
562	2002	11	5	11:59:20.00	33.0000	76.0000		4.2			NAO
563	2002	11	8	02:22:05.00	33.0000	76.0000		4.2			NAO
564	2002	11	8	02:51:22.00	33.0000	76.0000		3.7			NAO
565	2002	11	11	09:17:04.06	34.1842	75.3474	0	4.0			IDC
566	2002	11	13	18:40:45.00	35.0000	72.0000		3.4			NAO
567	2002	11	13	21:17:12.00	33.0000	72.0000		3.7			NAO
568	2002	11	16	14:18:36.00	35.0000	72.0000		3.9			NAO
569	2002	11	19	04:30:09.00	34.0000	76.0000		3.8			NAO
570	2002	11	20	19:22:26.00	32.0000	75.0000		3.9			NAO
571	2002	11	20	22:28:31.80	34.8068	74.3212	0	3.9		2.9	IDC
572	2002	11	20	22:50:17.00	34.0000	74.0000		4.0			NAO
573	2002	11	21	00:02:01.00	34.0000	76.0000		4.1			NAO
574	2002	11	21	03:10:22.00	34.0000	75.0000		3.8			NAO
575	2002	11	22	07:10:30.00	34.0000	76.0000		4.3			NAO
576	2002	11	22	09:12:12.60	33.4080	73.5240	33	4.5			MOS
577	2002	11	24	09:35:25.34	32.4224	73.1631	0	4.0		2.9	IDC
578	2002	11	24	12:56:47.00	34.0000	76.0000		4.5			NAO
579	2002	11	24	14:57:52.20	34.9015	73.7414	0	3.8		3.0	IDC
580	2002	11	25	11:06:18.00	33.0000	76.0000		4.2			NAO
581	2002	11	28	14:07:19.00	33.0000	72.0000		4.7			NAO
582	2002	11	30	19:19:49.00	35.0000	75.0000		3.9			NAO
583	2002	12	2	00:56:51.00	33.0000	72.0000		4.2			NAO
584	2002	12	4	10:29:35.00	33.0000	75.0000		4.3			NAO
585	2002	12	11	04:54:33.00	35.0000	75.0000		4.1			NAO
586	2002	12	17	10:28:08.00	33.3288	75.8066	46	3.6	3.0	3.2	IDC
587	2002	12	19	15:22:50.00	32.0000	75.0000		4.0			NAO
588	2002	12	19	16:13:32.21	33.4550	73.2430	0	3.9		3.5	IDC
589	2002	12	20	18:57:33.00	33.0000	75.0000		4.0			NAO
590	2002	12	23	00:12:41.00	33.0000	72.0000		5.2			NAO
591	2002	12	23	02:19:32.00	32.0000	73.0000		4.2			NAO
592	2002	12	29	07:29:17.00	33.0000	76.0000		3.7			NAO
593	2002	12	29	20:15:48.57	34.8821	73.8705	0	4.0		2.6	IDC

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
594	2002	12	31	01:07:45.00	33.0000	75.0000		3.7			NAO

Seismicity Pattern

The microseismic data of the region indicate that the region is very active on a microseismic level with frequent earthquakes of magnitude greater than 4.

The largest earthquake recorded by regional network is the Kangra earthquake of magnitude Ms=8.0 occurred on 4th April 1905 about 200 km southeast of the project. Two earthquakes of magnitude greater than 6 have also been recorded in this area.

Figure 8 shows distribution of seismicity with depth in the region as recorded by Mangla microseismic network. Major concentration of earthquakes is within upper 20 km. It is important to note that all the events having magnitude 5 or greater are originated within shallow depth (< 20 km). This aspect of seismicity depicts that seismic forces are active at shallow depth, which increases earthquake hazard within this region. Majority of the events falls within focal depths less than 30 km. Though, events with magnitude greater than 5 do not seem to occur beyond 30 km depth, nevertheless, events with magnitude 4 to 5 do occur at depths upto as much as 60 km. There is only one earthquake that was located at focal depth of 79.3 km.

From the spatial point of view, number of earthquakes is quite less south of latitude 32.5o. This low level of seismicity may be true as no prominent causative seismotectonic feature is recognized in the plain areas of Punjab due to thick alluvial cover. However, another factor for this reduced level could be the fact that no local seismic network properly covers this area. Generally the spread of earthquake epicentres seems to be random for magnitudes less than 4. However, for the events having magnitudes more than 4, most of these show association with local tectonic features except in Potwar and Punjab plain (**Figure 8**). The concentration of events in zone near latitude 34.0o and longitude 72.75o may be associated with Tarbela reservoir induced effect. The concentration of events west of Abbotabad appears to be partially associated with HLSZ (Hazara Lower Seismic Zone) as suggested by Seeber et al.[44] extending northwest-southeast from Hazara thrust system of faults except the event of February 25, 1996 of magnitude 5.2 with focal depth of five kilometers located only four kilometers downstream of Tarbela dam, which was an induced event. Lot of seismicity is associated with MBT and other faults of the Hazara thrust system, which indicates that these faults are active. In Salt Range, a lot of seismicity appears to be associated with Kahuta fault and Dil Jabba thrust, therefore indicating these faults as seismically active. A concentration of seismic activity is seen along river Jhelum north of Mangla. This could probably be associated with the mapped portion of the Jhelum fault, which is also considered as a possible extension of Dil Jabba thrust along the axis of the syntaxial bend, as suggested by the study of fault plane solutions of a few earthquakes in this area. This association of seismicity suggests that this portion of Jhelum fault upto Kahuta may be considered as active tectonic feature. Another concentration of epicenters is seen northeast of Mangla, which could be associated with Riasi fault and a possible associated fault closer to Mangla.

[44] Seeber, L., et al; Seismicity of the Hazara arc in northern Pakistan; Decollement vs. basement faulting; Geodynamics of Pakistan (1979).

Further towards northeast, lot of seismicity is associated with Riasi thrust, MBT and other tectonic features of the Himalayan range.

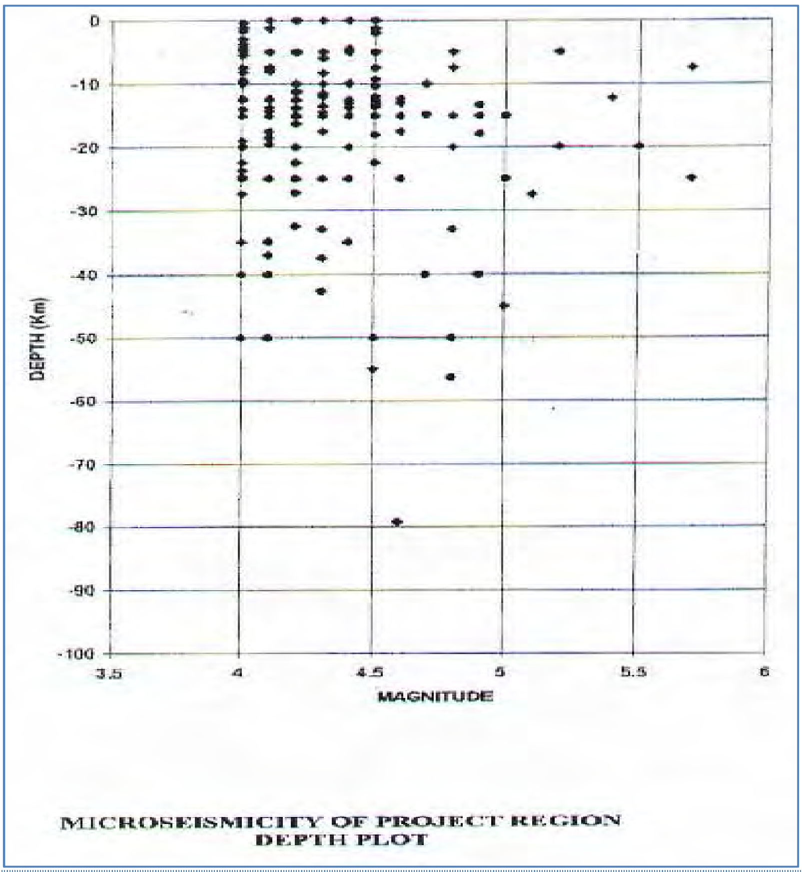


Figure 8: Microseismicity of the Project Region Depth plot

Seismotectonic Setting

Seismotectonic Model

Based on the synthesis of geological and seismicity data described above, a seismotectonic model of the project region is presented below which provides the basis for seismic hazard analysis for the Project.

The Project site is located near the base of Himalayan range where major tectonic features of this gigantic range are present. The other prominent tectonic feature is the presence of Hazara-Kashmir syntaxial bend which is very sharp near Muzaffarabad and gradually dies out southwards. All geological features show NW-SE trend towards east of the syntaxial bend while these have NE-SW trend on the western side of the syntaxial bend.

The seismotectonic features that have been considered critical for the seismic hazard to the Project include:

i. Himalayan Frontal Thrusts i.e. Main Boundary Thrust (MBT) and Riasi Thrust and associated parallel faults, having NW-SE trend and located east of the syntaxial axis;

ii. Jhelum Fault, trending N-S, and running along the axis of the syntaxial bend; and
iii. Dil Jabba thrust, Kahuta Fault and Salt Range Frontal Thrust, all have NE-SW trend and located west of the axis of the syntaxis.

The entire region is dominated mainly by thrust type of faults that do have some strike- slip component at places also. These faults are considered active because of association of observed seismicity with these faults (**Figure 7**). The faults critical to the project are discussed below:

Project Area Faults

The main tectonic features controlling the seismic hazard for the Project are as follows:

a) Main Boundary Thrust

Main Boundary thrust is the main frontal thrust of the Himalayan range which runs along the Himalayan arc for about 2500 km from Assam in the east to Kashmir in the west. Near the Project site, it takes a northwest trend due to the syntaxial bend. Near it surface trace, it dips towards northeast at steep angle but becomes sub-horizontal in the subsurface away from the surface trace. Seeber et al.[45] have shown that the series of large earthquakes which occurred along the Himalayan range are probably related to slip along this sub-horizontal surface, termed as detachment. The MBT is seismically active and have seismic potential to generate large earthquakes. The closest distance of MBT from project site is 40 km towards northeast.

b) Riasi Thrust

Another important fault of the Himalayan front is the Riasi Thrust which is a branch of the MBT and runs almost parallel to MBT for a distance of about 220 km. Lot of observed seismicity can be associated with this fault. This fault passes at a distance of only 8 km northeast of the Project site. Near the site, it has a trend of NW-SE, dipping towards northeast away from the site. Because of its close association with the MBT and recorded seismicity, this fault is considered as an active tectonic feature.

c) Jhelum Fault

This is a north-south trending left lateral strike-slip fault with steep dip towards east. Kazmi[46] has shown that this fault may extend from north of Muzaffarabad to near Jhelum towards south along the axis of the syntaxial bend. The mapped length of this fault is, however, limited to about 20 km only between Mangla and Kahuta (**Figure 4**). The alignment of observed seismicity along this fault suggests that this fault may extend towards south up to the northeastern termination of Dil Jabba thrust. A 50 km length of this fault is taken as active with nearest trace at 30 km west of the project site.

[45] Seeber L. et al; Seismicity and continental subduction in the Himalayan arc, in Zagros – Hindukush Himalayas; Geodynamics Evolution, A.G.U. Geodynamics Services, Vol.3 (1981).
[46] Farah, A., De Jong, K.A; Geodynamics of Pakistan: An introduction; Geodynamics of Pakistan, Geological Survey of Pakistan (1979).

d) Dil Jabba Thrust:

Dil Jabba Thrust is a north east trending fault present near the eastern side of Salt Range with a surface trace 86 km long. This thrust dips towards northwest and terminates on the western side of River Jhelum. Some disturbance of Quaternary deposits has been reported near the surface trace of this fault and epicenters of many earthquakes can be associated with this fault, therefore indicating that this fault is seismically active. Its eastern termination is at a distance of about 35 km from the Project site.

e) Kahuta Fault:

This fault is present north of Dil Jabba Thrust and runs parallel to it. This fault starts northwest of GT Road and terminates near the axis of the syntaxis. It length is about 50 km. Because of its similarity with Dil Jabba Thrust and observed seismicity of the area, this fault is also taken as active.

Seismic Hazard Evaluation

Both probabilistic as well as deterministic hazard evaluation procedures were employed for seismic hazard analysis of the project in accordance with the ICOLD guidelines[47].

Probabilistic Approach

Methodology

In probabilistic hazard evaluation method, the seismic activity of seismic source (line or area) is specified by a recurrence relationship, defing the cumulative number of events per year versus the magnitude. Distribution of earthquake is assumed to be uniform within the source zone and independent of time[48].

The principle of the analysis is to evaluate at the site of interest the probability of exceedence of a ground motion parameter (e.g. acceleration) due to the occurrence of a strong event, at a certain distance from the site. This approach combines the probability of exceedence of the earthquake size (recurrence relationship), and probability on the distance from the epicenter to the site.

Each source zone is split into elementary zones at a constant distance from the site. Integration is carried out within each zone by summing the effects of the various elementary zones taking into account the attenuation effect with distance. Total hazard is obtained by adding the influence of various sources. The results are expressed in terms of a ground motion parameter associated to the total number of expected events per year (i.e. the inverse of the return period), or in terms of annual hazard.

A seismic hazard model is developed based on findings of the seismotectonic synthesis. The seismic hazard model relies upon the concept of seismotectonic zones. Each zone is defined as a zone with homogenous seismic and tectonic features, inferred from geological, tectonic and seismic data.

[47] International Commission on Large Dams (ICOLD); Guidelines for selecting seismic parameters for large dams, Paris (1989).
[48] Cornell, C.A.; Engineering seismic risk analysis, Bull. Seism. Soc .Am., Vol.58, No.5 (1968).

These zones are first defined, then a maximum earthquake and an earthquake recurrence equation is elaborated for each of these source zones.

The seismic parameters attached to the various seismic zones are a recurrence relationship relating the number of events for a specific period of time to the magnitude, the maximum earthquake giving an upper bound of potential magnitude in the zone, and an attenuation relationship representing the decrease of acceleration with distance.

Seismic Source Modeling

For the definition of seismic sources, either line (i.e. fault) or area sources can be used for modeling. Because of uncertainty in the epicentral locations, it is difficult to relate the recorded earthquakes to the faults present in the area and to develop recurrence relationship for each fault. The area around the site was therefore divided into six seismic zones (area sources) based on their homogeneous tectonic and seismic characteristics. These zones are MBT, Riasi, Hazara, Potwar, Salt Range and Punjab seismic zones (**Figure 9**).

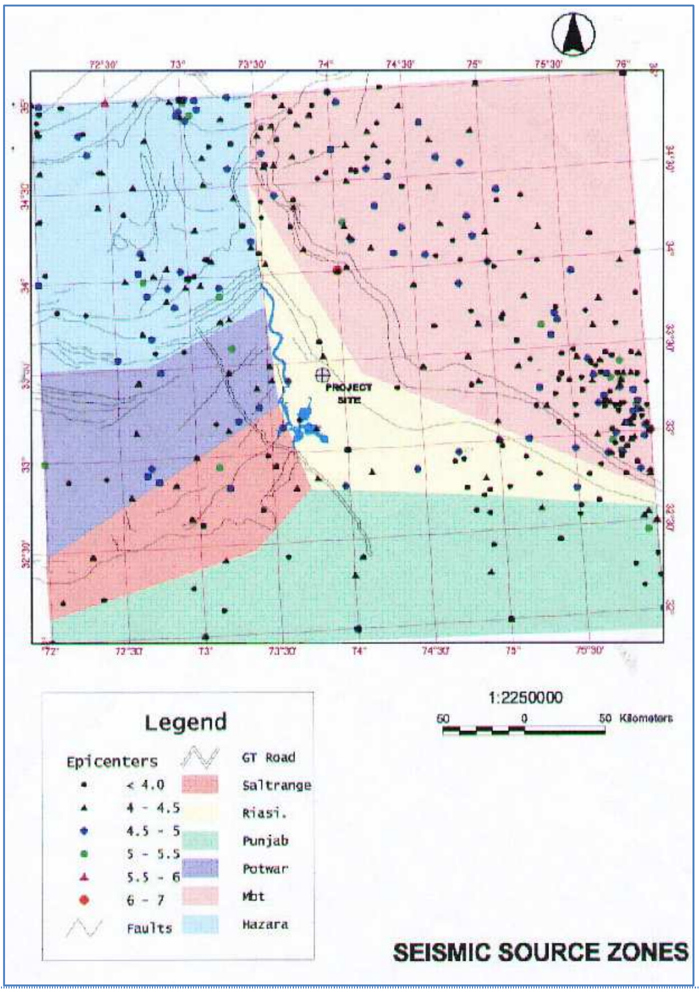


Figure 9: Seismic Source Zones

Each of these areas was assigned a maximum magnitude potential. As the shallow earthquakes are of more concern to seismic hazard, the minimum depth of the earthquakes is taken as 5 km for all sources except Punjab seismic zone where the minimum depth of earthquakes is taken as 30 km. The source parameters used in probabilistic hazard analysis are given in **Table 3**.

Table 3: Source Parameters for Probabilistic Analysis

Source Zone	*Minimum Magnitude M0*	*No. of Earthquakes of Mb >= M0*	*Activity Rate No. /Year*	*b-value*	*Maximum Potential Magnitude Mb*
Main Boundary Thrust (MBT)	4.0	146	1.5052	0.81	8.3
Riasi	4.0	40	0.4124	1.03	7.5
Hazara	4.2	55	0.5670	1.28	7.0
Potwar	4.0	33	0.3402	0.93	7.0
Salt Range	4.2	7	0.0722	0.82	7.0
Punjab	4.0	35	0.3608	0.85	6.0

Magnitude–Frequency Relationship

A general equation that described earthquake recurrence may be expressed as follows:

$$N(m) = f(m, t) \qquad (1)$$

Where N (m) is the number of earthquakes with magnitude equal to or greater than m, and t is time period

The simplest form of equation (1) that has been used in most engineering applications is the well known Richter's law which states that the cumulated number of earthquakes occurred in a given period of time can be approximated by the relationship

$$\log N(m) = a - b\,m \qquad (2)$$

Equation (2) assumes spatial and temporal independence of all earthquakes, i.e. it has the properties of a Poisson model. Coefficient a is related to the total number of events occurred in the source zone and depends on its area, while coefficient b represents the coefficient of proportionality between log N(m) and the magnitude. Coefficients a and b can be derived from seismic data relative to the source of interest.

The composite list of earthquakes given in **Table 2** for the window 32.0oN to 35.0oN and 72.0oE to 76.0oE covering an area within about 200 km radius of the project provided the necessary data base for the computation of b-value for each seismic source zone.

The seismic data from 1904-2002 contain magnitude values in the form of surface wave, body wave or local magnitude scales. Since attenuation relationships are based on magnitudes of given type, a single scale must be selected. All the magnitudes above 4 were therefore converted to body wave (mb) by using the following equations as suggested by Ambraseys and Bommer[49]:

$$0.87\,(mb) - 0.50\,(Ms) = 1.91$$

[49] Ambraseys N.N. & Bommer J.J.; Uniform magnitude re-evaluation for the strong motion database of Europe and adjacent areas, European Earthquake Engineering, Vol.4 No.2 (1990).

0.82 (Ml) – 0.58 (Ms) = 1.20

Where mb is body–wave magnitude, Ms is surface-wave magnitude and Ml is local magnitude.

The converted body wave magnitudes values are given is **Table 2**. Separate list of earthquakes occurring within each seismic zone was extracted from the composite list through GIS software. Magnitude-frequency plot was then drawn and b-values were calculated for each zone through regression analysis of data. The b–values and activity rate for the six seismic zones used in the probabilistic analysis are shown in **Table 3**.

Attenuation Relationships

Because of lack of sufficient strong–motion data covering a larger range of magnitudes and distances, attenuation relationships for the South Asian region could not be developed. For probabilistic hazard analysis, the attenuation equations of Boore et al.[50], Idriss[51], Sadigh[52] and Abrahamson-Silva[53] have been used. As the Project is founded on rock, the average shear wave velocity up to 30 meters depth was taken as 800 m/sec, which was observed at proposed Kalabagh damsite for similar rock formations.

Results of Peak Ground Acceleration (PGA)

The probabilistic hazard analysis was carried out by using EZ-FRISK software developed by Risk Engineering Inc. of Colorado, USA. The parameters for all the six seismic zones (area sources) given in **Table 3** were fed to the software. The results of the hazard analysis are presented in **Figure 10** in the form of total hazard at the Project site in terms of annual frequency of exceedence of peak horizontal ground acceleration.

[50] Boore et al.; Equations for estimating horizontal response spectra and peak acceleration from western north American earthquakes: A summary of recent work, Seism. Res. Letters, Vol. 68 (1997).

[51] Idriss, I. M.; Procedure for selecting earthquakes ground motions at rock sites, National Institute of Standards and Technology, NIST GCR 93-625 (1993).

[52] Sadigh K. et al.; Attenuation relationships for shallow crustal earthquakes based on California strong motion data, Seism. Res. Letters, Vol. 68 (1997).

[53] Abrahamson, N.A. and Silva W.J.; Empirical response spectral attenuation relations for shallow crustal earthquakes, Seism. Res. Letters, Vol. 68 (1997).

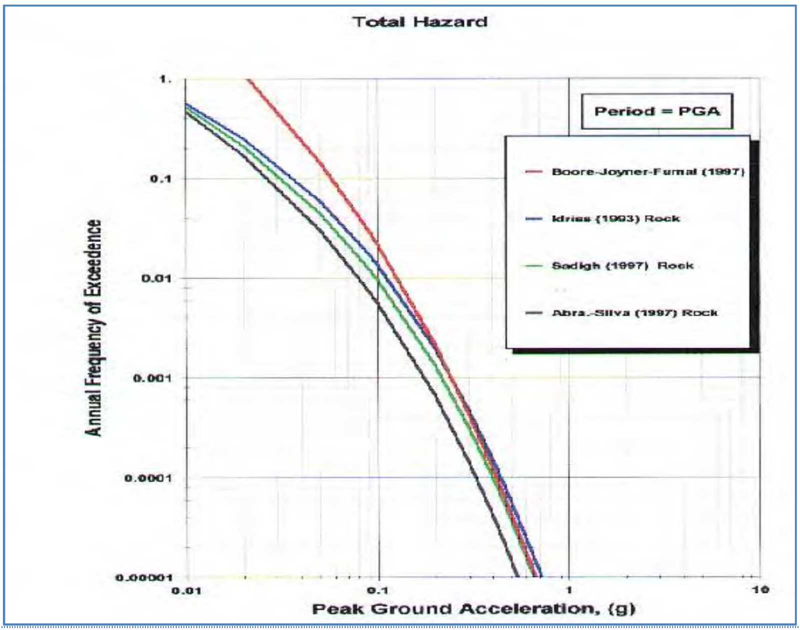


Figure 10: Total Hazard Plot

Deterministic Approach

Methodology

In the deterministic procedure, critical seismogenic sources, like capable fault, representing a threat to the Project are identified and a maximum magnitude assigned to each of these faults. The capability of the faults is ascertained through observation of historical and instrumental seismic data and geological criteria such as the rupture length – magnitude relationship or fault movement - magnitude relationship. The maximum seismic design parameter is obtained by considering the most severe combination of maximum magnitude and minimum distance to the Project site, independently of the return period.

Maximum Earthquake Potential

Table 4 gives the various active faults present around the Project site and their lengths. The maximum rupture length of the faults has generally been taken as 50% of the total length. The Main Boundary Thrust (MBT) is a long active feature extending all along the Himalayan front from Assam to Kashmir, its maximum rupture length has been taken same as that observed in Kangra earthquake of 1905.

The maximum potential magnitude of each of these faults (**Table 4**) was calculated on the basis of fault rupture length and rupture area using various available relationships[54] and a maximum magnitude was selected accordingly for each of these active tectonic features as shown in **Table 4**.

[54] Slemmons, D.B., Bodin, P., and Zhang Xiaoyi ; Determination of earthquake size from surface faulting events, Proc . Seminar on Seismic Zonation, Guangzhou, China, State Seismological Bureau (Beijing) (1987).

Table 4: Maximum Potential Magnitudes of Critical Faults

Tectonic Feature	Fault Length (Km)	Fault Rupture Length (Km)	Rupture Length Basis				Rupture Area Basis				Selected Max. Mag.
			Slemmons 1982	Patwardhan et al. 1975	Tocher, Seed & Housner	Wells Coppersmith 1994	Rupture Area Lgt. (Km)	Rupture Area Wdt. (Km)	Wells & Coppersmith 1994	Wyss 1979	
Main Boundary Thrust (MBT)	1200	300	8.0	8.0	8.1	8.2	300	150	8.6	8.8	8.3
Riasi Thrust	220	110	7.4	7.4	7.3	7.5	100	40	7.6	7.7	7.5
Jhelum Fault	50	25	6.6	6.6	6.7	6.6	25	15	6.6	6.7	6.6
Dil Jabba Thrust	86	43	7.0	7.0	7.0	7.0	43	15	6.8	7.0	7.0
Kahuta Fault	50	25	6.6	6.6	6.7	6.6	25	15	6.6	6.7	6.6

Results of PGA

Horizontal Peak Ground Acceleration (PGA) at the project site induced by each seismic source was computed considering that maximum earthquake can occur at the closest distance from the site. The computed accelerations using several attenuation relationships of common use in engineering practice are summarized in **Table 5**. This table shows that the maximum accelerations at the site are caused by Riasi thrust being at a closest distance of 8 km from the site.

