ENVIRONMENT IMPACT6 ASSESSMENT FOR PRPOSED

BAGLIHAR H.E.P. STAGE - II

A PROJECT

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision of

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HIMACHAL PRADESH INDIA

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CERTIFICATE

This is to certify that the work which is being presented in the project title **"Environment Impact Assessment For Prposed Baglihar H.E.P. Stage- II"** in partial fulfillment of the requirements for the award of the degree of Bachelor of technology and submitted in Civil Engineering Department, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Rajdeep Sharma** during a period from July 2015 to June 2016 2015 under the supervision of **Prof. Dr. Veeresh Gali** , Professor, Civil Engineering Department, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of my knowledge.

Date: - 28th May 2016

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INTRODUCTION

1.1 BACKGROUND

In the past few years, India has turned into a vibrant economy. With the growth of the Industrial sector and an improved quality of life, the demand for electric power is increasing day by day. Quality power is required to maintain the sustained growth of agricultural and industrial sectors, to accomplish a higher GDP and sustainable development. The electrical energy may be generated from fossil fuels, thermal power, nuclear energy, and hydropower or from renewable sources like solar or wind energy. Deriving electrical energy from fossil fuels like coal is becoming increasingly unmanageable because of environmental implications.

Considering the vast and untapped potential and availability, of the hydro resources in India, the development of hydropower projects is thus required to be explored fully. Power generation from such projects is also comparatively less damaging for the environment. Though power production from hydro resources does have its environmental concerns such as large inundations, disposal of muck and rehabilitation and resettlement (R&R) problems, they can be suitably handled with appropriate plans. e.g. the problem of muck disposal is always resolvable if the restoration of disposal areas is carried out in a scientific way. It would also be appropriate to state here that the problems related to large inundations and R&R may be tackled by going in for run-of-the-river schemes in place of large reservoir schemes as the quantum of inundation and displacement will be much less in run-of-the-river scheme projects.

1.2 HYDRO-POWER POTENTIAL OF INDIA

Geo-morphologically, India offers great sources of hydropower with well-defined regions, which are topographically favourable for the run-off river hydro development. The generation from hydel is assumed at plant load factor of 40% for the period 1999-2019. Like the Green Revolution of the past, which concentrated on Punjab and Haryana, the new "Power Revolution" is focusing on power producing states like Chhattisgarh, Himachal Pradesh and Uttarakhand, which have a potential to produce nearly 50000 MW of power because of their rich natural resources. India currently generates about 83% of its electricity from conventional thermal power plants and about 15% from hydroelectric plants (mainly located in J & K State, Himachal Pradesh, Uttarakhand, and the Northeast). Accordingly, GOI has launched a 50,000-megawatt (MW) hydroelectric initiative. Hydropower is a renewable source of energy and much cheaper as compared to thermal power.

As per the assessment of CEA the country is endowed with hydro potential of 84000 MW at 60% load factor or an installed capacity of around 1,50,000 MW. The region wise hydro potential is shown in **Table-1.1**.

Table-1.1: Region wise Breakup of Hydropower Potential in the Country

Region	Potential at 60% load factor, MW	Feasible Installed Capacity, MW	Potential in billion, KWH/year	Pumped Storage Feasible Installed Capacity, MW	Small Hydro (up to 15 MW Potential), MW
Northern	30155	53405	225	13065	3180
Western	5697	8928	31.4	39684	661
Southern	10768	16446	61.8	17750	801
Eastern	5590	10965	42.5	9125	530
North Eastern	31857	58956	239.3	16900	1610
Total	**84044**	**148700**	**600**	**95524**	**6782**

It is significant to note that the country has harnessed barely 15 percent of its hydro potential whereas only about 7 percent more is under various stages of development. This leaves 78 percent hydropower potential of our rivers un-harnessed and rivers flow down to the sea unused, in the process causing severe damage through flood year after year. Data collected by Central Water Commission for the period 1953-1999 suggests that an annual of 8.113 million hectare gets floods of which 3.567 million hectares comprises of cropped area. Average damage to crops, houses, and public utilities has been estimated around Rs.1,399 crore at the year 2000 price level. The exploitable global hydropower potential is estimated around 15,000 billion units, of which India's potential counts for about 4 percent. But all the same, India ranks fifth in hydro potential. In 62 countries, hydropower share in total power output is 50 percent, in 23 countries 90 percent and in 15 countries 100 percent. But in India hydropower share is only 15 percent. It is a well-known fact that countries having a larger share of hydropower have been able to offer to their consumers significantly lower power tariffs.

1.3 HYDRO POWER DEVELOPMENT OF JAMMU & KASHMIR

Jammu & Kashmir is predominantly a mountainous state located in north-west of the country, bounded on the south by Himachal Pradesh and Punjab, on west and south by Pakistan and on the north by China and Turkistan and on the east by China (Tibet). The state comprises mostly mountains terrain rising in several tiers from the plain in the south to high altitude valleys with average altitude El. 1800 masl with mountains rising upto 5000 masl and above. A small hydropower plant, Mohora Hydro Power Station, 2 x 4.5 MW on Jhelum river was the first major hydropower

development in 1905 in the then princely state of J & K. After independence, the hydropower development got some momentum albeit very slow. In 1955-56, Ganderbal hydropower station of installed capacity 15 MW (2 x 3 + 2 x 4.5) was constructed in Jhelum basin. Another hydropower project at Rajouri of installed capacity 0.70 MW (2 X 0.35) was commissioned, in 1960, in the Chenab basin which was followed by a Chenani-I with installed capacity 23.30 MW which was commissioned in 1971-72. Upper Sindh Hydropower Plant, installed capacity 22.6 MW (2 x 11.3) in Jhelum basin was commissioned in 1973-74, followed by commissioning of Lower Jhelum (105 MW) in the year 1978-79. The development of hydropower got momentum in mid 1990 when major projects viz. Salal 690 MW (6 x 115) and Uri-1, 480 MW (4 x 120) were commissioned in 1994-1997 and 1997-98 respectively in the Central Sector. In Jhelum basin, Upper Sindh-II, 105 MW was developed in State Sector and commissioned in 2002-03. With the commissioning of Dul Hasli (390 MW) and Baghlihar-I (450 MW) in Central and State sector, the total installed capacity of the commissioned plants stands at 2318.70 MW.

1.4 HYDRO POWER POTENTIAL OF JAMMU & KASHMIR

The state of Jammu & Kashmir, located in the north-western corner of India between 32° 17' and 37° 05' N latitude and 72°26' and 80°30' E longitude, covers an area of 22.2 Mha being 6.7% of the total geographic area of the country. The J & K region consists of four prominent mountain ranges of the Great Himalayas, the Karakoram, the Ladakh, the Zanskar and Pir Panjal. Between these ranges are the longitudinal valleys of the Gilgit, the Shyok, the Indus and the Jhelum. South of Pir Panjal is the Siwalik range, comparatively much lower in elevation and known as Jammu hills, further south there is a narrow strip of foot-hill plains (25 km wide) merging into plains.

The altitude ranges from 366 to 7980 masl at Jammu and Nanga Parbat respectively. The state is blessed with abundant water resource in its three major rivers viz. the Indus, the Jhelum and the Chenab and their tributaries, which emanate from the Western Himalayas and flow through the state. These snowed rivers and their tributaries carry copious discharge all the year round, which can be exploited for power generation. Roads and other communication networks connect all the river basins and valleys.

The identified hydropower generation potential of the state is 16200 MW, being about 19.3% of the total hydel potential of the country i.e. 84000 MW, out of which only around 2318.70 MW stand harnessed so far. The balance potential (85.7%), if harnessed expeditiously in a judicious and eco-friendly manner, can provide adequate resources to the state to promote its development activities. The basin-wise total hydropower potential identified including their operation are shown in **Table-1.2** and **Table-1.3** respectively.

Table-1.2: Basin-wise Hydro Potential and Development

Sl. No.	Name of Basin	Hydro-power Potential, MW	
		Identified	Developed
1.	Jhelum	3560	732.60
2.	Chenab	10360	1563.80
3.	Indus	2060	13.30
4.	Ravi	2220	9.00
		18200	**2318.70**

The break-up of the commissioned schemes in the state and the central sector is presented under **Table-1.3**.

Table-1.3: Basin-wise Hydropower Development

Sl. No.	Name of HEP	Configuration	Installed Capacity (MW)
A. State Sector			
Jhelum Basin			
1.	Lower Jhelum	3 x 35	105.00
2.	Upper Sindh-I	2 x 11.3	22.60
3.	Ganderbal	2 x 3 + 2 x 4.5	15.00
4.	Upper Sindh-II	3 x 35	105.00
5.	Pahalgam	2 x 1.5	3.00
6.	Karnah	2 x 1	2.00
Sub-Total			**252.60**
Chenab Basin			
1.	Chenani-I	5 x 4.66	23.30
2.	Chenani-II	2 x 1	2.00
3.	Chenani-III	3 x 2.5	7.50
4.	Bhaderwah	2 x 0.5	1.00
5.	Baglihar	3 x 150	450.00
Sub-Total			**483.80**
Ravi Basin			
1.	Sewa-III	3 x 3	9.00
Sub-Total			**9.00**
Indus Basin			
1.	Iqbal	3 x 1.25	3.75
2.	Hunder	2 x 0.2	0.40
3.	Sumoor	2 x 0.05	0.10
4.	Igo-mercellong	2 x 1.50	3.00
5.	Haftal	2 x 0.5	1.00
6.	Marpachoo	3 x 0.25	0.75
7.	Bazgo	2 x 0.15	0.30
8.	Stakna	2 x 2	4.00
Sub-Total			**13.30**
Total State Sector			**758.70**
B. Central Sector			

Sl. No.	Name of HEP	Configuration	Installed Capacity (MW)
1.	Salal	6 x 115	690.00
2.	Uri-I	4 x 120	480.00
3.	Dul-Hasti	3 x 130	390.00
Total Central Sector			**1560.00**
Grand Total (A) + (B)			**2318.70**

Basin-wise break-up of the upcoming and the projects taken up for development in state/ central sector is shown in **Table-1.4** and **Table-1.5** respectively.

Table-1.4: Upcoming Hydroelectric Projects

Sl. No.	Name of HEP	Installed Capacity (MW)
A. State Sector		
1.	Bagliher-II	450.00
2.	Pahalgaon (3rd Unit)	1.50
3.	Matchil	0.35
4.	Baderwah (3rd Unit)	0.50
5.	Sanjak	1.26
	Sub-Total (A)	**453.61**
B. Central Sector		
1.	Uri-II	240.00
2.	Sewa-II	120.00
3.	Nimo Bazgo	45.00
4.	Chutak	44.00
Sub-Total (B)		**449.00**
Grand Total (A) + (B)		**1002.61**

Table-1.5: Hydro-Electric Projects Taken-up for Development

Sl. No.	Name of HEP	Name of Basin	Estimated Capacity (MW)
A. State Sector			
1.	Swalikot I & II	Chenab	1200.00
2.	Lower Kalnai	Chenab	50.00
3.	Kirthai-I	Chenab	240.00
4.	Kiru	Chenab	600.00
5.	Rattle	Chenab	690.00
6.	Kawar	Chenab	520.00
7.	Parnai	Jhelum	37.50
8.	New Ganderbal	Jhelum	93.00
		Sub-total (A)	**3430.50**
B. Central Sector			
1.	Pakal Dul	Chenab	1000.00
2.	Bursar	Chenab	1020.00
3.	Kishan ganga	Jhelum	330.00
4.	Ujh Multipurpose Project	Ravi	280.00
		Sub-Total (B)	**2630.00**
		Grand Total (A) + (B)	**6060.50**

1.4.1 Benefits and Scope of Hydropower Development

Apart from being non-polluting and clean energy, hydropower cost of generation progressively goes down in contrast to other sources like thermal, gas, oil, etc. where the cost of fuel goes on increasing. A very significant benefit of hydropower in contrast to thermal power is the inherent ability of hydro plants for quick starting and stopping and almost instantaneous load acceptance and rejection. This makes them ideal for meeting peaking power shortage (current peaking power shortage in India is around 18 per cent). In a typical power system, it is seen that only 60 percent of the demand may be for 24 hours, the balance 40 percent arises only for six to eight hours per day. In this context, it is worth pointing out that the latest policy on hydropower development framed by the Union Government has given a thrust to ensure exploitation of the hydro potential. The policy envisages benefits to investors such as normative level for incentives, simplification of procedures and further reassurances of return on investments. It is envisaged in the policy on hydro development, that steps will be taken to accelerate hydropower development by higher budgetary allocation for the hydro sector by giving priority to languishing state sector. The policy lays a greater emphasis on the ideal hydro thermal mix, which should be in the ratio of 40:60.

1.4.2 Hydro Power Potential of Chenab Basin

In view of the Chenab, which has its genesis in the confluence of the Chandra and the Bhaga, which emanates from the opposite faces of Barelacha Pass in Lahul and Spiti part of the Zaskar range and flow through Himachal Pradesh before entering Jammu and Kashmir state, the hydro potential of the river has been studied in toto. The hydro-power potential of Chandrabhaga or Chenab draining about 7844 sq km upper catchment of Chenab, lying in Himachal Pradesh, has been estimated as 2728.30 MW out of which 5.30 MW has so far been harnessed in state sector through throat HEP (4.50 MW) and four other micro hydel schemes. The balance potential of 2723 MW, in respect of 15 other identified schemes, is proposed to be developed in private sector.

The hydro-power potential of the Chenab and its tributaries has been assessed as 10360 MW out of which 1563.80 MW stand harnessed. The total hydro-power potential of the Chenab and its tributaries in the two states and its utilization is shown in **Table-1.6**, which reveals that only 12% identified potential has been harnessed thus far.

Table-1.6: Hydro-Power Potential of the Chenab Basin

Sl. No.	Name of State	Identified Potential (MW)	Capacity Utilized (MW)	% Utilization
1.	Himachal Pradesh	2728.30	5.30	1.94
2.	Jammu & Kashmir	10360.00	1563.80	15.09
	Total	**13088.30**	**1569.10**	**12**

1.5 CASCADE DEVELOPMENT OF HYDRO POWER IN CHENAB BASIN

The Chenab, in its 535 km long journey from source to the international border with Pakistan, flows through high cliffs except for a small river stretch between Reasi and Akhnoor, where it flows through flat terrain. The main river and the several tributaries contributing to it have their origin in glaciated areas, are therefore, perennial in nature and flow with copions discharge round the year. The main Chenab, having its course mostly cut through deep gorges and steep bed slope due to altitudinal variation of 5350 m in its bed level within its course in India coupled with enormous discharge, presents umpteen locations for cascade development of hydro-power within the ambit and frame work of the existing Indus Water Treaty, 1960, signed between India and Pakistan. With a view to harness the enormous power potential of the river, Chenab Coordination Committee was constituted to identify the potential hydro-electric schemes within the constraints laid down in the Indus Water Treaty, in general, and the proviso set out under Annexure 'D' and 'D' of the Article III of the Treaty, the former enunciates the major design aspects whereas the latter deals with the provisions regarding storage capacity of water on the Western Rivers elucidated in **Table-1.7**.

Table-1.7: Storage Limitations Imposed by the IWT

Sl. No.	River System	General Storage Capacity (million acre feet)	Power Storage Capacity (million acre feet)	Flood Storage Capacity (million acre feet)
1.	The Indus	0.25	0.15	Nil
2.	The Jhelum (excluding the Jhelum Main)	0.50	0.25	0.75
3.	The Jhelum main	Nil	Nil	As provided in paragraph
4.	The Chenab (excluding the Chenab Main)	0.50	0.60	Nil
5.	The Chenab Main	Nil	0.60	Nil

Out of 190 schemes in the Indus basin, 31 schemes are identified in the Chenab basin with a hydroelectric potential of 12345 MW at 60% load factor. Major hydropower projects planned on River Chenab are listed in **Table-1.8** and their locations are shown in **Figure-1.1**.

Table-1.8: Cascade of identified Hydropower Project in Chenab Basin

Sl. No.	Hydro Project	Sl. No.	Hydro Project
1	Chhatru (108 MW)	17	Barinium (240 MW)
2	Telling (69 MW)	18	Kirthai-I (240 MW)
3	Khoksar (90 MW)	19	Bhutnallah (338 MW)
4	Gyspa (240 MW)	20	Kirthai-II (990 MW)
5	Tandi (150 MW)	21	Naunatoo-Naigad (400 MW)
6	Rasil (150 MW)	22	Kiru (600 MW)
7	Bardang (114 MW)	23	Kwar (520 MW)
8	Miyar (120 MW)	24	Dulhasti (390 MW) - commissioned
9	Tinget (81 MW)	25	Pakul Dul (1000 MW)
10	Patam (60 MW)	26	Bursar (1020 MW)
11	Seli (400 MW)	27	Ratle (850 MW)
12	Reoli-Dugli (420 MW)	28	Lower Kalna i(50 MW)
13	Purthi (300 MW)	29	Baglihar I & II (450 + 450 MW) - Stage I commissioned
14	Sachkhas (149 MW)		
15	Dugar (236 MW)	30	Swalkot (1200 MW)
16	Shou (230 MW)	31	Salal (690 MW) - commissioned

1.6 NECESSITY & JUSTIFICATION FOR IMPLEMENTING THE PROJECT

Comparing the projected growth of peak demand and anticipated increase in the generating capacity on the basis of new projects proposed and/or under construction / consideration during 10th and 11th Five Year Plans, it is evident that there is a dire need to provide additional power to the Northern Grid to meet the increasing demand of power. New schemes have to be taken up immediately and implemented to derive timely benefits. The most important source of power development in the Northern region is hydroelectric power located in Himachal Pradesh, Uttarakhand and Jammu & Kashmir.

The need for the Baglihar HEP, Stage-II, installed capacity 450 MW, in the lower reach of the Chenab Basin, which stores 10360 MW power potential being 85.7% of the total hydropower potential of the state, has therefore been considered in context of power shortage in the Northern region in general and in the country as whole. The project has been conceptualized as a run-of-the-river scheme, under the ambitions cascading development programme of hydropower in the Chenab basin abstracting water from the intake, already constructed with the works of Baglihar HEP, Stage-I. The project is an upstream development of the Sawalkote HEP (1200 MW) and is on the downstream of the proposed Bhamnot HEP, installed capacity 370 MW. Thus, Baglihar HEP, Stage-II shall utilize already established gross storage of 428.28 MCM at EL 840 masl. Baglihar HEP, Stage-II shall provide power during monsoon period (June to September) and also in such 10-daily periods in other months when the river discharges are in excess of the requirement of Stage-I. The power house of Stage-II can be operated as peaking station together with Stage-I power house subject to water availability for peaking during non-monsoon months. It presents itself as techno-viable and an attractive scheme for statutory clearance and development.

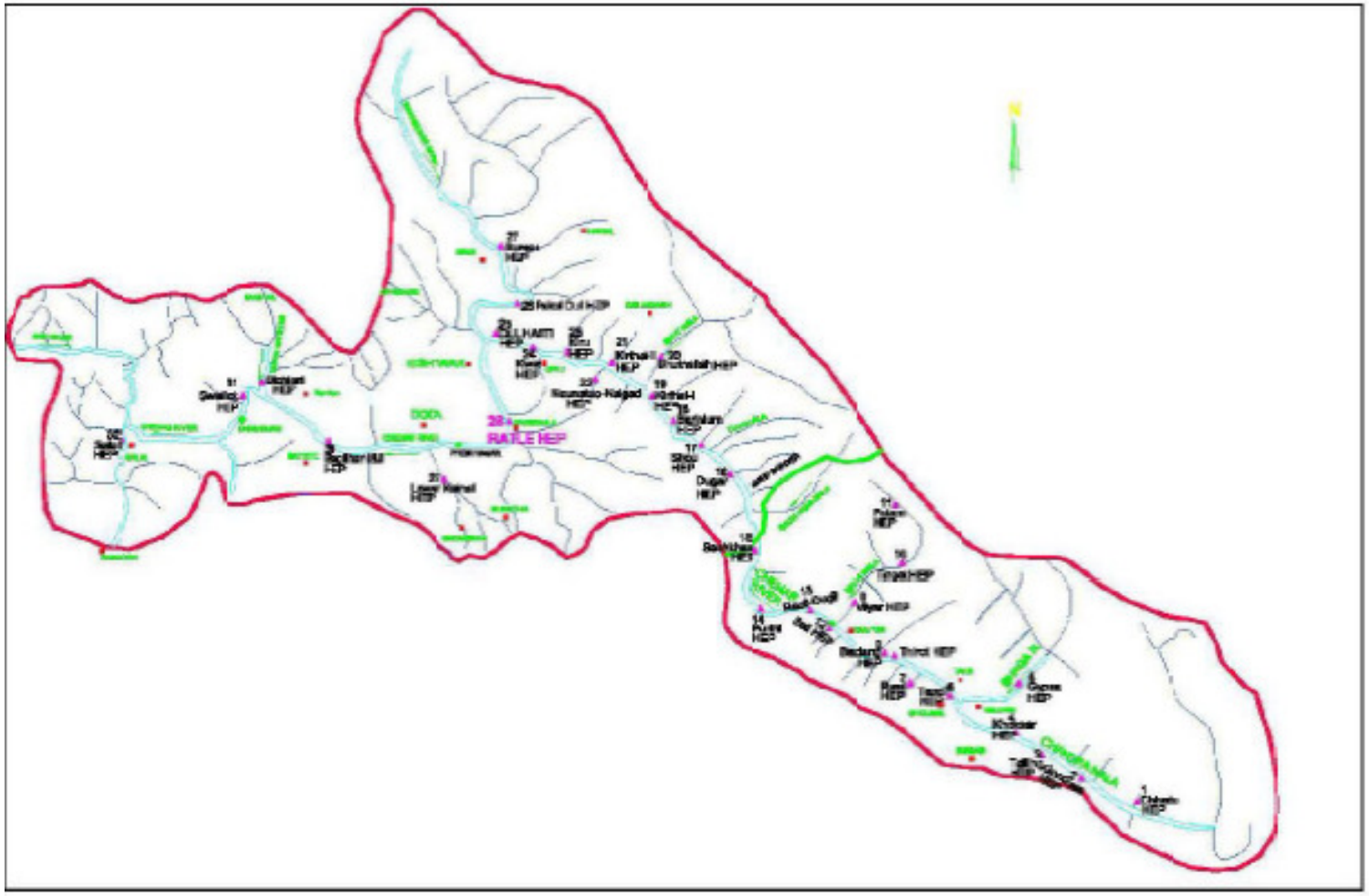


Figure-1.1: Schematic Map of the Cascade of Hydropower Development

1.7 BAGLIHAR HEP, STAGE – I : AN OVERVIEW

Baglihar HEP, Stage-I (3x150 MW), encompasses 143 m high concrete dam on the Chenab near village Baglihar, Power Intake structure for both stages on the right bank, 2.081 km long and 10.15 m diameter HRT for Stage-I and 50 m long for Stage-II, 27.5 m dia and 77.0 high restricted orifice type Upstream Surge Shaft, three Pressure Shafts, an underground Power House (3x150 MW), a Downstream Collection Gallery and 130 m long Tail Race Tunnel (varying from 8.8 m at collection gallery end to 10 m at its outfall end). Three Pressure Shafts off-take at the bottom of Surge Shaft to feed three turbines installed in the Power House Cavity. The Tail Race Tunnel of Stage-I Project is free flowing. The works of Stage-I commenced in the year 1999 and completed in October, 2008 and it is running successfully since its commissioning. In order to provide ease in construction of Stage-II works and to avoid closure of Stage-I power house, the essential works like intake for Stage-II along with initial 50 m length of HRT have been constructed concurrently with the construction of Stage-I.

1.8 BAGLIHAR HEP, STAGE – II : AN OVERVIEW

Baglihar HEP, Stage-II comprises a Power Intake (already constructed with Stage-I works), about 1889 m long and 10.15 m dia Head Race Tunnel, 27.5 m dia restricted orifice type Upstream Surge Shaft, three Pressure Shafts, an underground Machine Hall, Transformer Hall, three Draft Tubes & Bus Ducts, a Downstream Surge Gallery and 10.15 m dia. 342.6 m long Tail Race Tunnel and gated Outfall Structure.

1.8.1 Location and Approach

The Baglihar Hydro Electric Project (Stage-I & Stage-II) is located in the Ramban district of Jammu division of Jammu & Kashmir state. The nearest railhead is Udhampur, 65 km from Jammu. The project is about 18 km from Batote and 150 km from Jammu on Jammu-Srinagar National Highway 1-A on Nasri bypass road. The nearest airports are Jammu and Srinagar.

The location map of the project is shown in **Figure-1.2**.

1.8.2 Description of Project Components

1.8.2.1 Power Intake

The Power Intake for Stage-II project, constructed along with the intake of Stage-I, consists of two rectangular openings 10m x 7.5m with a 5 m thick intermediate pier. Provisions of stoplogs as well as the fixed wheel type intake gates have been made.

1.8.2.2 Head Race Tunnel

10.15 m finished internal dia. circular HRT to pass a maximum discharge of 430 cumec has been proposed in 1888.8 m length including 50 m initial portion constructed concurrently with Stage-I. Two adits have been proposed for construction of HRT for Stage-II, one near intake and the other near surge shaft end. Sixteen meter vertical distance has been proposed at the point of crossing of the two HRT.

1.8.2.3 Surge Shaft

A restricted orifice type Surge Shaft has been proposed at the d/s end of HRT. The dia of surge shaft is 27.5 m. Keeping a free board with respect to maximum surge level, the top of surge shaft has been kept at EL 867.0 masl. The bottom of 27.5 m dia Surge Shaft is proposed at EL. 812.0 masl. A riser of 20 m dia which can accommodate the gate grooves of the three penstock gates is proposed between EL. 812.0 masl upto top of the HRT-II.

1.8.2.4 Pressure Shafts

Three steel lined, 5.5 m inner diameter, Pressure Shafts shall take off from the surge shaft to negotiate a drop of 82.1 m between the centre line of HRT at junction with the surge shaft at EL 778.1 masl and centre line of machine at EL 696.0 masl.

1.8.2.5 Power House and Transformer Hall

The underground Power House and Transformer Hall Cavities of Stage-II are aligned parallel to Stage-I cavities and are located about 180 m u/s of Stage-I cavities on Right Bank of Chenab River. Machine Hall Caven will be of size 121 m (L) x 24 m (W) x 52.3 m (H). The Transformer Hall Cavern of size 113.15 m (L) x 15 m (W) x 24.5 (H) and shall be located 30 m away from the downstream wall of Machine Hall.

1.8.2.6 Collection Gallery

A Collection Gallery, 95 m (L) x 14 m (W) X 19.15 m (H) shall be provided on the downstream of the power house to help stabilize the pressure level caused by load fluctuations.

1.8.2.7 Tail Race Tunnel and Outlet Structure

A 342.60 m long, 10.15 m diameter circular Tail Race Tunnel shall be provided to carry the turbine discharges to the river Chenab. It shall rise from El 688 masl to El 700 masl at the outlet structure conceived in the shape of diffuser with two bays of 5.0 m width x 8.1 m height each.

The general layout of entire scheme of Baglihar HEP, Stage-I and II is shown in Figure ….