Table 5: Peak Horizontal Accelerations

Tectonic Feature	Max. Magnitude	Closest Distance to Fault (Km.)	Computed Accelerations (g) Median (50-percentile)					
			Boore, Joyner & Fumel 1997	Ambraseys et al. 1996	Idriss 1993	Sadigh et al. 1997	Ambraseys & Bommer 1991	Campbell & Bozorgnia 1993
Main Boundary Thrust (MBT)	8.3	40	0.21	0.24	0.27	0.26	0.18	0.24
Riasi Thrust	7.5	8	0.41	0.59	0.53	0.57	0.49	0.43
Jhelum Fault	6.6	30	0.09	0.11	0.12	0.11	0.10	0.13
Dil Jabba Thrust	7.0	35	0.12	0.12	0.16	0.12	0.10	0.14
Kahuta Fault	6.6	40	0.08	0.08	0.11	0.09	0.07	0.09

Seismic Design Parameters

Design seismic parameters are selected herein on the basis of the results provided by probabilistic and deterministic approaches, and in compliance with the recommendations of ICOLD[55].

OBE Acceleration

According to ICOLD guidelines, "Operating Basis Earthquake (OBE) represents the level of ground motion at the dam site at which only minor damage is acceptable. The dam, appurtenant structures and equipment should remain functional and damage easily repairable from the occurrence of

[55] International Commission on Large Dams (ICOLD); Guidelines for selecting seismic parameters for large dams, Paris (1989).

earthquake shaking not exceeding the OBE". Because of its definition, the OBE is best determined by using probabilistic procedures, for instance, such as specifying a 50% probability of not being exceeded in 100 years, the corresponding return period is equal to 144 years. In any case the OBE accelerations are significantly lower than those for MCE.

Figure 10 shows the results of probabilistic analysis for Gulpur Hydropower project obtained through EZ-FRISK software as total hazard in terms of annual frequency of proximity exceedence of peak ground accelerations. The source contribution analysis shows that maximum contribution to total hazard is from Riasi source zone. Keeping in view the proximity of the most critical tectonic feature, the recommended OBE acceleration for the project structures is 0.24g with a return period of 1000 years.

MCE Acceleration

According to ICOLD guidelines, "the MCE is the largest reasonable conceivable earthquake that appears possible along a recognized fault or within a geographically defined tectonic province, under the presently known or presumed tectonic framework". This definition is inspired by that of Seed[56]: "the largest rationally conceivable event that could occur in the tectonics environment in which the project is located". The MCE can be evaluated through a deterministic or a probabilistic procedure. If the probabilistic seismic hazard evaluation is used, the MCE is linked to a very long return period for this event.

For Gulpur Hydropower Project, the most critical tectonic feature controlling the MCE is the Riasi thrust which is causing maximum accelerations at the project site (**Table 5**). Various attenuation relationships give peak horizontal accelerations ranging from 0.41g to 0.59g. For the peak horizontal acceleration associated with MCE, an average value of 0.50g is selected. This value is conservative but selected in view of the proximity of the most critical tectonic structure from the project.

Conclusions and Recommendations

The seismic hazard evaluation for Gulpur Hydropower Project was carried out on the basis of understanding of local tectonic environment, desk studies of faults in the vicinity of the Project and synthesis of available seismological and tectonic data to evaluate the capability of active tectonic features and assigning ground motion associated with them. The main conclusions based on the present study are as follows:

- The project site is located close to the Riasi Thrust which is a branch of MBT, the main source of destructive earthquakes in the Himalayan region.
- The critical surface tectonic features around the Project site are MBT and Riasi thrusts towards east and Dil Jabba Thrust, Kahuta Fault and Jhelum Fault towards west of the Project.
- Historical record shows that earthquakes in this region have caused maximum intensity of VIII-IX several times in the past. The instrumentally recorded seismicity shows that faults in this area are seismically active. Several epicenters of recorded earthquakes can be associated with the known faults of the area.

[56] Seed, H. B.; The selection of design earthquake for critical structures. Bull. Seis. Soc. Am., Vol.72 (1982)

- Seismic hazard evaluation was carried out in accordance with the ICOLD guidelines for selecting seismic design parameters using both probabilistic as well as deterministic approaches.
- The probabilistic approach was used to select the Operating Basis Earthquake (OBE) using the instrumentally recorded earthquake data for the last century. For the project life of 100 years, recommended OBE acceleration is 0.24g.
- Based upon the deterministic evaluation, peak horizontal ground acceleration of 0.50g associated with Maximum Credible Earthquake (MCE) is recommended for the Project.

Annexure 2: Hydrometeorological Data

There are number of meteorological stations within and in the vicinity of the catchment area where data is available for meteorological parameters. These include Sehr Kakota, Plandari, Mangla, Bagh, Rawalakot and Khandar. However, Kotli is the representative station for which meteorological parameters like temperature, precipitation, humidity and evaporation are available since 1952. These climatic parameters are narrated in the following paragraphs.

Temperature

Record of maximum and minimum temperatures at Kotli starting from 1952 are available with Pakistan Meteorological Department. Monthly mean maximum and minimum temperatures are presented in **Tables 1** and **2** respectively. These tables show that average of monthly mean maximum temperature varies between 17.6°C in January to 38.4°C in June, whereas monthly mean minimum temperature ranges between 4.8°C in January and 24.9°C in June.

Table 1: Monthly Mean Maximum Temperature at Kotli (°C)

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Year*
1952	-	-	-	-	-	-	-	32.6	34.3	32.0	26.9	20.1	29.18
1953	16.1	21.2	27.1	31.9	37.2	39.6	33.9	32.5	32.2	30.4	25.0	22.5	29.13
1954	15.2	17.3	24.2	31.8	37.8	39.2	36.1	35.0	32.7	28.3	24.0	20.3	28.49
1955	17.4	22.6	25.5	29.3	32.6	40.8	36.2	30.7	32.2	29.4	26.1	19.1	28.49
1956	17.2	21.9	22.8	30.8	40.1	37.7	31.7	30.0	33.4	27.8	24.3	19.1	28.07
1957	14.6	18.3	22.5	25.6	31.7	37.1	37.4	33.1	32.2	29.4	23.1	17.3	26.86
1958	18.3	20.7	25.3	33.6	35.3	39.3	34.0	32.6	31.7	30.3	25.7	18.8	28.80
1959	16.7	16.7	25.7	30.8	33.7	39.7	32.4	32.5	31.6	30.2	23.2	20.2	27.78
1960	17.7	24.2	21.6	28.8	37.3	40.6	35.6	32.7	33.7	31.9	25.4	20.7	29.18
1961	17.6	16.8	24.8	28.4	35.5	38.8	34.0	33.4	32.3	29.6	22.6	18.4	27.68
1962	18.3	19.9	24.6	30.8	35.9	39.6	36.1	33.9	31.3	30.4	24.8	19.3	28.74
1963	20.3	23.9	23.6	27.7	33.2	39.3	36.1	33.1	32.4	31.8	24.1	21.7	28.93
1964	14.4	19.2	26.9	30.6	34.5	38.2	33.3	32.9	31.7	32.2	26.7	18.9	28.29
1965	18.6	16.4	23.8	24.4	32.8	38.2	35.5	32.9	34.6	31.6	25.5	20.9	27.93
1966	21.2	21.0	24.1	27.8	35.5	37.4	35.3	32.8	30.9	29.6	25.8	20.3	28.48
1967	18.7	21.8	23.4	28.7	34.6	39.4	34.3	32.2	32.8	29.5	23.9	18.4	28.14
1968	15.1	18.2	25.1	31.1	32.9	39.6	34.6	32.8	35.6	29.4	25.0	19.2	28.22
1969	17.4	18.8	28.4	29.4	32.8	40.1	35.0	33.2	33.2	30.6	27.4	23.4	29.14
1970	18.8	20.7	23.4	34.4	38.2	38.1	35.9	32.8	32.2	31.4	25.0	22.5	29.45
1971	18.7	21.3	27.4	32.2	35.2	35.3	32.7	32.3	33.3	31.7	25.7	21.3	28.93
1972	19.1	16.6	24.9	28.9	35.7	39.5	35.5	33.1	32.1	29.7	25.6	18.6	28.28
1973	16.3	20.9	23.2	32.5	36.1	37.2	33.3	37.6	32.6	30.2	26.1	20.0	28.83
1974	16.8	17.6	26.5	32.7	35.6	37.0	34.5	33.9	34.3	32.3	27.0	17.9	28.84
1975	17.3	18.2	23.6	31.0	35.4	37.9	33.2	32.7	32.1	32.2	26.1	21.5	28.43
1976	18.6	16.9	23.2	28.8	35.4	37.3	34.1	30.5	32.2	30.9	27.3	20.7	27.99
1977	16.5	22.9	30.3	30.1	32.8	36.3	32.5	32.3	33.4	31.2	27.2	20.2	28.81
1978	17.6	19.5	21.5	31.1	39.7	38.1	31.5	32.6	32.9	32.1	25.0	22.8	28.70
1979	20.3	19.3	22.1	32.7	33.1	38.8	34.6	33.7	33.6	33.0	27.2	21.4	29.15
1980	17.4	19.2	22.2	32.9	38.3	38.4	33.7	33.7	33.9	31.7	26.0	20.3	28.98
1981	16.4	18.9	21.2	30.9	35.6	38.0	32.7	33.0	32.6	30.5	25.3	21.4	28.04
1982	17.8	15.9	19.1	28.3	30.7	37.1	36.1	32.1	33.3	30.1	23.9	18.3	26.89
1983	16.0	18.6	21.0	25.7	32.2	36.0	34.5	32.5	32.5	29.4	26.2	20.4	27.08
1984	18.8	17.5	27.0	30.2	39.8	39.4	32.6	32.3	31.2	30.7	24.2	18.9	28.55
1985	17.4	23.3	28.5	32.2	39.1	40.7	33.4	33.0	33.1	29.4	23.3	18.6	29.33
1986	18.7	19.2	22.1	29.9	32.3	37.7	32.8	31.7	32.8	29.2	25.2	18.9	27.54
1987	20.4	21.0	23.5	30.8	29.3	37.1	37.3	34.9	34.1	29.8	28.5	22.8	29.13
1988	20.2	22.4	23.2	32.8	38.7	38.0	29.4	32.1	32.3	30.0	25.7	20.2	28.75
1989	17.4	19.0	23.5	29.1	35.7	38.3	34.2	32.5	34.3	31.6	25.2	19.2	28.33

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
1990	19.3	18.7	21.5	28.4	37.1	38.7	33.9	32.1	32.5	29.6	26.4	18.8	28.08
1991	17.0	18.5	23.6	26.6	34.1	37.8	36.7	33.0	31.8	30.3	25.3	19.6	27.86
1992	16.2	19.2	22.5	29.1	33.2	37.7	33.8	32.5	31.5	30.3	24.9	20.5	27.62
1993	16.0	22.7	21.8	31.2	37.6	38.5	33.2	36.1	32.8	33.2	27.1	22.9	29.43
1994	18.5	19.0	27.2	29.0	36.5	39.2	32.7	31.7	32.8	30.2	25.8	17.8	28.37
1995	16.6	18.5	23.4	27.0	35.9	40.1	32.1	31.6	32.6	29.5	24.8	17.6	27.48
Average	**17.65**	**19.64**	**24.11**	**30.00**	**35.27**	**38.44**	**34.15**	**32.85**	**32.76**	**30.56**	**25.44**	**20.04**	**28.42**

Table 2: Monthly Mean Minimum Temperature at Kotli (^{o}C)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
1952	-	-	-	-	-	-	-	22.6	22.4	17.9	10.2	5.2	15.66
1953	4.8	9.6	15.3	18.7	24.1	26.4	24.8	23.1	21.6	16.7	10.1	7.3	16.88
1954	4.9	8.8	12.4	18.7	23.7	26.2	24.4	24.3	22.6	15.5	10.8	4.9	16.43
1955	4.8	7.8	14.8	16.4	20.7	27.0	24.2	23.3	22.1	17.0	9.8	6.3	16.18
1956	5.6	7.5	12.7	18.3	26.1	25.8	23.6	22.7	22.8	17.0	8.9	5.7	16.39
1957	5.0	6.3	11.6	15.2	19.7	24.0	25.8	23.6	21.3	16.9	11.4	6.8	15.63
1958	6.6	7.0	13.1	19.8	22.6	26.2	24.8	22.9	22.3	16.9	8.9	7.1	16.52
1959	5.4	6.6	12.8	17.8	22.0	26.2	23.2	-	23.2	18.3	10.2	5.9	15.60
1960	4.4	9.6	11.3	16.1	23.2	26.8	24.7	24.5	22.2	16.7	9.4	4.3	16.10
1961	5.7	6.1	12.6	16.9	21.9	25.7	24.9	24.3	23.2	16.1	9.5	4.0	15.91
1962	3.8	8.3	12.7	18.5	22.8	25.9	25.7	23.7	21.1	16.1	9.8	5.1	16.13
1963	2.5	9.1	12.1	16.7	20.7	25.4	24.8	24.0	21.3	18.6	11.9	5.2	16.03
1964	3.8	6.9	13.2	17.6	20.7	25.8	24.2	24.6	21.8	16.3	8.5	6.2	15.80
1965	6.5	7.6	11.4	15.0	19.8	24.9	24.6	22.5	21.9	18.4	12.1	4.2	15.74
1966	4.1	9.6	12.5	16.2	21.6	26.1	24.2	23.3	20.6	16.7	9.6	3.2	15.64
1967	3.6	9.2	11.3	16.4	20.9	26.4	24.6	23.5	21.8	16.0	10.8	7.1	15.97
1968	5.1	6.1	11.8	17.2	20.3	25.9	24.7	23.1	22.7	16.2	10.2	5.6	15.74
1969	4.3	7.8	14.5	17.1	20.9	25.1	24.4	24.2	21.4	17.9	11.4	4.3	16.11
1970	4.7	7.7	12.4	20.1	24.2	25.2	24.9	23.9	21.9	18.2	9.3	5.1	16.47
1971	2.9	7.2	13.7	18.9	22.2	24.4	23.9	23.7	20.6	16.7	10.1	4.0	15.69
1972	5.1	5.8	12.8	16.5	22.1	25.6	24.2	23.0	20.6	16.4	11.2	6.9	15.85
1973	4.9	8.9	11.7	18.6	23.8	26.1	24.8	23.9	22.5	16.3	10.1	4.7	16.36
1974	4.3	6.3	13.5	19.7	22.2	22.3	24.5	23.9	21.6	15.7	9.2	6.4	15.80
1975	6.0	6.6	11.6	17.8	21.3	24.5	23.3	23.5	20.9	17.3	8.3	4.9	15.50
1976	5.6	7.7	11.5	16.0	21.7	23.5	24.8	22.4	21.3	16.8	9.7	4.4	15.45
1977	4.5	6.4	14.0	17.8	20.0	24.2	24.2	23.7	21.3	17.9	12.3	7.3	16.13
1978	5.1	7.7	10.7	17.7	24.6	26.1	24.1	23.7	21.1	17.1	11.2	4.9	16.17
1979	5.5	7.6	10.5	19.0	20.3	24.9	25.3	23.0	20.0	16.7	12.6	7.5	16.08
1980	6.5	8.8	11.4	18.3	23.7	25.1	24.1	23.5	20.8	17.3	10.8	6.3	16.38
1981	5.7	8.7	11.5	17.6	22.4	24.5	24.5	23.8	20.5	16.5	9.9	3.6	15.77
1982	5.2	6.6	9.8	15.9	18.8	23.5	24.5	23.4	20.2	16.9	11.2	7.4	15.28
1983	4.4	6.6	10.3	14.6	19.9	22.2	22.5	23.8	22.1	15.0	8.7	4.4	14.54
1984	2.4	5.7	13.5	17.2	24.1	26.3	23.5	23.8	19.8	14.7	9.3	5.1	15.45
1985	6.1	7.2	13.2	16.8	21.0	24.3	23.3	20.9	17.6	11.6	6.2	3.6	14.32
1986	0.2	3.2	6.5	12.7	15.3	20.6	20.0	20.8	20.5	16.1	10.7	5.6	12.68
1987	4.6	7.4	12.2	16.7	18.1	23.0	24.1	23.6	21.6	15.6	8.6	4.6	15.01
1988	6.7	7.9	12.0	19.1	24.5	25.2	24.3	23.6	21.8	15.7	9.9	5.4	16.34
1989	4.2	6.3	11.5	15.3	21.0	24.0	23.9	22.6	21.5	15.7	10.5	6.3	15.23
1990	7.2	7.5	9.9	15.7	22.7	25.1	23.9	23.6	22.8	15.2	10.1	5.2	15.74
1991	4.4	7.8	11.5	14.8	20.3	23.6	24.5	23.6	21.5	14.0	7.9	6.4	15.03
1992	6.0	6.3	10.8	14.4	18.8	23.0	23.8	24.2	20.6	15.4	9.3	6.6	14.93
1993	4.2	8.0	9.2	16.6	-	-	23.4	23.6	21.1	14.7	9.7	4.2	13.47
1994	5.8	6.5	9.5	11.7	15.3	25.1	24.4	24.4	20.3	14.6	9.5	6.4	14.46
1995	3.3	6.6	10.6	14.8	21.3	25.5	24.2	23.8	20.8	16.1	8.3	6.1	15.12
Average	**4.80**	**7.37**	**11.90**	**16.90**	**21.46**	**24.94**	**24.20**	**23.44**	**21.40**	**16.35**	**9.96**	**5.49**	**15.63**

Precipitation

Monthly rainfall data at Kotli is given in **Table 3** which shows an average precipitation of 1,237 mm/year over the period of 1952-2012. Minimum rainfall occurs in November with an average of 24 mm while the maximum rainfall months are July and August with the average values of 266 mm and 270 mm respectively.

Table 3: Mean Monthly Rainfall at Kotli (mm)

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*
1960	62.0	1.5	194.3	47.2	7.6	12.4	349.8	301.8	47.8	0.0	5.3	51.6	1081.3
1961	152.7	94.7	49.0	142.5	34.0	74.2	366.5	250.7	229.6	96.8	29.0	28.2	1547.9
1962	16.0	118.4	60.2	82.5	20.3	56.6	202.7	286.5	129.8	3.6	70.1	70.4	1117.1
1963	0.0	26.2	109.2	136.1	59.4	90.4	238.5	156.0	99.3	7.6	49.5	45.7	1017.9
1964	233.9	29.5	28.7	90.7	44.2	26.9	338.3	278.4	105.9	0.0	10.9	75.2	1262.6
1965	111.0	189.5	77.0	165.4	123.7	29.5	281.7	131.1	10.2	14.0	58.2	7.1	1198.4
1966	0.0	181.6	107.9	57.7	118.4	83.1	321.1	272.3	178.6	120.9	0.5	48.8	1490.9
1967	0.0	127.5	169.9	93.2	30.0	21.8	265.7	317.5	127.8	51.1	11.4	196.1	1412.0
1968	140.2	106.2	80.3	69.3	119.1	54.1	195.3	292.0	104.3	79.0	47.5	39.1	1326.4
1969	26.4	83.1	105.4	108.7	63.0	45.5	267.2	239.0	63.2	40.1	0.0	0.0	1041.6
1970	69.6	48.0	56.1	16.0	29.2	165.4	146.6	356.9	203.5	32.3	0.0	8.1	1131.7
1971	13.7	91.2	11.4	99.8	72.6	243.3	219.2	337.6	17.3	7.9	40.6	5.8	1160.4
1972	84.3	119.4	82.3	51.1	37.6	62.0	326.9	333.5	110.7	31.2	21.3	73.7	1334.0
1973	110.7	100.1	101.6	41.4	69.3	91.7	341.4	466.6	133.4	27.2	0.0	42.9	1526.3
1974	95.4	78.2	50.0	25.4	16.3	125.0	234.8	201.4	43.0	4.9	0.0	53.4	927.8
1975	65.0	97.4	78.5	35.2	62.6	53.5	305.4	370.9	160.1	0.0	0.0	0.0	1228.6
1976	116.9	231.3	124.1	95.7	35.3	83.7	481.5	547.5	149.9	55.4	0.0	8.0	1929.3
1977	175.8	5.9	0.0	96.8	119.7	171.1	279.7	305.8	80.2	54.2	50.1	67.4	1406.7
1978	82.1	31.1	256.6	38.3	16.7	204.0	350.7	510.4	80.2	2.5	52.3	0.0	1624.9
1979	86.3	97.5	203.1	35.8	45.9	62.8	81.5	316.1	55.8	11.4	35.3	33.8	1065.3
1980	65.5	68.4	67.4	17.8	21.3	180.0	105.4	107.1	103.2	55.0	32.2	30.5	853.8
1981	152.4	161.4	328.0	14.0	53.6	21.0	291.4	112.6	49.9	10.2	4.6	0.0	1199.1
1982	106.6	128.9	270.6	252.2	86.0	48.2	189.6	269.4	73.4	33.0	85.6	50.7	1594.2
1983	108.5	101.3	179.7	274.0	53.9	37.6	323.5	490.2	121.9	93.8	0.8	4.6	1789.8
1984	2.0	88.0	67.5	53.6	28.9	85.0	244.6	476.2	86.6	0.0	45.5	39.2	1217.1
1985	71.7	16.3	14.0	65.1	55.4	4.8	453.8	186.0	117.0	72.1	0.0	200.7	1256.9
1986	14.0	125.4	198.6	122.1	30.9	52.2	240.2	216.2	55.0	64.3	93.7	115.8	1328.4
1987	8.6	111.9	100.0	42.1	133.2	41.9	94.2	156.4	59.4	46.8	0.0	0.0	794.5
1988	18.6	102.9	175.0	25.6	6.5	126.0	711.0	301.8	81.6	12.2	0.0	115.2	1676.4
1989	116.8	27.3	141.9	47.4	26.9	45.8	345.2	142.7	47.2	46.2	45.9	61.5	1094.8
1990	35.7	185.5	266.5	36.3	11.4	69.9	247.1	352.7	66.4	28.2	15.7	309.3	1624.7
1991	23.9	127.5	98.3	171.8	20.3	86.7	212.1	263.2	168.8	2.4	0.0	59.3	1234.3
1992	211.4	121.5	236.8	61.6	73.5	45.5	176.5	228.1	212.1	42.0	46.1	9.0	1464.1
1993	63.2	60.0	187.4	33.0	3.0	61.0	169.4	94.0	77.2	1.0	47.0	0.0	796.2
1994	56.2	73.6	56.6	79.9	65.0	161.6	500.0	305.0	25.0	30.0	0.0	152.0	1504.9
1995	66.6	154.0	87.6	77.2	14.0	103.0	387.0	412.5	41.9	45.0	59.0	1.3	1449.1
1996	81.6	126.0	130.7	35.0	71.0	144.2	78.0	337.6	40.8	49.0	2.0	5.0	1100.9
2003	13.7	279.3	85.1	26.6	18.5	104.3	178.8	149.2	99.8	7.1	26.9	26.9	1016.2
2004	137.8	23.2	5.6	78.5	75.2	67.4	165.3	197.5	23.4	38.9	24.9	43.7	881.4
2005	98.1	151.7	96.8	3.8	18.1	21.1	193.5	89.9	51.7	15.8	2.0	0.0	742.5
2006	91.9	50.5	67.1	17.8	63.4	139.5	381.0	308.3	72.6	32.8	57.3	128.7	1410.9
2007	1.3	160.3	247.7	21.1	47.2	100.8	161.3	188.2	64.3	0.0	7.1	4.1	1003.4
2008	156.7	60.2	10.7	120.7	55.6	244.9	265.2	134.4	76.7	68.8	2.5	101.6	1298.0
2009	62.2	97.8	52.6	46.0	5.8	34.5	132.3	142.0	9.7	2.8	33.5	5.6	624.8
2010	21.6	122.2	69.6	15.2	65.8	65.3	304.5	182.1	53.1	55.1	4.3	18.3	977.1
2011	8.9	120.1	152.4	97.8	78.2	132.6	140.2	196.1	217.4	13.2	1.3	0.0	1158.2

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2012	97.3	50.8	11.7	79.0	17.5	39.9	217.4	417.1	168.9	7.6	12.2	91.5	1210.9
Average	**75.2**	**101.2**	**113.9**	**73.3**	**49.5**	**85.6**	**266.0**	**270.8**	**93.5**	**32.2**	**24.1**	**51.7**	**1236.9**

Evaporation

Evaporation data for a number of stations is available including Kotli, Mangla, Sehr Kakota, Khandar, Plandri, Bagh and Palak. However, reservoir evaporation given in Mangla Dam Raising Study is preferred because it has been worked out from the existing reservoir and as such includes all the losses and gains including evaporation. The data is therefore considered representative of the proposed Gulpur Reservoir and hence adopted in the Study. This data is presented in **Table 4**. This table depicts that mean monthly evaporation varies between 46 mm in December to 229 mm in June, while mean annual evaporation is 1,427 mm.