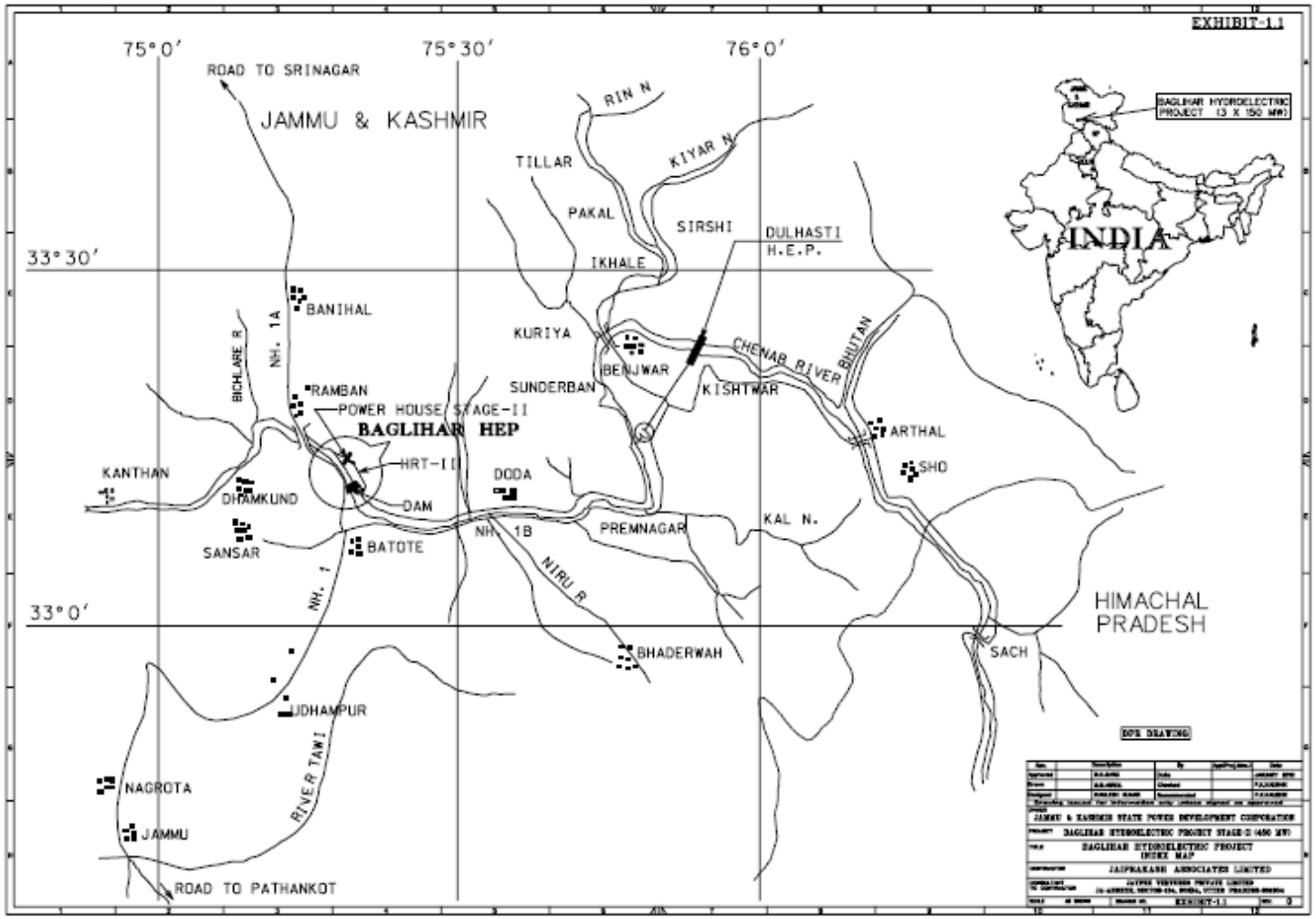
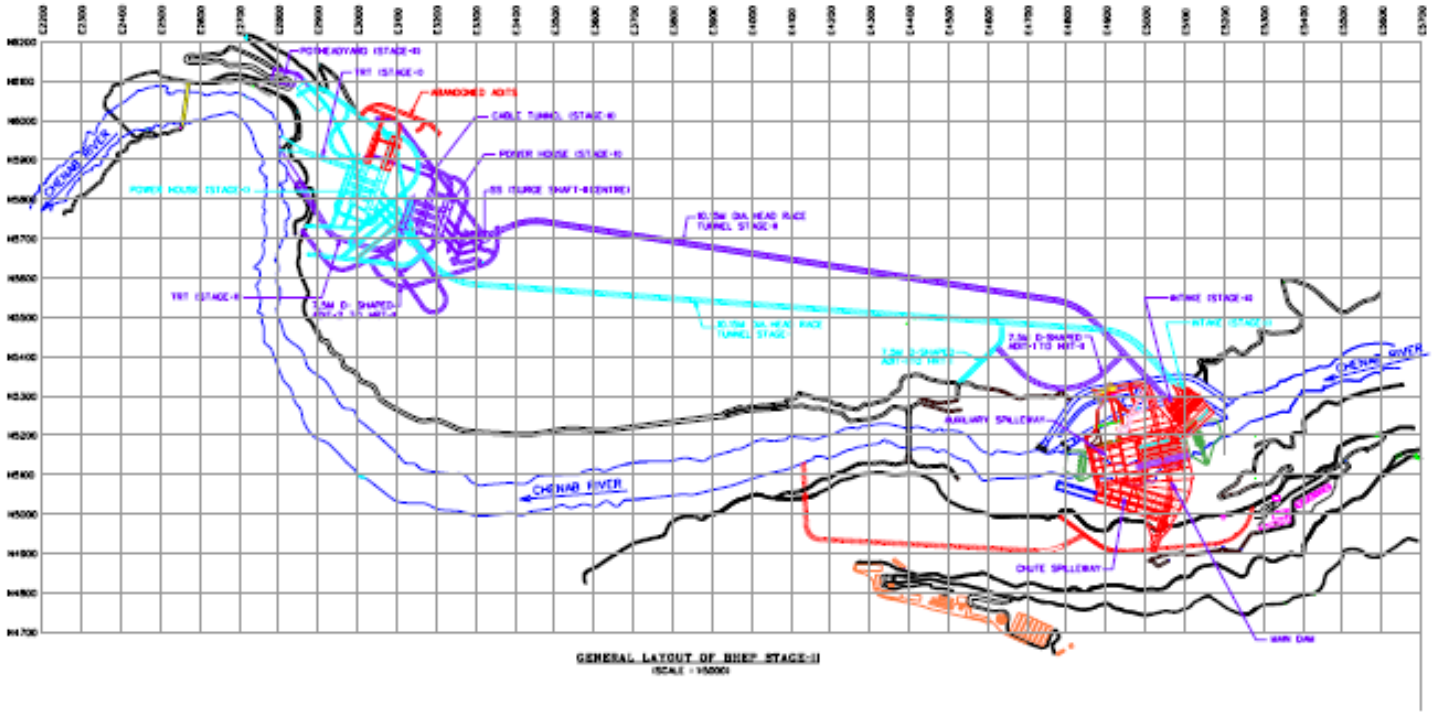


Figure-1.2: Location Map of the Project



DPR DRAWING

JAMMU & KASHMIR STATE POWER DEVELOPMENT CORPORATION

BAGLIHAR HYDROELECTRIC PROJECT STAGE-II (450 MW)

GENERAL LAYOUT OF BHEP STAGE-II

JAIPRAKASH ASSOCIATES LIMITED

Figure-1.3: General Layout Plan of the Project

1.9 SALIENT FEATURES OF BAGLIHAR HEP, STAGE-II

The salient features of commissioned Stage-I project, which are common to Stage-II also along with such features which are exclusive for Stage-II have been elucidated in **Table-1.9.**

Table-1.9: Salient Features

LOCATION	**STAGE-I & II**
State	Jammu & Kashmir
District	Ramban
Longitude	75°18'10" - 75°20' East
Latitude	33°9'30" - 33°11' North
HYDROLOGY	**STAGE-I & II**
Name of the River	Chenab
Type of Scheme	Run-of-the-river
Design Flood (PMF)	16,500 cumec
Diversion Flood (1:25 year)	3000 cumec
Maximum and minimum temperature in summer	42°C and 20°C
Maximum and minimum temperature in winter	15°C and -4°C
RESERVOIR (ALREADY ESTABLISHED)	**STAGE-I & II**
Full Reservoir Level	840 masl
Minimum Draw Down level	836 masl
Gross Storage up to FRL (EL 840.0 m)	EL 428.28 MCM
Operating Pool (above MDDL at EL 836 m)	32.56 MCM
DAM (ALREADY CONSTRUCTED IN STAGE-I)	**STAGE-I & II**
Type	Solid concrete gravity dam
Length	364.362 m
Height (from deepest foundation level)	143.0 m
Road level at top	843.0 masl
Design Flood	16,500 cumec
MAIN SPILLWAY (SLUICE TYPE) (ALREADY CONSTRUCTED IN STAGE-I)	**STAGE-I & II**
Design Discharge	10,500 cumec
Spillway Crest Elevation	808.0 masl
Number of Spillway bays	5 Nos.
Sizes of gates	10.0m (W) x 10.5m (H)
Type of gates	Radial gates (top sealing type) with Hydraulic Hoists
CHUTE SPILLWAY (ALREADY CONSTRUCTED IN STAGE-I)	**STAGE-I & II**
Design Discharge	5947 cumec
Spillway Crest Elevation	821.0 masl
Number of Spillway bays	3 Nos.
Sizes of gates	12.0m (W) x 19.6m (H)

Type of gates	Radial gates with Hydraulic Hoists	
AUXILIARY SPILLWAY (ALREADY CONSTRUCTED IN STAGE-I)	**STAGE-I & II**	
Design Flood	53 cumec	
Crest Elevation	837.0 masl	
Number of bays	One	
Size of gate	6.0m (W) x 3.3m (H)	
Type of gate	Fixed wheel gates with Hydraulic Hoists	
INTAKE (FOR STAGE-I & II WORKS) (ALREADY CONSTRUCTED IN STAGE-I)	**STAGE-I**	**STAGE-II**
Capacity	430 cumec	430 cumec
Sill Elevation	EL 821.0 masl	EL 821.0 masl
Openings - 2 Nos.	10m (W) x 7.5m (H)	10m (W) x 7.5m (H)
Type of Gates	Fixed wheel gates with Hydraulic Hoists	Fixed wheel gates with Hydraulic Hoists
HEAD RACE TUNNEL	**STAGE-II**	
Number	One	
Size and shape	10.15m dia Circular	
Length	1888.80 m	
Discharge	430 cumec	
Invert level at intake	815.35 masl	
Invert level at junction with surge shaft	775.35 masl	
SURGE SHAFT	**STAGE-II**	
Location	Upstream of Power House (fully underground approach to top through an access cum air vent adit)	
Type	Restricted orifice type	
Size	27.5 m dia	
Height	79.5 m (above orifice slab)	
Size of Dome	48.0 m Dia. And 18.0 m Height	
Emergency Gates	3 Nos. Vertical Gates, one for each Pressure Shaft located in Surge Shaft.	
PRESSURE SHAFTS / PENSTOCKS	**STAGE-II**	
Number	Three (one for each unit)	
Shape	Circular	
Size	5.5 m dia	
Length	184 m, 190 m, 213 m	
POWER HOUSE COMPLEX	**STAGE-II**	
Type	Underground	
Installed Capacity (Stage-I)	450 MW (3 x 150 MW)	
Number of Cavities	Three	
Size of Cavities:		
a) For Machine Hall	121m (L)x24m (W)x52.3m (H)	
b) For transformer Hall cum GIS Chamber	113.15m (L)x15m (W)x24.5m (H)	
c) Collection gallery	95.0m (L)x14.0m (W)x20.65m (H)	
d) Vertical Shaft	3 Nos., 12.0m (L)x14.0m (W)x28.85m (H)	
e) Gate Operating Gallery	57.0m (L) x 16.0m (W) x 9.0m (H)	
Maximum Operating Tail Water Level	717.2 m	
Minimum Operating Tail Water Level	704.351 m	

ACCESS TUNNEL TO POWERHOUSE	**STAGE-II**	
Size	7.5m D-shaped	
Length	113.7 m	
SWITCHYARD (Outdoor pothead yard)	**STAGE-II**	
Size	60m x 35m	
TAIL RACE TUNNEL	**STAGE-II**	
Shape	Circular	
Size	10.15 m dia.	
Length	342.60 m	
Discharge	430 cumec	
POWER OUTPUT	**STAGE-II**	
Installed Capacity	3 x 150 MW	
Minimum discharge in 90% availability year	136 cumec	
Minimum mean discharge	144 cumec	
Annual Energy Generation:		
90% availability year	1302.00 GWH	
50% availability year (mean year)	1636.50 GWH	
TARIFF (AS PER JKSERC)	**STAGE-II**	
Tariff for First Year	Rs. 3.52/kWH	Without Mega Power Project Status
Levelised Tariff for 35 Years	Rs. 2.58/KwH	
Tariff for First Year	Rs. 3.34/Kwh	With Mega Power Project Status
Levelised Tariff for 35 Years	Rs. 2.45/Kwh	

1.10 POLICY, LEGAL & ADMINISTRATIVE FRAMEWORK

The emerging environmental scenario calls for requisite attention on conservation and proper use of natural resources and also development without destruction. There is a need to integrate the environmental consequences of the development activities and to planning suitable mitigation measures in order to ensure sustainable development in the region. The environmental considerations in any development process have become a necessity for achieving sustainable development. To achieve these goals, the Govt. of India, Ministry of Environment & Forests, and the state of J & K has enacted Acts, Legislations, Guidelines and Standards from time to time in this context.

The regulation of environmental acts, legislation, guidelines and standards is the responsibility of different government agencies. The principal environmental regulatory agency in India is the Ministry of Environment & Forests, New Delhi. MoEF formulates environmental policies and accords environmental clearances for different projects. The important environmental legislations as applicable in J & K are given in **Table-1.10**.

Table-1.10: Key Environmental Legislations as applicable to J & K

Name	Scope and Objective	Key Areas	Operational Agencies / Key Players
Water (Prevention and Control of Pollution) Act, 1974	To provide for the prevention and control of water pollution and enhancing the quality of water	Control sewage and industrial effluent discharges	State Pollution Control Boards
Air (Prevention and Control of Pollution) Act, 1982	To provide for the prevention and control of air pollution	Controls emissions of air pollutants	State Pollution Control Board
Forest (Conservation) Act, 1987	To consolidate acquisition of common property such as forests, halt India's rapid deforestation and resulting environmental degradation	Regulates access to natural resources, state has a monopoly right over land, categories forests, restriction on de-reservation and using forest for non forest purpose	State Government
Wildlife (Protection) Act, 1978	To protect wildlife	Creates protected areas (national parks / sanctuaries) categories of wildlife which are protected	Wildlife Advisory Boards, Central zoo Authorities
Environment (Protection) Act, 1986	To provide for the protection and improvement of environment	An umbrella legislation, supplements pollution laws	Central government nodal agency, MoEF can delegate powers to state departments of environment
National Policy on R & R, 2007	Resettlement and rehabilitation of project affected people	Social issues	State Government
EIA Notification 14th September 2006 and its amendment dated 1st December 2009	Environmental Impact Assessment	Environmental Protection	Project Developer, State and Central Government

As per MoEF notification dated 14th September 2006 and its amendment dated 1st December 2009, construction of new project or activities or the expansion or modernization of existing projects or activities listed in the schedule to the notification shall be undertaken in any part of India only after the prior environmental clearance from the Central Government in the Ministry of Environment and Forests, New Delhi for matters falling under Category 'A' in the schedule and at state level the State Environment Impact Assessment Authority (SEIAA) for matters falling under Category 'B' in the said schedule, the later duly constituted by the Central Government under sub-section (3) of section 3 of the said act.

Baglihar HEP, Stage-II, having installed capacity of 450 MW is a river valley project falling under project category with threshold limit "A", and as such the environmental clearance shall have to be sought from the MoEF.

1.11 SCOPING OF THE PROJECT

In consonance with the provision under section-6 of the MoEF notification, dated 14th September 2006, the project proponent shall have to apply an application, to the MoEF, in the prescribed Form-I duly filled along a copy of the DPR of the project. In view of the project being classified as Category 'A' project the first step required in the environment clearance process is 'Scoping' by which the Expert Appraisal Committee of the MoEF determines detailed and comprehensive Terms of Reference (TOR) addressing all relevant environment concerns for the preparation of an Environmental Impact Assessment (EIA) Report in respect of the project for which prior environment clearance is sought.

After having set out the ToR proposed for environmental impact assessment studies and preparation of environmental management plan for Baglihar HEP, Stage-II, the EAC vide letter no. J-12011/39/2009-1A-1 dated 24/05/2010 conveyed to the project proponent a copy of the ToR.

CHAPTER 2

METHODOLOGY

2.1 INTRODUCTION

The EIA study includes the study of various baseline parameters of environment viz. land, water, air, noise, flora, fauna and socio-economics. Integration of these parameters gives an overall perception of positive and negative impacts due to construction of a hydroelectric project, if any. For overall prediction of impacts, the Study Area considered was 10 km radius covering all consequential project components viz. dam and power house etc for conducting study in respect of attributes like air, noise, water and soil and up to the next upstream proposed HEP. Baseline study was carried out for three seasons covering period April 2011 to March 2012 as per terms of the agreement of the ToR issued by the Ministry of Environment & Forests, New Delhi.

2.2 PHYSICAL ENVIRONMENT STUDY

The Digital Satellite data IRS P6 LISS-III for the specific site was acquired from NRSA and evaluated on ERDAS Imagine Software. The standard False Colour Composite (FCC) was generated by assigning blue, green and red colours to visible green, visible red and near infrared bands respectively. Expressing image pixel addresses in terms of a map coordinate base is often referred to as geo-coding. As various thematic layers were to be overlaid for this project, all the layers were geo-referenced to real world coordinates. The 1:50,000 scale toposheets of the study area were used for the purpose of geo-referencing. A large number of GCPs were selected for reasonably accurate geo-referencing/geo-coding. A map projection system (real world) was also defined.

Histogram of the scene under study has been generated to check the range of special values present in the scene. In order to use total grey level range and to optimize the contrast, the actual grey level ranges of three bands were linearly stretched independently. The zoomed images were studied wherever necessary. The interpretation key necessary for identifying different features has been developed systematically on the basis of image characteristics and associated elements viz. shape, size, shadow, pattern, color/tone, texture, association, location and available ground truth. Among these characteristics shape, size, shadow and pattern are basically dependent on the scale of the image whereas the color/tone and texture depend upon the brightness, contrast and resolution of the image. Various land units were identified, delineated and the map was validated.

Detailed field survey was conducted for study of soil characteristics of erosion prone areas and landslides in the catchment area. The vulnerable and problematic areas were identified in different physiographic zones in the entire catchment area. The data was generated on physiography,

landuse/landcover, lithology, structure, drainage pattern, slope characteristics, landslides/slips etc. These data sets were used for preparation of the thematic maps, calculation of sediment yield index and Erosion Intensity Units in the catchment area according to the following procedures.

2.2.1 Landuse – Landcover Classification

- Prior to ground truthing, the satellite data was classified using unsupervised classification technique. Further after collecting ground truth details maximum likelihood classification based on supervised classification method was used with remote sensing image data.

- After the supervised classification procedure, a land use map was prepared which the team at field verified, and errors or omissions were identified.

- A reclassification of the land use categories implementing the details and corrections, if any, was done. The reclassification output was used for the preparation of the final land use classification map. This map after due verification was then composed and printed, as desired.

2.2.2 Slope

- Slope is a measure of change in the value of altitudes over distance, which can be expressed in degrees or as a percent .The first step in generation of slope map is to create surface using the elevation values stored in the form of contours or points. Surface is a representation of geographic information as a set of continuous data in which the map features are not spatially discrete, i.e., between any two locations, there are no clear or well defined breaks between possible values of the map features. Models built from regularly or irregularly spaced sample points on the surface can represent the surface.

- Slope map of the study area was prepared using the elevation information for the area from contour heights. Toposheets of the scale 1:50,000 were collected for the entire free/directly draining catchment area. These toposheets were then manually pasted together to form a seamless mosaic of the area and the catchment boundary for the proposed project was marked on them.

- After marking the study area, all the contours on the toposheet were digitized. The output of the digitization procedure was the contours as well as points contours in the form of x, y and z points (x, y location and their elevation). All this information was in real world coordinates (latitude, longitude and height in meter above sea level).

- A Digital Terrain Model (DTM) of the area was then prepared, which was used to derive a slope map. The slope was divided in classes of slope percentages.

2.2.3 Soil

- Based on a 3-tier approach (Landform analysis, field survey and laboratory investigation) soil resource map of study area has been prepared.

- The results were superimposed with the soil map of J & K prepared by National Bureau of Soil Survey and Land use Planning (NBSS and LUP), Nagpur. NBSS Publication 62 (soil of India series) was followed.

- The taxonomy of soils are used as per USDA system of soil classification.

- The soil map as prepared was then brought into GIS environment and used along with ERDAS Imagine Software as base map of further analysis.

2.3 AIR, NOISE AND WATER ENVIRONMENT STUDY

2.3.1 Air Quality Assessment

The number of sampling at each of 05 stations was done for two consecutive days for a week in a month. The baseline data of ambient air environment was generated for the mentioned parameters as given below.

1. Suspended Particulate Matter (SPM)
2. Respirable Suspended Particulate Matter (RSPM)
3. Sulphur dioxide (SO2)
4. Nitrogen oxide (NOx)

In regard to the techniques for collection of sample of particulate matter, the "Respirable Dust Sampler Envirotech Model APM 460 BL" was used for air monitoring. The dust particulate matter was collected on filter paper (size GF/A20.3x25.4 cm) and dust cup and the gaseous pollutants were collected simultaneously by a known volume of air through a number of bubblers of different flow rate through appropriate solution for absorbing different gases. The collected sample was analyzed according to standard method for different pollutants.

Theory of Respirable Dust Sampler (RDS)
The principle involved in Suspended Particulate Matter (SPM) sampling method is that the particles are filtered from known volume of an air sample by a suction apparatus and the particle are deposited on a filter paper. Generally the gaseous pollutants in air are made to react with liquid absorbing media at atmospheric temperature and pressure when

air is bubbled through the absorbing solution in the impinger. RD sampler measures only the concentration of SPM and Gases in the ambient air.

Calculation

For particulate matter

RSPM ($\mu g/m^3$) = (weight of filter paper after sampling – initial weight of filter paper) / volume of air.

SPM ($\mu g/m^3$) = RSPM + (final weight of cyclonic cup – initial weight of cyclonic cup) / volume of air.

For gaseous pollutants

SO_2 ($\mu g/m^3$) = $(A - A_0) \times 1000 \times B \times D / V$

NO_x ($\mu g/m^3$) = $(A - A_0) \times 1000 \times B \times D / 0.82V$

Where, A = Sample Absorbance,

A_0 = Reagent blank Absorbance, and

B = Calibration factor (µg/absorbance)

D = Volume of absorbance solution in impinger during monitoring / volume of absorbing solution taken for analysis.

V = Volume of Air Sample in liters.

2.3.2 Noise Level Measurement

The noise level was measured for 05 locations by sound level meter RS 232 (digital Instrument). It consists of the following major section.

1. The Sensor or Microphone

The sensor is a high precision electrode condenser microphone, which must be protected from physical abuse, dirt, oil, water or ingress of any such substance.

2. The Control Panel

The control panel comprises of the:-

1. Recorder for the maximum level of sound and minimum level of sound
2. Range selector
3. Auto and manual rest switches
4. Hold on max and min level

3. The Range Selector

These switches can be used for selecting the relevant range of the sound level.

Methodology

The calibrated and charged sound level meter is adjusted for slow time response. The noise level was measured at different sites for 24 hrs continuously and maximum and minimum level of noise was recorded for the particular site and then average was calculated which gave the final readings. Readings were taken in each division of north, south, east and west around each source and at various distances and the maximum minimum for particular hours were recorded.

Sources

The major sources of air pollutants in the project area are vehicular traffic, blasting (during road construction at present), dust arising from local and village road, forest fire and domestic fuel burning.

2.3.3 Water Quality Assessment

The baseline data for water quality assessment was done based on the parameters given below.

1. General survey of river Chenab upstream up to Rattle HEP and on downstream of proposed dam site and along Nachhar and Pira nala.
2. Selection of spots for water sampling and collection of aquatic organisms.
3. Distribution and population density of macro-zoo benthos in river Chenab.
4. Periodical monitoring of physical, chemical and biological characteristics of river water.
5. Estimation of coliform (MPN) and *E. Coli* organisms in river water.
6. Importance of water quality on existing aquatic fauna in mountain rivers.

2.3.3.1 Water Quality Analysis

Fourteen sites covering surface and ground water (spring) were selected for water sampling. The selection of sites was done considering the location of different project components, junction of streams and river course, spots of high water velocity and some of the stagnated pools along with the areas having human interference. The sampling was carried out for winter season. The limnological parameters were recorded mainly following the standard methods described by Welch (1948), CSIR (1974). Mackereth *et.al.* (1978) and APHA, AWWA, WPCF (1995) as following:

Parameters Instrumentation

Ambient temperature	: Digithermometer (stainless steel sensor probe)
Transparency	: Seehi dise method (Weleh 1948)
Water velocity	: EMCON digi current meter
Turbidity	: Nephelometer
Total Dissolved Solids	: Titration method
pH	: Digi pH meter (HANNA)
Alkalinity, Acidity, Chlorides, Silicates, DO, Free CO2, Zn, Si, Fe and Nutrients (Phosphorus, Sulphates)	: Aquamerck / Aquaquant kits
Total Ca and Mg Hardness – EDTA	: Titrametric methods (Natrajan and Jhingran 1988)
Inorganic phosphates	: Colorimetric Methods
BOD	: Titration
E-Coli and Total Coliform	: Macconkey broth

2.3.3.2 Aquatic Environment

Data on existing aquatic environmental conditions in and around proposed project has been generated as per following:

- Biological characteristics of river water.
- Inventorization of phytobenthos and Zoobenthos
- Estimation of coliform organisms.
- Present status of riverine fish fauna: Identification of obligate fish species.
- Their Migratory pattern, diseases, feeding and breeding grounds.

Evaluation of Phytobenthos

Samples of periphyton were obtained by scraping off 3 cm^2 area of the boulders and preserving it in 1 ml of Lugol's solution. The upper surface of boulders was scraped with the help of sharp razor. Three replicates were obtained and integrated. Thus the total area sampled amounted to 9 cm^2. Sedgewick-Rafter cell counts (APHA 1992) were made and density was recorded as cell m m^2. For qualitative studies the keys of Trivedy and Goel (1984) and Ward and Whipple (1959) were being used for identifying the filametous and non-filamentous algae.

However, for identifying diatoms, permanent mounts were prepared and identified. For computing abundance (as %) 300-400 diatom cells were identified in each sample (with BX-40).

Evaluation of Benthic Macro-Invertebrates

Benthic macro-invertebrates were collected from the designated sampling sites in river Chenab, Nachhar and Pira Nala using surber's square foot sampler (Welch, 1948) adopting random sampling device. All collected specimens were preserved in 8% formalin solution and identified upto the generic level with the aid of keys given by Usinger (1950), Ward and Whipple (1959), Needham and Needham (1962), Macan (1979), Tonapi (1980) and Edington and Hildrew (1995). The density of benthic macroinvertebrates was expressed as unit per meter square (unit/m2).

Benthic macroinvertebrates were sampled from an area of one ft^2. All the stones of the area were collected in a bucket with as little disturbance as possible and washed thoroughly. Three replicates were obtained and integrated. The sampleswere sieved and preserved in 70% alcohol for further analysis. The benthic macroinverterbrates could be identified upto order/family/genus level with the help of keys given by Edmondson (1959) and Pennak (1953). Counts of the identified organisms were made in each sample and density was recorded as individual's m-2. The spatial variations in community structure were recorded by computing percentage abundance.

Evaluation of Total Coliform

To assess the quality of water in terms of pathogenic and parasitic organisms, the use of indicator system has been thought to be best

method. The coliform organisms are considered to be the best indicators of pathogenic organisms. The standard test for the estimation of number of coliform group had been carried out generally by multiple tube dilution technique which gave most probable number (MPN) of bacteria. A selective medium was used to develop only coliform bacteria. Coliform ferments lactose and produce acid and gas which could be detected by uplifting of Durham's tube by vision. MPN was not an actual enumeration of coliform bacteria but merely an index of the probable.

Culture Media

A. Mac Conkey Broth: For Presumptive Test of Coliform

Peptone 20 g.
Lactose 10 g.
Sodium chloride 5 g.
Bile salt 5 g. (may be replaced by sodium taurocholate or sodium taurogly – chocholate)
Distilled water 1000 ml.

B. EC Medium: This medium is used for the test of presence of coliform group of fecal origin.

Tryptose or trypton : 20 g.
Lactose : 5 g.
Bile salt mixture : 1.5 g.
Bile salt No. 3
Dipotassium hydrogenphosphate : 4 g. KH_2PO_4
Potassium dihydrogen phosphate : 1.5 g. KH_2PO_4
Sodium chloride : 5 g.
Distilled water : 1 lit.

C. Buffered Dilution Water: To prepare stock phosphate buffer solution 34 g of potassium dihydrogen phosphate is to be dissolved in 500 ml distilled water at pH 7.2 with 1N NaOH and be diluted in 1 lit with distilled water. 1.25 ml stock phosphate buffer solution will be added to 1 lit distilled water. Dispense in amounts that will provide 9 ml in 150 x 25 mm test tubes sterilized autoclave at 121 °C for 15 min.

Calculation: Coliform density was determined by using a standard MPN Table. The density was given against various +ve tube combinations. Expression of Results: It was convenient to express the results of the examination of replicate tubes and dilution in terms of the Most Probable Number (MPN). In usual practice the results were expressed in terms of MPN index/100 ml of various combinations of +ve and -ve results generally given in most of the microbiological manuals.

Fecal Coliform (MPN) procedure: For separation of coliform organisms of fecal origin from that of non fecal, elevated temperature tests had been used. Gas formation in subculture of the +ve tubes from presumptive tests of coliform in EC medium at 44.5 ±0.2 0C for 24 hrs gave the + ve test of fecal coliform.

Total Count: Total bacterial count is indicative of the presence of chemosynthetic heterotrophic group of bacteria (Exotic) and is often performed in conjunction with total coliform (MPN) in waters. The test is not differential between pathogens and indicator organisms but is considered affirmative to population.
Total count was often performed to assess:

1. Progress of self-purification in rivers, ponds and lakes in time and space.
2. Efficiency of bacterial removal during storage and treatment processes.
3. Ascertaining quality in general.

Culture Media
Nutrient Agar
Beef extract 3 g.
Peptone 5 g.
Agar 15 g.

2.4 BIOLOGICAL ENVIRONMENT

2.4.1 Floral Study

The present report on the plants of project area is based on extensive field survey of the area. The seasonal study has been conducted during April 2011 to March 2012. The plant species were identified with the help of Botany Division, FRI, Dehradun.

Besides the collection of plant species, information was also collected on the vernacular names and uses of plants made by local inhabitants.

2.4.1.1 Phytosociology

A nested quadrates technique was used for sampling the vegetation. The size and number of quadrates needed were determined using the species area curve (Mishra, 1968) and the running mean method (Kershaw, 1973). Summarization of previously used methods and recommendations led to the use of more than often (10 x10 m) quadrates laid out for sampling the tree stratum and 1x1m quadrates for herbs, grasses and seedlings of tree species less than 1.3 cm dbh (diameter at breast height) at different altitudinal gradients using GPS. However, for examining the shrub species 3x3m sample plots were laid out. The enumeration of the vegetation in each of the quadrate was done by measuring dbh individually in case of woody vegetation and collar diameter in case of herbs and grasses, with the help of tree caliper and electronic digital caliper. In case of grasses and sedges, each erect shoot is considered to a plant tiller and the enumeration was done by laying 1x1m quadrates at random, further subdivided into 10x10 cm segments.

Four such segments selected at random were analyzed from each quadrate by counting the tillers individually. The method used was that of Singh and Yadava (1974).

The vegetation data collected for phytosociological information was quantitatively analyzed for density, frequency and abundance according to Curtis and McIntosh (1950). The relative values of frequency, density and dominance of all the species were summed up to represent Importance Value Index (IVI). The following are the formulae to derive frequency, density, dominance, IVI etc.

$$\text{Frequency} = \frac{\text{Total number of quadrats in which species occurred}}{\text{Total number of quadrats studied}}$$

$$\text{Abundance} = \frac{\text{Total number of individuals of species in all quadrats}}{\text{Total number of quadrats in which species occurred}}$$

$$\text{Density} = \frac{\text{Total number of individuals of a species}}{\text{Total number of quadrats studied}}$$

IVI = Relative frequency + Relative dominance (basal area) + Relative density

$$\text{Relative Frequency} = \frac{\text{Frequency of the species}}{\text{Total frequency of all species}} \times 100$$

$$\text{Relative Density} = \frac{\text{Density of the species}}{\text{Total density of all species}} \times 100$$

$$\text{Relative Dominance} = \frac{\text{Dominance of the species}}{\text{Total dominance of all species}} \times 100$$

$$\text{Relative Abundance} = \frac{\text{Abundance of the species}}{\text{Total abundance of all species}} \times 100$$

2.4.1.2 Diversity of The Forest Vegetation

The tree species diversity for each stand in different forest types was determined using Shannon Wiener information function (Shannon and Wiener, 1963), which is:

$$H = -\sum_{i=1}^{s} (Ni/N) \ln (Ni/N)$$

Where, Ni is the total number of individuals of species i and N is the total number of all species in a stand.