Table 4: Mangla Reservoir Observed Lake Evaporation (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1983	-	-	-	-	-	-	-	-	108	86	65	48	-
1984	59	68	150	187	327	242	110	108	91	93	57	43	1,534
1985	41	82	137	167	287	281	153	113	117	90	62	45	1,575
1986	45	59	93	157	198	244	142	109	118	82	55	33	1,333
1987	44	55	79	154	144	205	186	156	124	94	70	44	1,354
1988	56	80	108	197	275	232	142	117	106	91	46	37	1,487
1989	46	71	100	157	234	224	156	113	121	110	62	36	1,432
1990	52	52	91	151	215	224	154	120	99	85	61	39	1,341
1991	41	58	91	115	190	227	210	142	130	104	70	51	1,428
1992	57	66	131	144	194	211	177	153	76	0	45	40	1,294
1993	60	74	94	126	178	191	165	152	123	94	66	58	1,382
1994	62	65	125	157	209	260	134	103	108	92	46	29	1,391
1995	39	56	102	116	221	235	128	112	133	107	62	44	1,357
1996	60	64	94	181	230	175	180	105	115	103	70	52	1,427
1997	37	71	119	125	197	220	178	121	123	85	53	86	1,415
1998	45	114	91	152	235	272	170	125	104	100	66	38	1,511
1999	38	57	117	203	277	252	156	117	104	90	160	45	1,614
2000	39	62	116	201	226	196	130	119	92	92	65	54	1,390
Average	**48**	**68**	**108**	**158**	**226**	**229**	**157**	**123**	**111**	**89**	**66**	**46**	**1,427**

Streamflow and Sediment Data

A stream gauging station on Punch River is being maintained at Rehman Bridge by SWHP of WAPDA since 1960. Measurements include stream flows and suspended sediment concentrations. Rehman Bridge Gauging Station is located just downstream of Bann Nullah about 5 Km south east of Kotli Town. **Figure 1** shows that between Rehman Bridge gauge site and proposed weir site, there are no major tributary/nallahs joining the main river, thus discharge and sediment data available at Rehman Bridge gauge is considered directly applicable for the Project. The data have been collected up to the year 2002 and used in the present study.

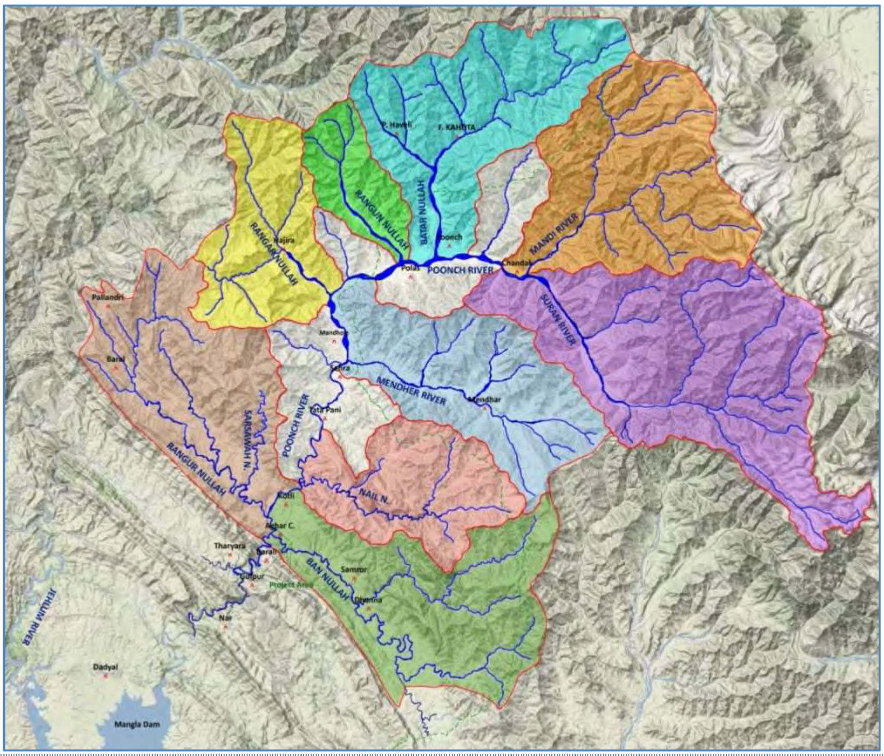


Figure 1: Catchment and Drainage of Poonch River

Annexure 3: Water Availability Study

The objective of water availability study is to assess the magnitude of water for power generation during different periods of the year. This is done by formulating a 10 daily/ monthly time series from the daily mean flow data recorded at Rehman Bridge for the period of record from 1960 to 2002.

Consistency of Data

Before a data set is used for formulation of a time series, it is required that consistency of the record is checked. For this purpose, Basic Screening Procedure of Hydrological Data recommended by Dahmen and Hall[57] has been adopted using a statistical approach to test for absence of trend and for stability of mean and variance of the mean annual flows. From the analysis, it was found that there is no trend and mean as well as variance of annual flows are stable. This shows that the time series of flows recorded at Rehman Bridge is consistent and homogeneous with no obvious trend on mean annual basis.

Inflow Time Series

Streamflow record of Punch River at Rehman Bridge for the period 1960 to 2011 available in the form of mean daily flows has been used for formulation of inflow time series. Mean monthly discharges computed from the mean daily flows are given in **Table 1**, which shows a minimum value of 12 cumecs observed in January 1966 and maximum value of 830 cumecs in September 1992. Mean monthly flows (in cumecs) are graphically shown in **Figure 1** and monthly runoff (in MCM) in **Figure 2**. These figures depict that mean monthly flows vary between 41 cumecs (106 MCM) in November to 264 cumecs (963 MCM) in August.

Table 1: Summary of Mean Monthly Flows of Punch River at Rehman Bridge (1960-2002)

Year	*Mean Monthly Flow (Cumecs)*												*Annual Flow*		
	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Cumecs*	*MCM*	*(MAF)*
1960	38	39	161	113	81	56	330	233	74	30	20	16	100	3,160	2.56
1961	48	97	85	208	75	111	297	238	324	73	51	40	137	4,327	3.51
1962	22	53	78	159	83	70	155	143	122	45	33	32	83	2,617	2.12
1963	23	35	123	138	142	122	212	267	85	19	20	30	102	3,220	2.61
1964	156	85	107	138	87	77	331	361	126	43	21	33	131	4,146	3.36
1965	55	159	129	293	194	146	224	147	61	26	21	15	122	3,851	3.12
1966	12	94	153	143	141	138	239	286	354	120	35	29	145	4,587	3.72
1967	23	69	216	191	127	104	226	254	124	49	29	104	127	4,002	3.24
1968	115	145	160	140	91	103	171	272	68	55	42	26	116	3,666	2.97
1969	27	71	165	137	166	107	189	254	62	52	27	18	107	3,365	2.73
1970	26	33	76	73	53	76	114	297	257	54	23	17	92	2,898	2.35
1971	14	30	42	67	70	186	206	289	84	30	28	21	89	2,817	2.28
1972	27	85	137	106	98	72	181	196	121	60	36	43	97	3,067	2.49
1973	110	144	267	157	97	116	196	456	149	53	26	24	150	4,727	3.83
1974	35	74	101	76	53	119	158	111	45	26	15	17	69	2,180	1.77
1975	17	69	138	132	109	98	213	490	239	55	30	20	135	4,255	3.45
1976	52	190	217	197	151	147	355	665	177	60	31	25	190	5,996	4.86
1977	68	57	61	101	119	119	409	281	141	84	51	66	131	4,120	3.34
1978	74	95	362	201	163	166	452	456	155	67	75	35	193	6,086	4.93
1979	24	68	280	144	91	107	120	219	137	62	52	44	113	3,555	2.88
1980	59	98	168	110	97	147	133	150	75	44	45	33	97	3,054	2.48

57 Dahmen E.R. & M.J. Hall (1990): "Screening of Hydrologic Data", International Institute for Land Reclamation and Improvement (ILRI), Publication 49.

Year	*Mean Monthly Flow (Cumecs)*												*Annual Flow*		
	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Cumecs*	*MCM*	*(MAF)*
1981	74	181	315	217	130	80	293	202	52	36	26	20	136	4,274	3.47
1982	23	53	270	265	190	120	197	324	59	41	53	42	137	4,321	3.50
1983	65	83	283	396	221	143	226	303	194	57	46	25	171	5,380	4.36
1984	20	30	57	104	68	100	130	375	234	63	40	35	105	3,320	2.69
1985	49	54	56	80	78	69	231	219	63	63	45	98	93	2,923	2.37
1986	46	99	304	257	169	148	224	319	86	72	114	171	168	5,302	4.30
1987	70	94	169	160	214	164	110	119	58	79	38	33	109	3,441	2.79
1988	33	50	234	127	71	75	633	353	112	65	45	51	155	4,910	3.98
1989	75	46	142	169	110	91	271	198	84	54	44	42	111	3,508	2.84
1990	54	108	338	180	142	106	162	271	115	49	29	164	144	4,535	3.68
1991	91	193	256	339	120	113	163	124	161	49	30	31	139	4,372	3.54
1992	113	140	277	325	217	149	183	364	830	220	162	144	260	8,215	6.66
1993	143	93	246	189	162	193	324	128	102	36	43	26	141	4,440	3.60
1994	36	68	81	180	141	133	485	427	190	69	41	110	165	5,192	4.21
1995	71	132	180	209	136	134	484	352	103	46	33	35	160	5,051	4.10
1996	77	186	357	203	173	263	193	378	115	70	33	25	173	5,469	4.43
1997	25	26	104	172	100	125	213	482	198	112	86	88	145	4,579	3.71
1998	67	282	380	340	161	94	194	98	72	35	24	22	147	4,621	3.75
1999	54	61	92	84	59	58	108	168	122	54	39	25	77	2,430	1.97
2000	50	73	64	76	75	80	195	277	102	44	31	29	92	2,901	2.35
2001	22	21	27	56	65	133	231	219	93	39	28	20	80	2,524	2.05
2002	33	63	94	80	77	103	81	210	123	39	25	21	79	2,490	2.00
2003	17	293	268	176	63	73	122	106	111	36	26	30	109	3,428	2.78
2004	67	83	53	53	84	70	80	113	59	52	36	42	66	2,086	1.69
2005	64	250	284	191	124	112	199	90	74	53	43	32	126	3,958	3.21
2006	64	89	108	106	116	89	206	346	161	44	68	187	133	4,187	3.40
2007	49	80	402	234	161	156	167	127	74	32	22	19	127	4,018	3.26
2008	77	73	92	145	104	203	193	283	103	48	34	84	120	3,794	3.08
2009	61	135	95	155	107	71	121	140	90	37	30	22	88	2,782	2.26
2010	19	157	140	97	121	98	241	355	128	61	30	24	123	3,868	3.14
2011	25	138	210	203	147	111	109	187	266	105	74	43	134	4,239	3.44
Maximum	**156**	**293**	**402**	**396**	**221**	**263**	**633**	**665**	**830**	**220**	**162**	**187**	**260**	**8215**	**6.66**
Minimum	**12**	**21**	**27**	**53**	**53**	**56**	**80**	**90**	**45**	**19**	**15**	**15**	**66**	**2086**	**1.69**
Runoff	**144**	**272**	**375**	**343**	**168**	**207**	**553**	**575**	**785**	**201**	**147**	**172**	**194**	**6129**	**4.97**
Mean	**53**	**100**	**177**	**165**	**119**	**116**	**225**	**264**	**141**	**57**	**41**	**47**	**126**	**3966**	**3.22**

Remarks: Cumecs: Cubic Meters per Second MCM: Million Cubic Meters MAF:Million Acre-Foot

Figure 1: Mean Monthly Flows of Punch River at Rehman Bridge (1960-2011)

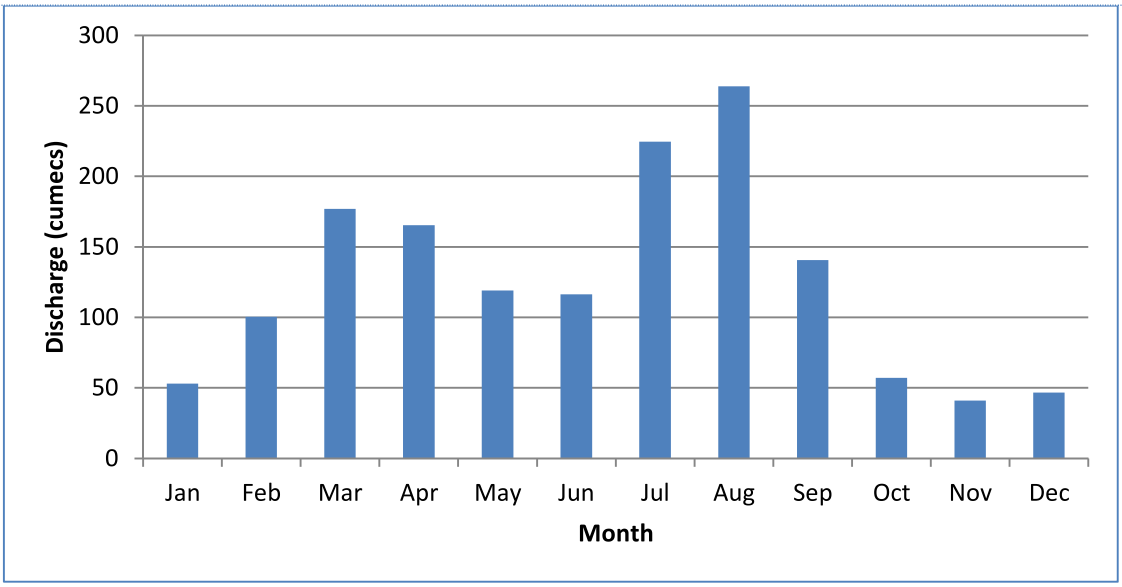


Figure 2: Mean Monthly Runoff of Punch River at Rehman Bridge (1960-2011)

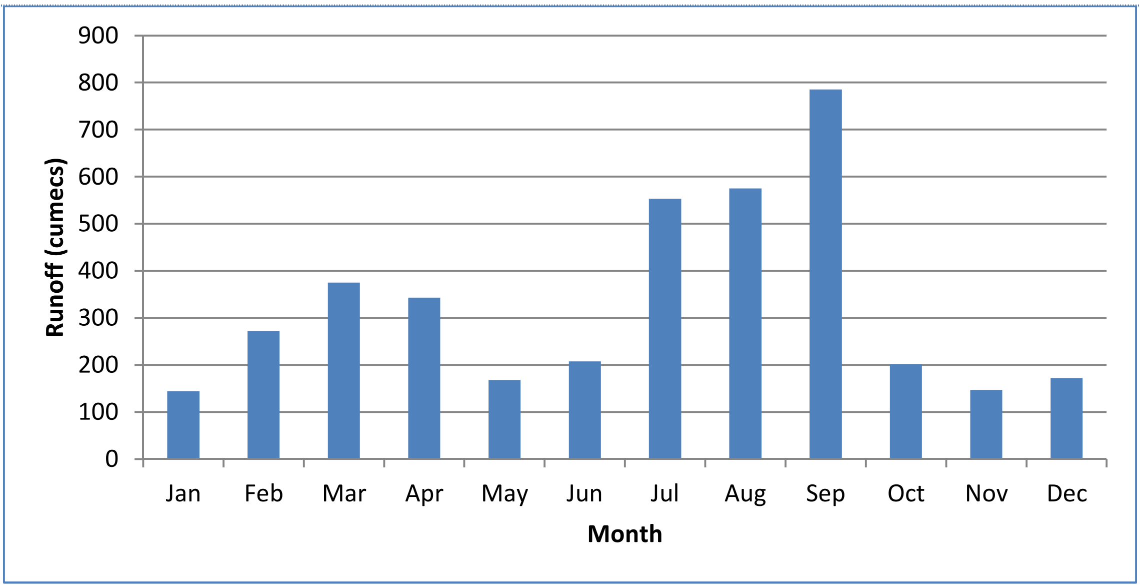
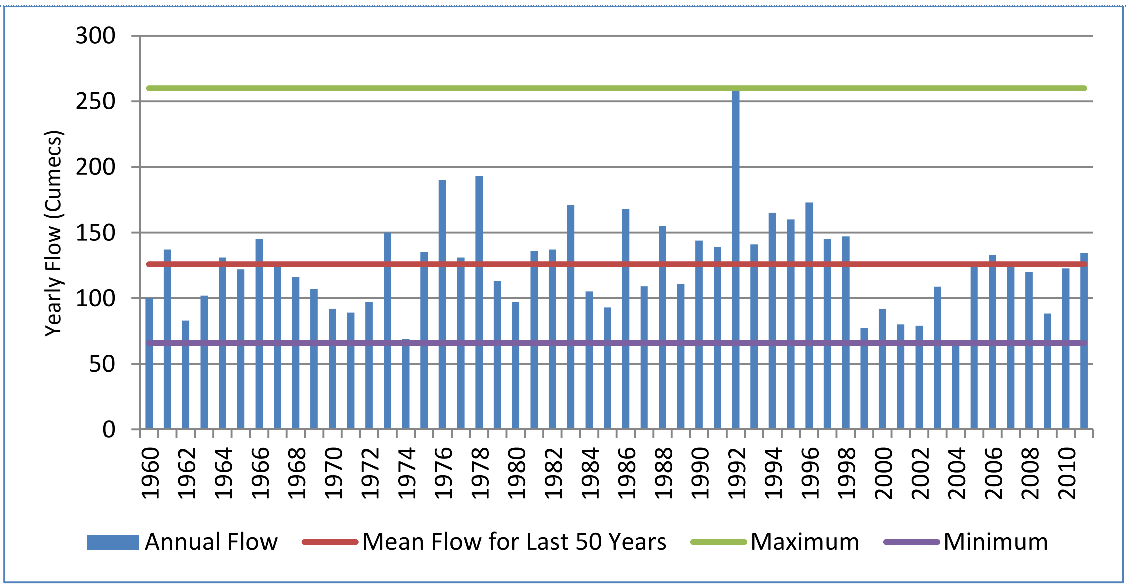


Figure 3: Mean Annual Flows of Punch River at Rehman Bridge (1960-2011)



Mean annual flows also presented in **Table 1** and **Figure 3** show mean annual value of 128 cumecs with corresponding runoff of 4,044 MCM (3.28 MAF). The minimum mean annual flow of 69 cumecs (2,180 MCM) was recorded in 1974 while the maximum mean annual flow of 260 cumecs (8,215 MCM) observed in 1992.

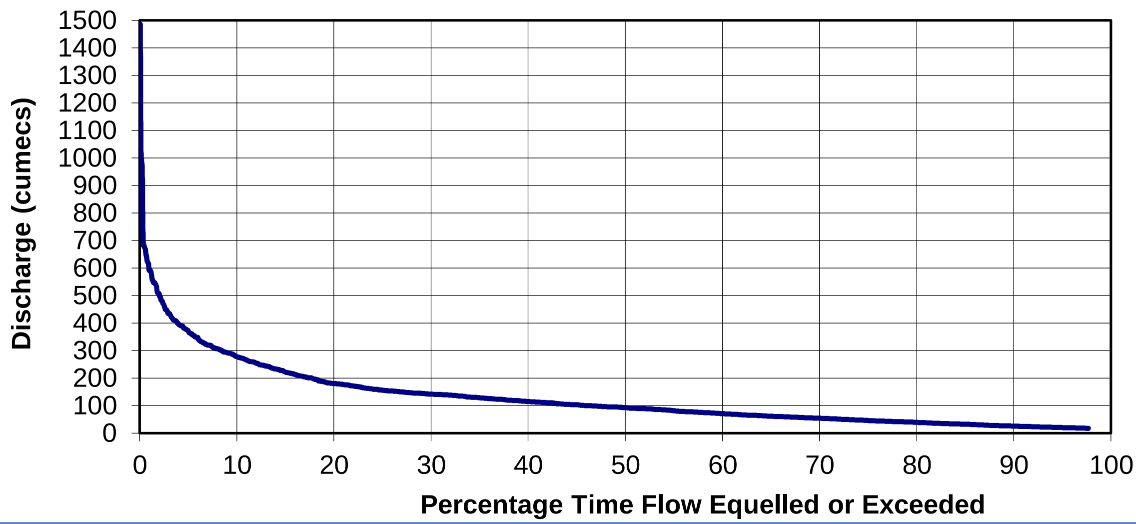
Flow Duration Curve

For possible capacity sizing of a power plant a flow duration data is required to represent time variability of water discharge. A flow duration curve represents relationship between magnitude and frequency of daily, 10 daily or monthly stream flows for a particular river basin at a particular location. This provides estimation of cumulative percentage of time a given streamflow was equaled or exceeded over the given period of time.

In the present study, a flow duration curve has been prepared using 10 daily mean flow time series. The flow duration curve thus developed is presented in **Figure 4**. It can be seen from the curve that flow has following distribution:

Time Exceeded	*10%*	*20%*	*30%*	*40%*	*50%*	*60%*	*70%*	*80%*	*90%*
Flow m^3/s	279	180	142	115	92	71	55	40	26

Figure 4: Flow Duration Curve of Punch River at Rehman Bridge (1960-2002)



Annexure 4: Environmental Monitoring Report

1. Introduction

Sustainable Solutions Pvt. Ltd hired the services of SGS Pakistan (Pvt.) Ltd. to conduct an environmental monitoring at its project sites Azad Jammu & Kashmir. A comprehensive environmental monitoring was conducted at mutually agreed sampling points in the project area. This report is prepared on the basis of assessment conducted at project site. Field survey was carried out on August 26-30, 2013 for ambient air quality monitoring, meteorological conditions, noise level monitoring, lux monitoring and sampling & analysis of drinking water & soil samples from mutually agreed sampling points.

1.1 Study Objectives

The objective of the study is to:

- Comply with the regulatory requirements of the project;
- Monitor air, water, soil, noise level and lux at periodic intervals in project area;
- Ensure effective implementation of EMP.

1.2 Scope of Services

Scope of services covered following main components:

- Ambient Air Quality Monitoring
- Weather Conditions
- Noise Level Monitoring
- Lux Monitoring
- Drinking Water & Soil Sampling & Analysis

1.2.1 Ambient Air Quality Monitoring

In accordance to USEPA National Ambient Air Quality standards (NAAQS) the following priority pollutants were monitored in the ambient air.

- Carbon Monoxide (CO)
- Oxides of Nitrogen (NO_X)
- Sulphur Dioxide (SO_2)
- Particulate Matter (PM_{10})

In addition to above mentioned parameters, the meteorological conditions were also monitored in order to interpret ambient air quality. For the purpose following parameters would be monitored:

- Ambient Temperature
- Relative Humidity
- Barometric Pressure
- Wind Direction
- Wind Velocity

1.2.2 Noise Level Monitoring

Noise level using portable digital sound meter was monitored at same location where the ambient air quality was monitored. The duration of monitoring was according to the standard at sampling points.

1.2.3 Instant Lux Monitoring

Light monitoring was conducted at only one point i.e near community area.

1.2.4 Drinking Water & Soil Sampling

Twenty five drinking water and five soil samples were collected from mutually agreed sampling points and submitted to SGS labs for analysis according to parameters as per contract.

Analysis Parameters and Analysis Methods:

The collected drinking water samples were microbiologically and chemically analyzed according to APHA and USEPA methods.