2.4.1.3 Concentration of dominance

Concentration of dominance (Cd) was measured by Simpson Index (Simpson, 1949):

$$C = \sum_{i=1}^{s} (Ni/N)^2$$

Where, Ni and N were the same as for Shannon Wiener information function. This index ranges from one, if all the individuals belong to one species, to (1/s) if they are equally divided among species (S).

2.4.2 Faunal Study

Ground surveys were carried out by trekking the impact zone for identification of important animal groups such as butterflies (insects), birds, mammals, reptiles, and some fishes inhabiting the area, along the riverbanks, adjoining forest on the slopes, nallahs, hill top and agricultural fields.

- For sampling butterflies the standard 'Pollard Walk' methodology was used by recording all the species that were encountered while trekking along the foot trails between these two sites, daily. Voucher specimens of species were collected by means of a butterfly net for only those species that could not identified in the field besides photographing them for the same purpose. Sampling was done for 1 hour in a stretch on each transect (n = 4).

- For sampling birds 'point sampling' along the fixed transects (foot trails) was carried out to record all the species of birds observed with the help of binoculars; field guides and photography for 1 hour on each transect (n=4).

- For sampling mammals, 'direct count on open width (20m) transect' was used on the same transects (n=4) for 1 hour in each transect. Besides, information on recent sightings/records of mammals by the villagers and locals was also collected from these areas.

- 'Reptiles' mainly lizards were sampled by 'direct count on open width transects' (n = 4) for 1 hour in each transect.

- Seasonal variation in species diversity of different groups of animals (butterflies and birds) were evaluated using Shannon-diversity Index (***H'***) to know the season of peak diversity in the area amongst the two seasons i.e. winter and pre-monsoon studied.

$$H' = -\sum_{1}^{N} Pi \ln Pi$$

(from species 1 to n; n= total number of species)

Where **Pi** is the proportion of the individual species in the total population.

2.4.2.1 Aquatic Fauna

Evaluation of Aquatic Fauna

An extensive survey of river Chenab upstream and downstream of dam and up to Rattel HEP, Nachhar and Pira Nala during April 2011 to March

2012, with the intention to examine aquatic animal species such as fishes, insects, arthropods, amphibians, snakes, water-birds, otters etc.

2.5 SOCIOECONOMIC STUDY

The data on socio economic and dependency aspects were collected in two stages. The first stage involved a rapid assessment of the study area in order to obtain an overall perspective of the villages that were located in the project area. The second stage of data collection was done in the villages which are going to be directly affected by acquisition of land for construction of project. A sampling frame for survey area was initially devised and as per this the villages going to be affected due to project construction were surveyed. These villages fall in District Ramban. Data collection from secondary sources has also been made to validate some of the information and to supplement the data on demographic aspects.

Secondary information was collected from different government and non government offices. The data collected mainly was of secondary nature and involved information regarding access to facilities such as PHC's, schools, bus services, LPG distribution centers, type of roads, livestock information, land utilization, demographic profile of the villages, location and distribution of villages with respect to Project.

2.6 SECONDARY SOURCES OF DATA

Metrological department	: Climatic data
Survey of India	: Topo sheet
National Remote Sensing Agency	: Satellite Data
Forest Survey of India	: Forest cover
Botanical Survey of India	: Floral characteristics/vegetation of Chenab Valley
Zoological Survey of India	: Distribution of fauna in Chenab valley and identification key.
Revenue Department	: Land data / population statistics

CHAPTER-3

PHYSICAL ENVIRONMENT

3.1 INTRODUCTION

Catchment area of the Chenab River up to the proposed diversion dam of Baglihar, Stage-I/II and u/s, investigated and allotted HEP in private sector (GVK Ratle Hydro Electric Project Pvt. Ltd.), i.e. Ratle HEP and proposed Shamnot HEP (370 MW) has been assessed from available information and is computed to be 17325 km^2, 14209 km^2 and 15625 km^2 respectively. Thus, the free draining catchment area above Baglihar HEP to proposed Shamnot HEP comprises 1700 sq. km.

The catchment is characterized by diversified climate zones. The catchment, therefore, has variable physiography, climate, geology, slope, soil types and land use / land cover. While evaluating the land environment these parameters were analyzed in detail and the environmental impacts were predicted accordingly. The study area for evaluating physical environment comprises of area within 10 km radius from the dam and also includes the submergence area and the free draining catchment. The physical environment of the study area was evaluated in the light of its climate, topography, geology, slope, seismicity, soil and land use / land cover etc.

3.2 CLIMATE

The climate of Chenab river basin can be broadly classified in four climatic zones.

a. Cold Arid Zone: - This zone represents high altitude area of Greater Himalayas, Lahaul and Spiti region, characterized by severe cold, dry winter, moderately hot and dry summer.

b. **Temperate Zone:-** Pir Panjal region falls in the zone and is characterized by wet and cold winter, relatively dry and moderately hot summer.

c. **Sub-Tropical Temperate Transitional Zone:-** It represents mid to high altitude intimated zones like Bhadarwah and Kistwar, characterized by colder winter, high annual rainfall, low mean annual temperature as compared to low altitude sub-tropical zones.

d. **Low Altitude Sub-Tropical Zone:-** The area which falls under this region are foot hill plains and Siwalik hills of Jammu region and is characterized by monsoon precipitation, hot summer, relatively dry but pronounce winter.

The climate of the upper Chenab is arid and extreme cold specially in Lahaul and Spiti region of Himachal Pradesh, which experiences scanty

rainfall albeit very heavy snow fall in winter season. The average maximum temperature in Keylong area ranges from 0.7^0C in February to 23.1^0C in August and the average minimum from -10^0C in February to 10^0C in July. Average annual rainfall in Lahaul and Pangi area is about 450 mm. and 30 mm. respectively. The elevation of catchment area falling within Jammu & Kashmir widely varies from El. 7000 masl at mountain's peak to El. 366 masl. Udhampur, Doda, Kishtwar, Rajori and Jammu have relatively moderate climate in general. Patnitop and contiguous areas are quiet cold and invariably experience snow fall in winter. The high altitude uplands in Doda and Kishtwar viz. Bhadarwah, Banihar, Kishtwar and Batote have a very cold climate and heavy snowfall takes place in thee area during winter months. The average annual rainfall in the basin is about 121.7 cms.

3.3 METEOROLOGICAL CHARACTERISTICS

Once pollutants are discharged in the atmosphere, the meteorological factors play an important role in transport, dispersion and diffusion within the environment. Since these factors show wide fluctuations with time, it felt necessary and desirable as part of this EIA study, to collect meteorological data for the period of thirty years at different IMD stations in the region. The climatological data of some of the important stations in J & K is presented in **Table-3.1**.

Table-3.1: Climatic Data of Some Important Stations of J & K

Station	Average Annual Temp. ^{0}C		Relative Humidity (%)		Annual Rainfall (mm)
	Max.	Min.	08:30 Hrs.	17:30 Hrs.	
Gulmarg (El. 2655 masl)	11.8	1.4	72	71	1478.7
Jammu (El. 367 masl)	30.1	17.7	61	47	1087.7
Leh (El. 3514 masl)	12.8	-1.3	42	38	105.5
Quazigund (El. 1739 masl)	18.3	6.5	80	59	1292.3
Shrinagar (El. 1587 masl)	19.2	7.3	82	57	674.9
Dalhousie (El. 1959 masl)	20.2	10.3	64	68	2407.2

Source : Indian Meteorological Department

3.3.1 Rainfall

The average annual rainfall in the Chenab basin is about 121.17 mm. The average monthly rainfall at various places in the main Chenab catchment area is given in **Table-3.2**.

Table-3.2: Average Monthly Rainfall in cm. in Chenab Catchment

Month	Keylong	Kishtwar	Bhadarwah	Ramban	Reasi	Akhnoor
January	7.1	11.3	15.1	17.0	10.6	6.4
February	7.2	12.0	16.9	15.6	9.8	5.7
March	9.7	14.4	15.0	14.4	9.4	5.8
April	8.0	11.0	10.1	9.3	5.6	3.0
May	6.6	6.2	6.4	5.0	3.5	1.9
June	2.8	4.3	5.6	5.3	8.8	5.6
July	3.5	8.4	12.8	15.5	45.3	31.3
August	3.7	7.5	12.6	13.7	48.9	35.4
September	4.9	5.2	4.7	6.9	16.0	12.8
October	1.3	3.5	4.2	2.8	2.5	1.2
November	0.9	2.0	2.5	1.8	1.0	0.5
December	2.5	6.4	9.1	8.4	4.7	3.5
Total Annual Rainfall	**58.2**	**92.3**	**115.0**	**115.7**	**166.1**	**113.1**

Under the aegis of Central Water Commission, a good network comprising of 21 rain gauge and snow fall stations besides 9 hydrological observations sites and 08 silt observation sites is functioning in the basin. In winter, the precipitation is attributed to western disturbances and during summer it is caused by south west monsoon. Average monthly precipitation for the period 1967-2006 at three of the rain gauge / snow gauge stations near to the site is shown in **Table-3.3** and presented in **Figure-3.1**.

Table-3.3: Average Monthly Precipitation observed at Rainfall Stations near the Study Area (in mm)

Month	Kishtwar (El. 1615 masl)	Ohli (El. 1585 masl)	Mou (El. 2900 masl)
January	108	92	104
February	151	115	136
March	120	159	135
April	72	101	89
May	49	68	71
June	33	41	44
July	50	75	80
August	56	46	68
September	48	49	47
October	29	23	27
November	22	17	32
December	61	41	70
Average Annual Precipitation	**785**	**797**	**903**
Maximum one day	360 (29-12-1994)	215.1 (08-05-1979)	222 (29-12-1990)
Maximum Monthly	798.4 (Dec. 994)	776.0 (March 1979)	655.3 (Dec. 1990)
Maximum Yearly	1959 (1994)	1908 (2005)	1830 (1989)
Minimum Yearly	277.7 (2005)	369.0 (2000)	377 (1982)

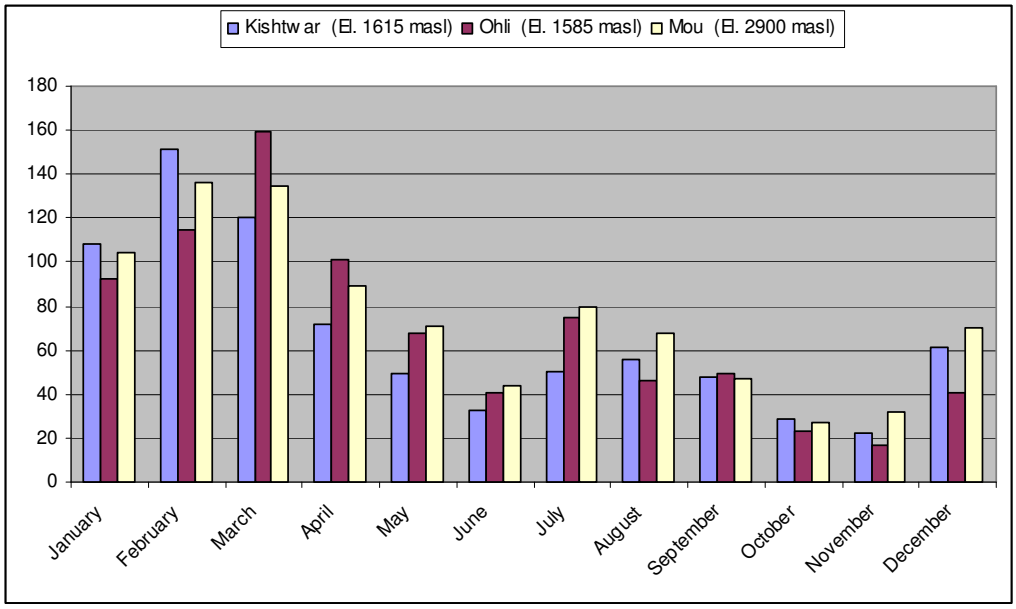


Figure-3.1: Mean Monthly Rainfall

3.3.2 Temperature

The Central Water Commission has been manning three climatological stations in Chenab basin viz. Sirshi, Dhamkund and Tillar. The latter has now become defunct. The data in respect of temperature is presented in **Table-3.4** and shown station-wise in **Figure 3.2 to 3.4**.

Table-3.4: Mean Daily Maximum and Minimum Temperature

Sl. No.	Month	Dhamkund (El. 640 masl)		Sirsi (El. 1675 masl)		Tillar (El. 2130 masl)	
		Max., ^{0}C	Min. , ^{0}C	Max. , ^{0}C	Min. , ^{0}C	Max. , ^{0}C	Min. , ^{0}C
1.	January	15.8	5.6	9.5	1.5	4.1	-2.8
2.	February	17.4	6.9	11.4	2.4	5.1	-2.8
3.	March	23.5	11.3	16.4	5.3	10.8	-0.3
4.	April	28.2	16.9	23.4	9.1	16.8	4.1
5.	May	33.1	18.9	26.7	11.4	20.7	7.2
6.	June	35.2	21.5	30.8	14.5	27.3	10.5
7.	July	32.8	22.6	30.2	17.6	26.3	14.0
8.	August	32.1	22.0	29.9	17.2	25.6	14.0
9.	September	31.5	19.5	28.5	14.6	24.0	9.0
10.	October	29.2	14.6	23.4	8.6	20.1	3.5
11.	November	33.0	9.2	19.5	4.5	14.5	0.2
12.	December	16.7	6.0	13.6	2.2	8.1	-2.4
Average Annual		**27.38**	**14.58**	**21.94**	**9.08**	**16.95**	**4.52**

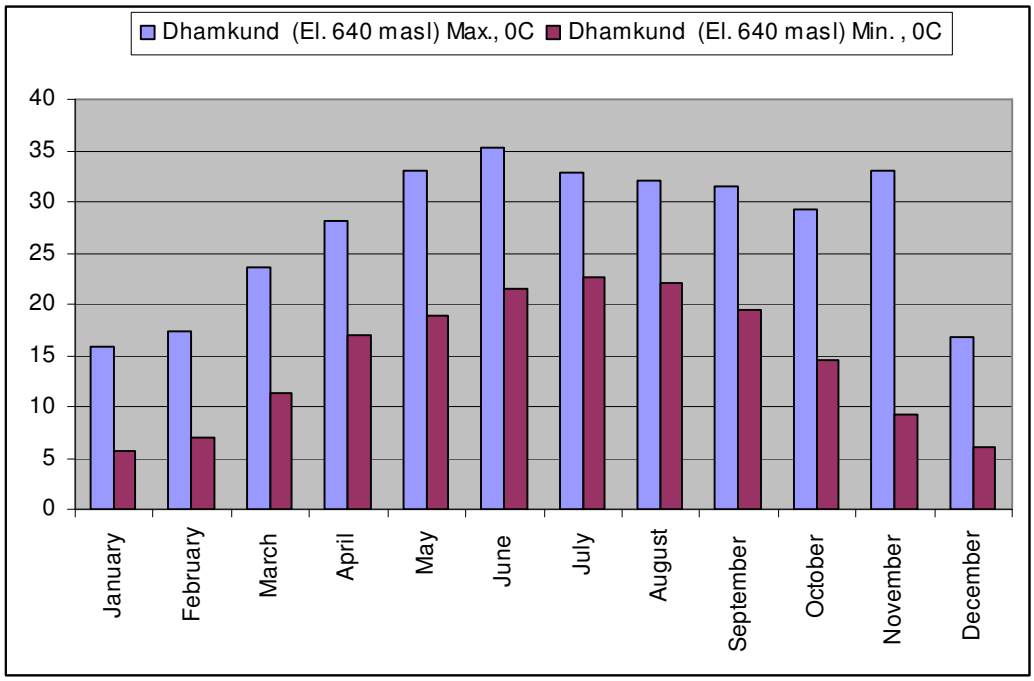


Figure-3.2: Mean Daily Maximum and Minimum Temperature at Dhamkund

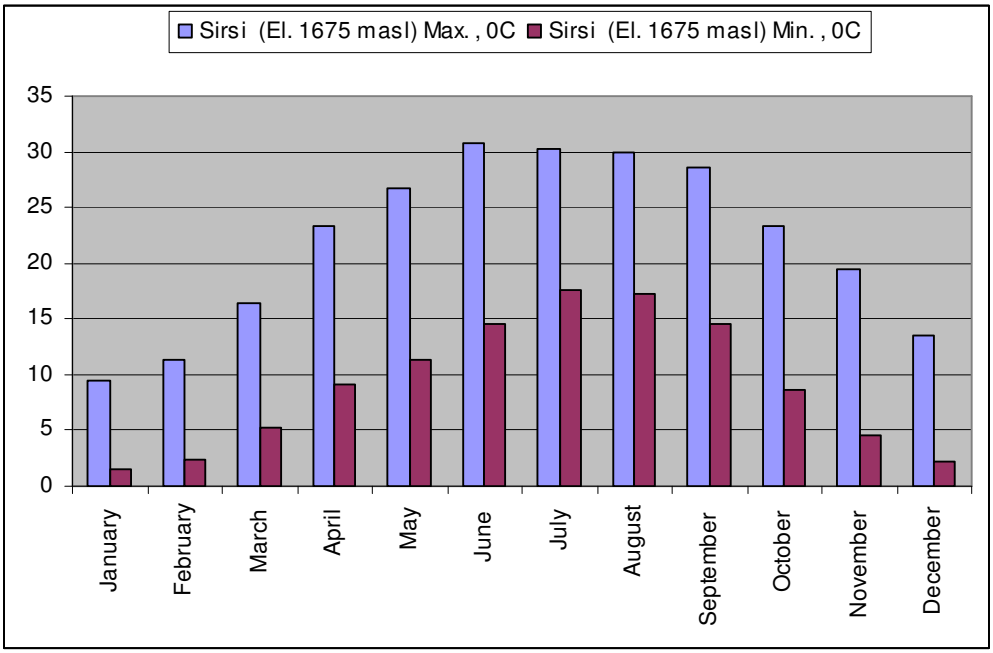


Figure-3.3: Mean Daily Maximum and Minimum Temperature at Sirsi

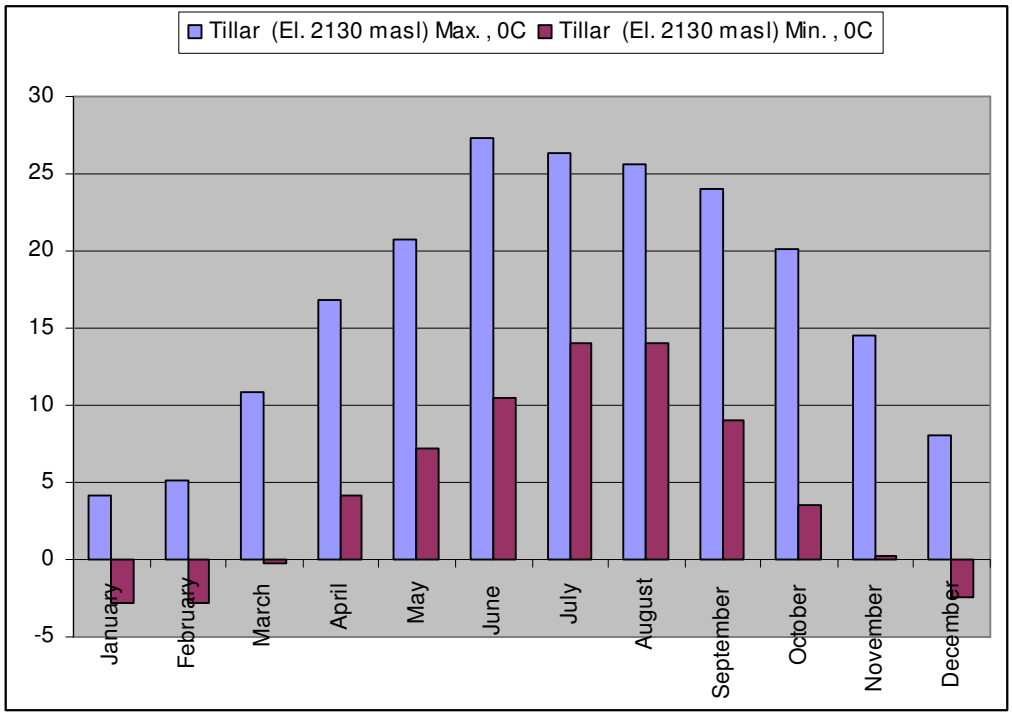


Figure-3.4: Mean Daily Maximum and Minimum Temperature at Tillar

3.4 PHYSIOGRAPHY, RELIEF & DRAINAGE

The J & K region consists of four great mountain ranges of Himalayas, the Karakoram, the Ladakh, the Zanskar and Pir Panjal. Between these ranges are the longitudinal valleys of the Gilgit, the Shyok, the Indus and the Jhelum. South of Pir Panjal is the Siwalik range, comparatively much lower in elevation and known as the Jammu hills; further south there is a narrow strip of foot-hill plains (25 km wide) merging into Punjab plains. The state can be divided into five physiographic regions viz. Trans Himalayas, Greater Himalayas, Lesser Himalayas, Siwaliks and Plains, which have been further subdivided into 9 landform types shown in **Figure 3.5**. The brief description of these is given below.

- **Trans Himalayas:-** These are prominent ranges in the Trans-Himalayan region with peaks ranging in elevation from 5000 to 6000 m but some exceed 8000 m. The Ladakh range is situated between Indus and Shyok rivers.

- **Greater Himalayas:-** Greater Himalayas include ranges of Karakoram, Ladakh, Zanskar and Himadri. The large number of peaks range from 4500-6000 m but some exceeds 7500 m in their elevation.

- **Lesser Himalayas:-** It comprises Vale of Kashmir and Pir Panjal ranges. Kashmir valley represents an old lacustrine bed and it stands 1600 m above sea level in the Jhelum flood plain. The elevation of Pir Panjal ranges varies from 3500-5000 m.

- **Siwaliks:-** The tract lying between Chenab and Ravi rivers is mostly ravine land locally known as Kandi areas of Jammu and Kashmir. The Jammu hills rise above the Punjab plain with gentle slope and follow a succession of narrow parallel ridges separated by valleys. They attain an altitude ranging from 1600-2400 m.

- **Plains:-** The narrow strip of plain bounded by Jhelum and Ravi rivers is situated in the south-western part of Jammu & Kashmir where it marks the border with Pakistan. In general, slope is towards southwest and is dissected by tributaries of Chenab and Ravi rivers.

Ladakh region is drained by river Indus and its tributaries like Shyok, Shigar, Gilgit and Astor. Jhelum River drains out vale of Kashmir while the Chenab River drains the eastern section of southern slopes of the Pir Panjal, Jammu hills and the foothill plains. The parts of Jammu region adjoining Punjab and Himachal Pradesh are drained by river Ravi and its tributaries.

The project and the study area lie in Lesser Himalayas, while, a big portion of the free draining catchment lies in Greater Himalayas.

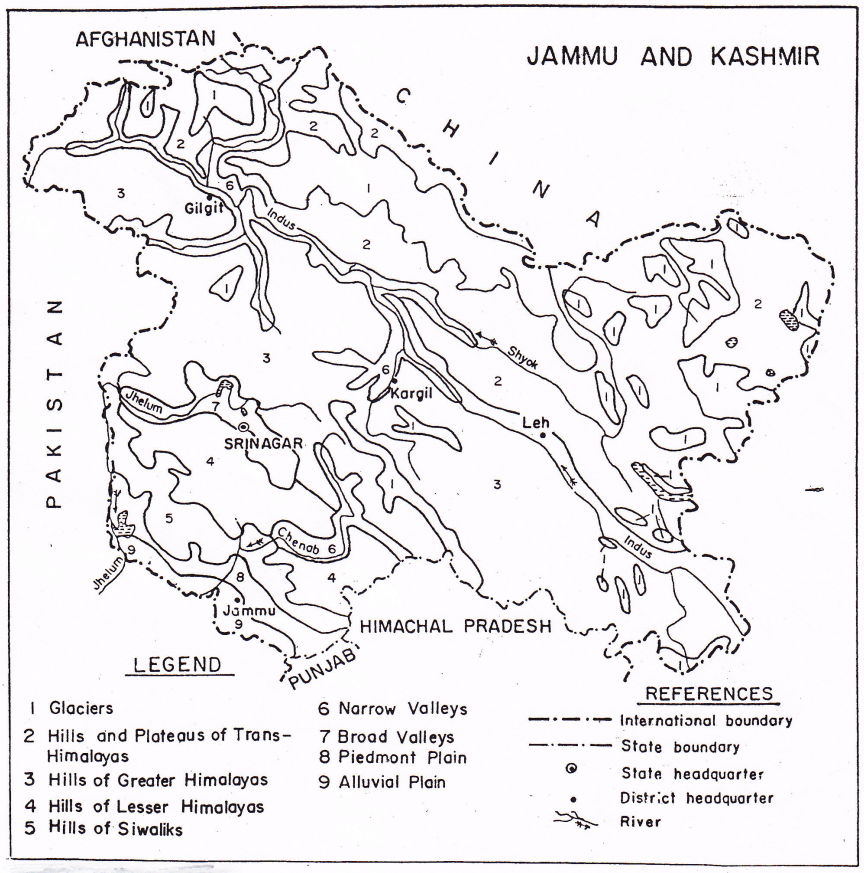


FIGURE 3.5

Figure-3.5: : Land Form Types of J & K Region

3.5 TOPOGRAPHY OF THE STUDY AREA

The project area lies in the inner lesser Himalayas, which encompasses steep, rugged terrain. The prominent geomorphic features include U and V shaped valleys, interlocking spurs, ridges, saddles and river terraces. The narrow valleys bounded by high ridges open out in their upper glacial parts. Slopes are very steep due to which the rockfall occurs at certain points often under the effect of gravity. The altitude of the study area varies from El 700 masl at dam site to 2980masl near Sotarkund. There are plentiful of grazing lands on the upper reaches of high mountains. A number of meadows and pastures on the uplands are well known. Fertile terraced fields in small chunks have also been observed on both banks of Chenab and also along its tributaries. The satellite imagery of the study area is shown in **Figure-3.6**.

Figure-3.6: Satellite Imagery of Study Area

3.6 REGIONAL GEOLOGY OF THE BAGLIHAR H. E. POROJECT AREA

The rocks exposed in the area encompassed by the Baglihar Hydro Electric Project consist of Quartzite, Phyllite and Slates. These interbedded meta-sedimentary rock units from an "Autochthonous Fold Belt". It is bound to the South West by the Murree Thrust separating it from the Tertiary rocks mainly Murree and Shiwalik of the Fore-land, whereas the Punjal Thrust marks the Northern limit with the "Nappe Zone" made up of older rocks forming the basement of the Tethyan sediments (Dogra Slates or Salkhala formation).

B.G. Jangapangi, G. Kumar et.al carried out detailed work in this part of the area and published their work entitled – Geology of the 'Autochthonous Fold Belt', J&K Himalaya with special reference to the Panjal Thrust – Published in the Vol.31, 1986 of the Journal of the Palaeontological Society of India. They have classified the Autochthonous belt into several formations. The project area rocks lie in the Ramban Formation (Pre-Cambrian age) basically consist of – Quartzite, Phyllitic Slates and Slates. The lithological units of the project area were classified belonging to Salkhala Series of Pre-Cambrian age in the earlier D.P.R. of the Project (year 1998). This classification was based on the Geological Report for Field Second 1971-1972 of the Geological Survey of India. The change in formation, from Salkhala series to Ramban Formation, both of Pre-Cambrian age, was based on detailed field studies and tectonic analysis by B. S. Jangapangi and Gopendva Kumar and their classificatioin has been followed in the present report.

3.6.1 Stratigraphy

General stratigraphy of the "Autochthonous Fold Belt" (in part only for Ramban – Sincha section)

----------Angular unconformity----------

Sincha	Light grey to grey sandy Dolomite, pink and grey Limestone, lenticular black Chert and Gypsum	Primitive microbiota
C	Grey-green Shale/Slate with bands of Quartzite	
Bhimdasa B	Purple & green Shale/Slate, micaceous Siltstone	
A	Grey pebbly Shale/Slate (Diamictite) & Slate with Pebble to boulder – size class	
Precambrian	----------Unconformity----------	
Ramban	Grey to dark grey Shale/Slate Grey Quartzite with Shale/Slate Bluish Grey Phyllitic Slate with bands of Gypsum	
Baila	Thin bedded laminate Limestone, nodular Limestone with Shale/Slate	
Gamir	White to bluish grey Quartzite, purple & green Shale/Slate with occasional thin bands of Limestone, Base not exposed.	

3.7 LOCAL GEOLOGY OF THE PROJECT AREA

The rocks exposed are grey quartzites with subordinate slate bands belonging to Dogra formations. The strike of the formations varies between N 20^0W-S 20^0E to N 40^0W-S 40^0E, 60^0 to 70^0 inclinations towards NE. The rocks exposed in the vicinity of the proposed power house site are grey quartzites belonging to Dogra formations. The quartzites are mostly jointed though massive at places. Trending N30^0W-S30^0E with 60^0 to 70^0 dip in North West direction. The prominent joint set recorded in the area is bedding joint.

3.7.1 Geology of HRT

The total length of the headrace tunnel from the junction with Intake Structure upto the junction with surge shaft is 1888.8 metres. The alignment of the tunnel is based on the surface geological explorations carried out along the tunnel alignment. The Intake Structure of Stage-II is on left side of Intake Structure of Stage-I whereas the Surge Shaft of Stage-II is on right side of Surge Shaft of Stage-I. Therefore, 271 m long U/S portion of the HRT-2 lie on left side of HRT-1 and remaining 1618 m D/S portion lies on right side of HRT-I. The D/S portion of HRT-2 is aligned almost parallel to HRT-1.

Headrace Tunnel is proposed on the right bank of the river Chenab. The alignment of the main Head Race Tunnel is almost parallel to the Head Race Tunnel of Stage-I. At the intake and surge tank side it is curved. The area along the proposed tunnel alignment is occupied by grey jointed quartzites, inter-bedded with dark grey slates belonging to Ramsu Formation referred as Dogra Formation. The quartzites are highly jointed and in addition to frequent bedding joints, five prominent sets of joints have been recorded.

The HRT-II is expected to encounter alternate bands of quartzite and phyllitic quartzite. In general rock mass with Q values lying between 4 and 0.1 (Poor and Very Poor) is anticipated along HRT except between RD 975 to RD 1125, where a fault zone with highly fractured rock is anticipated having Q of 0.1 to 0.01.

HRT will cross the Gajpat Nalla at approx. RD 1700 m where heavy to medium inflow of water is anticipated into HRT-II. The tunnel is expected to encounter minor shear seams and shear zones at various places. In general about 15% length of HRT may be required to be supported by steel ribs. Geological profile along HRT alignment is shown in **Figure-3.7**.

3.7.2 Geology of Surge Shaft

The Surge Shaft is located in well bedded Phyllitic Quartzite with minor Slate bands dipping at 65o – 70o. The rock is traversed by bedding shears

and four sets of shear and joint planes. However, there are no major adverse geological discontinuities.

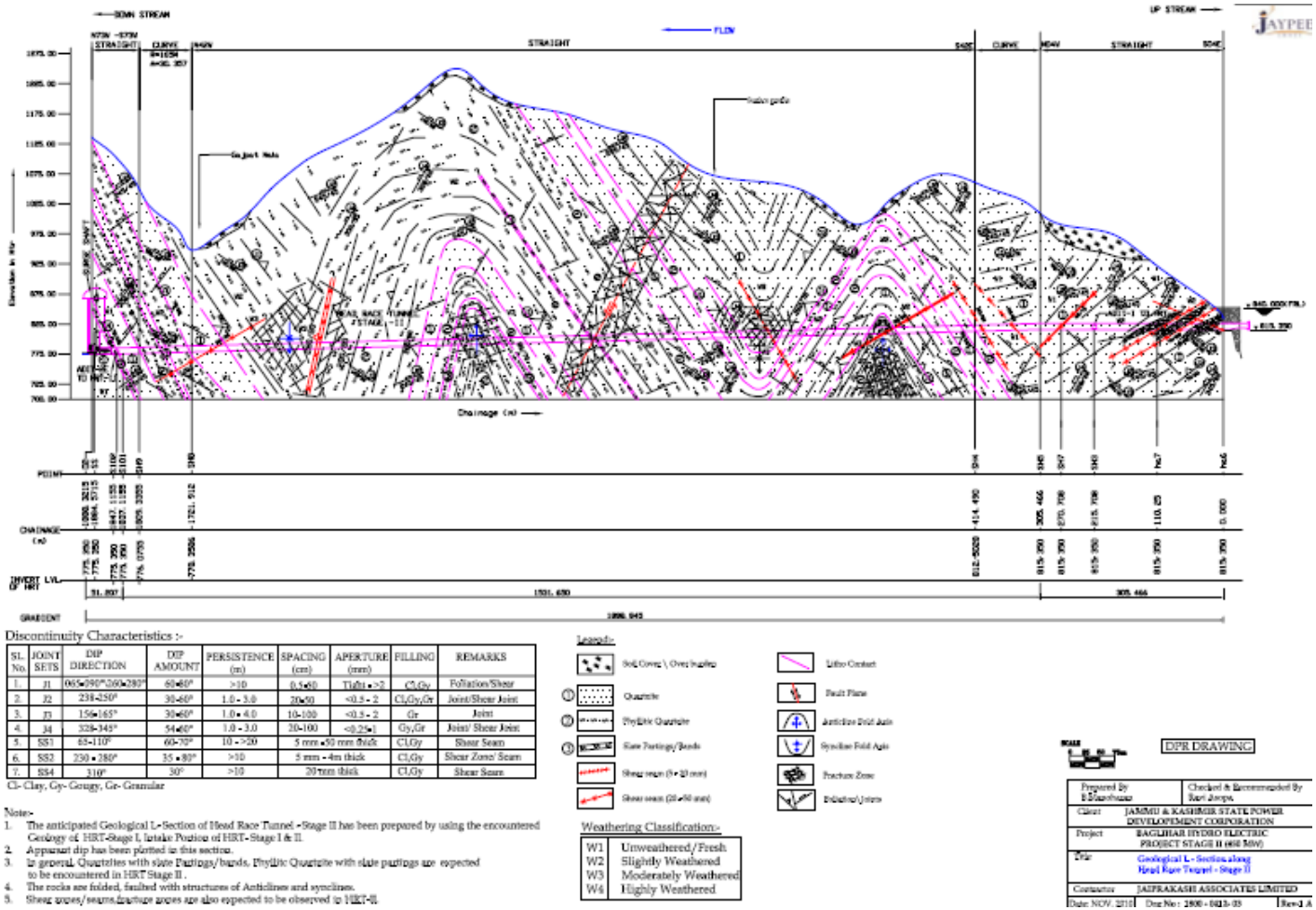
3.7.3 Geology of the Powerhouse Area

The Baglihar Hydro Electric Project Powerhouse is located inside the Gajpat hillock rising to a maximum elevation of 1150 m. The hillock is deeply cut by the river Chenab on its North-West side, and Gajpat stream on South and West side. The rock formations present in the hillock consist of Quartzite with occasional Slate partings, Phyllitic-Quartzite with its variants (crumbly Slaty Quartzite) and Slates. These rocks have been injection present in the shear zones is crushed to coarse grained sand size particles indicating that tectonic movements in the area have persisted post Quartz vein injection period. The surface geological map of the area along power house complex is shown in **Figure-3.8**.

3.7.4 Geology of the Tail Race Tunnel

A 342.60 m. long Tailrace Tunnel will carry the turbine discharge to the river Chenab. The tail race tunnel will have the same cross-section as the head race tunnel (10.15m dia circular) and will rise from EL 686.5 m at the collection chamber to EL 700.0 m at the outlet structure at a constant slope.

Excavation of TRT is expected to be met with quartzite with minor slate bands / partings. The tunnel shall be mainly excavated parallel to sub-parallel to the strike of the formation. From the geological data interpretations of the Power House of Stage-I and other adits already excavated, rock quality in TRT for Stage-II is expected to vary from poor to extremely poor. So, we can say expected Q value in 342.60 m length of TRT lies between 0.01 & 2.5. In transition reaches of TRT as well as at portals and junction with D/S Collection Gallery, rib supports will be required. In the Tailrace Tunnel, reinforced concrete transitions from rectangular to circular at inlet end and circular to rectangular at outlet end have been provided.



Sl. No.	JOINT SETS	DIP DIRECTION	DIP AMOUNT	PERSISTENCE (m)	SPACING (cm)	APERTURE (mm)	FILLING	REMARKS
1.	J1	065-090°/260-280°	60-80°	>10	0.5-60	Tight - >2	Cl,Gy	Foliation/Shear
2.	J2	238-250°	30-60°	1.0 - 3.0	20-60	<0.5 - 2	Cl,Gy,Gr	Joint/Shear Joint
3.	J3	156-165°	30-60°	1.0 - 4.0	10-100	<0.5 - 2	Gr	Joint
4.	J4	328-345°	54-60°	1.0 - 3.0	20-100	<0.25-1	Gy,Gr	Joint/ Shear Joint
5.	SS1	65-110°	60-75°	10 - >20	5 mm - 50 mm thick		Cl,Gy	Shear Seam
6.	SS2	230 - 280°	35 - 80°	>10	5 mm - 4m thick		Cl,Gy	Shear Zone/ Seam
7.	SS4	310°	30°	>10	20 mm thick		Cl,Gy	Shear Seam

Cl- Clay, Gy- Gouge, Gr- Granular

Note:-
1. The anticipated Geological L-Section of Head Race Tunnel - Stage II has been prepared by using the encountered Geology of HRT-Stage I, Intake Portion of HRT- Stage I & II.
2. Apparent dip has been plotted in this section.
3. In general, Quartzites with slate Partings/bands, Phyllitic Quartzite with slate partings are expected to be encountered in HRT Stage II .
4. The rocks are folded, faulted with structures of Anticlines and synclines.
5. Shear zones/seams/fracture zones are also expected to be observed in HRT-II.

Figure-3.7: Geological Profile along HRT Alignment, Stage-II

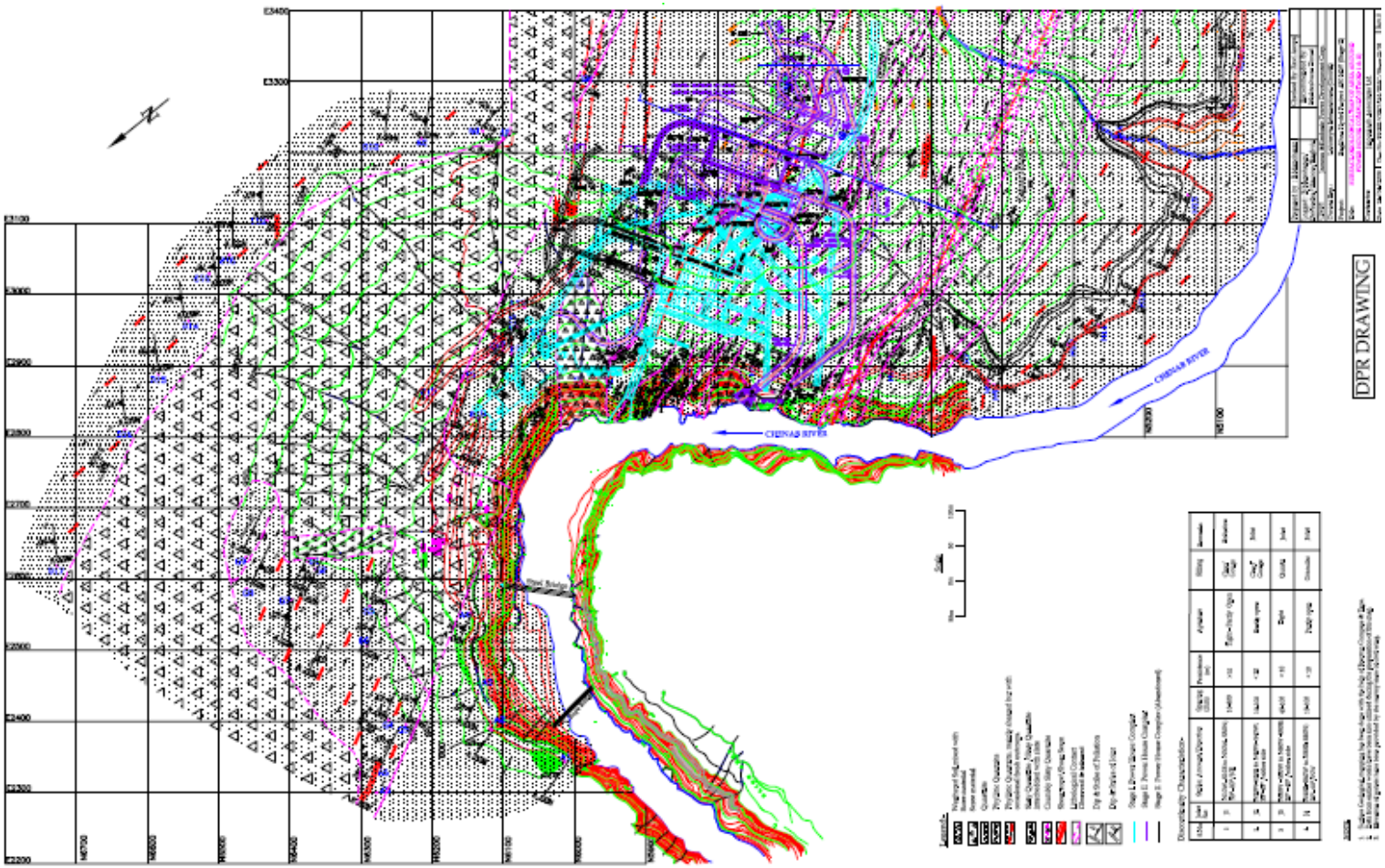


Figure-3.8: Surface Geological Map of the Area along Power House Complex

3.8 SEISMICITY OF THE PROJECT AREA

As per seismic zoning map of India (IS 1893:2000), **Figure 3.9** the project area falls within Zone IV. Therefore, suitable seismic factor in design of structure would be kept under consideration. As the project area lies in Zone-IV, the design of dam and all other structures including building structures with their foundation should carried out as per provision of IS:1893:2000, the Indian Standards for "Criteria for Earthquake Resistant Design of Structures". The general principles and design criteria given under para-6 of the code should be adhered to. In case of the buildings the provision under para-7 should be followed.

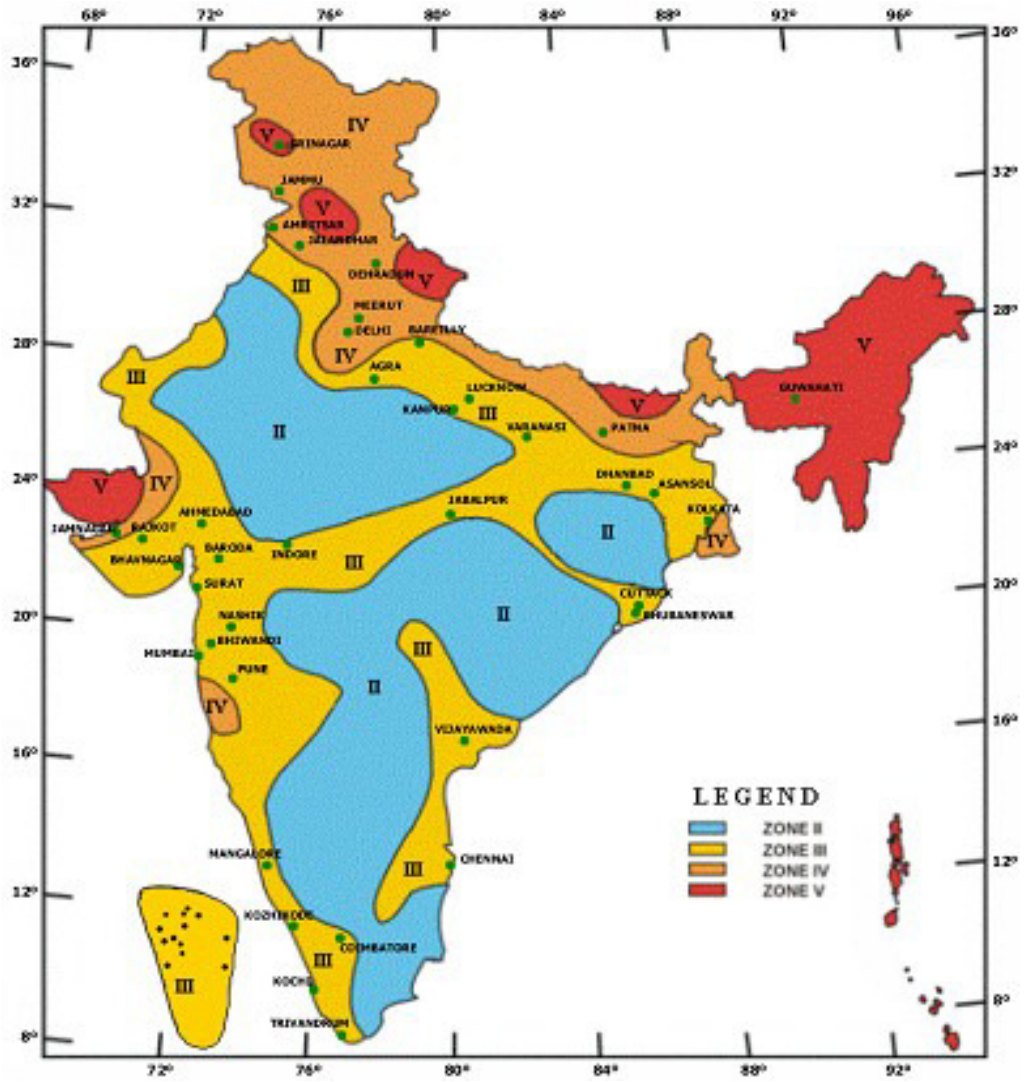


Figure-3.9: Seismic Zone Map of India

3.8.1 Earthquake Occurrence

Important earthquakes, magnitude 5 and above which have occurred in J & K and nearby Himachal Pradesh, are shown in **Table-3.5**.

Table-3.5: Earthquakes of Magnitude 5.0 and above on Ritcher Scale

Sl. No.	Date	Description	Origin Time	Latitude	Longitude	Magnitude
1.	17-06-1962	Felt at Bhunter and Banihal		33^{0}3'	76^{0}2'	5.5
2.	24-08-1980	Jammu-Kathua	03:06:52 03:20:02.9	32^{0}09' 32^{0}09'	75^{0}55' 75^{0}32'	5.4 5.5
3.	30-05-1985	Sopore (J & K)		34.1^0	74.6^0	7.0
4.	08-10-2005	Kashmir	03:50:38	34.43^0	73.40^0	7.6
5.	28-02-2010	Kashmir	12:50:00			5.7
6.	04-04-1905	Kangra		32^{0}25'	76^{0}25'	8.6
7.	28-02-1908	Kullu		32^0	77^0	7.0
8.	10-07-1947	Chamba	10:19:20	32^{0}6'	75^{0}9'	6.0
9.	14-06-1978	Dharamshala	21:42:09	32^{0}16'	76^{0}30'	5.0
10.	26-04-1986	Dharamshala	13:05:17	32^{0}1'	76^{0}3'	5.7

3.8.2 Seismic Sources Zones around BHEP, Stage-II

Study of the geological formations, structure and tectonics of the area show that the BHEP site is located northeast **of MBF-1**, **MBF-2** and west of the southern extension **of KIF** forming the eastern boundary of Kashmir block. The zone of intersection of **MBF-1 (Murree thrust) and MBF-2 (Riasi thrust) with KIF** zone appears to be the most probable seismic source zones (SSZ) from the **BHEP site.** However, such events for evaluation of earthquake hazards can be assumed to occur along them closest to the BHEP site.

Various tectonic lineaments have been interpreted from satellite imageries in North West Himalaya by GSI. A **mega lineament** has been reported about 30 km west of BHEP site with an approximate trend sub-parallel to KIF and two intermediate lineaments NW and SE of BHEP site.

For evaluation of seismic hazards for earthquake resistant design of structures in Baglihar Hydro Electric Project, the down dip influence zone of **MBT-1** and **MBT-2** on either side of their surface trace and **KIF** and **Mega lineament** (West of BHEP site) could be considered as seismic source zones (assuming their attitude to continue down dip up to 20 km or larger depth, to work out probable source dimension to evaluate maximum magnitudes) distinguishing the seismic conditions in the area around the

BHEP site situated in Kashmir block, for events with strike slip mechanism along KIF zone and mega lineament west of BHEP site and thrust (reverse) mechanism along MBF zones. The various SSZ around the BHEP site assumed to be capable of generating earthquakes are listed in **Table-3.6**.

The maximum magnitude of probable seismic events in these zones has been indicated keeping in view the association of epicenters of known earthquakes and probable source dimensions and types of fault ruptures (source mechanism).

Table-3.6: Assumed Seismic Source Zones around BHEP site in Kashmir Block

Sl. No.	Seismic Source Zone	Probable Source Mechanism	Maximum Magnitude	
			Known Events	Probable Events
1.	MBF-1	Thrust (Reverse)	Less than 6	6.5
2.	MBF-2	Thrust (Reverse)	5.6	6.5
3.	KIF	Strike Slip (Normal)	6.1	7.2
4.	Mega lineament (West of BHEP Site)	Strike Slip (Normal)	6	7.2

3.8.3 Design Earthquake Parameters

For dam designs, fundamental period of vibration was calculated using the formula given in IS Code 1893-1984 and corresponding spectral acceleration was determined from the smoothened acceleration response spectra for Baglihar Site developed in site specific studies under MCE and DBE conditions using 0.22 and 0.11 multiplying factors respectively. The same factors (i.e. 0.22 & 0.11 for MCE & DBE respectively) have been used for dam designs in Baglihar H.E. Project.

For underground works, significant reductions have been observed in ground motion recorded in underground installations with respect to the intensity at the ground level during earthquakes. The intensity of strong motion reduces with depth.

Keeping in view the likely predominant period of ground motion in hard rock formations and probable ratio of vertical ground particle acceleration with horizontal ground particle acceleration as 0.66 the following reduction factors were recommended at various depths as per site specific study for evaluation of amplitude of ground motion at various depth from the ground level.

3.9 SOIL

The soil resource map of J & K (NBSS Publication No 62) has been used in the present study. The soil is predominantly fine to coarse loamy soil. The soil map of the study area is presented in **Figure-3.10** reveals that the soil of the area belongs to those of lesser Himalayas having map units, 108 (soils on fluvial valley) , 85 (soil on summit and ridges), 88, 98, 105 being soil of side and reposed slopes. The characteristics of these soils are described hear under:

- **Soils on fluvial valley**

Soil Unit 108

Soil belonging to map unit 108 are soils on fluvial valley of Chenab river in project area. These soils are deep somewhat excessively drained, fine loamy, calcareous soil on moderate slopes with loamy surface, moderate erosion and slide stoniness associated with coarse loamy surface moderate erosion and moderate stoniness. Taxonomically the soils are classified as Typic Eutrochrepts and Typic Udifluvents.

- **Soils on Summit and Ridges**

Soil Unit 85

Soil belong to map unit 85 are deep, well drained, thermic, fine-loamy, soils on moderately steep slopes with loamy surface, moderate erosion and slight stoniness; associated with Medium deep, well drained, fine-loamy calcareous soils with loamy surface, moderate erosion and slight stoniness. Taxonomically the soils are classified as Dystric Eutrochrepts and Typic Eutrochrepts.

- **Soils on Side and Reposed Slopes**

Soil Unit 88

Shallow, excessively drained, loamy soils on very steep slopes with loamy surface, severe erosion and moderate stoniness; associated with medium deep, excessively drained, coarse-loamy soils with loamy surface, moderate erosion and moderate stoniness. Taxonomically the soils are classified as Lithic Udorthents and Typic Udorthents.

Soil Unit 98

Medium deep, somewhat excessively drained, coarse-loamy, calcareous soils on steep slopes with loamy surface, moderate erosion and moderate stoniness associated with Medium deep, excessively drained, fine-loamy soils with loamy surface, moderate erosion and moderate stoniness. Taxonomically the soils are classified as Typic Eutrochrepts and Typic Udorthents.

Soil Unit 105

Medium deep, excessively drained, coarse-loamy soils on steep slopes with loamy surface, severe erosion and moderate stoniness; associated with deep, well drained, fine-loamy, calcareous soils with loamy surface and moderate erosion. Taxonomically the soils are classified as Typic Udorthents and Typic Eutrochrepts.

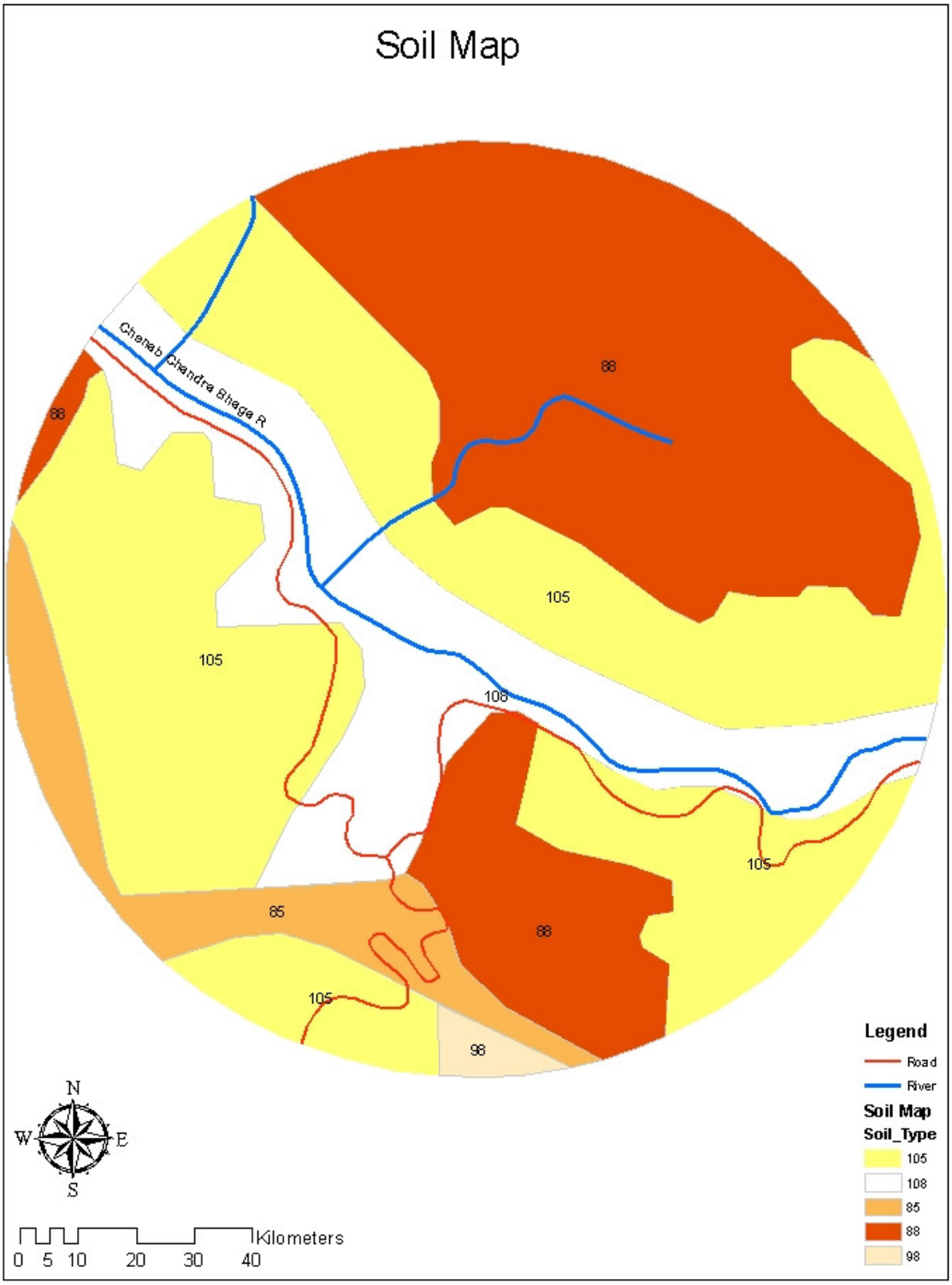


Figure-3.10: Soil Map of the Catchment Area

3.9.1 Soil Characteristics (Physical & Chemical)

The slope soils compose of silt and good for vegetation. Rocks are weathering due to heavy rainfall. The texture varies from sandy loam to loamy sand. Soil samples from various locations in the study area were collected; the sample locations have been selected to represent the area characteristics based on geology, land use and floristic pattern. The samples have been collected from four locations for soil quality in project area at three different depths from 5 to 15 cm and well mixed. The location of the soil samples is presented in **Table-3.7.** Locations of the soil sampling stations have been shown in **Figure-3.11**. The physical and chemical analysis results of the soil samples collected at site during three seasons is presented in **Table-3.8**.