Table 1a: Drinking Water Analysis Parameters & Methods (Microbiological Analysis)

Sr.#	Parameters	Procedure Reference
01	Total Coli form	APHA-9222 B
02	Total Colony Count	APHA-9215 B
03	Faecal E. Coli	APHA-9222 D
04	Faecal Streptococci/Enterococci	APHA-9230 C

Table 1b: Drinking Water Analysis Parameters & Methods (Chemical Analysis)

Sr.#	Parameter	Method	
		Technique	Reference
01	pH	Electrometric	APHA-4500H^+ B
02	Total Dissolved Solids (TDS)	Gravimetric	APHA-2540 C
03	Total Hardness	Gravimetric	APHA-2540 C
04	Chloride (Cl)	Titration	APHA-4500Cl^- B
05	Alkalinity, Total as $CaCO_3$	Titration	APHA-2320 B
06	Sulphate (SO_4)	Gravimetric	APHA-4500-SO4 C
07	Sodium (Na)	AAS/ICP-OES	APHA-3111/3120 B
08	Potassium (K)	AAS/ICP-OES	APHA-3111/3120 B
09	Iron (Fe) as Total	AAS/ICP-OES	APHA-3111/3120 B
10	*Arsenic (As)	AAS/ICP-OES	APHA-3111/3120 B
11	Lead (Pb)	AAS/ICP-OES	APHA-3111/3120 B

Table 2: Soil Analysis Parameters & Methods (Chemical Analysis)

Sr.#	Parameter	Method	
		Technique	Reference
01	Sulphate $(SO_4)^{2-}$	Gravimetric	In-House
02	Solids, Total dissolved (TDS)	Gravimetric	In-House
03	Cadmium (Cd)	AAS/ICP-OES	USEPA 3050 B
04	Total Phosphorous	Colorimetric	Based on APHA-4500 P C
05	Chromium Total (Cr)	AAS/ICP-OES	USEPA 3050 B

Sr.#	Parameter	Method	
		Technique	Reference
06	Iron (Fe) as Total	AAS/ICP-OES	USEPA 3050 B
07	Aluminium (Al)	AAS/ICP-OES	USEPA 3050 B
08	Lead (Pb)	AAS/ICP-OES	USEPA 3050 B
09	Total Nitrogen	Instrumental	Based on APHA-4500 N_{org} B

Test conducted at Sub Contracted Lab SGS Karachi.

APHA= American Public Health Association

1.3 Schedule

Detailed Environmental monitoring was conducted at the mutually agreed sites in the project area from August 26-30, 2013.

2. Methodology

Following is the brief description of methodology adopted for this environmental assessment:

2.1 Ambient Air Quality Monitoring

Ambient air quality of the selected locations was monitored for the estimation of carbon monoxide, nitrogen dioxide, sulphur dioxide and particulate matter concentrations.

2.1.1 Carbon Monoxide

Carbon monoxide at the project site was monitored using automatic portable analyzer. Measurement range of the analyzer is 1-100 ppm. Continuous data was recorded for duration of 8 hrs and hourly average is reported.

2.1.2 Nitrogen Dioxide

A measured volume of air is bubbled through a solution sample for duration of 8 hrs. The nitrogen dioxide absorbed in the solution is analyzed by colorimeter for NO2 concentration in ambient air.

2.1.3 Sulphur Dioxide

A measured volume of air is bubbled through a solution sample for 8 hrs duration. The solution after bubbling is analyzed by spectrophotometer and amount of SO2 is calculated.

Table 3: Methodology of Ambient Air Quality Monitoring

Air Pollutant	*Monitoring Technique*	*Method*	*Measurement Range*	*Lowest Detection Limit*
Carbon monoxide (CO)	Automatic Potable Analyzer	40 CFR 50, App. C (US-EPA)	1 -100 ppm	1 ppm
Sulfur Dioxide (SO_2)	Calorimetric Improved West & Gaeke (Sod. Tetrachloro Mercurate) Method	40 CFR 50, App. A (US-EPA)	0.01-0.4 ppm 25 ug/m^3 to 1000 ug/m^3	0.01 ppm
Nitrogen Dioxide (NO_2)	Griess Saltzman Method	ISO 6768	0.01-0.4 ppm 25 ug/m^3 to 1000 ug/m3	0.01 ppm
Particulate Matter (PM_{10})	High Volume PM_{10} Sampler	40 CFR 50, App. J (US-EPA)	2 - 750 ug/m^3	2 ug/m^3

2.1.4 Particulate Matter (PM_{10})

Particulate matter concentration in terms of PM10 was monitored in the ambient air with the help of high Volume PM10 sampler. Measurement range of the equipment is 2-750 u.g/m3 with lowest detection limit of 2 ug/m3. PM 10 sampling was conducted for 24 hours at mutually agreed sampling locations with the help of fibreglass filters. The filters were properly stored and placed in the vacuum desiccators and transported to SGS Pakistan (Pvt) Limited Environmental Laboratory for estimation of PM10.

2.2 Meteorological Conditions

In addition to the mutually agreed parameters for ambient air quality, weather conditions were also monitored continuously for 24 hours with the help of mobile weather station. Selection of sampling points was made considering the wind direction at the mutually agreed sampling site.

2.3 Noise Level Monitoring

24 hours noise level monitoring was conducted at mutually agreed locations using portable Digital Sound Meter. Sound Pressure Level (SPL) measurements (in dB) were performed utilizing Sound Level Meter (European Class 1 Standard) complying with standards IEC60051 TYPE 1 IE60804 TYPE 1 JIS C 1505 in accordance to SGS Standard Operating Procedures (SOP).The Noise level monitoring was conducted at mutually agreed monitoring points.

2.4 Instant Lux Monitoring

Instant Lux level using digital lux meter was monitored at mutually agreed sampling point Instant Lux level measurement was performed according to standard operating procedures and obtained results are attached as Annexure-IV of the report.

2.5 Water

Following methodology was adopted for water sampling and analysis:

2.4.1 Sample Collection and Preservation

The water samples were collected from mutually agreed sampling points based on the sampling technique in accordance to the SOP based on the recognized methods of United State Environmental Protection Agency (USEPA) and American Public Health Association (APHA) for water sampling and analysis. The collected water samples were preserved in appropriate containers as per APHA Guidelines. A shipping container (Ice box with eutectic cold packs instead of ice) with maintained temperature of 4° C ±5 °C was used for transporting the samples from the collection site to the SGS environmental laboratory.

2.4.2 Sample Identification and Chain of Custody

The collected samples were labelled and assigned a unique sample identification number, sampling date and time of collection. All the relevant information (sample location, time of collection, sample identification, temperature, pH, collected by, preservation techniques etc) was recorded immediately on the Chain of Custody form signed by SGS field Analyst.

2.4.3 Analysis Methods

Water & soil samples were collected from mutually agreed locations and were analyzed for parameters using APHA and USEPA methods for water analysis. Detail of parameters and analysis methods are described in 1.2.4 section of the report.

3. Results and Discussion

SGS Pakistan (Pvt.) Ltd. conducted a comprehensive environmental monitoring at mutually agreed sampling points. Scope of this assessment covered monitoring of ambient air quality, weather conditions, noise level monitoring, lux monitoring and sampling and analysis of drinking water & soil from mutually agreed sampling points. The monitoring and analysis results are given as Annexure I to VI.

The results of ambient air quality monitored are given in Annexure-II of the report. National Environmental Quality Standards (NEQS) for Ambient Air given in Table 4 are used for comparison.

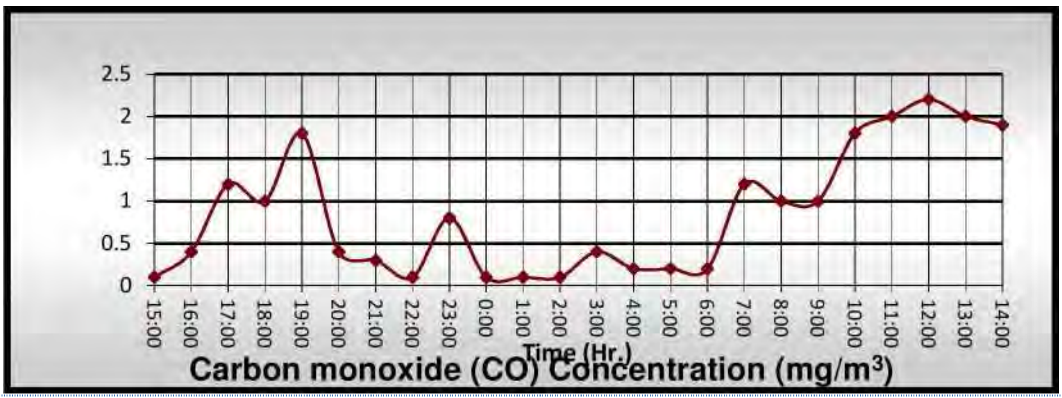
Table 4: National Environmental Quality Standards (NEQS) for Ambient Air

Pollutants	*Time-Weighted Average*	*Effective from 1st July 2010*	*Effective from 1st January 2013*
SO2	Annual Average*	80 ug/m^3	80 ug/m^3
	24 hrs**	120 ug/m^3	120 ug/m^3
NO2	Annual Average*	40 ug/m^3	40 ug/m^3
	24hrs**	80 ug/m^3	80 ug/m^3
Respirable Particulate Matter (PM_{10})	Annual Average*	200 ug/m^3	120 ug/m^3
	24 hrs**	250 ug/m^3	150 ug/m^3
	24 hrs**	40 ug/m^3	35 ug/m^3
Carbon Monoxide (CO)	8hrs**	5 mg/m^3	5 mg/m^3
	1 hr	10 mg/m^3	10 mg/m^3

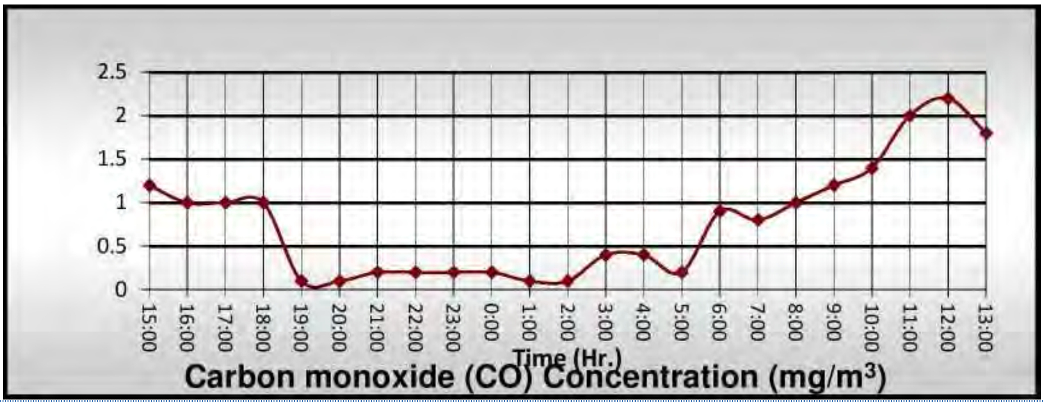
*Annual arithmetic mean of minimum 104 measurements in a year, taken twice a week 24 hourly at uniform interval.

**24 hourly/ 8 hourly values should be met 98% of the year 2% of the time. It may exceed but not on two consecutive days.

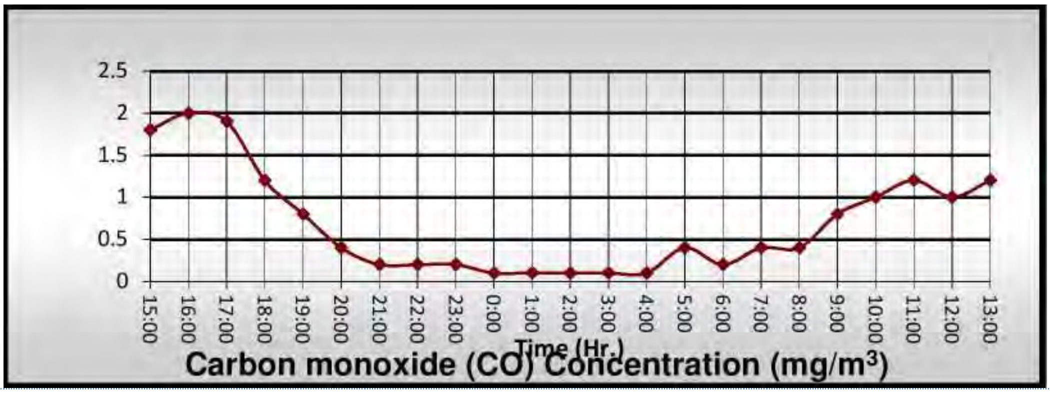
The average concentration of carbon monoxide (CO) for 08 hrs according to the National Environmental Quality Standards (NEQS) for Ambient Air should not exceed from 5.0 mg/m3. The values obtained are in compliance with National Environmental Quality Standards (NEQS). Graph 1, 2, 3 and 4 shows prevailing concentrations of CO in mg/m3 at project site during 24 hrs of monitoring.



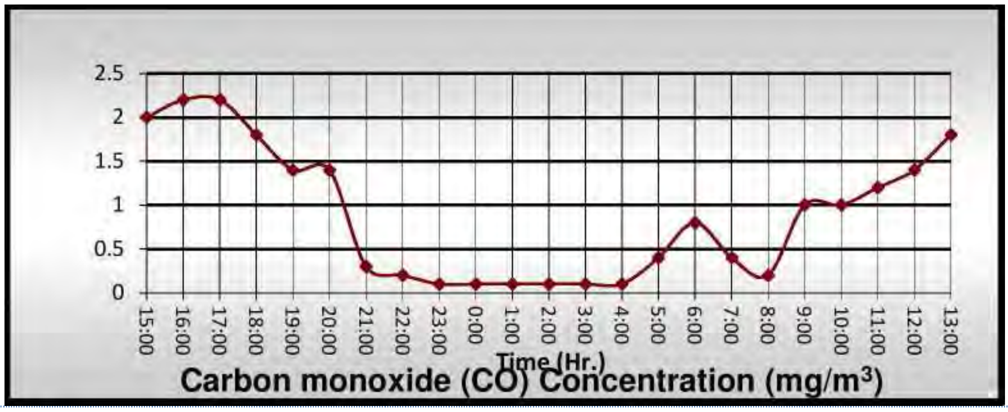
Graph 1: CO Concentration during 24 Hrs. Monitoring at Proposed Power House Site



Graph 2: CO Concentration during 24 Hrs. Monitoring at Proposed Camp Area



Graph 3: CO Concentration during 24 Hrs. Monitoring at Weir Site



Graph 4: CO Concentration during 24 Hrs. Monitoring at Proposed Batching Plant Site

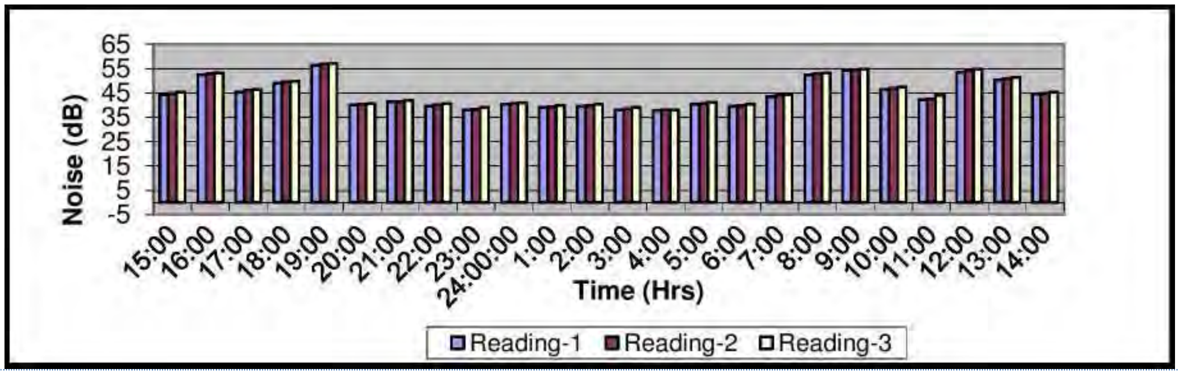
Average 24 hrs concentrations in Environmental Quality Standards (NEQS) for Ambient Air for Nitrogen Dioxide (NO2) is 80 ug/m^3 and average concentrations of Nitrogen Dioxide (NO_2) measured during monitoring were found in compliance with National Environmental Quality Standards. According to standard the 24 hrs concentration of Sulphur Dioxide (SO_2) in ambient air should not exceed from 120 ug/m^3, while concentration obtained was found within limit of National Environmental Quality Standards (NEQS).

The ambient particulate matter PM10 was found 97.14 ug/m^3 at proposed power house site, 87.90ug/m3 at proposed camp area, 75.19 ug/m^3 at proposed weir site and 66.77ug/m3 at proposed batching plant are within standard value of 150 ug/m^3.

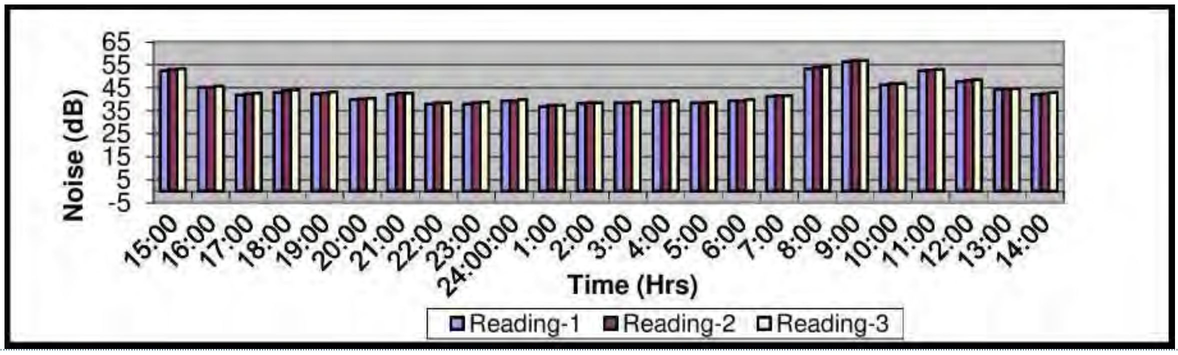
Table 5: Average Obtained Concentrations of Priority Pollutants

Parameter	*Unit*	*LDL*	*Proposed Power House Site*	*Proposed Camp Area*	*Proposed Weir Site*	*Proposed Batching Plant*
Nitrogen Dioxide (NO_2)	ug/m^3	5.0	<5.0	<5.0	<5.0	<5.0
Sulphur Dioxide (SO_2)	ug/m^3	5.0	<5.0	<5.0	<5.0	<5.0
Carbon Monoxide (CO)	mg/m^3	0.01	0.85	0.82	0.72	0.93
Particulate Matter (PM_{10})	ug/m^3	2.00	97.14	87.90	75.19	66.77

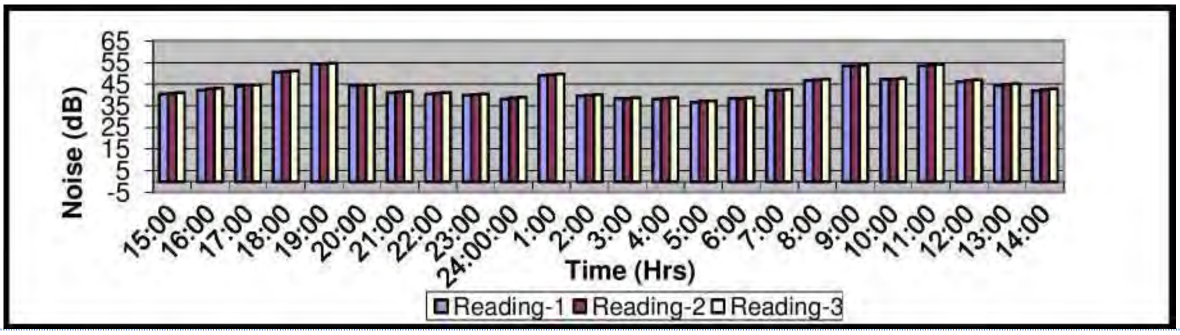
Noise level monitoring was conducted at the same location where the ambient air quality was monitored. Results were attached as Annexure-lll of the report. The noise level was found in range of 59.7 to 68.1 (dB.A) at proposed power house site, 37.0 to 57.0 (dB.A) at proposed camp site, 37.3 to 54.8 (dB.A) at proposed weir site and 35.9 to 48.9 (dB.A) at proposed batching plant. Graph 5, 6, 7 and 8 shows the values obtained during noise level monitoring at project sites respectively.



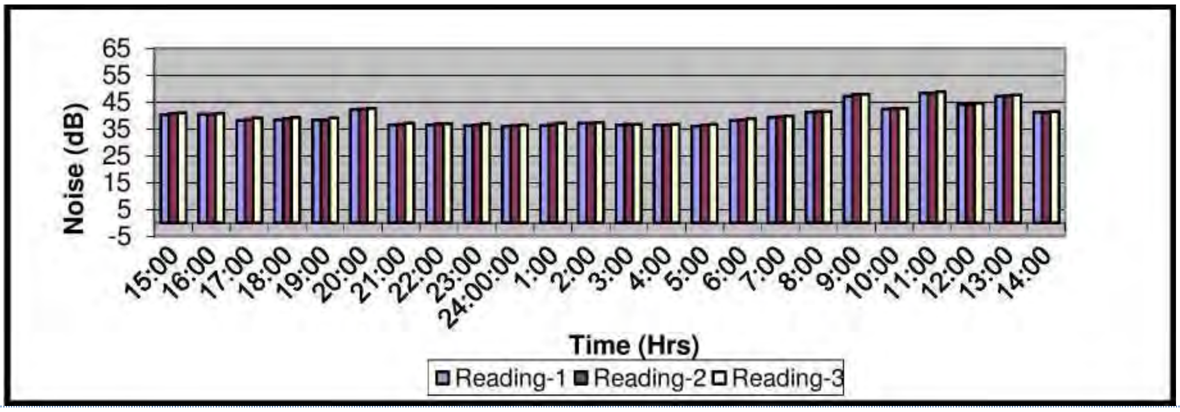
Graph 5: Variation of Noise with Time at Proposed Power house Site



Graph 6: Variation of Noise with Time at Proposed Camp Area



Graph 7: Variation of Noise with Time at Proposed Weir Site



Graph 8: Variation of Noise with Time at Proposed Batching Plant

Lux monitoring was also monitored from mutually agreed source. The monitoring results are tabulated as Annexure-IV.

Twenty five drinking water & five soil samples were also collected and submitted to SGS labs for the analysis as per contract. The analysis results are attached as Annexure -V & Annexure VI of the report.