Table-3.7: Location of Soil Quality Monitoring Stations

Station Code	Station Name	Location w.r.t. Dam Site		Description
		Distance (km.)	Direction	
S1	Baglihar village	1.0	E-S	Agriculture Land
S2	Kolthi village	1.0	E	Agriculture Land
S3	Killasheri	2.0	N-W	Forest Land
S4	Khani	3.5	W	Agriculture Land

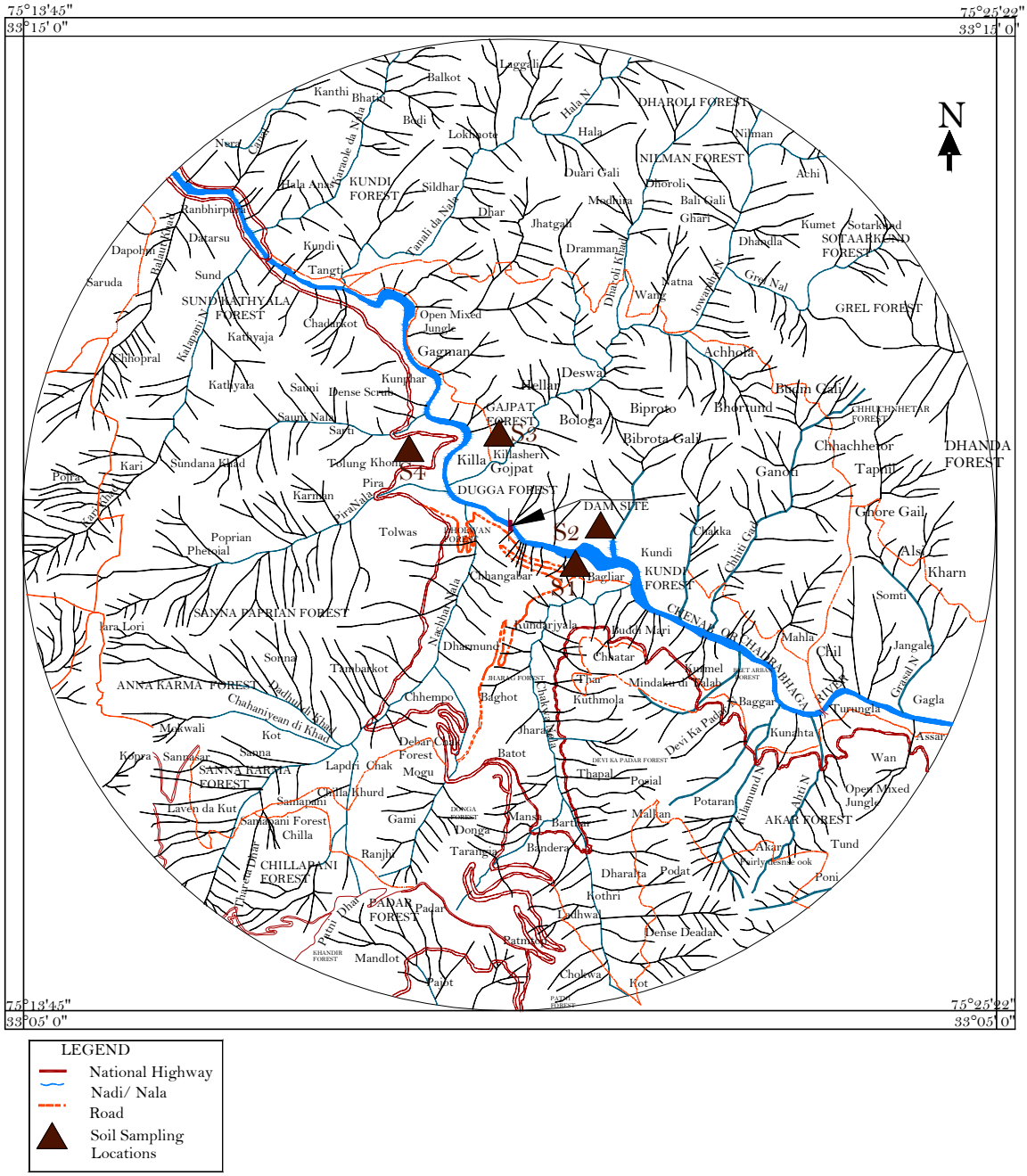


Figure-3.11: Locations of the Soil Sampling Stations

Table-3.8: Physical & Chemical Characteristics of Soil of the Study Area

Sl. No.		Pre-Monsoon, 2011				Monsoon, 2011				Winter, 2012			
		Baglihar village	Kolthi village	Kilasheri	Khani	Baglihar village	Kolthi village	Kilasheri	Khani	Baglihar village	Kolthi village	Kilasheri	Khani
1	pH	7.32	7.20	7.15	7.80	7.18	7.15	6.9	7.75	7.35	7.32	7.1	7.70
2	N (mg/100 gm)	45	39	38	42	46	47	41	40	42	41	35	41
3	P (mg / 100gm)	21	23	19	22	21	23	24	25	22	26	21	22
4	K (mg / 100gm)	12	10	08	13	11	11	09	14	13	11	09	13
5	Organic Mater %	4.4	4.2	3.1	5.1	4.6	4.7	3.3	5.4	4.5	4.2	3.2	5.1
6	Texture	Sandy Loam	Sandy Loam	Loamy sand	Sandy Loam	Sandy Loam	Sandy Loam	Loamy sand	Sandy Loam	Sandy Loam	Sandy Loam	Loamy sand	Sandy Loam
7	Sand %	75	71	81	71	77	72	82	73	73	71	81	72
8	Clay %	17	18	10	15	16	17	11	16	17	17	12	14
9	Silt %	08	11	09	14	07	11	07	11	10	12	07	14

The results of the soil analysis show that the soil is neutral to slightly basic at all the locations having pH varying from 6.90 to 7.80. The texture of the soil varies from sandy loam to loamy sand having predominantly sand. The percentage of sand, silt and clay ranged from 71-82%, 7-14% and 10-18% respectively. The micronutrients (N, P, K) have been found in all the soil samples and the organic matter varies from 3.1-5.4%.

3.10 LAND USE / LAND COVER

The modern technique of satellite remote sensing facilitates such type of studies. The inaccessibility to the region in diverse weather conditions, requirement of synoptic coverage at various locations, and the computer adaptability for land use classification makes the digital image processing and remote sensing an inevitable tool. As already stated under physiography that the catchment area is characterized by steep hills and deep valleys, the dominating classes are snow / glacier, river body, dense forest, open forest, waste land, agriculture & settlement patches and some degraded forest. The land use pattern of study area is exhibited in **Figure-3.12** and enumerated in **Table 3.9**.

Table-3.9: Land Use Details of the Study Area

Class Name	Area/Hectare	% of Class Area
Dense Forest	6320.22	20.11
Open Forest	5557.32	17.68
Degraded Forest	5432.02	17.28
Scrub and barren	2196.62	06.99
River / Water bodies	2539.66	08.08
Settlements	2442.66	07.72
Agriculture	6940.16	22.14
Total Area/Hectare	**31428.66**	**100**

3.10.1 Cropping Pattern

Despite situational problems, the study area has good scope of growing of cereals, fruits and vegetables. In the lower portion of Padder valley, during kharif crops like maize, paddy, pulses and buck wheat are grown, whereas, during rabi season emphasis is laid on growing of wheat, barley, oil seeds and vegetables. The area is known for its high quality rajma, apricot, kala zeera and buck wheat. In addition, small millets like cheena, kangni and finger millets are cultivated in draught prone areas. In high altitude, mono-cropping i.e. growing of single crop like maize or paddy in a year is practiced.

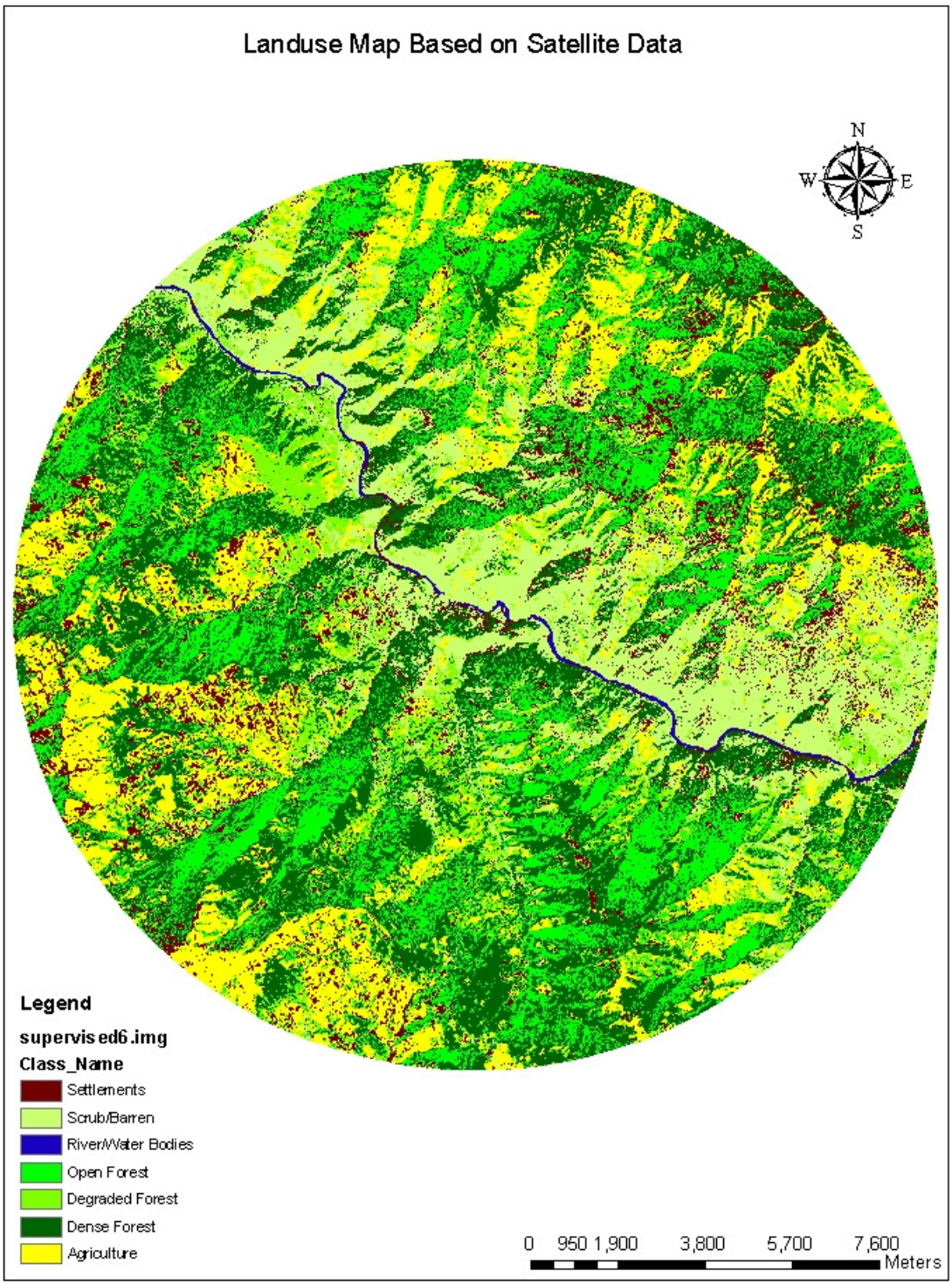


Figure-3.12: The Land Use Pattern of Study Area

3.11 PRESENCE OF ECONOMICALLY IMPORTANT MINERAL DEPOSIT

No major occurrence of economic deposit has been found in the reservoir area, except materials like boulder, shingle pebbles, sand which bears no economic mineral importance, save as the construction material.

3.12 TOTAL LAND INVOLVED IN CONSTRUCTION OF THE PROJECT

The labour camps established at Dharmund, Chandrakot and Kunifar and project colonies civil and electrical at Chandrakot and also dam colony constructed for stage-I works and all non-residential buildings will be used for stage-II works of Baglihar Hydro Electric project. Similarly, the project facilities like hospital at Chandrakot, mess for labours (Annapurna), field hostels, rest-house and offices, which are in fine condition, shall continue to be used for Stage-II also. Batching plants, crushing aggregate and processing plants, erection workshops, stores and steel yard constructed for Stage-I shall be used for Stage-II work also.

The land acquired for various project components, under submergence, and Khellani-Pul Doda road has already been acquired under Baglihar HEP, Stage-I, which entailed land requirement of Stage-II also. The detail of land involved under Baglihar HEP is shown in **Table-3.10**. Against most of the private land mutation has been done in favour of JK State Power Development Corporation

Table-3.10: Detail of Land for Baglihar HEP

Sl. No.	Description	Private Land	State Land	Forest Land	Total Land (Ha.)
1.	Project component / quarry / muck sites / roads etc.	72.9725	26.775	69.88	169.6275
2.	Submergence	443.5625	80.4825	57.445	581.49
3.	Khellani-Pul Doda road	15.380	1.0425	6.825	23.2475
	Total	**531.915**	**108.3**	**134.15**	**774.365**

3.13 ARCHAEOLOGICAL / RELIGIOUS / HISTORICAL MONUMENTS

No archaeological monument of national importance either lies in the project area or in its submergence area. There is also no structure of national heritage in the area.

3.14 SENSITIVE AREAS

No National Park, Sanctuary, Defence Establishments, Archeological Monuments, Notified Eco-sensitive areas or protected area under Wild Life (Protection) Act exists within the project area or within 15 km distance from it. Kishtwar High Altitude National Park is about 45 Km away from the dam site and 30 Km from the tip of the reservoir of Baglihar dam. The location of Kishtwar High Altitude National Park in relation to the Baglihar HEP is shown in **Figure-3.13**.

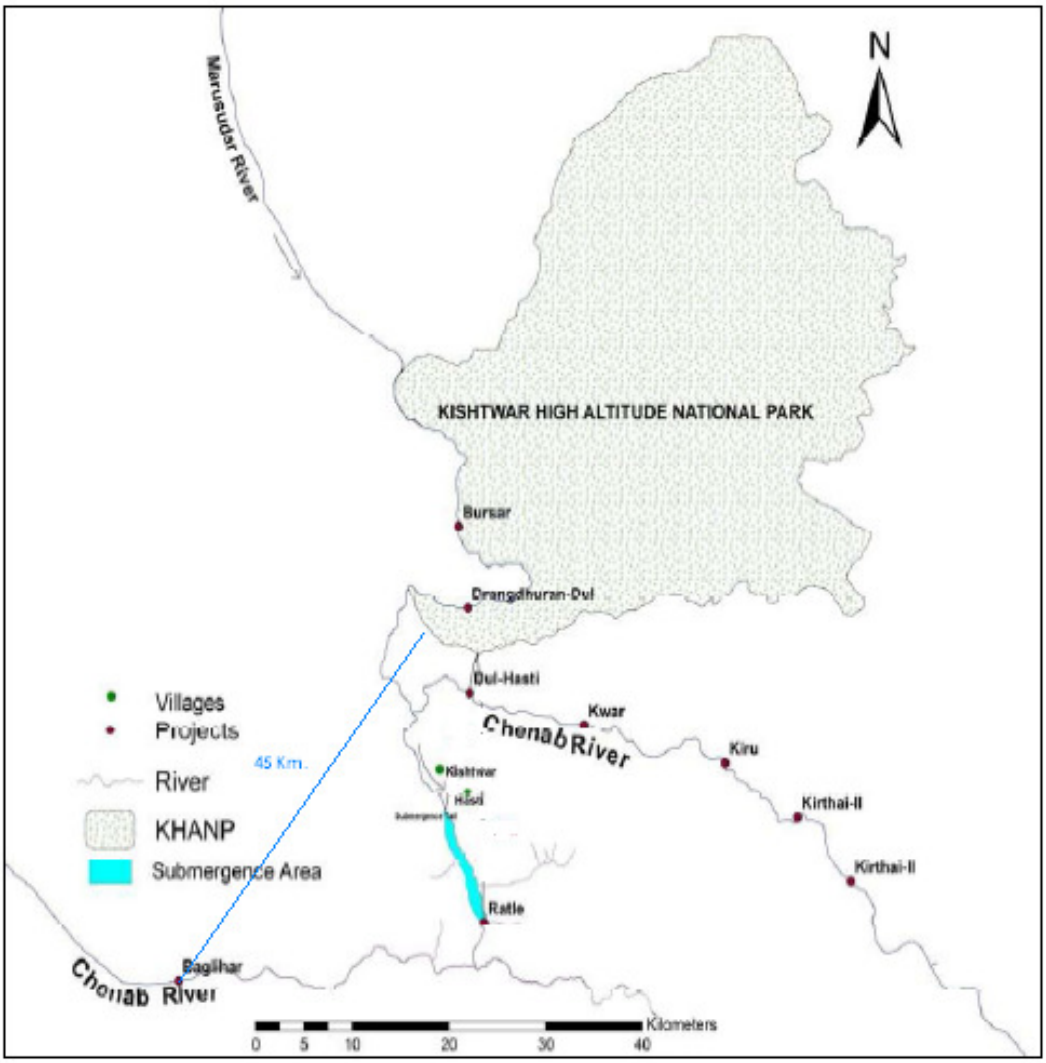


Figure-3.13: Location of Kishtwar High Altitude National Park

CHAPTER-4

WATER ENVIRONMENT

4.1 INTRODUCTION

The project area interacts with river Chenab which is one of six major components of the Indus drainage system, is one of the largest drainage systems of the world. In order to conduct EIA studies of Baglihar HEP, stage-II, whose Stage-I has already been established and commissioned in October, 2008, on lower segment of the Chenab, at Bagliar village in district Ramban, Jammu & Kashmir, baseline data pertaining to water environment of the project within the study area has been collected. The baseline data was studied for evaluating the basin characteristics, drainage pattern, hydrology, ground water regime and downstream water use. The existing physico-chemical and bacteriological parameters were also analyzed for the river and its tributaries at different sites.

4.2 BASIN CHARACTERISTICS OF THE CHENAB

The Chenab emanates from Baralacha pass in the Lahul and Spiti part of the Zaskar Range in Himachal Pradesh. Two small streams viz. the Chandra and the Bhaga rising from the south-west and north-west faces of the pass respectively, form its headwaters at about El 4890 masl. The Chandra flow south-eat for initial 88 km, after traversing 125 km confluence with the other limb, the Bhaga, at Tandi. The latter negotiates a total river course of 80 km with an average fall of about 24 m/km. The united stream, called the Chandrabhaga or Gador, flowing northwesterly for 46 kms. is joined on its right bank by the Miyar Nala. The Chandrabhaga, after flowing in general northwest direction almost parallel to the Pir Panjal range, crosses at El. 1838 masl the Pangi valley of Himachal Pradesh to enter Padder block of newly formed district Kishtwar of Jammu and Kashmir.

After entering the J & K, the Chadrabhaga continues to flow northwest for 56 km and receive at Bhandalkot on its right bank, the Marusudar, one of its biggest tributary. In this section it also meets Bhut Nala on its right bank. Near Kishtwar, it cuts a deep gorge, sometime 1000m deep. Flowing further downstream south wards for 34 km upto Thathri and is joined by Niru Nala on its left flank. Thereafter flowing generally in northwest direction for another 41 km it receives Bichleri, a right bank tributary, and continues to flow westwards for about 50 km reach where it is joined by small streams viz. Cheneni, Talsuen, Yabu and Ans on the right bank besides Katu Nala, Mandial and Painthal Khad on the left bank. After the confluence with river Ans, the Chenab changes its course to southerly direction for about 45 km and debouches into plains near Akhnoor in Jammu and Kashmir. Thereafter it swings to the South-West through the plains of Pakistan Punjab for a distance of 644 km to reach Panchand where it joins the Satluj after receiving waters of the Jhelum and the Ravi. The total length of the river from the confluence with the Chandra and

Bhaga upto Akhnoor is about 410 km where as the total length upto the point of confluence with the Satluj is 1108 km. the catchment area of the Chenab basin upto international border with Pakistan is 29050 Sqkm out of which 6242 Sqkm area is under perpetual snow.

4.2.1 Basin Characteristic of the Free Draining Area of Baglihar HEP

The total catchment area of the Chenab upto the established dam of Baglihar HEP, Stage-I/II is 17325 sqkm out of which the catchment area upto the next proposed upstream project viz. Shamnot HEP is 15341 sqkm. Thus the free draining catchment of the Chenab extended to the next upstream proposed development is 1984 sqkm. which is largely contributed by Desa nadi, Garsal nala, Chittigad, Jowarasha nadi, Dhoroh khad from right bank and Bach, Raggi Kanderi, Akri nadi, Kilamund nadi and Chakwa nadi from left bank. The altitude in the free draining catchment area varies from El 700 masl, at dam site, to El 4154 masl at Aghas. The free draining catchment area of Baglihar HEP, as shown in **Table-4.1**, is covered under the following catchment, as per study conducted by Department of Soil Conservation, J & K Government in context to formulating CAT plan for Stage-I (Report No. SDC/108/12/2003).

Table-4.1: Free Draining Catchment Area of Baglihar HEP

Name of Catchment	Code	No. of Micro Watersheds	Total Area, Ha
Batote	1DB	32	33,177
Desa	1DD	31	34,134
Kontwara	1DH	03	47,860
Neru	1ND	25	64,024
Raggi	1DF	08	19,171
	Total	**99**	**1,98,366**

4.2.2 Drainage Pattern

Drainage is the single most entity, which defines the network antecedent river. The drainage pattern of the study area exhibits dendritic pattern as shown in **Figure 4.1**. The rivulets /nadi in the study area confluencing with it from right are Garsal nala, Chittigad, Jowarasha nadi, Dhoroh khad on u/s of dam and Tanoli da nal, Karola d anal on d/s. The rivulets /nadi in the study area confluencing with it from left are Kanderi, Akri nadi, Kilamund nadi and Chakwa nadi on u/s of dam and Nechhar, Pira nala, Sauni nala, Kalapani nala, Balaur khad on d/s. The drainage pattern of the area may be classified into following classes.

4.2.2.1 Gross Trellis

The trellis drainage pattern is normally developed in the hillside slopes and usually aligned along the strike of the rock formation. The softer rocks like phyllitic slates exhibit such drainage. The trellis drainage pattern is well

developed in the terraces and lower most reaches of the valley. The majority of the area possesses a dendritic to sub-dendritic drainage containing irregular branching of the smaller tributaries. The closeness of these small branches is depending on the permeability of the underlying rocks and the amount and nature of precipitation. It is the most common drainage pattern of hillside slopes of the study area.

4.2.2.2 Gross Radial, Local Annular

The radial drainage pattern is a characteristic feature of the high altitudinal zone specially the summit surfaces. Litho logically, these areas are constituted by the resistant and impervious rocks with steep slopes. The sub-parallel drainage pattern comprises a series of streams which run approximately parallel to each other. They are evolved in areas of uniformly dipping rocks.

4.2.2.3 Gross Sub-Parallel, Local Sub-Rectangular

The major river in the study area is antecedent in nature. The sinuosity, braiding and meandering in the river course is generally noticed, although at some places, they are straight and narrow. Due to the increase of the drainage area and the discharge, the river valley becomes wider in downstream side with generally flattened gradient.

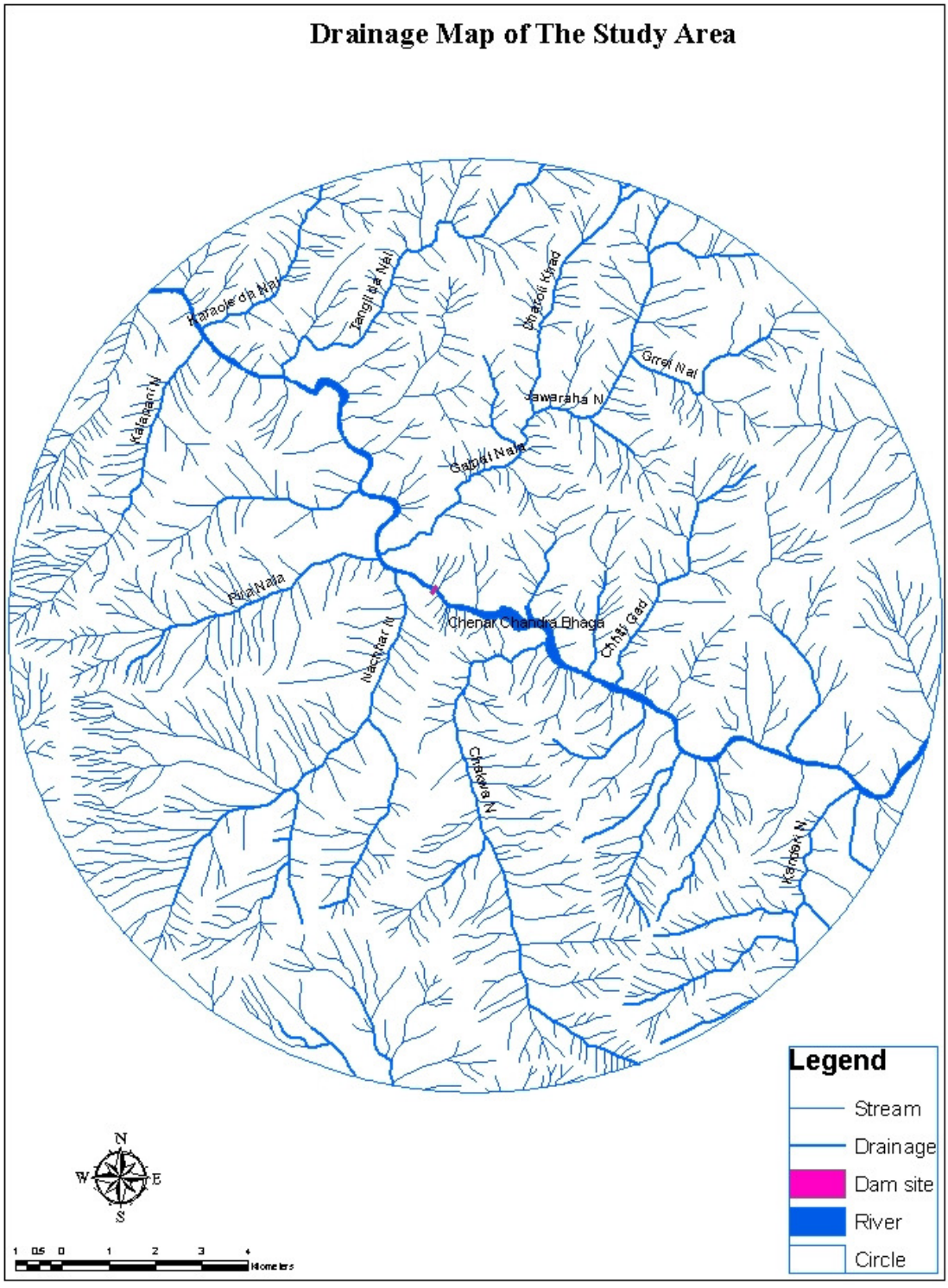


Figure 4.1: Drainage Pattern of the Study Area

4.3 HYDROLOGY

The Chenab, one of the six major components of the Indus drainage system, has its genesis in the confluence of two legendary snow-fed streams viz. Chandra and Bhaga emanating from the southwest and northwest faces of Bara – Lacha- La or Pass (El 4890 masl), connecting Lahul & Spiti district in Himachal Pradesh to Ladakh in Jammu & Kashmir, Situated along NH-21. The Bhaga, a tributary of the Chandrabhaga or Chenab, originates from Surya Tal lake, which is situated a few kilometer from the pass, runs for about 80 km before confluences at Tandi with the Chandra which has already traversed 125 km distance from its origin. The Chandrabhaga after crossing the Pangi valley of Himachal Pradesh enters the Padder block of district Kishtwar. The major tributaries of the Chandrabhaga are Miyar Nallah & Bhut Nadi upto the proposed dam site of Kirthai HEP, Stage-I and on its d/s upto Akhnoor it is joined by major tributaries viz., Marusudar, Tawi and Munawar Tawi. The total catchment area drained by the Chenab in its basin within India including 10130 sqkm permanently snow fed area, is 29050 sqkm which is spread over 21206 sqkm and 7844 sqkm area in J & K and Himachal Pradesh respectively. Precipitation over the basin upto Baglihar HEP is mainly attributed due to southwest monsoon is summer / monsoon and in winter due to the western disturbances. For a hydro-electric project the important hydrological parameters which have a bearing on the project and its design are the water availability, occurrence of storms in and around the basin, the flood estimation and the sediment inflow rate entering into the reservoir. Detailed Hydrological studies have already been approved by the Central Water Commission, New Delhi in respect of 10-daily water availability series, probable maximum design flood and silt rate at the diversion site of the dam of Stage-I. As regards Stage-II, the 10-daily water flow series after the year 2005, has been incorporated.

4.3.1 Water Availability

Chenab basin is a well gauged basin. Number of Gauge and Discharge (G & D) sites has been established by Central Water Commission and other agencies on river Chenab and its main tributary for which long term flow data is available. The Baglihar HE Project is located on Chenab d/s of the Prem Nagar G & D site and 30 km u/s of the Dhamkund G & D site where daily discharge observations are being carried out by Central Water Commission. In addition, a G & D site is being operated at Baglihar project site by the project authorities. A list of the G & D sites and period of data availability relevant to the project under consideration is given in **Table-4.2**.

Table-4.2: List of G&D Sites and Period of Data Availability

Sl. No.	Name of Site	Catchment Area, Sq. Km.	Period of Data Availability
1.	Prem Nagar	15490	1975-76 to 2008-2009
2.	Baglihar Project Site	17325	1976-77 to 1989-90 and 2005-06 to 2008-09
3.	Dhamkund	18750	1975-76 to 2008-09

The water availability series for the Baglihar HEP for the period 1976—77 to 2004-05 as earlier finalized for the Stage-I HEP has been retained and the series has been extended for the period 2005-06 to 2008-09. In the extended series the 10-daily flow at Baglihar for the year 2005-06 to 2008-09 has been worked out from the 10-daily flow observed at Dhamkund on catchment area proportion basis as the observed discharge data at Baglihar was not found to be of the desired quality. The finalized series for Baglihar HEP, approved by the Central Water Commission (vide hydrology(N)/Directorate/1/J & K/29/2010/179 dated 26-07-2010), is given in **Table-4.3.**

Table 4.3: Approved 10-daily Flow Observed at Baglihar HEP (Unit: Cumec)

Year	Jun			Jul			Aug			Sep		
	I	II	III	I	II	III	I	II	III	I	II	III
1976-77	1490	1096	920	1597	2031	2180	2299	1725	1360	1142	611	522
1977-78	961	672	1829	2023	2080	1666	1768	1220	1142	1071	822	511
1978-79	1503	1593	2603	2050	2050	2090	1917			612	712	505
1979-80	722	1238	1960	1614	1972	1430	1727	1474	987			
1980-81	1184	1436	1837	1711	1985	1791	2048	1098	1289	786	548	406
1981-82	893	900	1849	1548	2175	2391	1851	1719	1236	782	417	499
1982-83	1072	1444	1142	1437	1541	2329	2208	1773	1187	893	781	344
1983-84	999	967	1678	1603	1067	2385	2403	1911	2188	1746	1056	617
1984-85	1142			1567	1247	1628	1771	1830	1516	1080	657	337
1985-86	1115	1311	1379	1588	1926	1772	1858	1607	1459	1082	675	465
1986-87	751	1501	2161	1995	1984	2195	2190	1855	1368	1187	560	513
1987-88	1671	1380	1378	2240	1854	2869	1748	1588	2163	1456	874	655
1988-89	1176	1402	2241	2397	2460	2878	2197	2003	1604	1258	948	2183
1989-90	1829	1201	1152	1099	1865	2490	1181	1277	1174	872	861	473
1990-91	1374	1300	2581	2152	1577	1525	1781	1341	1288	1103	1004	906
1991-92	1961	2256	1977	2400	2307	2226	1943	1402	1411	1317	1078	564
1992-93	1076	1483	1745	1471	2134	2302	2011	1608	1572	1829	1153	800
1993-94	1490	1773	1659	2192	2888	1566	1561	1229	1306	1016	785	554
1994-95	1644	1511	3041	3300	2876	2827	2658	1807	1905	1408	601	279
1995-96	1073	1527	996	1589	2012	3354	1636	1567	1347	1516	782	580
1996-97	1303	2049	2888	1851	2025	2219	2513	2535	3151	1313	1005	731
1997-98	797	985	1389	1381	2022	1892	1405	1514	2671	1226	940	665
1998-99	1149	1003	1745	2553	2303	1712	1661	1672	1286	1094	733	787
1999-00	604	1121	1297	1555	1708	1646	2011	1335	1204	912	917	761
2000-01	701	883	1283	1292	1479	2014	1610	1416	1318	1130	709	459
2001-02	866	1146	917	1466	1606	1684	1307	1535	1274	842	528	342
2002-03	1247	1286	1271	1564	1432	1231	1432	1863	1405	838	668	386
2003-04	1806	1606	1645	1752	1663	1907	1636	1303	1148	1066	726	695
2004-05	786	1568	1226	1872	1408	1370	1434	1683	1215	930	1032	465
2005-06	1053	1409	2719	2667	2639	2287	2060	1496	1264	1372	850	494
2006-07	1047	774	1396	2094	1641	2134	2515	1832	1532	1536	878	524
2007-08	915	1565	1890	1826	1352	1685	1617	1634	1442	1108	629	516
2008-09	1086	2198	1622	1775	1519	1353	1688	1158	930	635	428	350

Table 4.3 (Contd…)

Year	Oct			Nov			Dec			Jan		
	I	II	III	I	II	III	I	II	III	I	II	III
1976-77	484	356	339	207	185	167	149	137	136	127	137	132
1977-78	361	295	299	238	189	161	158	141	146	132	134	128
1978-79	279	299	253	174	171	168	129	122	114	107	115	112
1979-80							122	112	111	115	111	108
1980-81	318	214	197	154	135	131	126	121	125	117	113	115
1981-82	245	188	172	156	134	118	113	104	108	105	98	95
1982-83	220	181	161	134	130	109	116	115	112	108	105	106
1983-84	424	289	236	161	144	132	134	112	107	105	107	96
1984-85							138	141	136	151	146	157
1985-86	392	317	263	221	197	181	129	132	146	141	133	127
1986-87	316	267	208	182	192	194	183	198	161	155	150	152
1987-88	345	368	278	249	225	199	173	164	153	150	149	143
1988-89	682	396	317	219	175	142	120	106	140	139	134	133
1989-90	432	355	335	210	199	177	161	162	166	110	108	138
1990-91	504	249	237	229	215	192	178	198	250	235	204	238
1991-92	452	380	328	278	236	198	183	173	166	146	145	217
1992-93	682	529	457	417	396	372	170	160	152	169	157	147
1993-94	412	351	286	265	235	212	183	163	159	167	175	193
1994-95	175	109	79	57	60	59	71	76	69	65	68	110
1995-96	439	691	274	240	219	193	210	215	205	176	254	225
1996-97	568	341	307	270	219	208	207	192	194	175	141	153
1997-98	446	407	385	315	280	328	243	247	225	202	221	205
1998-99	450	411	323	277	256	232	181	158	130	156	140	236
1999-00	433	276	248	315	237	192	199	182	133	116	228	191
2000-01	348	292	274	266	204	186	123	118	117	113	103	101
2001-02	304	247	219	213	163	153	133	126	123	105	123	117
2002-03	292	267	213	181	162	151	120	117	113	105	112	112
2003-04	367	280	243	212	223	194	154	196	141	142	170	278
2004-05	392	305	215	178	168	166	164	142	151	186	155	150
2005-06	404	301	251	220	190	174	161	146	135	140	198	169
2006-07	447	361	264	226	223	202	262	201	190	178	169	165
2007-08	316	255	227	212	201	188	177	167	164	182	208	177
2008-09	397	348	291	255	237	241	213	225	236	231	208	205

Table 4.3 (Contd…)

Year	Feb			Mar			Apr			May		
	I	II	III	I	II	III	I	II	III	I	II	III
1976-77	137	140	134	149	171	247	295	262	382	413	450	821
1977-78	124	137	143	225	321	256	291	592	767	945	1131	1418
1978-79	110	131	127	280	333	490	632	673	774	706	688	643
1979-80	136	180	178	197	238	285	351	437	474	647	617	727
1980-81	126	140	194	149	173	323	352	543	697	1082	1057	1434
1981-82	104	112	124	133	148	286	319	367	545	663	597	861
1982-83	108	111	215	204	290	338	387	414	653	717	903	992
1983-84	104	108	111	180	240	279	419	355	448	622	690	1116
1984-85	148	149	162	189	173	225	244	271	336	496	548	939
1985-86	125	142	159	164	355	387	430	699	855	679	922	682
1986-87	133	155	208	245	272	413	505	446	824	796	707	939
1987-88	179	177	193	196	332	305	295	609	764	946	1006	1331
1988-89	132	123	122	164	176	295	322	344	380	643	839	1253
1989-90	149	153	159	168	318	526	373	510	620	938	1650	1363
1990-91	260	334	359	420	456	565	677	804	742	876	1005	1012
1991-92	209	209	197	249	320	569	520	574	725	694	876	958
1992-93	155	161	202	230	528	796	797	1006	1237	1294	1335	1377
1993-94	183	178	200	225	296	301	352	404	544	685	684	1225
1994-95	100	284	289	298	324	518	575	633	690	1017	1343	1671
1995-96	233	292	377	306	662	546	511	675	850	818	715	984
1996-97	178	175	188	223	331	358	490	534	627	705	532	694
1997-98	177	393	468	603	505	517	746	694	988	868	862	1260
1998-99	201	218	215	320	274	243	382	516	713	669	820	924
1999-00	198	216	188	233	227	265	364	396	428	566	1043	925
2000-01	102	103	110	103	107	176	210	302	317	415	655	675
2001-02	114	122	148	166	255	289	325	399	475	490	1103	1016
2002-03	116	459	347	663	327	432	456	627	640	790	1076	1066
2003-04	252	256	263	274	325	284	369	347	517	565	734	814
2004-05	178	258	253	385	662	495	461	508	737	926	752	747
2005-06	168	197	252	226	247	306	376	360	593	937	1413	1647
2006-07	164	168	184	207	462	758	718	895	863	1063	1170	822
2007-08	180	162	229	275	302	271	281	426	470	647	839	953
2008-09	198	208	203	185	228	266	362	361	488	549	666	891

4.3.2 90 % and 50 % Dependable Flow For Power Study

For any hydro-electric project, the power output and energy potential are worked out on the basis of 90% dependable & 50% dependable flows. Power output and energy potential for a run of the river scheme is proportional to the natural inflow. The entire flow data 1976-77 to 2009-09 i.e. for a period of 33 years, has been arranged in descending order as shown in **Table 4.4** and on its basis 90% and 50% dependable years have been determined.

Table 4.4: Details of 50% and 90% Dependable flow Year

Finalized Series		Rank	Descending Order		Probability of Exceedence
Year	Annual flow MCM		Year	Annual flow MCM	
1976-77	20412	1	1994-95	28734	0.03
1977-78	21577	2	1992-93	28296	0.06
1978-79	23215	3	1996-97	27875	0.09
1979-80	19631	4	1988-89	26681	0.12
1980-81	21378	5	1991-92	26259	0.15
1981-82	19565	6	2005-06	25986	0.18
1982-83	20355	7	1987-88	25480	0.21
1983-84	22427	8	1997-98	25137	0.24
1984-85	19154	9	1995-96	24976	0.27
1985-86	21312	10	2006-07	24896	0.30
1986-87	23123	11	1990-91	24892	0.33
1987-88	25480	12	1978-79	23215	0.36
1988-89	26681	13	1986-87	23123	0.39
1989-90	22068	14	1998-99	22970	0.42
1990-91	24892	15	1993-94	22948	0.45
1991-92	26259	16	1983-84	22427	0.48
1992-93	28296	17	**1989-90**	**22068**	**0.52**
1993-94	22948	18	2003-04	21584	0.55
1994-95	28734	19	1977-78	21577	0.58
1995-96	24976	20	1980-81	21378	0.61
1996-97	27875	21	1985-86	21312	0.64
1997-98	25137	22	2007-08	20852	0.67
1998-99	22970	23	2004-05	20828	0.70
1999-00	20126	24	2002-03	20697	0.73
2000-01	17504	25	1976-77	20412	0.76
2001-02	18043	26	1982-83	20355	0.79
2002-03	20697	27	1999-00	20126	0.82
2003-04	21584	28	2008-09	19709	0.85
2004-05	20828	29	1979-80	19631	0.88
2005-06	25986	30	**1981-82**	**19565**	**0.91**
2006-07	24896	31	1984-85	19154	0.94
2007-08	20852	32	2001-02	18043	0.97
2008-09	19709	33	2000-01	17504	1.00

4.3.3 Maximum, Minimum, Average, 50%, 90% Dependable Flow at Baglihar

The 10-daily flow summary of water availability series (1976-77 to 2008-09) computed at Baglihar dam site is given in **Table-4.5** and shown in **Figure-4.2**. The annual flow with 50% and 90% probability of exceedence are found to be in year 1989-90 and 1981-82, respectively. The details of 10-daily flow in 50% and 90% dependable year are also given below. The 10-daily flow pattern in 50% and 90% dependable year at Baglihar HEP is shown in **Figure4.3**.

Table-4.5: 10-daily Flow Summary of Water Availability Series (1976-77 to 2008-09), Computed at Baglihar Dam Site

Month	Period	Average	Maximum	Minimum	50% Dep. 1989-90	90% Dep. 1981-82
Jun	I	1166	1644	701	1829	893
	II	1361	1511	883	1201	900
	III	1731	3041	1283	1152	1849
Jul	I	1855	3300	1292	1099	1548
	II	1904	2876	1479	1865	2175
	III	2031	2827	2014	2490	2391
Aug	I	1868	2658	1610	1181	1851
	II	1594	1807	1416	1277	1719
	III	1480	1905	1318	1174	1236
Sep	I	1130	1408	1130	872	782
	II	781	601	709	861	417
	III	591	279	459	473	499
Oct	I	392	175	348	432	245
	II	317	109	292	355	188
	III	263	79	274	335	175
Nov	I	222	57	266	210	156
	II	199	60	204	199	134
	III	183	59	186	177	118
Dec	I	160	71	123	161	113
	II	154	76	118	162	104
	III	149	69	117	166	108
Jan	I	144	65	113	110	105
	II	149	68	103	108	98
	III	156	110	101	138	95
Feb	I	157	100	102	149	104
	II	192	284	103	153	112
	III	209	289	110	159	124
Mar	I	250	298	103	168	133
	II	314	324	107	318	148
	III	382	518	176	526	286
Apr	I	430	575	210	373	319
	II	515	633	302	510	367
	III	641	690	317	620	545
May	I	754	1017	415	938	663
	II	892	1343	655	1650	597
	III	1036	1671	675	1363	861

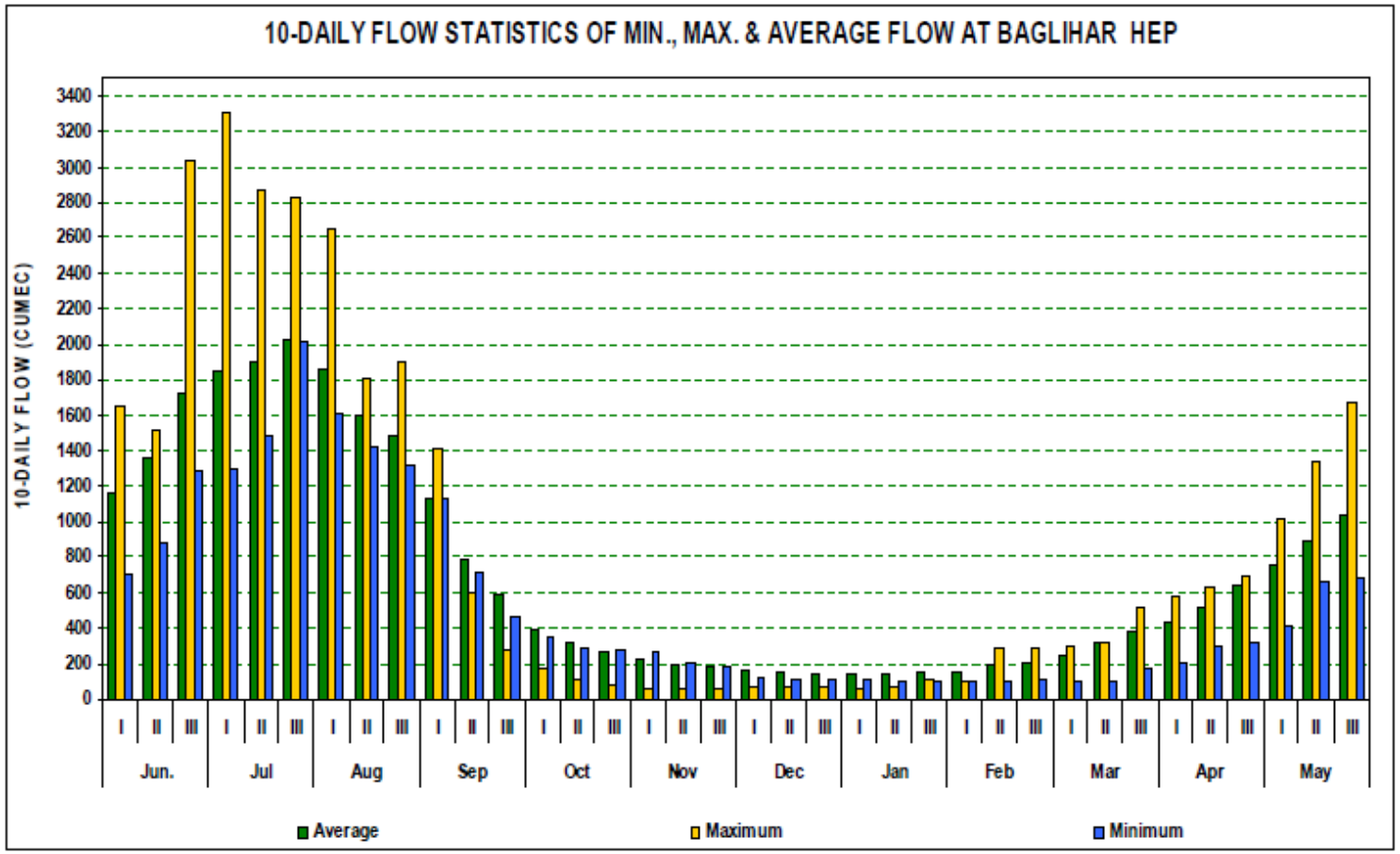


Figure-4.2: 10-daily Flow Summary of Water Availability Series (1976-77 to 2008-09)

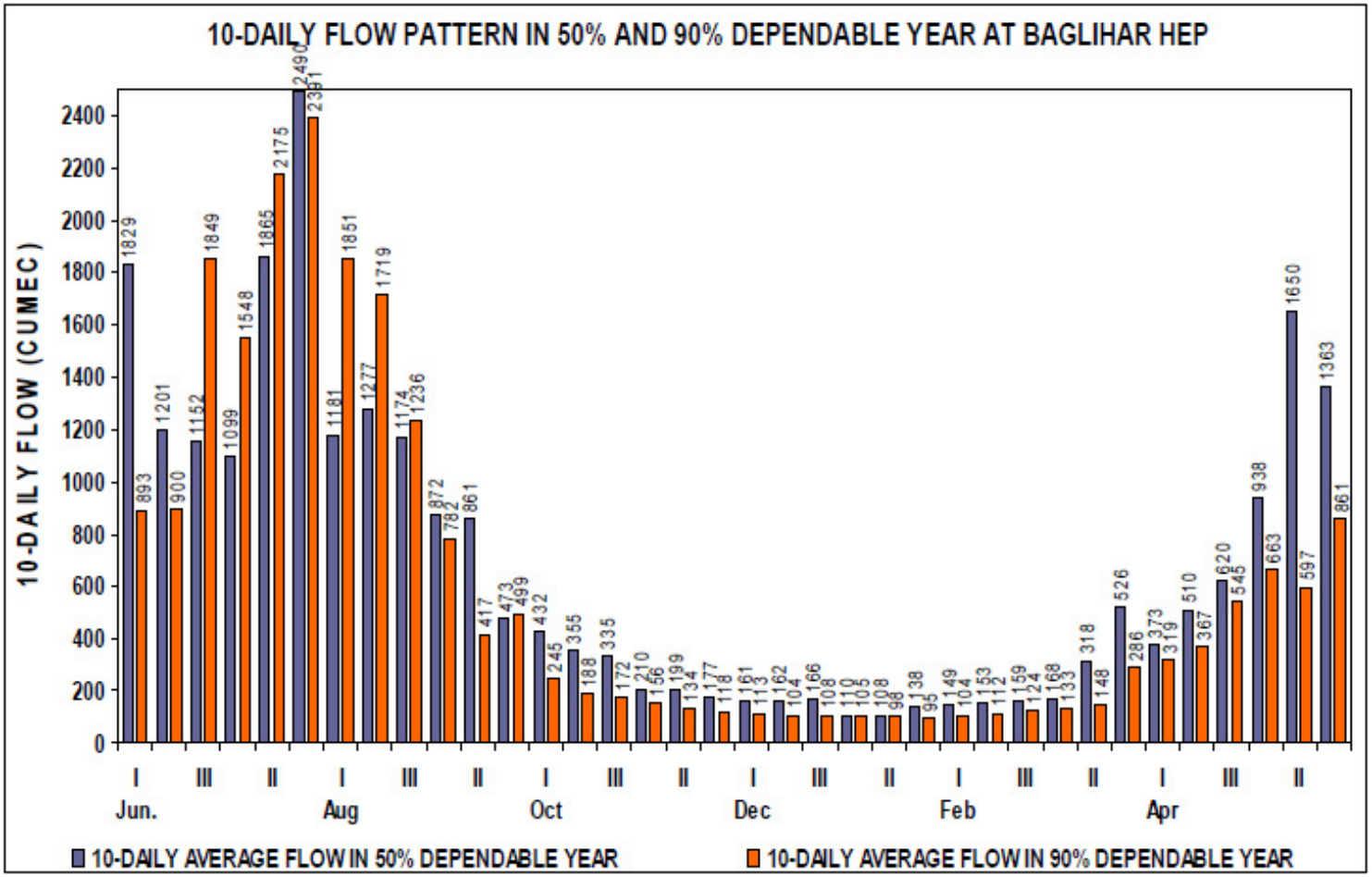


Figure-4.3: 10-daily flow pattern in 50% and 90% dependable year at Baglihar HEP

4.3.4 Flow Duration Curves

The flow duration curves showing probability exceedence vs 10-daily flow in 50%, 90% dependable years and average 10-daily flow is shown in **Figure-4.4** through **Figure-4.6**.

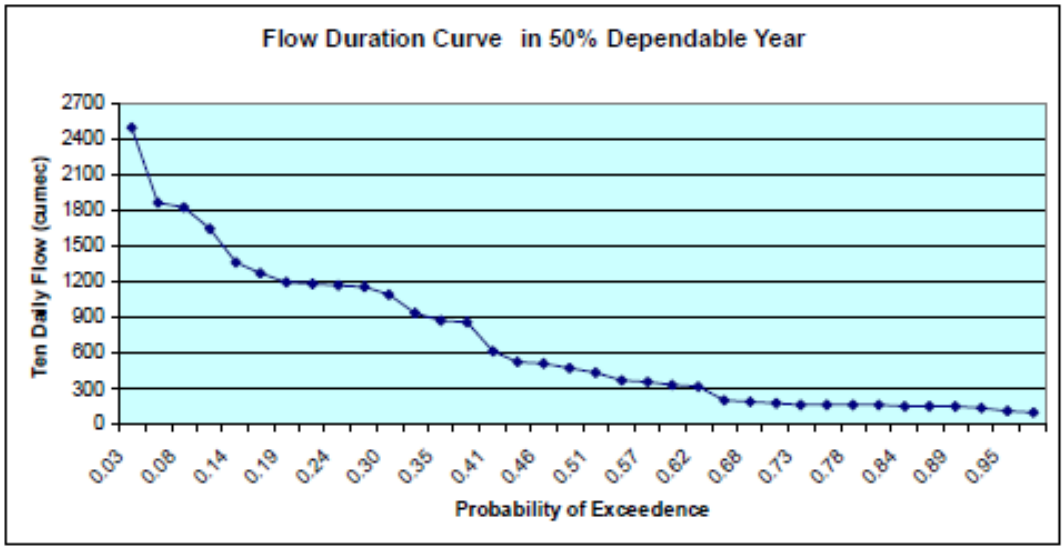


Figure-4.4: Flow Duration Cureve in 50% Dependable Year

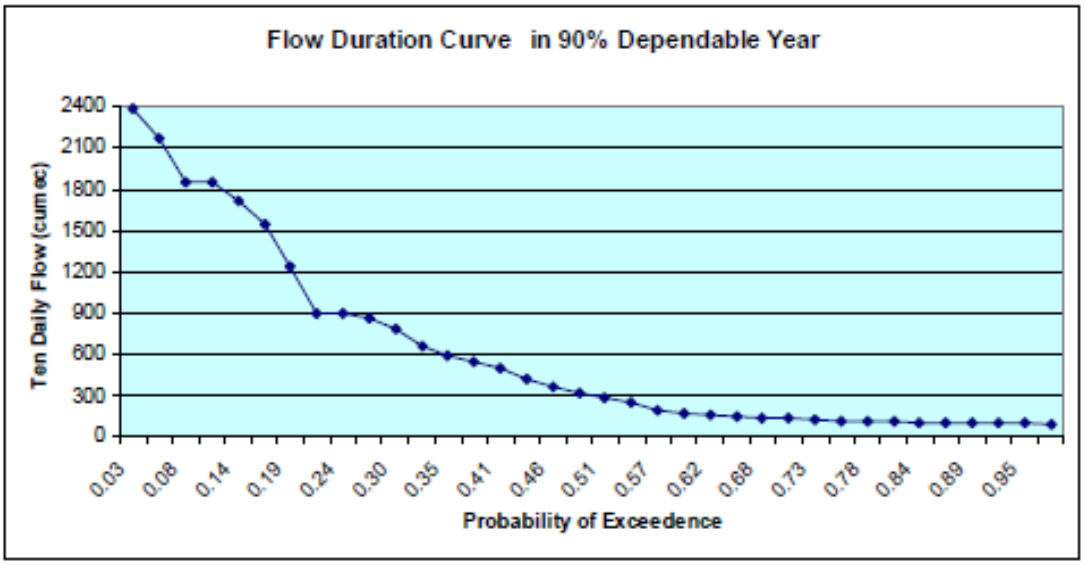


Figure-4.5: Flow Duration Cureve in 90% Dependable Year

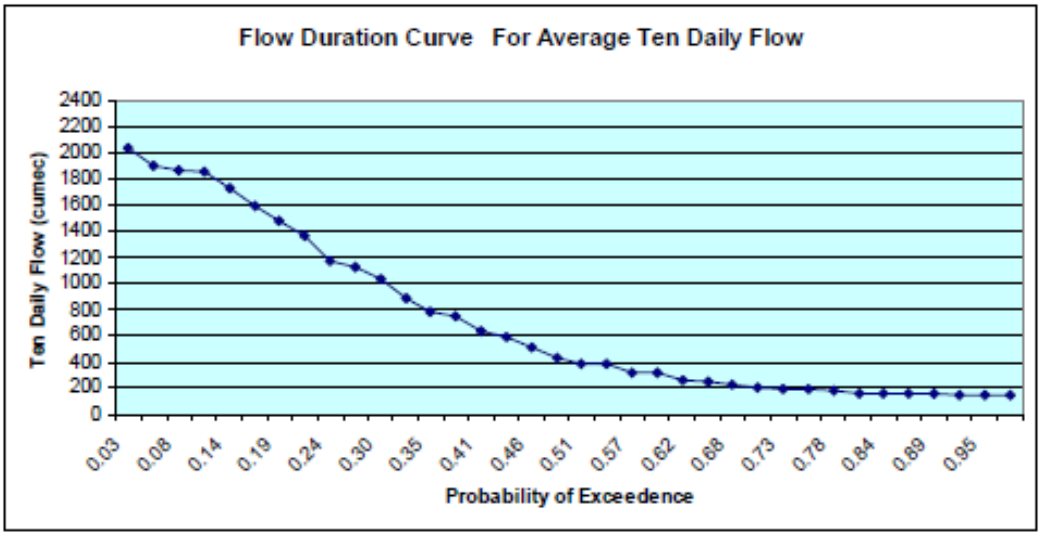


Figure-4.6: Flow Duration Curve for Average 10-Daily Flow

4.4 GROUND WATER REGIME

The sub-surface geological configuration and aquifer deposition is mainly studied on the basis of litho logical logs obtained from deep drillings. The project and reservoir area lies in deep gorge with high mountains on either bank constituting very thick or high water divide. In the absence of litho logical logs water regime can not be established in respect of terraces in the project area. The project area lies in lesser Himalayas. As stated, that both flanks of the river u/s and d/s of the project are high cliffs, deep water table is expected. In case of soils of fluvial valleys encountered in cultivated valleys, the ground water table is expected to be about 4-5 m below ground level. It is also brought out that due to creation of reservoir the ground water table in the reservoir area shall raise and effect the hydraulic gradient to insignificant level as the water divide on both the side is very high and no seepage to contiguous valleys is expected.

4.5 WATER USE

Baglihar HEP, Stage-II is conceived as R-o-R scheme to harness water of River Chenab for non-consumptive of power generation by diverting 430 cumec of water from the common reservoir of Stage-I to pass through 10.15 m diameter circular pressure tunnel 1.888 km long for utilizing 129.29 meter gross head of water for generating 1302.00 GWH power at 90% dependability. The water from TRT of Stage-II shall be released into the river about 1.8 km downstream of dam.

4.5.1 Upstream Water Use

On the upstream of the proposed Baglihar HEP, Stage-II, at present, only Dul-Hasti HEP (390 MW) and many more HEPs have either been investigated and proposed for construction or under investigation, as cascade development of Chenab river and its tributaries, both in the state of Himachal Pradesh and J &K.

All such hydro-electric schemes are based on non-consumptive use of water. Besides these there is neither any industry nor any lift/flow irrigation or water supply scheme utilizing the direct flow of river Chenab. All flow irrigation schemes (FIS) and water supply schemes on the upstream of the project take-off from the local nalas and spring respectively and thus are not dependant upon the discharge of the Chenab. In the study area, irrigation canal / gules off-take from local nalas to meet the water requirement of crops being raised in nearby villages. The irrigated area is very insignificant as always is the case in the hill and the irrigation water requirement is also very little due to low evapo-transpiration rates and the variety of the crops raised.

4.5.2 Downstream Water Use

On the d/s of proposed diversion dam to the point of release of tail race water in about 1.8 km length of the Chenab, there is no direct consumptive use of water of the Chenab either for industry or in irrigation/ water supply scheme and also due to sparse population d/s of the dam, there exist a few small guls, which take off from the hill streams that drain the catchment downstream of the existing dam. In view of the fact that the culturable area is very limited in the hilly terrain and therefore, minor irrigation schemes mainly small section kules is generally practiced. Due to high elevation, the evapo-transmission, based net irrigation water requirement is also very less.

The general altitude of the cultivable area varies between El 700 masl to 2300 masl, and the agro-climatic condition in the area is congenial for production of crops like maize, barley, paddy, pulses, oil seeds, vegetables, millets, potato and fodder. The water requirement for irrigation is comparatively inconsequential as compared to the flow/yield of the streams from which kul/gules system off-takes and thus notwithstanding their existence there is not significant decrease discharge of these streams.

Besides minor gules there are a few small water supply schemes (WSS) which take off from local springs in the vicinity of the village on left and right bank for which these are implemented. The water requirement of these schemes is almost inconsequential and these do not have any effect upon the flow of the Chenab flowing downstream of the existing dam. The daily water requirement varies from 3000 LPD to 15000 LPD.

4.5.3 Environmental Flow Requirement

Environmental consideration requires that a minimum flow is always guaranteed into the river downstream of the diversion structure to meet the requirement of aquatic life, drinking water, wild life, fisheries, riparian rights and religious rites of people. In present case, due to construction of Salal dam on d/s and Dul-Hasti dam on u/s of the project, the movement

of fishes for spawning has already been blocked and whatever movement is there that is limited to free flow stretch of the Chenab in between these projects. In view of the fact that the TRT of the power house of Stage-II shall discharge full water about 1.8 km d/s of the dam axis, a minimum release of 10% water at all the times including lean seasons shall be adequate. The minimum stipulated flow has been worked out on the basis of average flow in four consecutive lean months i.e. from November to February in 90% dependable year which is year 1981-82 for diversion site. The computation of minimum flow requirement works out to 11.18 cumec as presented in **Table-4.6**. However, a minimum d/s release of 13.6 cumec shall be maintained through spillways during lean season and calculation of power generation has been done accordingly.

Table-4.6: Computation of Minimum Flow Requirement

S. No	Month 10-daily	Inflow (Cumecs)
1.	November	
	1-10	156
	11-20	134
	21-30	118
2.	December	
	1-10	113
	11-20	104
	21-31	108
3.	January	
	1-10	105
	11-20	98
	21-31	95
4.	February	
	1-10	95
	11-20	104
	21-28	112
Total		**1342**
Average		**111.83**
Minimum Flow Requirement @ 10%		**11.18**
Minimum flow d/s of dam adopted in power studies		**13.6 cumec (11.5%)**

Besides, about 1.4 cumec of water shall be added through regeneration below dam, discharge pumped out from drainage gallery of the dam, sweating and seepage from banks and also through Nachari nala and Pira nala, which confluence with the Chenab on left bank about 0.7 km and 1.3 km and Gajpat nala, from right bank, about 1.3 km d/s of plunge pool of the dam. It is also brought out that the outfall discharge from TRT causes back water in Chenab, the stretch of which extends upto Gajpat nala. This implies that upto 1.3 km from plunge pool about 16 cumec of water shall be available in the lean season also. The view of TRT outlet fall and Gajpat nala on its u/s is shown in **Figure-4.7** and the vertical fall of Gajpat nala is shown in **Figure-4.8**. **Figure-4.9** shows the view of flowing water in the river d/s of the dam and confluence of Nachari Nala.