4. Meteorological Data

4.1 Meteorological Data

- Client : Sustainable Solutions Pvt. Ltd
- Sampling Point : Proposed Power House Site
- Date of Intervention : August 26 & 27, 2013

Time	Temperature	Wind Direction	Wind Speed	Humidity	Barometric Pressure
	°C		m/s	%	mm of Hg
15:00	34	W	5.4	63	742.1
16:00	34	W	4.3	60	742.3
17:00	33	W	4.7	58	741.4
18:00	32	WE	5.9	68	741.8
19:00	30	WE	5	70	741.3
20:00	30	WE	3.8	72	741
21:00	29	W	3	78	742.2
22:00	28	W	4.7	79	742.7
23:00	28	W	5.8	80	742.8
24:00	27	W	5.3	84	742.6
01:00	26	W	4.8	80	742.5
02:00	25	W	4.6	78	742.9
03:00	24	W	4.2	65	742.4
04:00	24	WE	4	63	742
05:00	26	WE	4.8	62	742.1
06:00	26	WE	5.3	60	742.5
07:00	26	WE	4.9	58	742.7
08:00	27	W	4.5	57	742.3
09:00	28	W	3	55	742.4
10:00	30	W	3.8	53	742.7
11:00	30	WE	3.1	52	742.8
12:00	30	WE	3	50	742.6
13:00	33	W	2.9	48	742.8
14:00	33	W	3.8	45	742.9

4.2 Meteorological Data

- Client : Sustainable Solutions Pvt. Ltd
- Sampling Point : Proposed Camp Area
- Date of Intervention : August 27 & 28, 2013

Time	Temperature	Wind Direction	Wind Speed	Humidity	Barometric Pressure
	°C		m/s	%	mm of Hg
15:00	36	W	2.7	52	740.3
16:00	36	W	2.8	55	740.8
17:00	34	W	4.5	54	740.1
18:00	34	WE	4.9	57	741.0
19:00	32	E	5.2	58	741.8
20:00	30	E	5.0	58	741.6
21:00	28	W	4.6	59	741.2
22:00	27	E	3.8	63	742.0
23:00	26	E	2.0	64	742.8
24:00	26	E	1.8	66	741.6
01:00	24	WE	1.8	67	741.5
02:00	24	E	1.3	69	741.1
03:00	23	E	1.0	75	741.7
04:00	22	E	0.8	74	741.3
05:00	20	WE	2.4	78	740.6
06:00	20	W	2.8	78	740.4
07:00	20	W	3.7	82	740.9
08:00	21	W	2.2	80	741.2
09:00	22	WE	4.0	64	741.7
10:00	24	WE	4.3	62	742.0
11:00	26	WE	5.3	60	742.3
12:00	27	W	5.0	55	742.9
13:00	30	W	5.1	52	742.1
14:00	32	W	4.7	50	742.8

4.3 Meteorological Data

- Client : Sustainable Solutions Pvt. Ltd
- Sampling Point : Proposed Weir Site
- Date of Intervention : August 28 & 29, 2013

Time	Temperature	Wind Direction	Wind Speed	Humidity	Barometric Pressure
	°C		m/s	%	mm of Hg
15:00	36	N	5.3	40	742.7
16:00	36	N	4.6	45	742.1
17:00	37	N	5.5	48	742.0
18:00	34	NW	4.0	52	742.5
19:00	33	N	3.8	52	742.9
20:00	30	N	1.0	53	742.8
21:00	27	N	3.2	55	742.7
22:00	26	N	1.8	57	742.6
23:00	25	N	1.4	60	742.3
24:00	24	NW	2.4	61	742.2
01:00	24	NW	2.2	63	742.8
02:00	23	NW	2.0	64	742.4
03:00	23	N	1.7	68	742.6
04:00	22	N	2.8	67	742.0
05:00	22	N	2.2	65	742.3
06:00	22	N	5.0	64	742.8
07:00	24	N	4.2	63	743.3
08:00	28	N	3.9	61	743.2
09:00	31	NE	3.5	59	743.6
10:00	32	NE	3.0	58	743.8
11:00	33	N	4.6	57	743.9
12:00	34	N	5.1	55	744.0
13:00	35	NE	5.4	53	744.5
14:00	36	NE	4.8	52	744.4

4.4 Meteorological Data

- Client : Sustainable Solutions Pvt. Ltd
- Sampling Point : Proposed Batching Plant
- Date of Intervention : August 29 & 30, 2013

Time	Temperature	Wind Direction	Wind Speed	Humidity	Barometric Pressure
	°C		m/s	%	mm of Hg
15:00	37	E	2.8	42	740.8
16:00	36	E	2.4	43	740.0
17:00	36	E	4.5	45	740.4
18:00	33	E	4.3	46	741.0
19:00	30	E	4.0	48	741.3
20:00	29	E	5.2	53	741.9
21:00	28	NE	5.4	56	740.7
22:00	26	NE	4.8	58	740.8
23:00	25	NE	3.1	59	740.6
24:00	24	E	2.0	60	740.9
01:00	23	E	1.9	62	740.2
02:00	22	E	1.4	63	740.5
03:00	21	E	0.9	65	742.8
04:00	20	E	1.8	68	742.3
05:00	22	E	1.2	69	742.7
06:00	24	NE	1.1	66	742.0
07:00	25	NE	2.6	64	741.9
08:00	28	NE	2.8	63	741.8
09:00	29	NE	3.5	60	741.6
10:00	29	E	4.8	57	741.7
11:00	30	E	4.6	56	741.5
12:00	32	E	4.0	55	741.9
13:00	34	E	4.4	54	741.4
14:00	34	E	4.1	52	741.8

5. Ambient Air Quality Monitoring Data

5.1 Ambient Air Quality

- Client : Sustainable Solutions Pvt. Ltd.
- Sampling Point : Proposed Power House Site
- Date of Intervention : August 26-27, 2013

Parameter	Unit	Duration	LDL	Average Obtained Concentration
Carbon Monoxide (CO)	mg/m^3	24 Hours	0.01	0.85
Nitrogen Dioxide(NO_2)	ug/m^3	24 Hours	5.0	<5.0
Sulfur Dioxide (SO_2)	ug/m^3	24 Hours	5.0	<5.0
Particulate Matter (PM_{10})	ug/m^3	24 Hours	2.00	97.14

ug/m^3: micrograms per cubic meter
mg/m^3: milligram per cubic meter
LDL: Lowest Detection Limit

5.2 Ambient Air Quality

- Client : Sustainable Solutions Pvt. Ltd.
- Sampling Point : Proposed Camp Area
- Date of Intervention : August 27-28, 2013

• Parameter	Unit	Duration	LDL	Average Obtained Concentration
Carbon Monoxide (CO)	mg/m^3	24 Hours	0.01	0.82
Nitrogen Dioxide(NO_2)	ug/m^3	24 Hours	5.0	<5.0
Sulfur Dioxide (SO_2)	ug/m^3	24 Hours	5.0	<5.0
Particulate Matter (PM_{10})	ug/m^3	24 Hours	2.00	87.90

ug/m^3: micrograms per cubic meter
mg/m^3: milligram per cubic meter
LDL: Lowest Detection Limit

5.3 Ambient Air Quality

- Client : Sustainable Solutions Pvt. Ltd.
- Sampling Point : Proposed Weir Site
- Date of Intervention : August 28-29, 2013

Parameter	Unit	Duration	LDL	Average Obtained Concentration
Carbon Monoxide (CO)	mg/m^3	24 Hours	0.01	0.72
Nitrogen Dioxide(NO_2)	ug/m^3	24 Hours	5.0	<5.0
Sulfur Dioxide (SO_2)	ug/m^3	24 Hours	5.0	<5.0
Particulate Matter (PM_{10})	ug/m^3	24 Hours	2.00	75.19

ug/m^3: micrograms per cubic meter
mg/m^3: milligram per cubic meter
LDL: Lowest Detection Limit

5.4 Ambient Air Quality

- Client : Sustainable Solutions Pvt. Ltd.
- Sampling Point : Proposed Batching Plant
- Date of Intervention : August 29-30, 2013

Parameter	Unit	Duration	LDL	Average Obtained Concentration
Carbon Monoxide (CO)	mg/m^3	24 Hours	0.01	0.93
Nitrogen Dioxide(NO_2)	ug/m^3	24 Hours	5.0	<5.0
Sulfur Dioxide (SO_2)	ug/m^3	24 Hours	5.0	<5.0
Particulate Matter (PM_{10})	ug/m^3	24 Hours	2.00	66.77

ug/m^3: micrograms per cubic meter
mg/m^3: milligram per cubic meter
LDL: Lowest Detection Limit

6. Noise Level Monitoring Data

6.1 Noise Level Monitoring

- Client : Sustainable Solutions Pvt. Ltd.
- Sampling Point : Proposed Powerhouse Site
- Date of Intervention : September 26-27, 2013

Sr.#	Time (Hrs)	Reading 1 (dBA)	Reading 2 (dBA)	Reading 3 (dBA)
1.	15:00	44.2	44.8	45.3
2.	16:00	52.5	52.9	53.3
3.	17:00	45.4	46.0	46.3
4.	18:00	49.1	49.6	49.8
5.	19:00	56.3	56.8	57.1
6.	20:00	40.1	40.4	40.6
7.	21:00	41.3	41.5	41.9
8.	22:00	39.5	40.2	40.6
9.	23:00	38.0	38.3	39.1
10.	24:00	40.3	40.5	40.9
11.	01:00	39.1	39.4	39.8
12.	02:00	39.5	39.9	40.3
13.	03:00	38.0	38.4	39.0
14.	04:00	37.8	38.1	38.0
15.	05:00	40.3	40.6	41.1
16.	06:00	39.5	39.9	40.4
17.	07:00	43.4	43.9	44.3
18.	08:00	52.5	52.9	53.3
19.	09:00	54.1	54.5	54.8
20.	10:00	46.3	46.9	47.4
21.	11:00	42.1	42.5	43.9
22.	12:00	53.5	54.1	54.8
23.	13:00	50.3	50.9	51.4
24.	14:00	44.5	44.8	45.3

6.2 Noise Level Monitoring

- Client : Sustainable Solutions Pvt. Ltd.
- Sampling Point : Proposed Camp Area
- Date of Intervention : September 27-28, 2013

Sr.#	Time (Hrs)	Reading 1 (dBA)	Reading 2 (dBA)	Reading 3 (dBA)
1.	15:00	52.4	53.0	53.2
2.	16:00	45.1	45.3	45.8
3.	17:00	42.0	42.5	42.6
4.	18:00	43.1	43.8	44.0
5.	19:00	42.5	42.6	43.2
6.	20:00	39.8	40.2	40.4
7.	21:00	42.3	42.6	42.8
8.	22:00	38.1	38.4	38.6
9.	23:00	38.0	38.6	38.7
10.	24:00	39.3	39.4	39.8
11.	01:00	37.0	37.3	37.5
12.	02:00	38.2	38.4	38.6
13.	03:00	38.4	38.5	38.9
14.	04:00	39.0	39.1	39.3
15.	05:00	38.4	38.6	38.8
16.	06:00	39.4	39.5	39.8
17.	07:00	41.2	41.5	41.7
18.	08:00	53.4	53.9	54.1
19.	09:00	56.3	56.9	57.0
20.	10:00	46.4	46.8	46.9
21.	11:00	52.4	52.7	53.0
22.	12:00	47.8	48.3	48.5
23.	13:00	44.3	44.6	44.7
24.	14:00	42.3	42.5	42.9

6.3 Noise Level Monitoring

- Client : Sustainable Solutions Pvt. Ltd.
- Sampling Point : Proposed Weir Site
- Date of Intervention : September 28-29, 2013

Sr.#	Time (Hrs)	Reading 1 (dBA)	Reading 2 (dBA)	Reading 3 (dBA)
1.	15:00	40.5	40.7	41.0
2.	16:00	42.3	42.8	43.1
3.	17:00	44.1	44.5	44.6
4.	18:00	50.7	50.9	51.3
5.	19:00	54.4	54.5	54.8
6.	20:00	44.3	44.6	44.7
7.	21:00	41.0	41.4	41.6
8.	22:00	40.4	40.8	41.2
9.	23:00	39.8	40.3	40.5
10.	24:00	38.1	38.6	38.9
11.	01:00	49.1	49.4	49.6
12.	02:00	39.5	39.9	40.3
13.	03:00	38.4	38.5	38.7
14.	04:00	38.0	38.4	38.6
15.	05:00	36.7	37.2	37.3
16.	06:00	38.3	38.5	38.8
17.	07:00	42.3	42.4	42.7
18.	08:00	46.7	46.9	47.2
19.	09:00	53.4	53.6	53.9
20.	10:00	47.2	47.3	47.7
21.	11:00	53.4	53.7	54.0
22.	12:00	46.2	46.8	47.1
23.	13:00	44.3	44.9	45.3
24.	14:00	42.1	42.5	42.8

6.4 Noise Level Monitoring

- Client : Sustainable Solutions Pvt. Ltd.
- Sampling Point : Proposed Batching Plant
- Date of Intervention : September 29-30, 2013

Sr.#	Time (Hrs)	Reading 1 (dBA)	Reading 2 (dBA)	Reading 3 (dBA)
1.	15:00	40.3	40.7	41.0
2.	16:00	40.5	40.6	40.8
3.	17:00	38.1	38.7	39.2
4.	18:00	38.5	38.9	39.4
5.	19:00	38.3	38.5	39.1
6.	20:00	42.3	42.5	42.7
7.	21:00	36.4	36.8	37.1
8.	22:00	36.5	36.9	37.0
9.	23:00	36.3	36.5	37.0
10.	24:00	35.9	36.2	36.5
11.	01:00	36.2	36.8	37.1
12.	02:00	37.1	37.2	37.5
13.	03:00	36.5	36.7	36.8
14.	04:00	36.4	36.6	36.8
15.	05:00	36.0	36.4	36.7
16.	06:00	38.2	38.5	38.9
17.	07:00	39.4	39.7	39.9
18.	08:00	41.2	41.4	41.5
19.	09:00	47.2	47.9	47.9
20.	10:00	42.4	42.6	42.8
21.	11:00	48.4	48.5	48.9
22.	12:00	44.2	44.2	44.7
23.	13:00	47.3	47.5	47.8
24.	14:00	41.2	41.3	41.6

7. Instant Lux Monitoring

7.1 Light Monitoring Report

- Client : Sustainable Solutions Pvt. Ltd.
- Monitoring Date : August 30, 2013
- Place of Intervention : Kotli Azad Jammu & Kashmir

Sr. #	Sampling Point	Method / Technique	Unit	Results
01.	Near Community Area	Illuminance Meter	LUX	1165

8. Water Analysis Report

8.1a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): M.Asif S/O M. Sadiq (Gulhar Colony)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	2.9×10^5
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	8
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	4

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.1b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): M.Asif S/O M. Sadiq (Gulhar Colony)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^+ B	-	0.1	7.57	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	427.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	346.5	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	324.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^- B	mg/L	0.5	29.35	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	27.16	NS
07	Lead (Pb $)^{+2}$	APHA-3111 B	mg/L	0.01	<0.01	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.022	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	31.10	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	2.52	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.2a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Mr. Abdullah S/O M. Hussain (Gulhar Colony)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$1.6x10^3$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	2
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	Absent

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.2b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Mr. Abdullah S/O M. Hussain (Gulhar Colony)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H$^+$ B	-	0.1	7.61	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	410.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	356.4	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	313.2	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl$^-$ B	mg/L	0.5	24.46	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	23.87	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	0.037	≤0.05
08	Arsenic (As)$^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as (Fe)$^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.02	NS
10	Sodium (Na)$^{+1}$	APHA-3111 B	mg/L	1.0	31.94	NS
11	Potassium (K)$^{+1}$	APHA-3111 B	mg/L	0.2	2.515	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.3a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Mr. Waseem S/O Abdul Karim (Gulhar Colony)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	2.1×10^4
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	6
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	2

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.3b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Mr. Waseem S/O Abdul Karim (Gulhar Colony)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^+ B	-	0.1	7.64	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	424.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	366.3	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	324.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^- B	mg/L	0.5	29.35	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	27.16	NS
07	Lead (Pb $)^{+2}$	APHA-3111 B	mg/L	0.01	0.061	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.033	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	32.76	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	2.619	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.4a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Mr. lrshad S/O M. Nazir (Gulhar Colony)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$1.7x10^5$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	7
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	1

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.4b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Mr. Irshad S/O M. Nazir (Gulhar Colony)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H$^+$ B	-	0.1	7.58	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	726.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	514.8	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	486.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl$^-$ B	mg/L	0.5	53.81	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	53.50	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	0.061	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	<0.02	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	82.12	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	9.282	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.5a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Mr. Afaq S/O Mr. Haider (Gulhar Colony)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$3.9x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	58
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	Absent

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.5b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Mr. Afaq S/O Mr. Haider (Gulhar Colony)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^{+} B	-	0.1	7.55	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	701.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	475.2	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	464.4	NS
05	Chloride (Cl)$^{-1}$	APHA-4500Cl^{-} B	mg/L	0.5	48.92	<250
06	Sulfate (SO4)$^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	61.17	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	<0.01	≤0.05
08	Arsenic (As)$^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as (Fe)$^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.052	NS
10	Sodium (Na)$^{+1}$	APHA-3111 B	mg/L	1.0	81.28	NS
11	Potassium (K)$^{+1}$	APHA-3111 B	mg/L	0.2	8.716	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.6a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Barali Spring
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$2.9x10^5$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	56
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	41
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	Absent

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.6b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Barali Spring
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^+ B	-	0.1	7.66	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	640.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	405.9	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	486.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^- B	mg/L	0.5	19.56	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	41.57	NS
07	Lead (Pb $)^{+2}$	APHA-3111 B	mg/L	0.01	0.027	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.033	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	83.76	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	3.869	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.7a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Barali (Spring Neeara)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$4.2x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	49
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	2

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.7b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Barali (Spring Neeara)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H$^+$ B	-	0.1	7.70	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	618.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	425.7	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	507.6	NS
05	Chloride (Cl)$^{-1}$	APHA-4500Cl$^-$ B	mg/L	0.5	19.56	<250
06	Sulfate (SO4)$^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	47.33	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	<0.01	≤0.05
08	Arsenic (As)$^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as (Fe)$^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.041	NS
10	Sodium (Na)$^{+1}$	APHA-3111 B	mg/L	1.0	83.60	NS
11	Potassium (K)$^{+1}$	APHA-3111 B	mg/L	0.2	3.805	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.8a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Dharang Spring
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$2.8x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	79
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	2
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	16

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.8b CHEMICAL LABORATORY TEST REPORT

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Dharang Spring
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H$^+$ B	-	0.1	7.68	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	832.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	356.4	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	378.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl$^-$ B	mg/L	0.5	127.19	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	171.63	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	0.021	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	0.034	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.700	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	191.85	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	7.026	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.9a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): M. Shafiq S/O M. Usman (Dharang)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$7.3x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	64
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	12

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.9b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): M. Shafiq S/O M. Usman (Dharang)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^{+} B	-	0.1	7.79	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	716.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	504.9	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	399.6	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^{-} B	mg/L	0.5	58.70	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	49.39	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	0.052	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.038	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	56.64	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	4.995	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.10a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Mr. Haider S/O M. Abdullah (Dharang)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$1.5x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	37
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	8

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.10b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Mr. Haider S/O M. Abdullah (Dharang)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^+ B	-	0.1	7.81	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	698.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	495.0	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	378.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^- B	mg/L	0.5	53.81	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	51.45	NS
07	Lead (Pb $)^{+2}$	APHA-3111 B	mg/L	0.01	0.025	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.029	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	57.06	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	5.00	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.11a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Mandi Juzvi (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$1.1x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	45
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	11

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.11b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Mandi Juzvi (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H$^+$ B	-	0.1	7.69	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	595.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	455.4	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	351.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl$^-$ B	mg/L	0.5	44.02	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	48.56	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	0.040	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.075	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	47.74	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	4.912	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.12a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Mandi Juzvi (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	9.9×10^4
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	52
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	24

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.12b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Mandi Juzvi (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^+ B	-	0.1	7.16	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	590.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	455.4	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	356.4	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^- B	mg/L	0.5	39.13	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	59.68	NS
07	Lead (Pb $)^{+2}$	APHA-3111 B	mg/L	0.01	<0.01	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.038	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	48.0	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	4.778	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.13a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Mandi Juzvi (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$9.1x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	48
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	48

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.13b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Mandi Juzvi (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^+ B	-	0.1	7.17	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	600.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	455.4	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	351.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^- B	mg/L	0.5	44.02	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	59.68	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	<0.01	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.021	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	48.06	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	4.775	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.14a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Hill Kalan (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$1.1x10^5$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	70
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	12
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	48

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.14b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Hill Kalan (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H$^+$ B	-	0.1	7.72	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	601.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	485.10	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	351.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl$^-$ B	mg/L	0.5	44.02	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	56.38	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	0.041	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.033	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	48.20	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	4.798	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.15a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Hill Kalan (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$6.2x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	74
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	18

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.15b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Hill Kalan (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^{+} B	-	0.1	7.80	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	580.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	435.6	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	340.2	NS
05	Chloride (Cl)$^{-1}$	APHA-4500Cl^{-} B	mg/L	0.5	44.02	<250
06	Sulfate (SO4)$^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	52.27	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	<0.01	≤0.05
08	Arsenic (As)$^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as (Fe)$^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.546	NS
10	Sodium (Na)$^{+1}$	APHA-3111 B	mg/L	1.0	47.84	NS
11	Potassium (K)$^{+1}$	APHA-3111 B	mg/L	0.2	4.753	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.16a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Hill Kalan (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$1.4x10^5$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	65
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	6
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	12

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.16b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Hill Kalan (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^+ B	-	0.1	7.80	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	590.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	504.9	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	334.8	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^- B	mg/L	0.5	39.13	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	51.45	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	<0.01	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.026	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	47.66	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	4.763	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.17a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Hill Khurd (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$1.1x10^5$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	55
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	4
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	14

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.17b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Hill Khurd (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^+ B	-	0.1	7.45	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	589.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	485.10	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	351.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^- B	mg/L	0.5	44.02	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	46.51	NS
07	Lead (Pb $)^{+2}$	APHA-3111 B	mg/L	0.01	0.080	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.024	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	48.46	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	4.784	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.18a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Hill Khurd (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	9.5×10^4
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	57
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	40

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.18b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Hill Khurd (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^{+} B	-	0.1	7.62	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	866.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	346.50	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	361.8	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^{-} B	mg/L	0.5	132.08	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	171.22	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	0.023	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	0.018	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.333	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	190.95	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	6.358	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.19a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Hill Khurd (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$8.3x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	63
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	18
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	22

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.19b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Hill Khurd (Spring Water)
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H$^+$ B	-	0.1	7.67	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	602.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	485.10	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	351.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl$^-$ B	mg/L	0.5	44.02	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	51.45	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	0.040	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.028	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	47.50	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	4.774	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.20a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Jamal Pur
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	3.9×10^4
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	TNTC
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	16

cfu: colony forming unit TNTC: Too Numerous To Count

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.20b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Jamal Pur
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^+ B	-	0.1	7.83	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	498.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	386.10	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	324.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^- B	mg/L	0.5	24.46	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	25.51	NS
07	Lead (Pb $)^{+2}$	APHA-3111 B	mg/L	0.01	0.021	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.027	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	31.10	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	2.710	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.21a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Jamal Pur
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$4.3x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	14
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	Absent
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	62

cfu: colony forming unit

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.21b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Jamal Pur
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^{+} B	-	0.1	7.52	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	494.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	405.9	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	329.4	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^{-} B	mg/L	0.5	24.46	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	22.63	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	0.101	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.030	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	32.28	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	2.710	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.22a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Jamal Pur
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$4.9x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	TNTC
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	24
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	50

cfu: colony forming unit TNTC: Too Numerous To Count

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.22b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Jamal Pur
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^+ B	-	0.1	7.67	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	508.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	366.30	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	313.2	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^- B	mg/L	0.5	29.35	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	24.28	NS
07	Lead (Pb $)^{+2}$	APHA-3111 B	mg/L	0.01	0.021	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.039	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	32.20	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	2.708	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.23a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Aghar Colony
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$6.5x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	TNTC
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	40
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	68

cfu: colony forming unit TNTC: Too Numerous To Count

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.23b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Aghar Colony
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H$^+$ B	-	0.1	7.63	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	508.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	396.0	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	324.0	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl$^-$ B	mg/L	0.5	19.56	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	23.87	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	0.041	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.038	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	33.92	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	2.690	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.24a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Aghar Colony
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	4.2×10^4
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	TNTC
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	34
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	44

cfu: colony forming unit TNTC: Too Numerous To Count

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.24b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Aghar Colony
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^+ B	-	0.1	7.80	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	506.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	386.10	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	334.8	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^- B	mg/L	0.5	29.35	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	20.58	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	0.041	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.029	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	31.24	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	2.670	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

8.25a Microbiological Analysis Report

- Job No: ENV- LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample: Drinking Water
- Marking (If Any): Aghar Colony
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr.#	Parameter	Procedure	Permissible Limits	Results
01	Total Colony Count	APHA: 9215 B	< 500 cfu / ml	$4.3x10^4$
02	Total Coli Forms	APHA: 9222 B	0 cfu / 100ml	TNTC
03	Faecal Coli Forms (E.Coli)	APHA: 9222 D	0 cfu / 100ml	58
04	Faecal Streptococci/ Enterococci	APHA: 9230 C	0 cfu / 100ml	30

cfu: colony forming unit TNTC: Too Numerous To Count

NOTE:

WHO/USEPA Guidelines for Drinking Water states that Total or Faecal Coli forms must be absent and are not tolerated in Potable water.