Figure-4.7: View of TRT outlet fall and Gajpat Nala

Figure-4.8: Vertical Fall of Gajpat Nala

Figure-4.9: D/s View of River and Dam

4.6 SEDIMENTATION

The river Chenab at Baglihar is with a rocky bed and with high banks. The catchment area intercepted at the site is 17325 sq. km. (6689.20 sq miles). The river has a steep gradient, maintaining fairly high velocity of flow and turbulence during high floods. However, there is no sediment observation station at project site. As such, for estimating the sediment yield at the site, the sediment data observed at Prem Nagar upstream of Baglihar on the main Chenab, with a catchment area of 15490 sq. km. (5980.70 sq. miles) has been utilized based on catchment area proportions.

The C.S.M.R.S. at New Delhi had analyzed the suspended load data for the year 1968 to 1976 available at Prem Nagar and indicated the average annual sediment load as 2163 hec meter. Assuming 20% of the suspended load as bed load, the annual sediment load at Baglihar works out to 2596 hec meter (25.96 million cum/year). The sediment index works out to 0.15 hec meter/sq. km./year on the above basis.

4.7 WATER QUALITY

The catchment of the Chenab upto the dam site is characterized by many snow-fed spring fed river / hill torrents. The attitudinal gradient of the drainage basin from higher reaches to project site shows height difference from El 700 m to 6722 m. The water is not polluted and bears a lot of dissolved oxygen in it. The natural treatment of water current takes place

for a considerable length in upper reaches where the ultraviolet radiation due to sun is quite high. In addition to this the water of the river is not exposed to sewerage in general although some sewerage during monsoon is brought by different streams passing through he inhabitation, during high fold season. The area is free of industrial pollutants as the industrial base is non existent. In view of the above, the water environment of the Chenab upto the project site is benign.

4.7.1 Water Quality Assessment

The quality of water is of vital concern for mankind since it is directly linked with human welfare. Water quality characteristics of aquatic environments arise from multitude of physical, chemical and biological interactions. The water bodies are continuously subjected to dynamic state of changes with respect to their geo-chemical characteristics. The dynamic balance in aquatic ecosystem is upset by human activities, resulting in pollution which is obvious by bad taste of drinking water, offensive odour and unchecked growth of aquatic weeds to decrease in umber of fish and oil and grease floating on water bodies. These disturb the normal uses of water for public water supply, industry, agriculture etc.

4.7.2 Reconnaissance Survey

A reconnaissance survey of the site and the surroundings was conducted during the beginning of the studies. After studying the drainage pattern of the entire catchment area, four surface water samples were collected from river Chenab and its tributaries joining the river. Three ground water samples have also been collected from the springs near the project site. The location details of the surface and ground water monitoring stations is presented in **Table-4.7** and shown in **Figure-4.10**.

Table-4.7: Location of Surface Water and Ground Water Quality Monitoring Stations

Station Code	Station Name	Distance (km), w.r.t. Dam Site
SW1	Chenab, BHEP Dam Site	-
SW2	Chenab, BHEP Power House Site	2.0 (d/s)
SW3	Chakwa Nadi	2.0 (u/s)
SW4	Nachhar Nadi	0.7 (d/s)
GW5	Pira Nala	1.3 (d/s)
GW6	Gagman(Spring)	4.0(u/s)

4.7.3 Water Quality of the Study Area

The physicochemical and biological characteristics of the samples collected during April 2011 to March 2012 are presented in **Table-4.8** through **Table-4.10** and the relevant Water Quality Standards in **Table-4.11.**

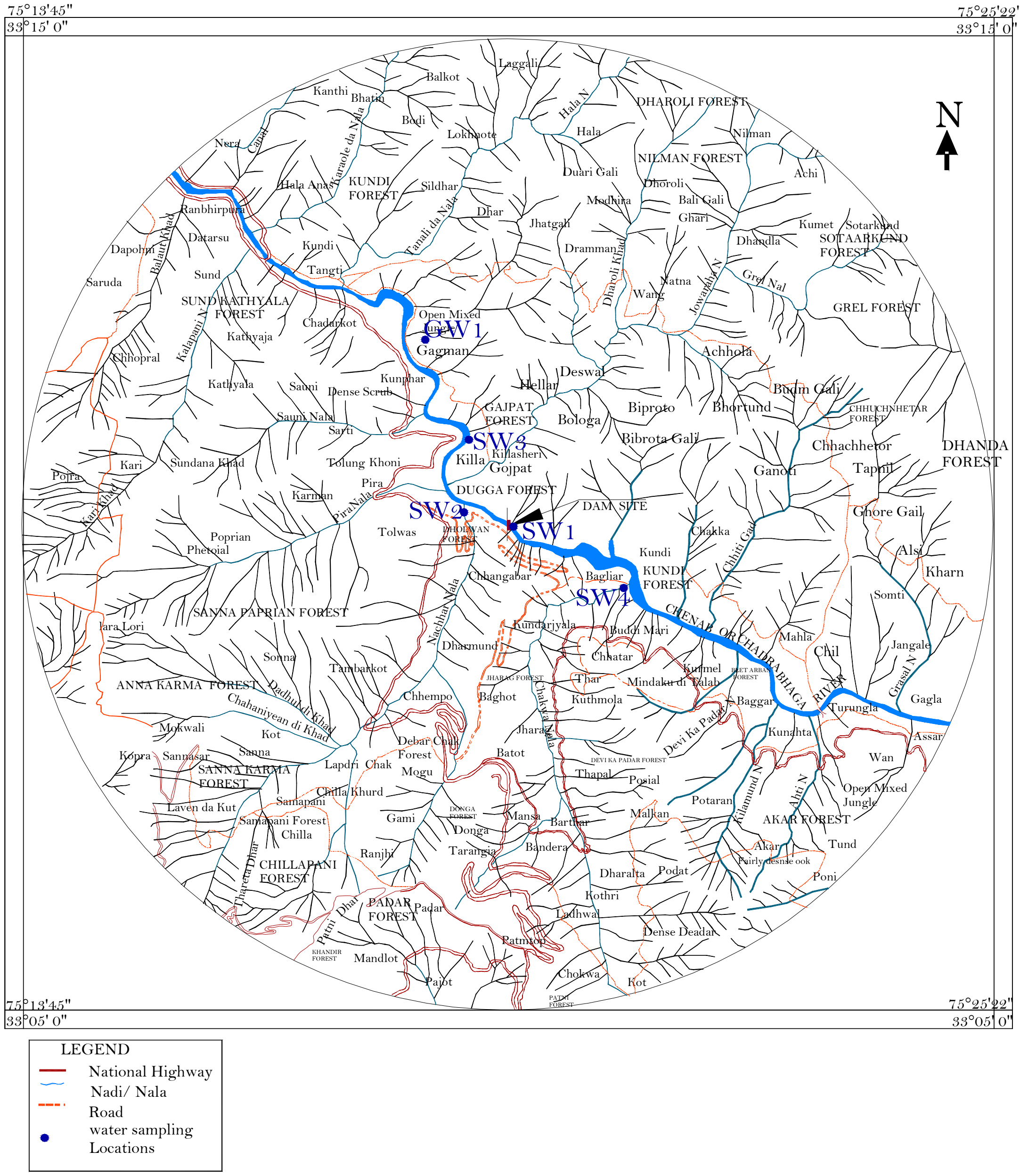


Figure-4.10: Map Showing Water Sampling Stations

Table-4.8: Physicochemical and Biological Characteristics of Water in the Study Area (Pre-Monsoon)

Sl. No.	Location	Chenab, BHEPDam Site	Chenab, BHEP Power House Site	Chakwa Nadi	Nachhar Nadi	Pira Nala	Gagman(Spring)
	Sampling Station Code	SW1	SW2	SW3	SW4	SW5	GW1
	Parameters						
1	pH	7.80	7.85	7.5	7.60	7.90	7.85
2	Conductivity, µmhos/cm	220	222	142	260	145	310
3	Total Dissolved Solids, mg/l	142	145	94	165	90	195
4	Dissolve Oxygen (mg/l)	6.5	7.0	9.5	8.0	9.0	4.50
5	Total Hardness (as $CaCO_3$), mg/l	92	94	50	60	48	136
6	Calcium (as $CaCO_3$), mg/l	72	74	38	44	38	115
7	Magnesium (as $CaCO_3$), mg/l	20	20	12	16	10	21
8	COD, mg/l	<2	<2	<2	<2	<2	<2
9	BOD, mg/l	<4	<4	<4	<4	<4	<4
10	Phosphate (as PO_4 mg/l)	0.32	0.32	0.21	0.25	0.21	0.18
11	Nitrate	0.45	0.46	0.42	0.36	0.15	0.19
12	Sulphate as SO_4	50	51	10	18	10	24
13	Chloride as Cl	6	6	12	14	12	22
14	Sodium (as Na), mg/l	8	9	8	10	5	4
15	Potassium(as K), mg/l	3	3	2	5	2	5
16	Mercury as Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
17	Lead as Pb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
18	Cadmium as Cd	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
19	Chromium as Cr^{+6}	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
20	Fluorides	0.09	0.09	0.09	0.12	0.20	0.20
21	Zinc as Zn	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
22	Total Coliform MPN/100ml	60	82	110	131	115	absent
23	Faecal Coliform MPN/100ml	12	18	28	24	20	absent

Table-4.9: Physicochemical and Biological Characteristics of Water in the Study Area (Monsoon)

Sl. No.	Location	Chenab, BHEPDam Site	Chenab, BHEP Power House Site	Chakwa Nadi	Nachhar Nadi	Pira Nala	Gagman(Spring)
	Sampling Station Code	SW1	SW2	SW3	SW4	SW5	GW1
	Parameters						
1	pH	7.82	7.86	7.54	7.62	7.88	7.70
2	Conductivity, µmhos/cm	232	235	146	262	148	315
3	Total Dissolved Solids, mg/l	145	147	96	168	94	201
4	Dissolve Oxygen (mg/l)	6.8	7.2	9.5	8.5	9.2	4.40
5	Total Hardness (as $CaCO_3$), mg/l	94	95	52	62	50	128
6	Calcium (as $CaCO_3$), mg/l	73	75	39	45	38	112
7	Magnesium (as $CaCO_3$), mg/l	21	22	13	17	12	26
8	COD, mg/l	<2	<2	<2	<2	<2	<2
9	BOD, mg/l	<4	<4	<4	<4	<4	<4
10	Phosphate (as PO_4 mg/l)	0.35	0.36	0.28	0.29	0.25	0.15
11	Nitrate	0.42	0.42	0.38	0.45	0.21	0.18
12	Sulphate as SO_4	52	50	12	22	15	28
13	Chloride as Cl	7	8	14	18	15	24
14	Sodium (as Na), mg/l	9	9	10	12	6	5
15	Potassium(as K), mg/l	4	4	3	6	3	4
16	Mercury as Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
17	Lead as Pb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
18	Cadmium as Cd	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
19	Chromium as Cr^{+6}	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
20	Fluorides	0.10	0.10	0.11	0.13	0.20	0.24
21	Zinc as Zn	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
22	Total Coliform MPN/100ml	50	64	88	120	110	absent
23	Faecal Coliform MPN/100ml	10	12	22	20	15	absent

Table-4.10: Physicochemical and Biological Characteristics of Water in the Study Area (Winter)

Sl. No.	Location	Chenab, BHEPDam Site	Chenab, BHEP Power House Site	Chakwa Nadi	Nachhar Nadi	Pira Nala	Gagman(Spring)
	Sampling Station Code	SW1	SW2	SW3	SW4	SW5	GW1
	Parameters						
1	pH	7.70	7.75	7.60	7.60	7.85	7.90
2	Conductivity, µmhos/cm	215	218	138	255	140	299
3	Total Dissolved Solids, mg/l	89	137	92	160	86	190
4	Dissolve Oxygen (mg/l)	6.5	6.6	9.0	7.5	8.6	4.20
5	Total Hardness (as $CaCO_3$), mg/l	90	92	48	55	45	132
6	Calcium (as $CaCO_3$), mg/l	72	73	38	42	36	110
7	Magnesium (as $CaCO_3$), mg/l	18	19	10	13	9	22
8	COD, mg/l	<2	<2	<2	<2	<2	<2
9	BOD, mg/l	<4	<4	<4	<4	<4	<4
10	Phosphate (as PO_4 mg/l)	0.30	0.29	0.18	0.22	0.21	0.16
11	Nitrate	0.44	0.44	0.38	0.36	0.12	0.18
12	Sulphate as SO_4	47	48	8	16	11	22
13	Chloride as Cl	5	6	10	13	10	19
14	Sodium (as Na), mg/l	8	8	7	9	4	5
15	Potassium(as K), mg/l	2	3	2	4	3	4
16	Mercury as Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
17	Lead as Pb	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
18	Cadmium as Cd	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
19	Chromium as Cr^{+6}	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
20	Fluorides	0.09	0.09	0.09	0.12	0.20	0.20
21	Zinc as Zn	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
22	Total Coliform MPN/100ml	52	65	105	128	98	absent
23	Faecal Coliform MPN/100ml	10	14	24	22	17	absent

The quality of surface and ground water is generally good. pH varies from 7.5 to 7.90 and Dissolve Oxygen varies from 9.50 to 6.50 mg/l in surface water samples. This indicates that surface water is good for aquatic life. The other parameters are also meeting the requirements of drinking water quality standard except the bacteriological parameters in surface water samples.

The coliform group consists of several genera of bacteria belonging to the family *Enterobacteriaceae*. *Escherichia coli (E-coli)* is a member of the fecal coliform group of bacteria which is indigenous fecal flora of warm blooded animals. It also resides in the intestine of human. The occurrence of E-coli is considered a specific indicator of fecal contamination. In the present case, the presence of E-coli is attributed to the discharge of untreated sewerage into the Chenab and tributaries passing through human settlement and also to the habit of people defecating in the open.

Table-4.11: National River Water Quality Standards for Different Uses*

Sl. No.	Characteristics	Tolerance Limit				
		Drinking water source with conventional treatment	Outdoor bathing	Dinking water source with conventional treatment but after disinfection	Fish culture and wildlife propagation	Irrigation industrial cooling or controlled water disposal
		A	**B**	**C**	**D**	**E**
1.	pH value	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
2.	Dissolved Oxygen (mg/l), min	6	5	4	4	-
3.	BOD (5-days at 20^0 C, mg/l, min	2	3	3	-	-
4.	Total Coliform Organism, MPN/100, max	50	500	5000	-	-
5.	Colour, Hazen units, max	10	300	300	-	-
6.	Odour	10	300	300	-	-
7.	Taste	Tasteless	-	-	-	-
8.	Total Dissolved Solids, mg/l, max	500	-	1500	-	2100
9.	Total Hardness (as $CaCO_3$),mg/l, max.	300	-	-	-	-
10.	Calcium Hardness (as $CaCO_3$), mg/l, max	200	-	-	-	-
11.	Magnesium Hardness (as $CaCO_3$), mg/l, max	100	-	-	-	-
12.	Copper (as Cu), mg/l, max	1.5	-	1.5	-	-
13.	Iron (as Fe), mg/l, max	0.3	-	0.5	-	-
14.	Manganese (as Mn), mg/l, max	0.5	-	-	-	
15.	Chloride (as Cl), mg/l, max	250	-	600	-	600
16.	Sulphates (as SO_4), mg/l, max	400	-	400	-	1000
17.	Nitrates (as NO_3), mg/l, max	20	-	50	-	-
18.	Fluorides (as F), mg/l, max	1.5	1.5	1.5	-	-
19.	Phenolic Compounds (as C6H5OH), mg/l, max	0.002	0.005	0.005	-	-
20.	Mercury (as Hg), mg/l, max	0.001	-	-	-	-
21.	Cadmium (as CD), mg/l, max	0.01	-	0.01	-	-
22.	Selenium (as Se), mg/l, max	0.01	-	0.05	-	-
23.	Arsenic (as As), mg/l, max	0.05	0.2	0.2	-	-
24.	Cyanide (as CN), mg/l, max	0.05	0.05	0.05	-	-

25.	Lead (as Pb), mg/l, max	0.1	-	0.1	-	-
26.	Zinc (as Zn), mg/l, max	15	-	15	-	-
27.	Chromium (as Cr^{6+}), mg/l, max	0.05	-	0.05	-	-
28.	Anionic Detergents (as MBAS), mg/l, max.	0.2	1	1	-	-
29.	Polynuclear Aromatic Hydrocarbons (as PAH)	0.2	-	-	-	-
30.	Mineral Oil, mg/l, max	0.01	-	0.1	0.1	-
31.	Barium (as Ba), mg/l, max	1	-	-	-	-
32.	Silver (as Ag), mg/l, max	0.05	-	-	-	-
33.	Pesticides	Absent	-	-	-	-
34.	Alpha emitters, uC/ml, max	10^{-9}	10^{-9}	10^{-9}	-	-
35.	Beta emitters, uC/ml, max	10^{-8}	10^{-8}	10^{-8}	10^{-8}	10^{-8}
36.	Free Ammonia (as N), mg/l, max	-	-	-	1.2	
37.	Electrical Conductance at 25^0C, mhos, max	-	-	-	1000 x 10^{-6}	2250 x 10^{-6}
38.	Free Carbon dioxide (as CO), mg/l, max	-	-	-	61	
39.	Sodium absorption ratio	-	-	-	-	26
40.	Boron (as B), mg/l, max	-	-	-	-	-
41.	Percent sodium, max	-	-	-	-	-

* IS: 2296

CHAPTER 5

AIR AND NOISE ENVIRONMENT

5.1 INTRODUCTION

Hydroelectric power projects are site specific in nature, whereby, the construction activity such as excavation of roads, construction of dam and powerhouse along with other appurtenant structures remain confined to a specific area. In addition to this, the construction activity also entails operation of heavy vehicles and other machines along with operation of crushing and batching plants, which emit dust and aerosols in the atmosphere causing air pollution. Operation of heavy vehicles and other plants also causes noise pollution in such an area.

5.2 AMBIENT AIR QUALITY

The earth's atmosphere contains a number of gases such as Oxygen (21%), Nitrogen (78%), Water vapor (1-3%), Carbon dioxide (0.33%), Hydrogen, Nitrogen, Ozone, etc. in a relatively fixed ratio. The balance in distribution of the above gases may change due to man induced activities and the concentration of different gases may change accordingly.

Dust and vehicular emissions may change the concentration of suspended solid particles in the air and may cause drastic changes in the levels of Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM), which is hazardous to human being and plants. Sulpher dioxide (SO2), Oxides of Nitrogen (NO_x), SPM and RSPM are the four major air pollutants, which cause concern to environment and other living beings. In order to generate, a database on the existing status of these pollutants, the study area was evaluated for setting up four locations to conduct air quality monitoring as per the details given in **Table-5.1** and **Figure-5.1**.

5.2.1 Ambient Air Quality Analysis

A well-designed monitoring programme was carried out to assess the status of ambient air quality in the project area. The parameters studied were RPM, SPM, SO2 and NO_x. Ambient air quality was monitored covering pre-monsoon (Arpil-2011), monsoon (July, 2011) and winter seasons (March, 2012) for a period of four weeks at all the four stations at each season. The 24 hrs monitoring have been carried out covering RPM, SPM, SO_2, and NO_x. The monitoring was done by using Respirable Dust Sampler. The samples were collected and analyzed as per methods specified by Bureau of Indian Standards (IS: 5182). The objective was to assess the existing level of air pollutants. 24 hourly sampling for two consecutive days was done at each station. The results are presented in **Table-5.2 to Table-5.5**.

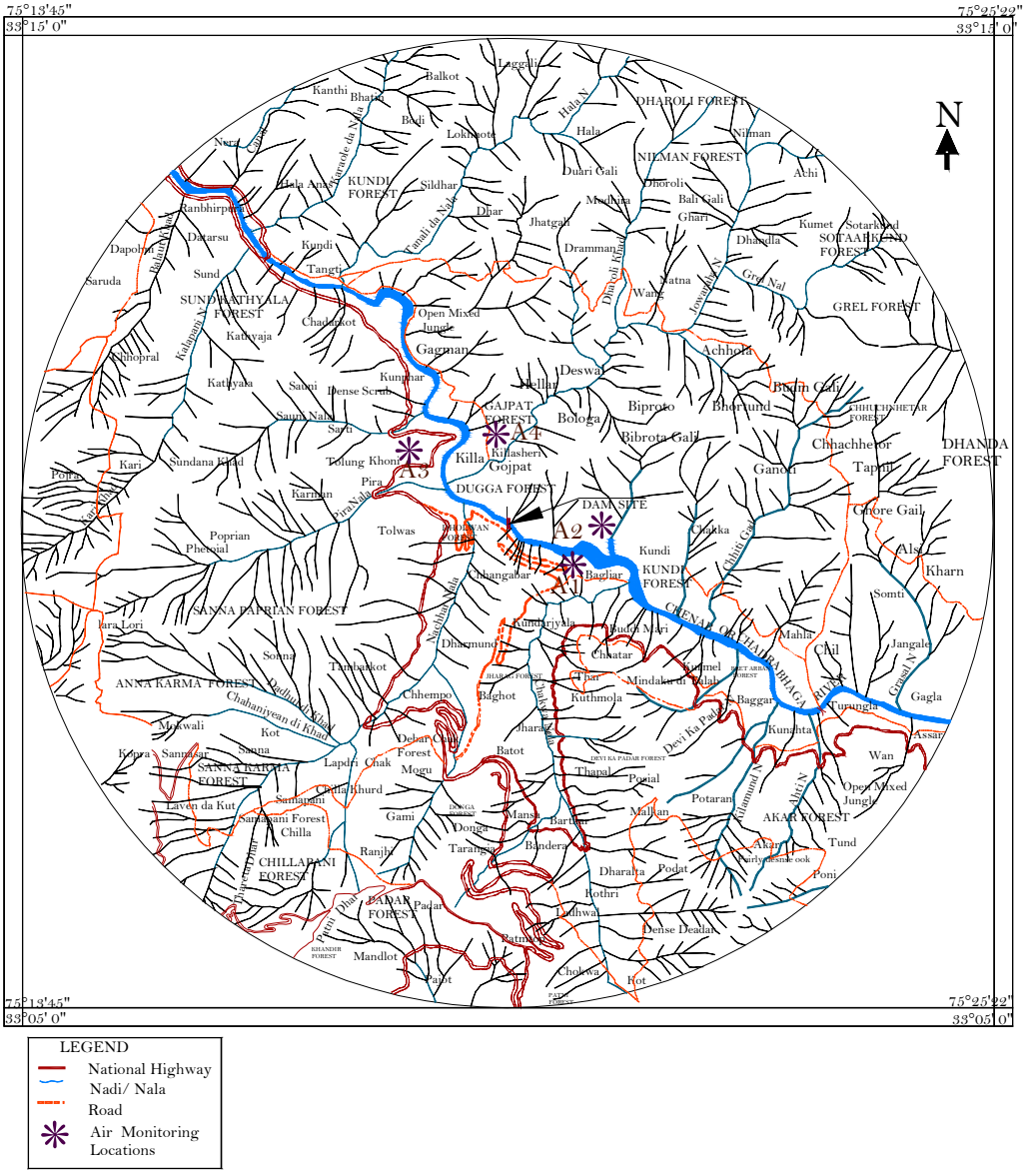


Figure-5.1: Map Showing Location of Ambient Air Quality Stations

Table 5.1: Location of Ambient Air Quality Monitoring Stations

Location Code	Station Name	Direction *	Distance, Km. u/s or d/s of Dam (Approx.)*
A1	Baglihar	E-S	1.0
A2	Chandrakot Camp	W	2.5
A3	Khani	W	3.5
A4	Killasheri	N-W	2.0

Table-5.2: Ambient Air Quality Status w.r.t. Respirable Particulate Matter

Location Code	Pre-Monsoon, 2011			Monsoon, 2011			Winter, 2012			NAAQ Standards, µg/m³ (for Industrial, Residential, Rural and Other areas) for 24 hrs
	Concentration, µg/m³									
	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	
A1	66	60	62	54	47	52	72	61	66	100
A2	71	62	69	55	50	52	74	65	70	100
A3	69	62	64	55	38	45	78	70	73	100
A4	76	65	73	65	54	60	80	73	76	100

Table-5.3: Ambient Air Quality Status w.r.t. Suspended Particulate Matter

Location Code	Pre-Monsoon, 2011			Monsoon, 2011			Winter, 2012			NAAQ Standards, µg/m³ (for Industrial, Residential, Rural and Other areas) for 24 hrs
	Concentration, µg/m³									
	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	
A1	112	96	105	90	78	82	115	104	109	200
A2	121	104	115	96	88	92	126	110	116	200
A3	126	105	112	94	81	86	132	116	122	200
A4	130	110	122	110	92	98	142	125	135	200

Table-5.4: Ambient Air Quality Status w.r.t. Sulphur Dioxide

Location Code	Pre-Monsoon, 2011			Monsoon, 2011			Winter, 2012			NAAQ Standards, µg/m³ (for Industrial, Residential, Rural and Other areas) for 24 hrs
	Concentration, µg/m³									
	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	
A1	12	7	9	10	6	8	13	10	11	80
A2	14	8	10	12	7	9	15	10	12	80
A3	12	9	10	10	7	8	14	11	12	80
A4	16	12	14	12	8	10	17	14	15	80

Table-5.5: Ambient Air Quality Status w.r.t. Nitrogen Oxide

Location Code	Pre-Monsoon, 2011			Monsoon, 2011			Winter, 2012			NAAQ Standards, µg/m³ (for Industrial, Residential, Rural and Other areas) for 24 hrs
	Concentration, µg/m³									
	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	
A1	14	9	12	10	8	9	16	12	14	80
A2	18	10	12	14	10	12	20	14	16	80
A3	17	11	13	12	8	10	19	14	17	80
A4	20	15	17	16	12	14	21	18	19	80

Result of ambient air quality shows that all the parameters are well within the National Ambient Air Quality Standards for residential, rural and other areas.

It is evident from the above Tables that the air quality in the proposed project area and its surroundings is pollution free. The pollutant concentration in the air is well below the permissible limit as there are no industries in the area and the density of vehicular traffic is not alarming. The forest cover in and around the site is quite dense and serves as a carbon sink. All the pollutant gases in the atmosphere are also within safe limits. In addition to this there are plenty of water vapours in the air, acting as dilutant and do not allow dust to scatter much. The phenomenon like smog and acid rains has never been observed in these areas and neither do such conditions are likely to occur.

However, with the construction of the dam, powerhouse, colonies and other infrastructural facilities in the area, the air quality will be affected during construction period. The movement of heavy vehicles and

operation of other construction equipments will also add to the obnoxious gases being released into the atmosphere. The concentration of these kinds of gases and dust emission, however, will be cleared on daily basis as the area is located in a valley and the gush of strong winds during morning and evening hours is a common phenomenon.

5.3 NOISE ENVIRONNENT

Noise is an important pollutant, which affects the environment and poses health and communication hazards. The intensity of noise is measured in decibel (db). The intensity of more than 65 db becomes alarming from pollution point of view. At the construction sites, the intensity of noise will usually be much higher for which safeguard measures will be adopted so that the noise pollution can be controlled.

The noise levels have been expressed as an equivalent noise level (Leq) which is the measurement duration of sound pressure level as the averaging time. It is calculated as follows:

$$Leq = 10 \text{ Log}10 \left[\sum^{n} \frac{1}{Li \quad n10^{n/10}} \right]$$

Where, Li = Instantaneous sound intensity level dB (A)

n = No. of observations

5.3.1 Reconnaissance Survey

A reconnaissance survey was done in the beginning of the study period to select the locations of noise monitoring stations. The locations have been selected covering all the categories i.e. residential, commercial and sensitive except the industrial locations, as there are no industrial activities surrounding the proposed project. Four locations were selected for the 24 hourly day and night noise monitoring are presented in **Table-5.6** and shown in **Figure 5.2**.

Table 5.6: Location of Noise Monitoring

Location Code	Station Name	Direction *	Distance, Km. u/s or d/s of Dam (Approx.)*
N1	Baglihar	E-S	1.0
N2	Chandrakot Camp	W	2.5
N3	Khani	W	3.5
N4	Killasheri	N-W	2.0

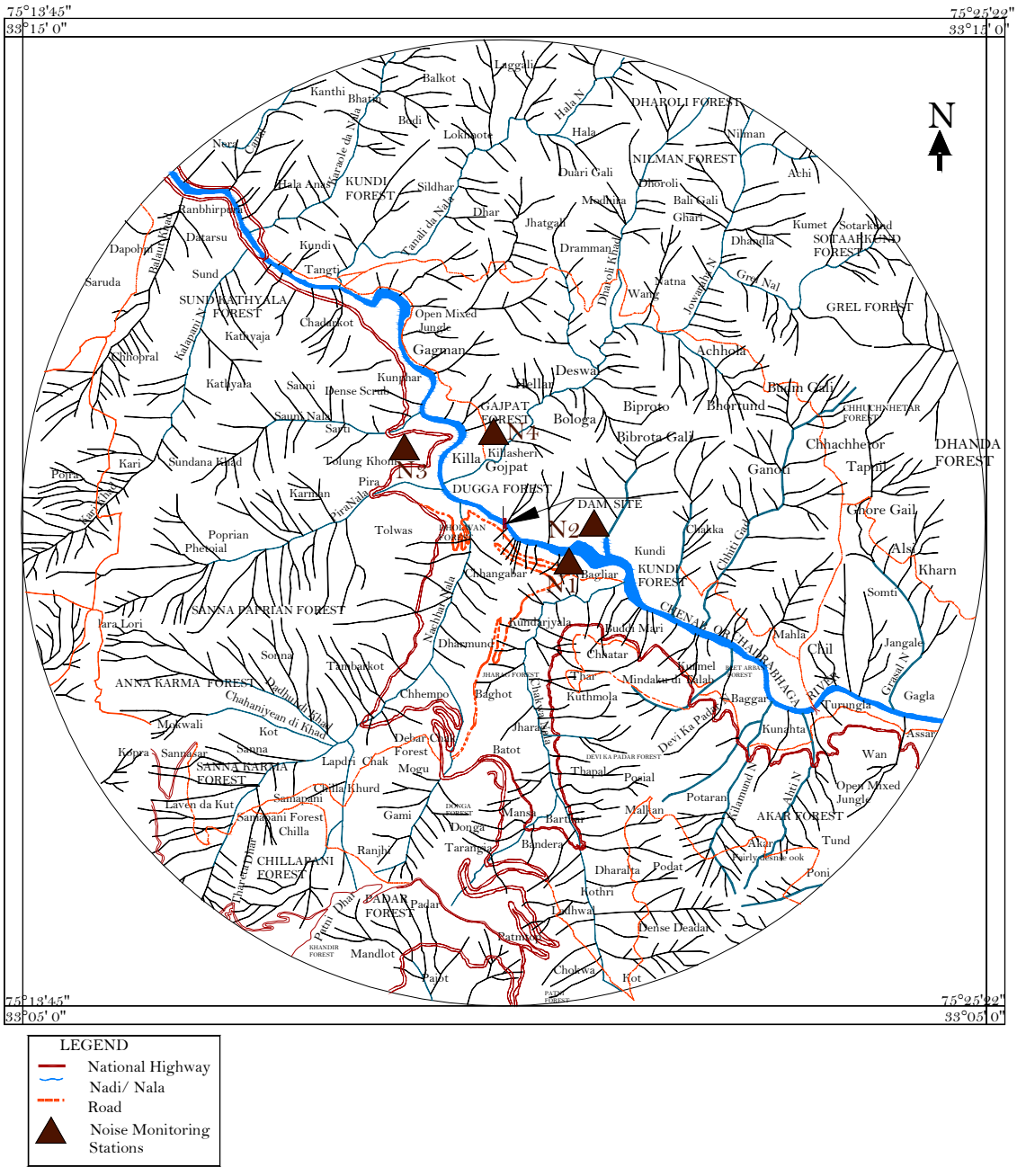


Figure-5.2: Location of Noise Monitoring Stations

5.3.2 Noise Level Status

The noise level monitored covering pre-monsoon (Arpil-2011), monsoon (July, 2011) and winter seasons (March, 2012) and result is presented in **Table-5.7**.