8.25b Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address: Sustainable Solutions Pvt. Ltd Peshawar
- Description of Sample: Drinking Water
- Marking (If Any): Aghar Colony
- No. of sample: 01
- Sample Condition upon Receipt: Satisfactory
- Sample Collection Date: 30-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results	Limits As Per NEQS
01	pH @ 25 °C	APHA-4500H^+ B	-	0.1	7.81	6.5-8.5
02	Solids, Total dissolved (TDS)	APHA-2540 C	mg/L	5.0	494.0	<1000
03	Hardness, Total as $CaCO_3$	APHA-2340 B & C	mg/L	0.5	386.10	<500
04	Alkalinity, Total as CaCO3	APHA-2320 B	mg/L	0.5	334.8	NS
05	Chloride $(Cl)^{-1}$	APHA-4500Cl^- B	mg/L	0.5	24.46	<250
06	Sulfate $(SO4)^{-2}$	APHA-4500-SO_4 C	mg/L	5.0	23.46	NS
07	Lead (Pb)$^{+2}$	APHA-3111 B	mg/L	0.01	<0.01	≤0.05
08	Arsenic $(As)^{+3}$	APHA-3120 B	mg/L	0.005	< 0.005	0.01
09	Total Iron as $(Fe)^{+3/+2}$	APHA-3111 B	mg/L	0.02	0.046	NS
10	Sodium $(Na)^{+1}$	APHA-3111 B	mg/L	1.0	31.50	NS
11	Potassium $(K)^{+1}$	APHA-3111 B	mg/L	0.2	2.69	NS

REMARKS: LDL: Lowest Detection Limit NS: Not Specified

9. Analysis Report

9.1 Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address : Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample : Soil Sample
- Marking (If Any): (Barali)
- No. of sample: 01
- Sample Condition Upon Receipt: Satisfactory
- Sample Collection Date: 29-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results
1.	Total Nitrogen (TKN)	Based on APHA-4500 N_{org} B	mg/kg	0.1	1.53
2.	Total Phosphorous	Based on APHA-4500 P C	mg/kg	0.05	2.0
3.	Cadmium $(Cd)^{+2}$	USEPA 3050 B	mg/kg	0.50	3.55
4.	Total Chromium (Cr)	USEPA 3050 B	mg/kg	0.50	19.32
5.	Lead $(Pb)^{+2}$	USEPA 3050 B	mg/kg	0.50	75.16
6.	Total Iron as $(Fe)^{+3/+2}$	USEPA 3050 B	mg/kg	0.02	27153.91
7.	Aluminium $(Al)^{+2}$	USEPA 3050 B	mg/kg	0.5	<0.5
8.	Sulfate $(SO4)^{-2}$	In-House /Gravimetric	mg/kg	5.0	*
9.	Total Dissolved Solids (TDS)	In-House /Gravimetric	mg/kg	5.0	*

Remarks: LDL: Lowest Detection Limit <: Less Than. *: Result Will Follow Soon

9.2 Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address : Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample : Soil Sample
- Marking (If Any): (Gulhar)
- No. of sample: 01
- Sample Condition Upon Receipt: Satisfactory
- Sample Collection Date: 29-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results
1.	Total Nitrogen (TKN)	Based on APHA-4500 N_{org} B	mg/kg	0.1	3.02
2.	Total Phosphorous	Based on APHA-4500 P C	mg/kg	0.05	1.72
3.	Cadmium $(Cd)^{+2}$	USEPA 3050 B	mg/kg	0.50	<0.50
4.	Total Chromium (Cr)	USEPA 3050 B	mg/kg	0.50	15.76
5.	Lead $(Pb)^{+2}$	USEPA 3050 B	mg/kg	0.50	95.19
6.	Total Iron as $(Fe)^{+3/+2}$	USEPA 3050 B	mg/kg	0.02	21934.86
7.	Aluminium $(Al)^{+2}$	USEPA 3050 B	mg/kg	0.5	<0.5
8.	Sulfate $(SO4)^{-2}$	In-House /Gravimetric	mg/kg	5.0	*
9.	Total Dissolved Solids (TDS)	In-House /Gravimetric	mg/kg	5.0	*

Remarks: LDL: Lowest Detection Limit <: Less Than. *: Result Will Follow Soon

9.3 Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address : Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample : Soil Sample
- Marking (If Any): (Mandi Juzvi)
- No. of sample: 01
- Sample Condition Upon Receipt: Satisfactory
- Sample Collection Date: 29-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results
1.	Total Nitrogen (TKN)	Based on APHA-4500 N_{org} B	mg/kg	0.1	1.86
2.	Total Phosphorous	Based on APHA-4500 P C	mg/kg	0.05	2.60
3.	Cadmium $(Cd)^{+2}$	USEPA 3050 B	mg/kg	0.50	<0.50
4.	Total Chromium (Cr)	USEPA 3050 B	mg/kg	0.50	25.27
5.	Lead $(Pb)^{+2}$	USEPA 3050 B	mg/kg	0.50	77.76
6.	Total Iron as $(Fe)^{+3/+2}$	USEPA 3050 B	mg/kg	0.02	25545.50
7.	Aluminium $(Al)^{+2}$	USEPA 3050 B	mg/kg	0.5	<0.5
8.	Sulfate $(SO4)^{-2}$	In-House /Gravimetric	mg/kg	5.0	*
9.	Total Dissolved Solids (TDS)	In-House /Gravimetric	mg/kg	5.0	*

Remarks: LDL: Lowest Detection Limit <: Less Than. *: Result Will Follow Soon

9.4 Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address : Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample : Soil Sample
- Marking (If Any): (Jamal Pur)
- No. of sample: 01
- Sample Condition Upon Receipt: Satisfactory
- Sample Collection Date: 29-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results
1.	Total Nitrogen (TKN)	Based on APHA-4500 N_{org} B	mg/kg	0.1	1.38
2.	Total Phosphorous	Based on APHA-4500 P C	mg/kg	0.05	2.60
3.	Cadmium $(Cd)^{+2}$	USEPA 3050 B	mg/kg	0.50	<0.50
4.	Total Chromium (Cr)	USEPA 3050 B	mg/kg	0.50	28.65
5.	Lead $(Pb)^{+2}$	USEPA 3050 B	mg/kg	0.50	100.90
6.	Total Iron as $(Fe)^{+3/+2}$	USEPA 3050 B	mg/kg	0.02	26119.6
7.	Aluminium $(Al)^{+2}$	USEPA 3050 B	mg/kg	0.5	<0.5
8.	Sulfate $(SO4)^{-2}$	In-House /Gravimetric	mg/kg	5.0	*
9.	Total Dissolved Solids (TDS)	In-House /Gravimetric	mg/kg	5.0	*

Remarks: LDL: Lowest Detection Limit <: Less Than. *: Result Will Follow Soon

9.5 Chemical Laboratory Test Report

- Job No: ENV - LHR - 495 / 2013
- Client Name / Address : Sustainable Solutions Pvt. Ltd Peshawar
- Description Of Sample : Soil Sample
- Marking (If Any): (Weir Site)
- No. of sample: 01
- Sample Condition Upon Receipt: Satisfactory
- Sample Collection Date: 29-08-13
- Environmental Conditions: Temperature: NA Humidity: NA

Sr. #	Parameters	Method	Unit	LDL	Test Results
1.	Total Nitrogen (TKN)	Based on APHA-4500 N_{org} B	mg/kg	0.1	1.80
2.	Total Phosphorous	Based on APHA-4500 P C	mg/kg	0.05	2.36
3.	Cadmium $(Cd)^{+2}$	USEPA 3050 B	mg/kg	0.50	<0.50
4.	Total Chromium (Cr)	USEPA 3050 B	mg/kg	0.50	26.11
5.	Lead $(Pb)^{+2}$	USEPA 3050 B	mg/kg	0.50	76.69
6.	Total Iron as $(Fe)^{+3/+2}$	USEPA 3050 B	mg/kg	0.02	25842.05
7.	Aluminium $(Al)^{+2}$	USEPA 3050 B	mg/kg	0.5	<0.5
8.	Sulfate $(SO4)^{-2}$	In-House /Gravimetric	mg/kg	5.0	*
9.	Total Dissolved Solids (TDS)	In-House /Gravimetric	mg/kg	5.0	*

Remarks: LDL: Lowest Detection Limit <: Less Than. *: Result Will Follow Soon

10. Standards

10.1 National Environmental Quality Standards (NEQS) for Ambient Air

Concentration in Ambient Air

Pollutants	Time-Weighted Average	Effective from 1st July 2010	Effective from 1st January 2013	Method of measurement
SO_2	Annual Average*	80 ug/m^3	80 ug/m^3	-Ultraviolet Fluorescence Method
	24 hrs**	120 ug/m^3	120 ug/m^3	
NO	Annual Average*	40 ug/m^3	40 ug/m^3	Gas Phase Chemiluminescence
	24 hrs**	40 ug/m^3	40 ug/m^3	
NO_2	Annual Average*	40 ug/m^3	40 ug/m^3	Gas Phase Chemiluminescence
	24 hrs**	80 ug/m^3	80 ug/m^3	
O_3	1 hr	180 ug/m^3	130 ug/m^3	Non Dispersive UV Absorption Method
Suspended Particulate Matter (SPM)	Annual Average*	400 ug/m^3	360 ug/m^3	High Volume Sampling (average flow rate not less than 1.1 m3/minute)
	24 hrs**	550 ug/m^3	500 ug/m^3	
Respirable Particulate Matter (PM_{10})	Annual Average*	200 ug/m^3	120 ug/m^3	-β Ray Absorption Method
	24 hrs**	250 ug/m^3	150 ug/m^3	
Respirable Particulate Matter ($PM_{2.5}$)	Annual Average*	25 ug/m^3	15 ug/m^3	-β Ray Absorption Method
	24 hrs**	40 ug/m^3	35 ug/m^3	
	1 hr	25 ug/m^3	15 ug/m^3	
Lead (Pb)	Annual Average*	1.5 ug/m^3	1 ug/m^3	ASS Method after sampling using EPM 2060 or equivalent Filter paper
	24 hrs**	2 ug/m^3	1.5 ug/m^3	
Carbon Monoxide (CO)	8hrs**	5 ug/m^3	5 ug/m^3	Non Dispersive Infra Red (NDIR) Method
	1 hr	10 ug/m^3	10 ug/m^3	

*Annual arithmetic mean of minimum 104 measurements in a year, taken twice a week 24 hourly at uniform interval.

**24 hourly/ 8 hourly values should be met 98% of the in a year 2% of the time. It may exceed but not on two consecutive days.

Standards for Drinking Water (Bacterial)

Properties/ parameters	Standard values for Pakistan	Who Standards	Remarks
All water intended for drinking (e. Coli or Thermo tolerant Coliform Bacteria)	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample	Most Asian countries also follow WHO standards
Treated water entering the distribution system (e. Coli or Thermo tolerant Coliform and total Coliform Bacteria)	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample	Most Asian countries also follow WHO standards
Treated water in the distribution system (e. Coli or Thermo tolerant Coliform and total Coliform Bacteria)	Must not be detectable in any 100 ml sample. In case of large supplies where sufficient samples are examined, must not be present in 95% of the samples taken through out any 12-month period	Must not be detectable in any 100 ml sample. In case of large supplies where sufficient samples are examined, must not be present in 95% of the samples taken through out any 12-month period	Most Asian countries also follow WHO standards

National Standards for Drinking Water

Properties/ parameters	Standard values for Pakistan	Who Standards	Remarks
Physical			
Colour	< 15 TCU	< 15 TCU	
Taste	Non objectionable /Acceptable	Non objectionable /Acceptable	
Odour	Non objectionable /Acceptable	Non objectionable /Acceptable	
Turbidity	<5NTU	<5NTU	
Total Hardness as CaCO3	< 500mg/l		
TDS	<1000	<1000	
pH	6.5-8.5	6.5-8.5	
Chemical			
Essential Inorganic	**mg/Litre**	**mg/Litre**	
Aluminium (Al)	<0.2	0.2	
Antimony (Sb)	< 0.005 (P)	0.2	
Arsenic (As)	< 0.05 (P)	0.01	Standards for Pakistan similar to most Asian developing countries
Barium (Ba)	0.7	0.7	
Boron (B)	0.3	0.3	
Cadmium (Cd)	0.01	0.003	Standards for Pakistan similar to most Asian developing countries
Chloride (Cl)	<250	250	
Chromium (Cr)	<0.05	0.05	
Copper (Cu)	2	2	
Toxic inorganic			
Cyanide (CN)	<0.05	0.07	Standards for Pakistan similar to most Asian developing countries
Fluoride (F)*	<1.5	1.5	
Lead (Pb)	<0.05	0.01	
Manganese (Mn)	<0.5	0.5	
Mercury (Hg)	< 0.001	0.001	
Nickel (Ni)	<0.02	0.02	
Nitrate (NO3)	<50	50	
Nitrite (NO2)	<3(P)	3	
Selenium (Se)	0.01 (P)	0.01	
Residual Chlorine	0.2-0.5 at consumer end 0.5-1.5 at source		
Zinc (Zn)	5.0	3	Standards for Pakistan similar to most Asian developing countries
Organic			

Pesticides mg/L		PSQCA No. 4639-2004. Page No. 4 Table No. 3 Serial No. 20-58 may be Consulted***	Annex II
Penolic Compounds (as Phenols) mg/L		< 0.002	
Polynuclear aromatic hydrocarbons (as PAH) g/L		0.01 (by GC/MS method)	
Radio Active			
Alpha Emitters bq/L or pCi	0.1	0.1	
Beta Emitters	1	1	

Annexure 5A: Species Checklist and Auxiliary Data

Exhibit 5A.1: The Chorotypes assigned to the respective species and their symbols

Kingdom	*Origin*	*Symbol Used*
Holarctic/Circumpolar	Eurasian	EURAS
	Irano-Turanian Pamir High mountain sub-group of IRAN	IRAN PAMIR
	Centralasiatic	CAS
	Eastasiatic or Sino-Japanese	EAS
	Southeast Asiatic	SE.AS
	Himalayan	HIMAL
	West Himalayan	W.HIM
	Endemic	ENDEM
	Tibetan	TIBET
Tropical	Indian	INDIAN
	Indo-Malayan	INMAL
	Subtropical	SUBTR
	Tropical	TROP
--	Introduced or Cultivated	INTR
	Cosmopolitan	COSMO

Exhibit 5A.2: The number of GCPs used to map the respective landcover class

S. No	*Landcover*	*Code*	*No of GCPs*
1	Agriculture	AGR	300
2	Riverine	RIV	80
3	Open areas	OPA	68
4	Settlements	SET	87
5	Broadleave (Sparse)	BLS	182
6	Broadleave (Medium)	BLM	78
7	Broadleave (Dense)	BLD	39
8	Conifer (Sparse)	CNS	123
9	Conifer (Medium)	CNM	34
10	Conifer (Dense)	CND	29
Grand Total			1020

Exhibit 5A.3: List of plant species found in the area

GROUP
Family
Species

MON
Araceae
Sauromatum venosum (Aiton) Kunth
Cyperaceae

Cyperus niveus Retz.
Cyperus rotundus L.
Eriophorum comosum (Wallich) Nees
Liliaceae
Agave cantula Roxb.
Asparagus adscendens Roxb.
Orchidaceae
Harbennaria digitata Lidle.
Poaceae
Apluda mutica var. mutica L.
Arundo donax L.
Bothriochloa pertusa (L.) A. Camus
Brachiaria ramosa (Linn) Stapf
Cenchrus ciliaris L.
Cenchrus pennisetiformis Hochst & Steud
Chrysopogan serrulatus Trin
Cynodon dactylon (L.) Pers.
Desmostachya bipinnata (L.) Stapf
Dichanthium annulatum (Forssk.) Stapf
Digitaria bicornis (Lamk.) Roem & Schult. ex Loud
Echinochloa colona (L.) Link
Eragrostis poaeoides Beauvois
Heteropogon contortus (L.) Beauvois ex Roemer & Schultes
Imperata cylindrica var. cylindrica (L.) Beauvois
Paspalidium flavidum (Retz.) A. Camus
Phragmites karka (Retz.) Trin. ex Steudel
Poa annua L.
Polypogon monspeliensis (L.) Desf.
Setaria glauca (L.) Beauvois
Sorghum halepense (L.) Beauvois
Zea mays L.
ANG
Acanthaceae
Barleria cristata L.
Dicliptera roxburghiana Nees in Wall.
Justicia adhatoda L.
Amaranthaceae
Achyranthes aspera L.
Amaranthus viridis L.
Pupalia lappacea (Linn.) Juss.
Anacardiaceae
Mangifera indica L.
Apiaceae
Unknown 1
Unknown 2
Apocynaceae
Carissa opaca Stapf ex. Haines
Nerium indicum Miller
Asclepiadaceae

Calotropis procera (Aiton) Dryand.
Cynanchum atratum Bunge
Periploca aphylla subsp. aphylla Decne.
Tylophora hirsuta (Wall.) Wight
Asteraceae
Artemisia scoparia Besser
Bidens bipinnata L.
Conyza bonariensis (L.) Cronq.
Conyza canadensis (L.) Cronq.
Conyza japonica L.
Conyza stricta Willd.
Erigeron belloides Benth. ex Clarke.
Parthenium hysterophorus L.
Sonchus arvensis L.
Taraxacum officinale Wigg.
Xanthium strumarium L.
Bombacaceae
Bombax ceiba L.
Boraginaceae
Cynoglossum lanceolatum Forssk.
Heliotropium europaeum L
Lithospermum arvense L.
Trichodesma indicum (L.) R. Br.
Brassicaceae
Capsella bursa-pastoris (L.) Medic
Cardamine impatiens L.
Lepidium sativum L.
Cannabiaceae
Cannabis sativa L.
Celasteraceae
Gymnosporia royleana (Wall.) ex Laws
Celtaceae
Celtis australis L.
Chenopodiaceae
Chenopodium album subsp. album L.
Commelinaceae
Commelina benghalensis L.
Convolvulaceae
Convolvulus arvensis L.
Evolvulus alsinoides (Linn.) Linn.
Ipomoea carnea subsp. fistulosa Jacquem
Ipomoea purpurea (L.) Roth.
Cuscutaceae
Cuscuta reflexa var. reflexa Roxb.
Ebenaceae
Diospyros lotus L.
Euphorbiaceae
Euphorbia hirta L.
Euphorbia indica Lam.

Euphorbia prostrata Ait.
Mallotus philippensis (Lam.) Muell.-Arg.
Phyllanthus amarus Schum. & Thonn.
Flacourtiaceae
Flacourtia indica (Burm.) Merrill
Geraniaceae
Geranium nepalense Sweet
Geranium rotundifolium L.
Geranium wallichianum D. Don ex Sweet
Juglandaceae
Juglans regia L.
Labiatae
Ajuga bracteosa var. bracteosa Wall.
Ajuga bracteosa var. densiflora Wall.
Calamintha umbrosa (M. Bieb.) Fisch. & Mey
Colebrookea oppositifolia Smith
Mentha royleana Benth.
Micromeria biflora var. biflora (Buch.-Ham. ex D. Don) Benth.
Otostegia limbata (Benth.) Boiss.
Plectranthus rugosus Wall. ex. Bth.
Salvia sp.
Leguminoseae
Acacia modesta Wall.
Acacia nilotica subsp. indica (L.) Willd.
Albizia lebbeck (L.) Benth.
Astragalus leucocephalus Grah. ex Benth.
Cassia fistula L.
Cassia obtusifolia Linn.
Cassia occidentalis L.
Dalbergia sissoo Roxb. ex DC.
Desmodium monotorium (Houtt) Merril
Dumasia villosa var. villosa DC.
Indigofera linifolia (Linn.f.) Retz.
Lespedeza juncea (L. f.) Pers.
Medicago sativa L.
Melilotus parviflora Desf.
Mimosa himalayana Gamble
Rynchosia minima (L.) DC.
Uraria picta (Jacquin) Desv. ex DC.
Lytheraceae
Woodfordia fruticosa (L.) Kurz.
Malvaceae
Hibiscus trionum Linn.
Malvastrum coromandelianum (L.) Garcke
Sida cordifolia L.
Martyniaceaae
Martynia annua Linn.
Meliaceae
Cedrela serrata Royle.

Cedrela toona Roxb. ex Wild
Melia azedarach L.
Menispermaceae
Cissampelos pareira var. hirsuta L.
Tinospora cordifolia (DC.) Miers.
Moraceae
Broussonetia papyrifera (L.) L'H {rit. ex Vent.
Ficus auriculata Lour.
Ficus benghalensis L.
Ficus carica subsp. carica L.
Ficus religiosa L.
Morus alba L.
Morus nigra L.
Morus serrata Roxb.
Muscaceae
Musca sapientum L.
Myrsinaceae
Myrsine africana L.
Myrtaceae
Eucalyptus camaldulensis Dehnh
Nyctaginaceae
Alternanthera pungens Kunth
Boerhavia procumbens (Roxb.) Hk.F
Oleaceae
Olea ferruginea Royle
Onagraceae
Oenothera rosea L'H rit. ex Aiton
Oxalidaceae
Oxalis corniculata L.
Palmaceae
Phoenix sylvestris Roxb.
Polygalaceae
Polygala abyssinica R. Br. ex Fresen.
Polygonaceae
Polygonum plebejum R.Br
Polygonum sp.
Rumex chalepensis D. Don
Punicaceae
Punica granatum L.
Ranunculaceae
Thalictrum javanicum Bl.
Rhamnaceae
Zizyphus jujuba Lam.
Zizyphus mauritiana Lam.
Zizyphus nummularia (Burm. f.) Wight & Arn.
Zizyphus oxyphylla Edgew.
Rosaceae
Duchesnea indica var. microphylla (Andr.) Focke
Fragaria nubicola Lindl. ex Lacaita

Pyrus communis L.
Rubus ellipticus Smith
Rubus ulmifolius Schott.
Rubiaceae
Galium acutum Edgew.
Galium aparine var. aparine L.
Rubia cordata Thunb
Salicaceae
Populus alba L.
Populus caspica Bornm.
Populus ciliata Wall. Ex Royle
Populus nigra L.
Salix acmophylla Boiss.
Sapindaceae
Dodonaea viscosa (L.) Jacq.
Scrophulariaceae
Kickxia ramosissima (Wall) Janchen.
Linaria dalmatica (L.) Mill.
Verbascum thapsus L.
Veronica anagallis-aquatica L
Simarubaceae
Ailanthus altissima (Miller) Swingle
Solanaceae
Datura stramonium L.
Physalis divaricata D. Don
Solanum nigrum L.
Solanum surattense Burm. f.
Withania somnifera (L.) Dun.
Tiliaceae
Corchorus olitorius L.
Grewia optiva J. R. Drumm. ex Burret
Urticaceae
Debregeasia salicifolia (D. Don) Rendle
Verbenaceae
Callicarpa macrophylla Vahl
Vitex negundo L.
Violaceae
Viola sp
Vitaceae
Cissus carnosa (L) Lamk.
GYM
Pinaceae
Pinus roxburghii Sarg.
PTE
Pteridaceae
Adiantum capillus-veneris L.
Adiantum incisum Forssk.
Dryopteris pallida Formin

Exhibit 5A.4: Association of species with different Habitat types in GHP

Habitat	Broad leaved forest (Fb)				Coniferous forest (Fc)			Mix Forest (Fm)		Shrubland (S)			Open land (O)			Cultivated land (C)				Urban (U)			Riverine (R)		
Sub-category	FBL	FBO	FBR	FBS	FCS	FCO	FCL	FMS	FMO	SI	SO	SP	OS	OT	OR	CK	CB	CC	CP	UG	UT	UW	RS	RSS	RSR
Shannon Diversity																									
Species ▼																									
Aca mod		+																							
Aca nil		+																							
Ach asp										+	+		+		+		+					+	+		
Aga can																	+	+							
Ail alt																			+						
Aju bra													+												
Aju bra													+												
Alb leb		+																					+		
Ama vir																	+	+				+			
Apl mut		+		+	+								+				+								
Aru don		+				+							+		+										
Asp fil																									
Asp fil																									
Bar cri		+		+							+		+		+										
Bid bip				+									+		+					+					
Boe dif														+	+								+		
Bom cei																							+		
Bot per				+									+				+						+		
Bra ram														+		+	+								
Cal mac						+					+														
Cal pro																	+					+			+
Can sat													+	+			+	+				+			
Cap bur													+			+	+								
Car imp											+				+								+		
Car car			+	+									+		+										
Cas fis											+		+						+						
Cas obt		+											+	+			+					+			
Cas occ		+											+	+			+					+			
Cel aus																				+					

Habitat	Broad leaved forest (Fb)				Coniferous forest (Fc)			Mix Forest (Fm)		Shrubland (S)			Open land (O)			Cultivated land (C)				Urban (U)			Riverine (R)		
Sub-category	FBL	FBO	FBR	FBS	FCS	FCO	FCL	FMS	FMO	SI	SO	SP	OS	OT	OR	CK	CB	CC	CP	UG	UT	UW	RS	RSS	RSR
Shannon Diversity																									
Species ▼																									
Che alb													+				+	+				+	+		
Cis par		+										+			+										
Cis adn	+																								
Col opp		+									+		+												
Com ben				+												+	+							+	
Con arv										+	+	+			+		+				+				
Con bon													+	+			+								
Con can													+				+						+		
Con jap		+											+		+										
Con str													+			+	+								
Cus ref												+													
Cyn aur											+														+
Cyn dac													+	+		+	+			+					
Cyn lan													+	+			+								
Cyp niv		+		+									+		+		+								
Cyp rot														+		+	+					+	+		
Dal sis																			+				+		
Dat str														+			+					+			
Deb sal		+			+								+		+										
Des ele		+				+					+		+												+
Des bip				+										+									+		
Dic ann													+	+		+	+								
Dio lot																									
Dum vil		+		+																					
Ech col													+			+	+						+		
Eri bel													+		+		+								
Eri com													+		+										
Euc cam																				+					
Eup hir		+											+		+	+	+				+				+

Habitat	Broad leaved forest (Fb)				Coniferous forest (Fc)			Mix Forest (Fm)		Shrubland (S)			Open land (O)			Cultivated land (C)				Urban (U)			Riverine (R)		
Sub-category	FBL	FBO	FBR	FBS	FCS	FCO	FCL	FMS	FMO	SI	SO	SP	OS	OT	OR	CK	CB	CC	CP	UG	UT	UW	RS	RSS	RSR
Shannon Diversity																									
Species ▼																									
Eup pro													+		+						+		+		
Evo als				+	+						+		+		+										
Fic aur															+				+						
Fic ben																			+						
Fic rel																			+		+				
Fla ind																									
Fra nub											+		+												
Gal acu													+												
Gal apa				+	+			+					+												
Ger nep		+											+	+			+								
Ger wal		+				+		+	+		+														
Gre opt		+																							
Hab dig				+																					
Het con		+											+		+	+							+		
Imp cyl				+	+								+	+		+	+			+					
Ind lin														+	+		+						+		+
Ipo car				+															+			+			
Ipo pur																	+			+		+			
Jug reg																			+				+		
Jus adh											+		+						+			+			
Kic ram													+												
Lep sat																+	+								
Les jun																							+		
Lit arv															+		+								
Mal phi											+														
Man ind																	+								
Mar ann		+									+			+									+		
Med sat																+		+							
Mel aze																			+	+			+		

Habitat	Broad leaved forest (Fb)				Coniferous forest (Fc)			Mix Forest (Fm)		Shrubland (S)			Open land (O)			Cultivated land (C)				Urban (U)			Riverine (R)		
Sub-category	FBL	FBO	FBR	FBS	FCS	FCO	FCL	FMS	FMO	SI	SO	SP	OS	OT	OR	CK	CB	CC	CP	UG	UT	UW	RS	RSS	RSR
Shannon Diversity																									
Species ▼																									
Mel alb													+			+	+								
Mic bif													+		+								+		
Mor alb		+																	+						
Mor ser		+																	+				+		
Myr afr		+		+							+		+												
Ner ind																			+						
Oen ros																	+								
Oxa cor																+	+				+	+			
Par hys																						+			
Pas fla								+	+				+				+				+	+	+		
Phr kar		+											+	+		+	+						+		
Phy ama													+				+								
Phy div														+			+					+			
Pin rox					+																				
Ple rug		+		+									+		+										
Poa ann					+								+				+								
Pol aby				+									+		+										
Pol ple		+											+		+	+	+						+		
Pol mon																+	+						+		
Pop cil								+											+				+		
Pop nig																			+						
Pun gra											+								+	+					
Rub wal		+																							
Rub ell		+									+						+								
Sau ven															+										
Set gla				+											+	+	+								
Sid cor													+	+											
Sid cor																	+								
Sol nig																	+				+	+			

Habitat	Broad leaved forest (Fb)				Coniferous forest (Fc)			Mix Forest (Fm)		Shrubland (S)			Open land (O)			Cultivated land (C)				Urban (U)			Riverine (R)		
Sub-category	FBL	FBO	FBR	FBS	FCS	FCO	FCL	FMS	FMO	SI	SO	SP	OS	OT	OR	CK	CB	CC	CP	UG	UT	UW	RS	RSS	RSR
Shannon Diversity																									
Species ▼																									
Sol sur														+	+							+			
Sor hal																		+							
Tha jav		+		+	+								+										+		
Tin sin	+	+																				+			
Tri ind		+		+																					
Tyl hir	+						+								+										
Ura pic		+																							
Ver tha		+																							
Ver ana										+	+		+		+		+					+	+		
Vit neg																	+	+							
Woo fru																			+						
Xan str													+												
Zea may													+												
Ziz mau		+																					+		
Ziz num																	+	+				+			

	Broad leaved forest						Coniferous forest				Mix Forest			Shrubland				Open land				Cultivated land					Urban				Riverine			
0	F b	F B	FB L	FB O	FB R	FB S	F c	FC S	FC O	FC L	F m	FM S	FM O	S	S I	S O	S P	O	O S	O T	O R	C	C K	C B	C C	C P	U	U G	U T	U W	R	R S	RS S	RS R
Aca mod	5	1	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Aca nil	5	1	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Ach asp	5	0	0	0	0	0	3	0	0	0	0	0	0	3	1	1	0	3	1	0	1	4	0	1	0	0	3	0	0	1	3	1	0	0
Aga can	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	1	1	0	3	0	0	0	3	0	0	0
Ail alt	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	1	3	0	0	0	3	0	0	0
Aju bra	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0

	Broad leaved forest						Coniferous forest				Mix Forest			Shrubland				Open land				Cultivated land					Urban				Riverine			
	F	F	FB	FB	FB	FB	F	FC	FC	FC	F	FM	FM		S	S	S		O	O	O		C	C	C	C		U	U	U		R	RS	RS
0	b	B	L	O	R	S	c	S	O	L	m	S	O	S	I	O	P	O	S	T	R	C	K	B	C	P	U	G	T	W	R	S	S	R
Aju bra	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Alb leb	5	1	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	1	0	0
Ama vir	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	1	1	0	3	0	0	1	3	0	0	0
Apl mut	5	0	0	1	0	1	3	1	0	0	0	0	0	3	0	0	0	3	1	0	0	4	0	1	0	0	3	0	0	0	3	0	0	0
Aru don	5	0	0	1	0	0	3	0	1	0	0	0	0	3	0	0	0	3	1	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0
Asp fil	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Asp fil	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Bar cri	5	0	0	1	0	1	3	0	0	0	0	0	0	3	0	1	0	3	1	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0
Bid bip	5	0	0	0	0	1	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	0	0	0	0	3	1	0	0	3	0	0	0
Boe dif	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	1	1	4	0	0	0	0	3	0	0	0	3	1	0	0
Bom cei	5	1	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	1	0	0
Bot per	5	0	0	0	0	1	3	0	0	0	0	0	0	3	0	0	0	3	1	0	0	4	0	1	0	0	3	0	0	0	3	1	0	0
Bra ram	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	1	0	4	1	1	0	0	3	0	0	0	3	0	0	0
Cal mac	5	0	0	0	0	0	3	0	1	0	0	0	0	3	0	1	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Cal pro	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	1	0	0	3	0	0	1	3	0	0	1
Can sat	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	1	0	4	0	1	1	0	3	0	0	1	3	0	0	0
Cap bur	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	0	4	1	1	0	0	3	0	0	0	3	0	0	0
Car imp	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	1	0	3	0	0	1	4	0	0	0	0	3	0	0	0	3	1	0	0
Car car	5	0	0	0	1	1	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0
Cas fis	5	1	0	0	0	0	3	0	0	0	0	0	0	3	0	1	0	3	1	0	0	4	0	0	0	1	3	0	0	0	3	0	0	0
Cas obt	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	1	0	4	0	1	0	0	3	0	0	1	3	0	0	0
Cas occ	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	1	0	4	0	1	0	0	3	0	0	1	3	0	0	0
Cel aus	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	1	0	0	3	0	0	0

	Broad leaved forest						Coniferous forest				Mix Forest			Shrubland				Open land				Cultivated land					Urban				Riverine			
0	Fb	FB	FBL	FBO	FBR	FBS	Fc	FCS	FCO	FCL	Fm	FMS	FMO	S	SI	SO	SP	O	OS	OT	OR	C	CK	CB	CC	CP	U	UG	UT	UW	R	RS	RSS	RSR
Che alb	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	0	4	0	1	1	0	3	0	0	1	3	1	0	0
Cis par	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	1	3	0	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0
Cis adn	5	0	1	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Col opp	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	1	0	3	1	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Com ben	5	0	0	0	0	1	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	1	1	0	0	3	0	0	0	3	0	1	0
Con arv	5	0	0	0	0	0	3	0	0	0	0	0	0	3	1	1	1	3	0	0	1	4	0	1	0	0	3	0	1	0	3	0	0	0
Con bon	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	1	0	4	0	1	0	0	3	0	0	0	3	0	0	0
Con can	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	0	4	0	1	0	0	3	0	0	0	3	1	0	0
Con jap	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0
Con str	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	0	4	1	1	0	0	3	0	0	0	3	0	0	0
Cus ref	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	1	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Cyn aur	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	1	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	1
Cyn dac	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	1	0	4	1	1	0	0	3	1	0	0	3	0	0	0
Cyn lan	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	1	0	4	0	1	0	0	3	0	0	0	3	0	0	0
Cyp niv	5	0	0	1	0	1	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	0	1	0	0	3	0	0	0	3	0	0	0
Cyp rot	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	1	0	4	1	1	0	0	3	0	0	1	3	1	0	0
Dal sis	5	1	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	1	3	0	0	0	3	1	0	0
Dat str	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	1	0	4	0	1	0	0	3	0	0	1	3	0	0	0
Deb sal	5	1	0	1	0	0	3	1	0	0	0	0	0	3	0	0	0	3	1	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0
Des ele	5	1	0	1	0	0	3	0	1	0	0	0	0	3	0	1	0	3	1	0	0	4	0	0	0	0	3	0	0	0	3	0	0	1
Des bip	5	0	0	0	0	1	3	0	0	0	0	0	0	3	0	0	0	3	0	1	0	4	0	0	0	0	3	0	0	0	3	1	0	0
Dic ann	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	1	0	4	1	1	0	0	3	0	0	0	3	0	0	0
Dio lot	5	1	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Dum	5	0	0	1	0	1	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0

	Broad leaved forest						Coniferous forest				Mix Forest			Shrubland				Open land				Cultivated land					Urban				Riverine			
0	F b	F B	FB L	FB O	FB R	FB S	F c	FC S	FC O	FC L	F m	FM S	FM O	S	S I	S O	S P	O	O S	O T	O R	C	C K	C B	C C	C P	U	U G	U T	U W	R	R S	RS S	RS R
vil																																		
Ech col	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	0	4	1	1	0	0	3	0	0	0	3	1	0	0
Eri bel	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	0	1	0	0	3	0	0	0	3	0	0	0
Eri com	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0
Euc cam	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	1	0	0	3	0	0	0
Eup hir	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	1	1	0	0	3	0	1	0	3	0	0	1
Eup pro	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	0	0	0	0	3	0	1	0	3	1	0	0
Evo als	5	0	0	0	0	1	3	1	0	0	0	0	0	3	0	1	0	3	1	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0
Fic aur	5	1	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	1	4	0	0	0	1	3	0	0	0	3	0	0	0
Fic ben	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	1	3	0	0	0	3	0	0	0
Fic rel	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	1	3	0	1	0	3	0	0	0
Fla ind	5	1	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Fra nub	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	1	0	3	1	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Gal acu	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Gal apa	5	0	0	0	0	1	3	1	0	0	1	1	0	3	0	0	0	3	1	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Ger nep	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	1	0	4	0	1	0	0	3	0	0	0	3	0	0	0
Ger wal	5	0	0	1	0	0	3	0	1	0	2	1	1	3	0	1	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Gre opt	5	1	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Hab dig	5	0	0	0	0	1	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Het con	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	1	0	0	0	3	0	0	0	3	1	0	0
Imp cyl	5	0	0	0	0	1	3	1	0	0	0	0	0	3	0	0	0	3	1	1	0	4	1	1	0	0	3	1	0	0	3	0	0	0
Ind lin	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	1	1	4	0	1	0	0	3	0	0	0	3	1	0	1
Ipo car	5	0	0	0	0	1	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	1	3	0	0	1	3	0	0	0

	Broad leaved forest						Coniferous forest				Mix Forest			Shrubland				Open land				Cultivated land					Urban				Riverine			
0	F b	F B	FB L	FB O	FB R	FB S	F c	FC S	FC O	FC L	F m	FM S	FM O	S	S I	S O	S P	O	O S	O T	O R	C	C K	C B	C C	C P	U	U G	U T	U W	R	R S	RS S	RS R
Ipo pur	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	1	0	0	3	1	0	1	3	0	0	0
Jug reg	5	1	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	1	3	0	0	0	3	1	0	0
Jus adh	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	1	0	3	1	0	0	4	0	0	0	1	3	0	0	1	3	0	0	0
Kic ram	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Lep sat	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	1	1	0	0	3	0	0	0	3	0	0	0
Les jun	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	1	0	0
Lit arv	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	1	4	0	1	0	0	3	0	0	0	3	0	0	0
Mal phi	5	1	0	0	0	0	3	0	0	0	0	0	0	3	0	1	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Man ind	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	1	0	0	3	0	0	0	3	0	0	0
Mar ann	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	1	0	3	0	1	0	4	0	0	0	0	3	0	0	0	3	1	0	0
Med sat	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	1	0	1	0	3	0	0	0	3	0	0	0
Mel aze	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	1	3	1	0	0	3	1	0	0
Mel alb	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	0	4	1	1	0	0	3	0	0	0	3	0	0	0
Mic bif	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	0	0	0	0	3	0	0	0	3	1	0	0
Mor alb	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	1	3	0	0	0	3	0	0	0
Mor ser	5	1	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	1	3	0	0	0	3	1	0	0
Myr afr	5	0	0	1	0	1	3	0	0	0	0	0	0	3	0	1	0	3	1	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Ner ind	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	1	3	0	0	0	3	0	0	0
Oen ros	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	1	0	0	3	0	0	0	3	0	0	0
Oxa cor	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	1	1	0	0	3	0	1	1	3	0	0	0
Par hys	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	1	3	0	0	0
Pas fla	5	0	0	0	0	0	3	0	0	0	2	1	1	3	0	0	0	3	1	0	0	4	0	1	0	0	3	0	1	1	3	1	0	0

	Broad leaved forest						Coniferous forest				Mix Forest			Shrubland				Open land				Cultivated land					Urban				Riverine			
	F	F	FB	FB	FB	FB	F	FC	FC	FC	F	FM	FM		S	S	S		O	O	O		C	C	C	C		U	U	U		R	RS	RS
0	b	B	L	O	R	S	c	S	O	L	m	S	O	S	I	O	P	O	S	T	R	C	K	B	C	P	U	G	T	W	R	S	S	R
Phr kar	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	1	0	4	1	1	0	0	3	0	0	0	3	1	0	0
Phy ama	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	0	4	0	1	0	0	3	0	0	0	3	0	0	0
Phy div	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	1	0	4	0	1	0	0	3	0	0	1	3	0	0	0
Pin rox	5	0	0	0	0	0	3	1	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Ple rug	5	0	0	1	0	1	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0
Poa ann	5	0	0	0	0	0	3	1	0	0	0	0	0	3	0	0	0	3	1	0	0	4	0	1	0	0	3	0	0	0	3	0	0	0
Pol aby	5	0	0	0	0	1	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0
Pol ple	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	1	1	0	0	3	0	0	0	3	1	0	0
Pol mon	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	1	1	0	0	3	0	0	0	3	1	0	0
Pop cil	5	1	0	0	0	0	3	0	0	0	1	1	0	3	0	0	0	3	0	0	0	4	0	0	0	1	3	0	0	0	3	1	0	0
Pop nig	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	1	3	0	0	0	3	0	0	0
Pun gra	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	1	0	3	0	0	0	4	0	0	0	1	3	1	0	0	3	0	0	0
Rub wal	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Rub ell	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	1	0	3	0	0	0	4	0	1	0	0	3	0	0	0	3	0	0	0
Sau ven	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0
Set gla	5	0	0	0	0	1	3	0	0	0	0	0	0	3	0	0	0	3	0	0	1	4	1	1	0	0	3	0	0	0	3	0	0	0
Sid cor	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	1	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Sid cor	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	1	0	0	3	0	0	0	3	0	0	0
Sol nig	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	1	0	0	3	0	1	1	3	0	0	0
Sol sur	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	1	1	4	0	0	0	0	3	0	0	1	3	0	0	0
Sor hal	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	1	0	3	0	0	0	3	0	0	0
Tha jav	5	0	0	1	0	1	3	1	0	0	0	0	0	3	0	0	0	3	1	0	0	4	0	0	0	0	3	0	0	0	3	1	0	0
Tin sin	5	0	1	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	1	3	0	0	0
Tri ind	5	0	0	1	0	1	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Tyl hir	5	0	1	0	0	0	3	0	0	1	0	0	0	3	0	0	0	3	0	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0

	Broad leaved forest						Coniferous forest				Mix Forest			Shrubland				Open land				Cultivated land					Urban				Riverine			
0	F b	F B	FB L	FB O	FB R	FB S	F c	FC S	FC O	FC L	F m	FM S	FM O	S	S I	S O	S P	O	O S	O T	O R	C	C K	C B	C C	C P	U	U G	U T	U W	R	R S	RS S	RS R
Ura pic	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	1	0	4	0	0	0	0	3	0	0	0	3	0	0	0
Ver tha	5	0	0	0	0	0	3	0	1	0	0	0	0	3	0	0	0	3	1	0	1	4	0	1	0	0	3	0	0	0	3	0	0	0
Ver ana	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	1	0	0
Vit neg	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	1	0	0	3	0	0	1	3	0	0	0
Woo fru	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	0	1	4	0	0	0	0	3	0	0	0	3	0	0	0
Xan str	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	1	0	4	0	1	0	0	3	0	0	1	3	0	0	0
Zea may	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	1	0	3	0	0	0	3	0	0	0
Ziz mau	5	0	0	1	0	0	3	0	0	0	0	0	0	3	0	0	0	3	1	1	0	4	0	0	0	0	3	0	0	0	3	1	0	0
Ziz num	5	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	3	0	0	0	4	0	0	0	0	3	0	0	0	3	1	0	0

Exhibit 5A.5: Landuse at Project Facilities

Component	Code	Area (Hectare)	UCL	AGR	RIV	OPA	SET	BLS	BLM	BLD	CNS	CNM	CND
Study area (Polygon)	SA	25707.695	799.541	5562.344	303.515	1269.516	4294.065	3484.192	800.600	28.612	5292.298	3500.617	372.395
Project components		318.330	38.573	59.368	54.947	9.413	43.570	94.043	16.588	0.101	0.000	0.000	0.000
		1.238%	4.824%	1.067%	18.104%	0.741%	1.015%	2.699%	2.072%	0.355%	0.000%	0.000%	0.000%
Reservoir	RES	298.216	37.972	52.808	54.486	8.831	42.123	86.277	15.631	0.088			
Weir		2.242	0.424		0.333		0.212	1.152	0.121				
Camping Site (P)	CSP	2.738		2.296		0.088		0.353					
Camping Site (T)	CST	0.353						0.088	0.265				
Camping Site (W)	CSW	2.119		1.325		0.177		0.530	0.088				
Batching Plant	BCH	1.060	0.088	0.971									
M&E Yard	MEY	2.031					0.353	1.678					
Switch Yard	SWY	0.265						0.265					
Spoil Tip #1	ST1	0.000											
Spoil Tip #2	ST2	1.766		1.678				0.088					
Spoil Tip #3	ST3	1.060			0.088	0.265	0.088	0.530	0.088				
Spoil Tip #4	ST4	2.119	0.088				0.530	1.501					
		Length (km)											
Road #1	R#1	1.618		0.119	0.040		0.079	0.343	0.066				
Road #2	R#2	1.766					0.026	0.461	0.198	0.013			
Road #3	R#3	0.667				0.013	0.079	0.171	0.013				
Road #4	R#4	1.588		0.105		0.013	0.026	0.369	0.119				
Road #5	R#5	0.397				0.026	0.026	0.105					
Road #6	R#6	0.566		0.066			0.026	0.132					

R#1 Thalla road Bridge to Spoil Tip #2, R#2 Rehman Bridge to Spoil Tip #1 and mouth of headrace tunnel, R#3 Rehman Bridge to Weir, R#4 Kotli-Mirpur road to Spoil Tip #3, R#5 Kotli-Mirpur road to Weir, R#6 Kotli-Mirpur road to Batching Plant

Exhibit 5A.6: List of field equipment and supplies used to collect benthic macor invertebrates fauna from Poonch River

Field equipment / supplies
▪ Kick-net (500 µ opening mesh)
▪ Standard D-frame dip nets, 500 µ opening mesh, 0.3 m width (~ 1.0 ft frame width and handle stick at least 2meters)
▪ Sieve bucket, with 500 µ opening mesh (for sieving)
▪ 2.5 liters 95% ethanol will be converted to 70 % (750 mL of 95% ethanol topped up to 1 L with water = 70% ethanol)
▪ Sample containers (air tight & leak proof plastic jars of 500 ml capacity)
▪ Leak proof glass vials 35ml for sample preservation
▪ Sample container sticking labels
▪ Forceps (tweezers)
▪ Waders (chest-high or hip boots)
▪ Rubber gloves (arm-length)
▪ Global Positioning System (GPS) Unit

Exhibit 5A.7: Benthic macro invertebrate collection stations along with date, sampling equipment and co-ordinates

Stations (Locality Name)	*Date*	*Sampling Method*	*Co-ordinates*
S_1 (Agar Jamalpur)	13th August 2013	D frame dip net	33° .50168 N, 73°.88085 E & 33° .49997 N, 73°.88346 E
S_2 (Gheri Mandi)	13th August 2013	D frame dip net	33° .50185 N, 73°.87933 E
S_3 (Mandian)	14th August 2013	D frame dip net	33° .51896 N, 73°.88577 E
S_4 (Sarsawa Rangar Nullah)	14th August 2013	D frame dip net	33° .50528 N, 73°.87213 E
S_5 (Barali Bridge)	15th August 2013	Surber Net	33° .50528 N, 73°.87213 E
S_6 (Bhan Nullah)	16th August 2013	Surber Net	33° .483115 N, 73°.883593 E

Exhibit 5A.8: Different Models tested for Jackal and their AIC values, likelihood and number of parameters.

Model	*AIC*	*deltaAIC*	*AIC wgtModel*	*Likelihood*	*no.Par.*	*-2*LogLike*
psi(road-qd),p(terr)	138.78	0	0.3852	1	4	130.78
psi(.),p(terr)	140.4	1.62	0.1713	0.4449	3	134.4
psi(slop),p(terr)	141.24	2.46	0.1126	0.2923	5	131.24
psi(.),p(habt+terr)	141.88	3.1	0.0818	0.2122	6	129.88
psi(road),p(terr)	142.06	3.28	0.0747	0.194	5	132.06
psi(ndvi),p(terr)	142.36	3.58	0.0643	0.167	5	132.36
psi(sett-qd),p(terr)	142.38	3.6	0.0637	0.1653	4	134.38
psi(.),p(.)	143.01	4.23	0.0465	0.1206	2	139.01

Exhibit 5A.9: Different Models tested for Fox and their AIC values, likelihood and number of parameters.

Model	*AIC*	*deltaAIC*	*AIC wgtModel*	*Likelihood*	*no.Par.*	*-2*LogLike*
psi(.),p(terr)	60.01	0	0.3183	1	3	54.01
psi(.),p(terr+dist)	60.57	0.56	0.2406	0.7558	6	48.57

Model	AIC	deltaAIC	AIC wgtModel	Likelihood	no.Par.	-2*LogLike
psi(sett-qd),p(terr)	61.76	1.75	0.1327	0.4169	4	53.76
psi(ndvi),p(terr)	62.2	2.19	0.1065	0.3345	5	52.2
psi(slop),p(terr)	62.53	2.52	0.0903	0.2837	5	52.53
psi(elev),p(terr)	63.4	3.39	0.0584	0.1836	5	53.4
psi(.),p(.)	63.59	3.58	0.0531	0.167	2	59.59

Exhibit 5A.10: Evidence of goat poisoning and common leopard killing in forests adjacent to the project area. Information was provided by a local game guard.

a. Poisoned goat

b. Killed cubs

c. Killed animal

d. Face of killed one

e. Killed cubs

f. With wildlife gaurd

Exhibit 5A.11: List of Mammals observed and/ or collected from the Study area Exhibit

Sr. No.	*Scientific Name*	*Order/ Family*	*English Names*	*Local name*	*IUCN Status*	*Abundance*
1.	*Mus booduga*	Rodentia/ Muridae	Little Indian field mouse	Choohi	Least Concern (LC)	Common (C)
2.	*Rattus rattus*	Rodentia/ Muridae	Common Rat	Chooha	LC	C
3.	*Rattus pyctoris*	Rodentia/ Muridae	Turkestan Rat	Chooha	LC	C
4.	*Funambulus pennantii*	Rodentia/Petromidae	Palm Squirrel	Gulehri	LC	C
5.	*Lepus nigricollis*	Lagomorpha/ Leporidae	Indian Hare	Siah	LC	C
6.	*Herpestes edwardsii*	Carnivora/ Herpestidae	Common India Mongoose	Neola	LC	C
7.	*Herpestes javanicus*	Carnivora/ Herpestidae	Mongoose	Neola	LC	C
8.	*Lutrogale perspicillata*	Carnivora/ Mustelidae	Common Otter	Ludhar	Vulnerable	Rare
9.	*Hemiechinus collaris*	Insectivora/ Erinaceidae	Long-eared hedgehog	Kundyara Chooha	LC	C
10.	*Hystrix indica*	Rodentia/ Hystricidae	Indian crested porcupine	Seh	LC	C
11.	*Vulpes bengalensis*	Carnivora/ Canidae	Bengal Fox	Loomri	LC	C
12.	*Canis aureus*	Carnivora/Canidae	Asiatic Jackal	Gidar	LC	C
13.	*Suncus murinus*	Insectivora/Soricidae	Common Shrew	Kees	LC	C
14.	*Rousettus leschenaultii*	Chiroptera/Pteropidae	Fulvous Fruit Bat	Chamgadar	LC	C
15.	*Scotophilus heathii*	Chiroptera/ Vespertilionidae	Common Yellow-bellied Bat	Chumgadar	LC	C
16.	*Pipistrellus kuhlii*	Chiroptera/ Vespertilionidae	Kuhl's Pipistrelle	Chumgadar	LC	C
17.	*Pipistrellus tenuis*	Chiroptera/ Vespertilionidae	Least pipistrelle	Chumgadar	LC	C

Exhibit 5A.12: Reptile and Amphibian Species Found in the Study Area

Sr. No.	*Zoological Name*	*Common Name*	*Observation Records*	
			Direct	*Indirect*
1	*Bufo stomaticus*	Indus valley toad	√	-
2	*Bufo melanostictus*	Hazara toad	√	-
3	*Microhyla ornata*	Ant Frog	√	-
4	*Euphlyctis cyanophlyctis*	Skittering frog	√	-
5	*Fejevarya limnocharis*	Alpine cricket frog	√	-
6	*Hoplobatrachus tigerinus*	Bullfrog	√	-
7	*Lissemys punctata andersoni*	Indian flap-shell turtle	-	Interviews
8	*Laudakia agrorensis*	Agrore valley agama	√	-
9	*Laudakia himalayana*	Himalayan agama	√	-
10	*Eublepharis macularius*	Fat-tailed gecko	√	-
11	*Hemidactylus flaviviridis*	House gecko	√	-
12	*Hemidactylus brookii*	Spotted house gecko	√	-
13	*Indogekko rohtasfortai*	Rohtas gecko	√	-
14	*Ophisops jerdonii*	Rugose spectacled lacerta	√	-
15	*Eutropis dissimilis*	Striped grass skink	√	-
16	*Varanus bengalensis*	Bengal monitor	√	-
17	*Typhlops ductuliformes*	Slender blind snake	-	Interviews
18	*Eryx johnii*	Common sand boa	-	Interviews
19	*Xenochrophis piscator*	Checkered keel-back	-	Interviews
20	*Bungarus caeruleus*	Common krait	√	-
21	*Naja oxiana*	Brown cobra	-	Interviews

Exhibit 5A.13: Checklist of Avian Fauna

Order	*Family*	*Common Name*	*Scientific Name*	*IUCN*	*Status*
Passeriformes	Laniidae	Bay backed shrike	*Lanius vittatus*	-	SB
		Rufous-backed or long tailed shrike	*Lanius schach*	-	YRR
	Corvidae	Tree pie	*Dendrocitta vagabunda*	-	YRR
		House crow	*Corvus splendens*	-	YRR
		Large billed crow	*Corvus macrorhynchos*	-	YRR
		Common raven	*Corvus corax*	-	YRR
		Black headed jay	*Garrulus lanceolatus*	-	YRR
	Dicruridae	Black drongo	*Dicrurus macrocercus*	-	YRR
	Sturnidae	Indian myna	*Acridotheres tristis*	-	YRR
	Pycnonotidae	White cheeked bulbul	*Pycnonotus leucogenys*	-	YRR
		Red vented bulbul	*Pycnonotus cafer*	-	YRR
		Asian Black Bulbul	*Hypsipetes leucocephalus*	-	YRR
	Motacillidae	White wagtail	*Motacilla alba*	-	WV
		White browed wagtail	*Motacilla madaraspatensis*	-	YRR
		Paddy field pipit	*Anthus rufulus*	-	YRR
		Tree pipit	*Anthus trivialis*	-	SB
	Nectaribiidae	Purple sun bird	*Cinnyris asiaticus*	-	YRR
	Muscicapidae	Pied bush chat	*Saxicola caprata*	-	YRR
	-	Common bush chat	*Saxicola torquata*	-	PM
	-	Indian robin	*Luscinia brunnea*	-	YRR
		Oriental magpie robin	*Copsychus saularis*	-	YRR
	-	Blue caped redstart	*Phoenicurus caeruleocephala*	-	SB
	-	White-tailed Stonechat	*Saxicola leucurus*	-	YRR
	Timaliidae	Jungle babbler	*Turdoides striatus*	-	YRR
	-	Common babbler	*Turdoides caudatus*	-	YRR
	-	Striated laughing thrush	*Garrulax striatus*	-	YRR
	Sylviidae	Lesser whitethroat	*Sylvia curruca*	-	WV
	Alaudidae	Indian bush lark	*Mirafra erythroptera*	-	YRR
	Passeridae	House sparrow	*Passer domesticus*	-	YRR
	Cisticolidae	Striated prinia	*Prinia crinigera*	-	YRR
		Grey brested prinia	*Prinia hodgsonii*	-	YRR
		Rufous- fronted prinia	*Prinia buchanani*	-	YRR

Order	*Family*	*Common Name*	*Scientific Name*	*IUCN*	*Status*
		Graceful prinia	*Prinia gracilis*	-	YRR
	Sylviidae	Blunt winged warbler	*Acrocephalus concinens*	-	SB
		Oriental white eye	*Zosterops palpebrosus*	-	YRR
	Turdidae	Blue whistling thrush	*Myophonus caeruleus*	-	SB
	Monarchidae	Asian paradise flycatcher	*Terpsiphone paradisi*	-	SB
	Sturnidae	Brahminy Starling	*Sturnia pagodarum*	-	YRR
	Estrildidae	Scaly-breasted munia	*Lonchura punctulata*	-	YRR
	Paridae	Great tit	*Parus major*	-	YRR
Galiformes	Phasianidae	Black partridge	*Melanoperdix niger*	V	YRR
Columbiformes	Columbidae	Oriental turtle dove	*Streptopelia orientalis*	-	YRR
Coraciiformes	Alcedinidae	White throated kingfisher	*Halcyon smyrnensis*	-	YRR
	Coraciidae	Indian roller	*Coracias benghalensis*	-	YRR
	Upupidae	Common hoopoe	*Upupa epops*	-	SB
	Meropidae	Green bee eater	*Merops orientalis*	-	YRR
Falconiformes	Accipitridae	White rumped vulture	*Gyps bengalensis*	CE	YRR
		Himalayan griffon	*Gyps himalayensis*	Lc	YRR
		Egyptian vulture	*Neophron percnopterus*	End	W
		Shikra or Indian sparrow hawk	*Accipiter badius*	LC	YRR
		Eurasian sparrow hawk	*Accipiter nisus*	-	SB
		Tawny eagle	*Aquila rapax*	-	YRR
		Black kite	*Milvus migrans*	-	YRR
	Falconidae	Common kestrel	*Falco tinnunculus*	-	YRR
Apodiformes	Apodidae	House swift	*Apus affinis*	-	YRR
Piciformes	Picidae	Scaly billed woodpecker	*Picus squamatus*	-	YRR
		Brown fronted woodpecker	*Dendrocopos auriceps*	-	YRR
Cuculiformes	Cuculidae	Pied cuckoo	*Clamator jacobinus*	-	SB
-	-	Asian koel	*Eudynamys scolopaceus*	-	SB
Psittaciformes	Psittacidae	Rose ringed parakeet	*Psittacula krameri*	-	SB
Strigiformes	Strigidae	Spotted owlet	*Athene brama*	-	YRR

Key: LC= Least Concern; NT= Near Threatened; YRR+= Year Round Resident; WV= Winter Visitor; SB=Summer Breeding; PM= Passage Migrant (Data Source of residential status: Grimmett et al., 2008)

Annexure 5B: Description of Species of Concern

Fish Species

Species Bearing IUCN Status and having Commercial Importance

Tor Putitora (Golden Mahasher)

Status: Endangered (Year of assessment, 2010)

Justification: *Tor putitora* is a widely distributed species in south and Southeast Asia, with a restricted area of occupancy. However, the species is under severe threat from overfishing, loss of habitat, decline in quality of habitat resulting in loss of breeding grounds, and from other anthropogenic effects that have directly resulted in declines in its harvest. In addition, with several dams planned for construction in future in the Himalayan region, they could have a more drastic effect on tor populations blocking their migrations and affecting their breeding. Inferring population declines from observed cases with that of the trends across the entire distribution range, the species is estimated to have declined by more than 50% in the past and if the current trends continue and with the new dams being built, the population may decline even up to 80% in the future. The species is therefore assessed as Endangered and is in need of urgent conservation efforts to save it from becoming locally extinct in several locations.

Geographic Range: The species has been reported from across the Himalayan region and elsewhere in south Asia and southeast Asia, ranging from Afghanistan, Pakistan, India, Nepal, Bangladesh, Bhutan, Sri Lanka, Myanmar, western Iran to eastern Thailand.

Population: It is the most common and popular fish of the Himalaya and is also sometimes known as the golden, yellow-finned, grey-hound or the thick-lipped Mahasher. It grows up to 2.7 m. Since it is a heavily fished species, population declines in the entire range is inferred to be anywhere between 40-50% over the last ten years. Catches have declined in most of the areas due to overfishing.

Habitat and Ecology: The fish inhabits the montane and submontane regions, in streams and rivers. T. putitora is distributed in mid hills stretches of Himalayan region. It inhabits rapid streams with rocky bottom, riverine pools and lakes. The fish is a column feeder in freshwater found in pH ranges 7.4-7.9 and in subtropical condition 15°C-30°C. It is omnivorous in nature during their adult stage and feed on periphytic algae and diatoms in juvenile stage. The feeding and breeding habitats are lost almost throughout their distributional range.

Major Threat(s): The population of the fish is fast depleting and at present is chiefly localized to certain major river systems (Poonch River and Lower Swat River in Pakistan) and is fast approaching extinction in the streams and lakes of Himalayas. Large fishes are only found in some of the perennial pools. This species is declining from its natural habitat due to urbanization, illegal encroachment, over fishing and chemical and physical alterations of their natural habitats. The stress on the population is not only due to its over exploitation, but also due to the rise in developmental activities, especially the growing number of hydroelectric and irrigation projects which have fragmented and deteriorated its natural habitat.

Commercial Importance: It is the most common Mahasher of the Himalayas. It has afforded lucrative source of sport for the anglers all along the Himalayas since long. It grows up to 2.7m and weighs up to 54 Kg. The commercial fishery of Putitor Mahasher consists largely of individuals either ascending streams for breeding or the spent ones returning to perennial reservoirs. The population of this fish is fast depleting and at present is chiefly localized to certain rivers only. This most attractive sport fish with excellent food value is fast approaching extinction in the streams and lakes of Pakistan and India.

Cyprinus carpio (Common Carp)

Status: Vulnerable A2ce (Year of assessment, 2008)

Justification: The native populations are slowly but continuously declining due to river regulation. Also hybridization with domesticated introduced stocks, East Asian congeners and their hybrids is a serious long term threat for the species. However, superficially pure carp are still abundant in the lower parts of rivers within its native range. Very few stocks remain genetically unpolluted as a result of this long lasting process. The average age of the spawners is estimated to be between 20-25 years, as they are a long lived species (up to 50 years). Although no population data exists, it is suspected that in the past 60 to 75 years within the species native range, a population decline of over 30% has occurred due to hybridization with introduced stock and river channelization and dams impacting the species as they need flooded areas at very specific times to successfully spawn.

Distribution: Afghanistan, Armenia, Austria, Azerbaijan, Bulgaria, China, Croatia, Georgia, Germany, Hungary; Iran, Kazakhstan, Kyrgyzstan, Moldova, Pakistan, Romania, Russian Federation, Serbia, Slovakia, Tajikistan, Turkey, Turkmenistan, Ukraine, and Uzbekistan.

Habitat and Ecology: Warm, deep, slow-flowing and still waters, such as lowland rivers and large, well vegetated lakes. It has been introduced in all types of water bodies. Spawns along shores or in backwaters. Successful survival of larvae only takes place in very warm water, among shallow submerged vegetation.

Biology: Males reproduce for the first time at 3-5 years, females at 4-6. The fish lives up to 50 years and usually spawns every year. Age of maturity is related to latitude and altitude. It spawns in May-June at temperatures above 18°C. Adults often make considerable spawning migrations to suitable backwaters and flooded meadows. Individual females spawn with a few males in dense vegetation. The sticky eggs are attached to water plants or other submerged objects. Larvae and juveniles inhabit warm and shallow flooded river margins or backwaters, feeding mostly on very small zooplankton (rotifers). Reproductive success is restricted to years when the water level starts rising in May and when high temperatures and flooding of terrestrial vegetation last for a long period during May and June. Juveniles and adults feeds on a wide variety of benthic organisms and plant material. It is most active during dusk and dawn. The fish is very tolerant of low oxygen concentrations.

Major Threat(s): River regulation (they require flooded areas to spawn) and hybridization with introduced stocks is a major threat.

Commercial Importance: The carp is a bottom dwelling fish and mostly found at the bottom of water bodies. The growth of the carp is very rapid, particularly in favorable habitats. It can attain an enormous size of 110 cm and can weigh up to 40 kg. Its rapid growth tasty flesh, good reproductive ability and modest requirements have led to the carp’s becoming the stable fish of warm water fisheries. It surpasses all other fishes in breeding ability, resistance to disease, and high quality of its flesh; these characteristics, as its cleverness, adroitness and gameness on the hook also make it very popular among anglers.

Botia rostrata (Twin-banded Loach)

Status: Vulnerable A2cd (Year of assessment, 2010)

Justification: *Botia rostrata* is widespread in the hill streams across its range but faces threats such from destructive fishing practices and from the ornamental trade and habitat destruction due to sand and boulder mining. Population estimates of this species records a decline of more than 60% in five years. In some other areas, it is inferred that the species may have undergone more than 30% decline in its entire population. It is therefore assessed as Vulnerable.

Range Description: The species is recorded from the Brahmaputra basin in India and Bangladesh and the Indus drainage from Pakistan.

Population: Population estimates of this species were carried out in different parts of its distribution range. Catch frequency of *Botia rostrata* was 60% during 2004 but during 2009 it came down to 20% probably because it is a much sought after species firstly due to its good taste and secondly due to its ornamental value.

Habitat and Ecology: This species is reported to live in medium to fast current waters.

Commercial Importance: This fish carries no any importance as food fish but it is an ornamental fish and being exploited for aquarium trade.

Ompok bimaculatus (Butter catfish)

Status: Near Threatened (Year of assessment, 2010)

Justification: A widespread species that has undergone significant decline due to overexploitation as a food fish. The data shows declines throughout its range from overfishing and the species is assessed as Near Threatened with urgent need for taxonomic, harvest and population studies.

Range Description: *Ompok bimaculatus* is widely distributed in Pakistan, India, Sri Lanka, Bangladesh and Myanmar. However, given the uncertainties surrounding the identity of this species, it is possible that its range is more geographically circumscribed.

Population: This species is relatively abundant throughout its distribution. No empirical data on declines in its entire range is available, however, there are reports showing an average population decline of 29.3% over a period of four decades (1960-2000) for this species in some areas of its distribution. The average decline per decade since 1980 is about 60%. However, the difficulty in extrapolating data from a localized study and the taxonomic uncertainties surrounding the populations from throughout the subcontinent make it difficult to definitively consider this species to be in decline.

Habitat and Ecology: Inhabits plains and submontane regions, and is found in rivers, lakes, tanks and ponds.

Major Threat(s): Overexploitation of this species for food is a major threat and has resulted in marked population declines. The effects of other potential anthropogenic threats such as habitat destruction and competition from alien species need to be further ascertained.

Commercial Importance: It is considered a very tasty fish and is highly priced. It attains a length of 50 cm and weighs up to 200 grams.

Species not Bearing IUCN status but of Commercial Importance:

The species Tor putitora, Sperata seenghala, Clupisoma garua, Schizothorax plagiostomus (richardsonii), Cyprinus carpio and Mastacembelus armatus are commercially important species. Size and weights of these species are given in Table 2. Brief description of the commercially important species viz., *Tor putitora*, *Cyprinus carpio, Schizothorax plagiostomus* has already given above. Brief description of some of the other commercially important species is given below:

Clupisoma garua (Garua Bachwa)

Brief Description: Body elongate and compressed, abdominal edge keeled between pelvic fin and vent. Mouth is subterminal and teeth in villiform bands on jaws. Barbels in four pairs, the nasal barbells not reaching the eye while maxillary barbells extending o base of pelvic fins. Adipose fin is absent in adults.

Commercial importance: This fish is common in the rivers of Indus plain and grows to 60 cm and having a weight up to 500 grams. It is considered a good tasty food fish throughout its range. It is popular among the people who relish fishes without bones and so it fetches a good price. It is, however, not a good game fish as it is animal feeder.

Distribution: It is found in Pakistan, India, Bangladesh, and Nepal.

Biology: It inhabits large fresh water and tidal rivers. Feeds on insects, shrimps, other crustaceans and small fish.

Labeo dyocheilus (Dhi, Torki)

Brief Description: Body elongated and snout projecting beyond mouth with distinct lateral lobes. Mouth is wide and inferior with thick lips. Lower lip with an interrupted fold joined to isthmus by a narrow bridge. Barbels one short maxillary pair.

Commercial importance: This is a medium sized fish. It grows up to 90 cm and attains a weight of 5 kg. It is common species of Himalayas.

Distribution: Found in Pakistan, India, Bangladesh, Nepal, and Mekong basins.

Biology: Lives in clear active currents of large rivers. A migratory species spending winters in lower reaches of the Himalayan rivers while migrates upstream for breeding and feeding.

Mastacembelus armatus (Tire-track Spiny Eel)

Brief Description: The fish has dorsal spines from 33- 40 and dorsal soft rays from 67-82, anal soft rays 67 – 83. Body dull is brown with 1-3 darker longitudinal zigzag lines. These lines are more or less connected to form a reticulated pattern.

Commercial importance: This species attains a length of 90 cm and weighs up to 500 grams and is the largest spiny eel. It is very popular and a tasty food fish.

Distribution: Pakistan to Viet Nam and Indonesia.

Biology: A fish of economic importance species, both as food and aquarium trades. Lives in highland streams to lowland wetlands. Usually found in streams and rivers with sand, pebble, or boulder substrate. Seldom leaves the bottom except when disturbed. Also occurs in still waters, both in coastal marshes and dry zone tanks. Reported to occur in areas with rocky bottoms but enter canals, lakes and other floodplain areas during the flood season. It forages on benthic insect larvae, worms and some submerged plant material.

Endemic Fish Fauna of the Gulpur Hydropower Project Area

Schistura punjabensis (Hillstream Loach)

Brief Description: The dorsal and the ventral profiles in this hill stream loach run almost parallel to each other. The head is sub-triangular and depressed; its lower surface is greatly flattened. The caudal fin is longer than the head. The eyes are not visible from below and for a greater part lie in the anterior half of the head. There are six barbells, the inner maxillary are almost as long as the diameter of the eye while the others are much longer. Well-developed lips, which are continuous at the angles, border the mouth; the lower lip is provided with a free labial fold, which is widely interrupted, and the lip itself is divided in the middle. The lateral line is complete and the body is devoid of scales. There are from eleven to thirteen dark bands on the body but not meeting on the abdomen.

Distribution: Endemic in Pakistan and distributed in Punjab and Kashmir

Biology: Occurs in small streams and rivers with gravelly bottom. Apparently non-migratory and widespread in hill streams

Commercial Importance: This fish carries no any importance as food fish but it is an ornamental fish and being exploited for aquarium trade.

Barilius pakistanicus (Pakistani Chilwa)

Brief Description: A small sized fish, body laterally compressed and both the profiles arched. Head is triangular and pointed. Snout short and point¬ed, eyes lateral and situated in the anterior half of head. Mouth large and antero-superior; its gape extending below the level of middle of the eye; its lower jaw longer than the upper jaw and symphysial knob present, lower jaw with a pair of longitudinal hard folds, covered with hard papillae running on the ventral side but not meeting each other in front. Groove present around the angle of mouth. Nostrils are much nearer to the eye than to the tip of snout. Barbels two pairs, rostral pair much longer than maxillary one which may extend up to the posterior margin of eye. Dark brown on the dorsal side, 9-15 vertical dark bands extending below lateral line. Sometimes number of bands on one side is more than on the other side.

Distribution: Endemic to Pakistan. Found in hilly areas of Punjab, Azad Kashmir, Hazara, Vale of Peshawar, Kohi Sulaeman and Indus drainage of Balochistan.

Biology: Lives in hill streams with gravelly and rocky bottom. It is carnivorous fish living on aquatic insects. It breeds during Monsoon season.

Commercial Importance: This fish carries no any importance as food fish but it is an ornamental fish and being exploited for aquarium trade.

Reptile Species Account

Out of the 21 recorded herps at the project site, six species (Agrore valley agama, Himalayan agama, Rohtas gecko, Bengal monitor, slender blind snake and Checkered keel-back snake) were found important being the CITES species as well as from conservation point of view whereas; two species were found important due to being problem species in the area. The two problem species are the venomous snakes including Common Krait (*Bungarus caeruleus*) and Brown Cobra (*Naja oxiana*). These two snake species are also important because these can be life threat to human as well as the livestock in the area due to their bites. A brief description of the important species is given below.

Bungarus caeruleus (Schneider, 1801), (Common Krait)

This snake is locally known as Sang Choor and considered a deadly poisonous snake. It belongs to the Family Elapidae that includes all deadly poisonous snakes. During the survey, one specimen was collected at one of the study site. Different local residents, wildlife watchers and farmers interviewed during the survey also pointed out its existence in the area.


Fig. 3: Common Krait (*Bungarus caeruleus*) © M. Younus, SLF

Diagnostic Characters: Dorsal color is jet black to deep blue. A series of 3-9 light vertebral spots on anterior part of the body followed by a 38-56 narrow transverse bands usually in pairs. Ventral side of the body is white. This snake frequents open grass lands, semi deserts with alluvial soil. It is common in the marginal vegetation along tilled fields and extends into barns, farms, grooves and gardens. It lives in holes and crevices in the ground, piles of cut vegetation, bricks and debris etc. It is a nocturnal snake active just after sunset until dawn. Its food consists of toads, frogs, snakes, lizards and mice. A deadly poisonous snake in the area and killed by local residents whenever seen.

Naja oxiana (Echwald, 1831) (Brown Cobra)

This snake is locally known as Bhoora Naag and considered a deadly poisonous snake. This snake also belongs to the Family Elapidae that includes all deadly poisonous snakes. Different local residents, wildlife watchers and farmers interviewed during the survey pointed out its existence.


Fig. 4: Brown Cobra (*Naja oxiana*) © Waseem, PWF

Diagnostic Characters: Dorsal color is light yellow to light brown and with or without a hood mark. Ventrum is clouded with dark. The brown cobra inhabits dry wastelands where it lives in holes and crevices in uneven ground. In mountainous areas it lives in caverns and holes in rocks. It feeds on rodents, birds, snakes and lizards and often enters inhabited houses attracted by rodents.

Xenochrophis piscator (Schneider, 1799) Checkered Keeled back Snake

Diagnostic Characters: Head is slightly flattened and distinct from neck, supra-labials are 8-10 with 4th and 5th in eye and infra-labials are 9-10. Ventrals are 135-152 and sub-caudals 62-78. Dorsum is light green, grey or light reddish brown with five rows of blackish blotches. These blotches are smaller than inter-spaces and often fused with each other to form a reticulation. This pattern is more marked in the anterior half of the body and fades posteriorly. Ventrum is white or cream color. It is quite common in all major drainage systems in the upper and lower indus valley.

Habitat: This snake is more common in large ponds with thick emergent vegetation. It confines itself to side pools avoiding the main stream. In winter when most of the water bodies are dry, this snake is helpless and is killed in large numbers by people and other animals like mongoose and kites. Water visiting birds are said to take a high toll on young snakes. The snakes that have survived attacks usually have broken tails which is common in this species.

Habits: This semi aquatic snake is strong and active moving briskly both on land and in water. It is reported to move in jumps on land. It is known to be bad tempered; when cornered it rears up and flattens its body ready to bite. It strikes with great determination and rapidity, bites viciously holding on with such tenacity that it is difficult to dislodge and leaves nasty wounds. During winter it is diurnal whereas in summer, it becomes crepuscular and nocturnal. It is often seen swimming close to the upper warmer layers of pond in winter and basks on dry ground.

Fig. 5: Checkered Keeled back Snake © Waseem, PWF

Food: It feeds on fishes, frogs, and tadpoles. The prey is ambushed with the large teeth of the snake that play an important role in retaining a firm hold on slippery prey and subduing it.

Breeding: This snake breeds from February to May. Around 50-80 eggs measuring 27-31 mm by 15-18 mm in dimensions are laid in adhering clusters in holes away from water.

Himalayan Rock Agama Laudakia himalayana (Steindachner, 1869)

Five specimens of Himalayan Rock Agama (*Laudakia himalayana*) were collected from the study area. Laudakia himalayana is distributed from western Himalayas to Tajikistan. In Pakistan the species has been recorded from northern areas around Gilgit and Chitral (Khan M. S., 2006). Khan W. A., (2006) recorded it

Fig. 6: Himalayan Rock Agama © Waseem, PWF

from Qarchenai, Dhee and Shimshal valleys and also from Aagh, Zoi Saam, Toghraqeen, Padekishk and Arbab Kook nullahs at different elevations from 3000 m to 4000 m in Karakorum mountain ranges.

Diagnostic Characters: *Laudakia himalayana* is a diurnal and herbivore lizard. It breeds during May and June and juveniles can be seen by July and August. During the present study apart from adult individuals several juveniles were also observed. A grayish dorsal color was observed with light spots in large numbers without any specific sequence. Posterior side of head and neck was bearing small spinose scales. Tail was dorso-ventrally flattened at its base while rounded along rest of the part.