Table-5.7: Noise Level of the Study Area

Loca-tion Code	Pre-Monsoon, 2011			Monsoon, 2011			Winter, 2012		
	Leq (d), dB (A)	Leq (N), dB (A)	Leq, dB (A), day & night	Leq (d), dB (A)	Leq (N), dB (A)	Leq, dB (A), day & night	Leq (d), dB (A)	Leq (N), dB (A)	Leq, dB (A), day & night
N1	54	40	46	55	44	50	53	40	45
N2	56	42	48	58	47	53	54	39	46
N3	55	44	49	60	48	54	55	42	48
N4	60	48	55	62	50	56	58	44	53

The noise monitoring shows that day time noise levels are high at Killasheri as site is near power house. The major source of the noise in the study area is vehicular movement. The ambient air quality standards in respect of noise are 75, 65, 55 and 50 dB (A) Leq in day time and 70, 55, 45 and 40 dB (A) Leq during night time for industrial, commercial, residential and silence zone respectively. The daytime noise level measured during 6:00 a.m. to 10:00 p.m. and nighttime measured from 10:00 p.m. to 6:00 a.m. The noise level is within the prescribed limit in all the monitoring stations.

CHAPTER-0 6

BIOLOGICAL ENVIRONMENT

6.1 FOREST TYPES OF THE AREA

The proposed project area is situated in the lower ridges of Kashmir Himalaya. It is coming under the Ramban forest division which was earlier under Kishtwar Forest division. The forest of the area can be broadly divided based on the type of flora present in the area. The flora of the study area varies with the altitude and aspect with remarkable change in the type of vegetation from 700m a.s.l. (near dame site) to as high as 3020m a.s.l. As per the classification of the Champion & Seth, 1968 the forests of area can be broadly divided in to following four types:

1. Subtropical dry deciduous forests
2. Subtropical moist evergreen forests
3. Subtropical pine forests
4. Himalayan dry temperate forest

6.1.1 Subtropical dry deciduous vegetation

Sub tropical vegetation occurs up to approximately 1,500 m. asl. This vegetation type is present on the south facing slopes on the right bank of the Chenab River, and on few patches on the left bank and side valleys mostly along river. The overall scenario is the association of *Acacia catechu, Dalbergia sissoo, Acacia modesta* and *Bombax ceiba*. Besides common climbers *Vitis*, *Clematis* and *Deeringia* are also found. The soils are generally thin except few deep and rich patches. Some species are of practical use to the villagers, thus are valuable.

In the more disturbed state, particularly near villages *Dodonia viscosa*, *Woodfordia fruiticasa* and *Carisa spinarum* etc., dominate. *Euphorbia royleana* and other shrubs form small patches on dry and rocky sites. This type of vegetation serves as grazing area for goats and sheep, though relatively of low nutritional value. Branches of *Dodonia viscosa* serve as firewood in times of scarcity and different thorny bushes make good fences.

Around villages *Olea cuspidata* in association with Pomegranate (*Punica granatum*), *Pistacia chinensis*, *Acacia modesta*, *Dalbergia sissoo*, *Ficus palmate, Zenthxylum* spp. *Budlea* spp. and *Plectranthus regosus* predominate. *Olea cuspidata*, Pomegranate, *Accacia modesta* and the *Ficus* spp. are multi-propose trees, providing valuable fodder, fruits and fuel wood etc.

6.1.2 Subtropical moist vegetation

Some subtropical moist vegetation is also found on the extremely steep slopes in the project area which include angiosperms, ferns, mosses and sub-tropical humid species.

6.1.3 Subtropical pine forests

Sub-tropical pine forests occur generally on the north and NW facing slopes. In the project area, the pine forests are present in *Kilasheri*, *Baglihar* villages and along the Chenab at the North facing slopes right up to Assar. The dominating species is *Pinus roxburghii* (Chir Pine) with and open, light canopy.

Other species present are *Olea cuspidata, Acacia modesta, Dalbergia sissoo, Pysus pashia, Ficus roxburgii*, *Quercus incana*, *Woodfordia floribunda*, *Rubus ellipicus*, *Berberis* spp., *Myrsine* spp., *Punica granatum*, *Nerium indicum*, *Indigofera* spp., *Rumex* spp., *Plectranthus gallium*, *Desmodium* spp., *Rosa moschata*, *Clematis* sp. and *Jasminium* sp. This type of vegetation is commonly found in the project area.

6.1.4 Himalayan dry temperate forest

The higher ridges of the project area have vegetation dominated by species like the *Cedrus deodara*, *Pinus wallichiana*, *Abies pindrow*, *Picea smithiana*, *Juglans regia*, *Acer* spp., *Prunus* sp., *Aescules indica* and *Fraxinus excelsior,* etc. The conversion from sub-tropical pine forest into temperate forests is gradual.

6.2 BIOLOGICAL ENVIRONMENT

Fig.6.1: A view of Sub-tropical forest of the study

Biological environment of the area constitute all living beings of that area. In general it is representing by flora and fauna. Flora is categorized in to three groups as herbs, shrubs and trees. Fauna is divided into two groups i.e. terrestrial fauna which includes reptiles, birds and mammals whereas aquatic fauna consists of plankton, benthos and fishes. Biological environment is an integrate part of the environment. Hence, any change in the surrounding environment could cause loss of species or decrease in biodiversity of the area. Therefore, the present study is proposed to assess the impact of proposed project on biological environment. Accordingly, mitigation measures are evolved to sustain the biological diversity. Field survey was conducted for baseline study of existing ecological environment during April, 2011 to March, 2012.

6.2.1 Objectives

The biological study of the study area has been conducted in order to understand the ecological status of the existing flora and fauna to generate baseline information and evaluate the probable impacts on the biological environment.

FLORA (Vegetation)

1. To make an inventory/checklist of plants found in the study area.
2. To analyze the existing vegetation under influence zones of the project.
3. To know the density (trees/unit area) of each of the species under submergence and influence zones of the project.

FAUNA

Terrestrial Fauna

Terrestrial fauna was evaluated to gain an insight in the following respects for species of carnivore, primates, birds, reptiles and invertebrates.

1. To prepare an inventory of the terrestrial fauna present in the study area.
2. To assess present status of the terrestrial fauna present in the study area
3. To assess the impacts of the proposed dam on the terrestrial fauna.

Aquatic Fauna

1. Inventorization of different aquatic species (plankton, benthos, fishes).
2. To identify the feeding and breeding grounds of economically important fishes.
3. To assess the existing status of endangered species.

The biological study of terrestrial flora, fauna and aquatic biota has been done for different transects. However, the surveys have also been made in the entire area in the vicinity of proposed reservoir and downstream areas.

6.2.2 Methodology

6.2.2.1 Floral Study

This report on the flora of Baglihar stage-II HEP project site is based on an extensive field survey of the area. The study was conducted between April-2011 to March-2012, and the plant species were identified with the help of regional flora and the herbarium, Botanical Survey of India, Dehradun. Besides the collection of plant species, information was also collected on the vernacular names and uses of plants made by local inhabitants. Floral assessment was carried out:

1. To make the list of plants found in the study area.
2. To analyze the existing vegetation under influence zones of the project.
3. To know the density (trees/unit area) of each of the species under submergence and influence zones of the project site.

6.2.2.2 Phytosociology

A nested quadrates technique was used for sampling the vegetation. The size and number of quadrates needed were determined using species area curve (Mishra, 1968) and the runnings mean method (Kershaw, 1973). To study the phytosociological attributes quadrates of 10 m × 10 m size for trees, 5 m x 5 m. size for shrubs and 1m x 1m size for herbs, grasses and seedlings of tree species less than 1.3 cm dbh (diameter at breast height) were randomly laid out at each site at different elevations. The observations on the following parameters were recorded:

1. Name of the species.
2. Diameter of the species.
3. Number of the occurrence of each species in each quadrate.

The enumeration of vegetation in each of the quadrate was done by measuring dbh individually in case of woody vegetation and collar diameter in case of herbs and grasses, with Verniers digital caliper.

The vegetation data collected for phyto-sociological information was quantitatively analyzed for density, frequency and abundance of each species according to the method developed by Curtis and McIntosh (1950). The relative values of frequency, density, and dominance of all the species were summed up to represent Importance Value Index (IVI). The following are the formulae to derive frequency, density, dominance and IVI etc:-

$$\text{Density} = \frac{\text{Total number of individuals of a species in all the quadrates}}{\text{Total number of quadrates studied}}$$

$$\text{Frequency (\%)} = \frac{\text{Total number of quadrates in which species occurred}}{\text{Total number of quadrates studied}} \times 100$$

$$\text{Abundance} = \frac{\text{Total number of individuals of a species in all quadrates}}{\text{Total number of quadrates in which species occurred}}$$

$$\text{Mean basal area} = \frac{C^2}{4\pi}$$ (C= Mean of the circumference)

Total basal area = Mean basal area × Density

$$\text{Mean of the circumference (C)} = \frac{\text{Sum of all dbh of a species}}{\text{Total number of individuals of a species}}$$

$$\text{Relative Density} = \frac{\text{The density of a species}}{\text{Total density of all species}} \times 100$$

$$\text{Relative Frequency} = \frac{\text{The frequency of a species}}{\text{Total frequency of all species}} \times 100$$

$$\text{Relative Dominance} = \frac{\text{Total basal cover of a species}}{\text{Total basal cover of all species}} \times 100$$

Importance Value Index (IVI) = Relative Density + Relative Frequency + Relative Dominance

6.2.2.3 Diversity of the Forest Vegetation

The tree species diversity for each stand in different forest types was determined using Shannon Wiener information function (Shannon and Wiener, 1963), which is:

$$H = -\sum_{i=1}^{s} (Ni/N) \ln (Ni/N)$$

Where, Ni is the total number of individuals of species i and N is the total number of all species in a stand.

6.2.2.4 Concentration of Dominance

Concentration of dominance (Cd) was measured by Simpson Index (Simpson, 1949):

$$C = \sum_{i=1}^{S} (Ni/N)^2$$

Where, Ni and N were the same as for Shannon Wiener information function. This index ranges from one, if all the individuals belong to one species, to (1/s) if they are equally divided among species (S).

6.2.2.5 Faunal Study

6.2.2.5.1 Terrestrial Fauna

Ground surveys were carried out by trekking the impact zone for identification of important animal groups such as birds, mammals and

reptiles inhabiting the area along the riverbanks, adjoining forest on the slopes, nallahs, hill top and agricultural fields.

- For sampling birds 'point sampling' along the fixed transects (foot trails) was carried out to record all the species of birds observed with the help of binoculars; field guides and photography for 1 hour on each transect (n=4).
- For sampling mammals, 'direct count on open width (20 m) transect' was used on the same transects (n=4) for 1 hour in each transect. Besides, information on recent sightings / records of mammals by the villagers and locals was also collected form these areas.
- 'Reptiles' mainly lizards were sampled by 'direct count on open width transects' (n = 4) for 1 hour in each transect.

Survey was conducted during all the three seasons therefore; listing of terrestrial fauna was done to assess the species richness/diversity of different groups of animals.

6.2.2.5.2 Aquatic Fauna

Evaluation of Phytobenthos and Plankton

Samples of periphyton were obtained by scraping of 3 cm^2 area of the boulders and preserved in 1 ml of Lugol's solution. Plankton samples were collected using a tericot ring net. The samples were preserved in lugol's solution and carried to the laboratory for their study. Sedgewick-Rafter cell counts (APHA 1992, 1998) were made and density was recorded as cell mm^2. Zooplanktons were also counted and the density was recorded as cell per litre volume of water. The total area sampled up to 100m thawleg distance of stream at each sampling site. For identification of genera, the keys of Trivedy and Goel (1984) and Ward and Whipple (1959) have been used.

Evaluation of Benthic Macro-Invertebrates

Benthic macro-invertebrates were collected from the designated sampling sites adopting random sampling device (Welch, 1948). The samples were collected from the pebbles, cobbles and gravels surface up to 15 cm sediment depth at different elevations. All collected specimens were preserved in 8% formalin solution or 70 % alcohol and identified up to the generic level with the aid of keys given by Usinger (1950), Pennak (1953), Ward and Whipple (1959), Edmondson (1959), Needham and Needham (1962), Macan (1979), Tonapi (1980) and Edington and Hildrew (1995).

Evaluation of Fish Fauna

To assess the fish diversity different fishing gears like cast net, scoop net, hand net, hook and line method and pot method were used. They were also visually observed in different habitats. The fishes were caught on spot, counted and immediately released back into the water. The cast net was thrown in different habitats in a stretch of about 500 m of the river reach

length at all study sites. Collected samples are preserved in 10% formalin solution and brought to the laboratory for their identification. Fishes were identified up to the species level with the help of keys given in Day-Fauna, Jayaram (1981), Menon (1987) and Talwar and Jhingran (1997). The information were also sought from primary sources as well as secondary sources**.** IUCN red data list (2008) was used for identification of threatened, endangered and vulnerable species in the Chenab river, which are based on the fish occurrence in the given area.

6.3 FLORA (VEGETATION)

The entire tract is extremely mountainous bearing very steep slopes pierced by deep valleys. The area is devoid of any flat ground, small river terraces are scattered along the sides of main valleys which have been brought under cultivation. Suitable hill sides are cultivated after having been terraced in to fields. The project area does not have good vegetation cover due to the rocky tract and hill slopes. The vegetation/tree cover in the area is very sparse or patchy type.
The detailed survey was conducted in the project area to collect the baseline information on floral diversity, to generate baseline information and to predict the probable impacts due to the proposed project on the floral diversity of the area.

6.3.1 Flora of the project Area

The vegetation of study area of the Baglihar HEP project-II was surveyed according to above given methodology. The observations made in the flora of the study area reveal that the diversity and affinities of the flora of the region has approximately 117 taxa of flowering plants. It is evident from the study that, the study area is showing mixed vegetation. According to the growth habit these species are distributed as: 30 tree species (26%), 28 shrub species (24%), 56 herb species (48%), and 03 climber species (2%) **Table-6.1**. The commonly occurring species are *Acacia catechu Acacia modesta, Carisa spinarum*, *Dalbergia sissoo, Dodonia viscosa*, *Pistacia chinensis*, *Bombax ceiba*, *Woodfordia fruiticasa*, etc. **Table 6.2** represents the list of flora recorded from the study area.

Table 6.1: Analysis of the flora of the study area

S.No.	Habitat	No. of Species	Family	%
1.	Trees	30	18	26
2.	Shrubs	28	18	24
3.	Herbs	56	23	48
4	Climbers	03	03	02
Total		117	-	100

Table 6.2: Flora recorded from the study area

Sl. No	Scientific Name	Family	Habit
1.	*Abies pindrow*	Pinaceae	Tree
2.	*Acacia catechu*	Mimosaceae	Tree
3.	*Acacia modesta*	Mimosaceae	Tree
4.	*Aesculus indica*	Sapindaceae	Tree
5.	*Alnus nitida*	Betulaceae	Tree
6.	*Amaranthus hybridus*	Amaranthaceae	Herb
7.	*Anagallis arvensis*	Primulaceae	Herb
8.	*Andropogon guyanensis*	Poaceae	Herb
9.	*Arisaema jacqemontii*	Araceae	Herb
10.	*Artemisia maritima*	Asteraceae	Herb
11.	*Berberis lycium*	Berberidaceae	Shrub
12.	*Bistorta amplexicaule*	Polygonaceae	Herb
13.	*Bombax ceiba*	Malvaceae	Tree
14.	*Brachypodium sylvaticum*	Poaceae	Herb
15.	*Buddleja asiatica*	Buddlejaceae	Shrub
16.	*Buddleja sp.*	Buddlejiaceae	Shrub
17.	*Cannabis sativa*	Cannabaceae	Herb
18.	*Capparis sepiaria*	Capparaceae	Shrub
19.	*Carduus nutans*	Asteraceae	Herb
20.	*Carduus onopordioides*	Asteraceae	Herb
21.	*Carisa spinarum*	Apocynaceae	Shrub
22.	*Cedrus deodara*	Pinaceae	Tree
23.	*Celtis autralis*	Ulmaceae	Tree
24.	*Chenopodium album*	Chenopodiaceae	Herb
25.	*Cirsium arvense*	Asteraceae	Herb
26.	*Clematis sp.*	Ranunculaceae	Herb
27.	*Colocasia esculenta*	Araceae	Herb
28.	*Commelina paludosa*	Commelinaceae	Herb
29.	*Cousinia thomsonii*	Asteraceae	Herb
30.	*Cynodon dactylon*	Poaceae	Herb
31.	*Cyperus rotundus*	Cyperaceae	Herb
32.	*Dactylis glomerata*	Poaceae	Herb
33.	*Dalbergia sissoo*	Fabaceae	Tree
34.	*Daphne oleioides*	Thymelaeaceae	Shrub
35.	*Datura stramomium*	Solanaceae	Herb
36.	*Deeringia sp.*	Amaranthaceae	Herb
37.	*Desmodium elegans*	Fabaceae	Shrub
38.	*Desmodium triflorum*	Fabaceae	Shrub
39.	*Dioscorea bulbifera*	Dioscoreaceae	Climber
40.	*Dodonaea viscosa*	Sapindaceae	Shrub
41.	*Echinops cornigerus*	Asteraceae	Herb
42.	*Euphorbia hirta*	Euphorbiaceae	Herb
43.	*Euphorbia royleana*	Euphorbiaceae	Shrub
44.	*Ficus palmata*	Moraceae	Tree
45.	*Ficus roxburgii*	Moraceae	Tree
46.	*Fragaria nubicola*	Rosaceae	Herb
47.	*Fraxinus cornuta*	Oleaceae	Tree
48.	*Fraxinus excelsior*	Oleaceae	Tree
49.	*Geranium wallichianum*	Geraniaceae	Herb

Sl. No	Scientific Name	Family	Habit
50.	*Hyoscyamus niger*	Solanaceae	Herb
51.	*Impatiens glandulifera*	Balsaminaceae	Herb
52.	*Indigofera heterantha*	Fabaceae	Shrub
53.	*Inula royleana*	Asteraceae	Herb
54.	*Ipomoea pupurea*	Solanaceae	Climber
55.	*Jasminium sp.*	Oleaceae	Shrub
56.	*Juglans regia*	Juglandaceae	Tree
57.	*Justicia adhatoda*	Acanthaceae	Shrub
58.	*Lantana camara*	Verbenaceae	Shrub
59.	*Leonurus cardiaca*	Lamiaceae	Herb
60.	*Lespedeza cuneata*	Fabaceae	Herb
61.	*Melia azedarach*	Meliaceae	Tree
62.	*Mentha arvensis*	Lamiaceae	Herb
63.	*Micromeria biflora*	Lamiaceae	Herb
64.	*Myrsine sp.*	Myrsinaceae	Shrub
65.	*Nerium indicum*	Apocynaceae	Shrub
66.	*Olea cuspidata*	Oleaceae	Tree
67.	*Oplismenus unioloides*	Poaceae	Herb
68.	*Oxalis corniculata*	Oxalidaceae	Herb
69.	*Picea smithiana*	Pinaceae	Tree
70.	*Pinus roxburghii*	Pinaceae	Tree
71.	*Pinus wallichiana*	Pinaceae	Tree
72.	*Pistacia chinensis*	Anacardiaceae	Tree
73.	*Plantago lanceolata*	Plantaginaceae	Herb
74.	*Plantago sp.*	Plantaginaceae	Herb
75.	*Platanus orientalis*	Platanaceae	Tree
76.	*Plectranthus gallium*	Lamiaceae	Shrub
77.	*Plectranthus regosus*	Lamiaceae	Herb
78.	*Poa annua*	Poaceae	Herb
79.	*Poa pratensis*	Poaceae	Herb
80.	*Pogostemon benghalensis*	Lamiaceae	Herb
81.	*Polygonum nepalensis*	Polygonaceae	Herb
82.	*Polypogon monspeliensis*	Poaceae	Herb
83.	*Populus ciliata*	Salicaceae	Tree
84.	*Prunus cerasoides*	Rosaceae	Tree
85.	*Punica granatum*	Punicaceae	Tree
86.	*Pysus pashia*	Rosaceae	Tree
87.	*Quercus baloot*	Fagaceae	Tree
88.	*Quercus incana*	Fagaceae	Tree
89.	*Randia tetrasperma*	Rubiaceae	Shrub
90.	*Ranunculus arvensis*	Ranunculaceae	Herb
91.	*Ranunculus munroanus*	Ranunculaceae	Herb
92.	*Rhabdosia rugosa*	Lamiaceae	Shrub
93.	*Ricinus communis*	Euphorbiaceae	Shrub
94.	*Robinia pseudo acacia*	Fabaceae	Tree
95.	*Rosa macrophylla*	Rosaceae	Shrub
96.	*Rosa moschata*	Rosaceae	Shrub
97.	*Rubus ellipicus*	Rosaceae	Shrub
98.	*Rumex hastatus*	Polygonaceae	Herb
99.	*Salix lindleyana*	Salicaceae	Shrub
100.	*Sarcococca saligna*	Buxaceae	Shrub

Sl. No	Scientific Name	Family	Habit
101.	*Silene edgeworthii*	Caryophyllaceae	Herb
102.	*Solanum nigrum*	Solanaceae	Herb
103.	*Solanum surratense*	Solanaceae	Herb
104.	*Solanum xanthocarpum*	Solanaceae	Herb
105.	*Sonchus arvensis*	Asteraceae	Herb
106.	*Sorbaria tomentosa*	Rosaceae	Shrub
107.	*Stipa capillata*	Poaceae	Herb
108.	*Tagetes minuta*	Asteraceae	Herb
109.	*Trifolium repens*	Fabaceae	Herb
110.	*Urtica ardens*	Urticaceae	Herb
111.	*Urtica dioica*	Urticaceae	Herb
112.	*Valeriana hardwickii*	Valerianaceae	Herb
113.	*Viburnum grandiflora*	Caprifoliaceae	Shrub
114.	*Viburnum nervosum*	Caprifoliaceae	Shrub
115.	*Vitis sp.*	Vitaceae	Climber
116.	*Woodfordia floribunda*	Lytharaceae	Tree
117.	*Woodfordia fruiticasa*	Lythraceae	Tree

6.4 FAUNA

The Faunal study for the proposed Baglihar Hydro-electric project stage II was carried out in upstream and downstream of the proposed site in 10km radius**.** The climate of the region is subtropical deciduous & evergreen type as per Champion & Seth (1968).

6.4.1 Terrestrial fauna

The information of important terrestrial animal groups such as birds, reptiles and mammals were collected by trekking inhabiting area, along the river banks, adjoining forest on the slopes, nallahs, hill top and agricultural fields present in the impact zone. The species lists of animals recorded during this study are given below along with their conservation priority globally and nationally.

6.4.2 Mammals

Twenty five species of mammals from 13 families were recorded in the study area **(Table 6.3)**. Through direct sighting 7 species were recorded, 18 species were recorded as per indirect evidence and through secondary sources from Forest and Wildlife Department and local villagers. Three species namely Himalayan Tahr, Asiatic Black Bear and Himalayan Brown Bear come under the vulnerable category. All the species of mammals have been listed in various schedules of the Indian Wildlife (Protection) Act 1972 but 'commonly' occur in the region.

Table 6.3: Mammals in the study area of Baglihar HEPP-Stage II

Sl No	Family/ Common Name	Species	Report	Remarks
A	**Mustelidae**			
1	Himalayan Yellow-throated Marten	*Martes flavigula*	Indirect evidence	Reported from interviewing locals and the secondary data of forest department Ramban district.
2	Himalayan Weasel	*Mustela sibirica*	Indirect evidence	Reported from interviewing locals and the secondary data of forest department Ramban district.
B	**Viverridae**			
3	Himalayan Palm Civet	*Paguma larvata*	Direct sightings	Reported from interviewing locals and the secondary data of forest department Ramban district.
C	**Hystricidae**			
4	Indian Porcupine	*Hystrix indica*	Indirect evidence	Reported from interviewing locals and the secondary data of forest department Ramban district.
D	**Canidae**			
5	Jackal	*Canis aureus*	Direct sightings	Reported from interviewing locals and the secondary data of forest department Ramban district.
6	Red Fox	*Vulpes vulpes*	Direct sightings	Reported from interviewing locals and the secondary data of forest department Ramban district.
E	**Cercopithecidae**			
7	Hanuman Langur	*Semnopithecus entellus*	Direct sightings	Reported from interviewing locals and the secondary data of forest department Ramban district.
8	Monkeys red & white mouth	*Macaca mulatta*	Direct sightings	Reported from interviewing locals and the secondary data of forest department Ramban district.
F	**Sciuridae**			
9	Kashmir Flying Squirrel	*Eoglaucomys fimbriatus*	Indirect evidence	Reported from interviewing locals and the secondary data of forest department Ramban district.
G	**Bovidae**			

10	Himalayan Tahr	*Hemitragus jemlachicus*	Direct sightings	Herds dozens of individuals reported by villagers and forest staff during winter on east facing slopes of Chenab river along the village. Vulnerable (IUCN 2008)
11	Ghoral	*Naemorhedus goral*	Direct sightings	Few individuals reported regularly by villagers and forest staff on east facing slopes of Chenab river along the Haryatham-Lai villages.
12	Deer Red & Hangul	*Cervus elaphus hangula*	Indirect evidence	Reported from the forest department Ramban district.
H	**Felidae**			
13	Common Leopard	*Panthera pardus*	Indirect evidence	Reported from intervewing locals and the secondary data of forest department Ramban district.
14	Leopard cat	*Felis bengalensis*	Indirect evidence	Reported from intervewing locals and the secondary data of forest department Ramban district.
15	Cat jungle-	*Felis chaus*	Indirect evidence	Reported from intervewing locals and the secondary data of forest department Ramban district.
I	**Ursidae**			
16	Asiatic Black Bear	*Ursus thibetanus*	Indirect evidence	Reported from interviewing locals and the secondary data of forest department Ramban district. Vulnerable (IUCN 2008)
17	Himalayan black bear	*Salenarctos thibetanous*	Indirect evidence	Reported from intervewing locals and the secondary data of forest department Ramban district.
18	Brown Bear	*Ursus arctos*	Indirect evidence	Reported from higher reaches adjacent to the impact area by the villagers during summer and agricultural fields during winter. Vulnerable (IUCN 2008)
J	**Pteropodidae**			
19	Fruit Bat	Rousettus leschenaulli	Indirect evidence	Reported from interviewing locals and the secondary data of forest department Ramban district.
20	Short nosed fruit Bat	*Cynopterus sphinx*	Indirect evidence	Reported from interviewing locals and the secondary data of forest department Ramban district.
K	**Leporidae**			

21	Cape Hare	*Lepus capensis*	Indirect evidence	Reported from interviewing locals and the secondary data of forest department Ramban district.
22	Hare himalayon mouse-	*Ochotona roylei*	Indirect evidence	Reported from intervewing locals and the secondary data of forest department Ramban district.
L	**Herpestidae**			
23	Indian gray Mongoose	*Herpestes edwarsi*	Indirect evidence	Reported from interviewing locals and the secondary data of forest department Ramban district.
M	**Muridae**			
24	Bandicoot Rat	*Bandicota indica*	Indirect evidence	Reported from intervewing locals and the secondary data of forest department Ramban district.
25	Common rat	*Rattus rattus*	Indirect evidence	Reported from interviewing locals and the secondary data of forest department Ramban district.

6.4.3 Birds

As many as 54 bird species belonging to 18 families were observed in the study area **(Table 6.4).** Most of the species of birds are protected as their respective families have been listed under Schedule IV of Indian Wildlife (Protection) Act 1972. On the basis of their sighting the species are divided into common, fairly common, uncommon/rare and categories occasional.

Table 6.4: Aves fauna of the study area of Baglihar HEPP Stage -II

S.No.	Family / common name	Scientific Name	Abundance
A	**Pycnonotidae**		
1	Himalayan Bulbul	*Pycnonotus leucogenys*	Common
2	Black Bulbul	*Hypsipetes leucocephalus*	Common
B	**Passeridae**		
3	Russet Sparrow	*Passer rutilans*	Common
C	**Fringillidae**		
4	Rock Bunting	*Emberiza cia*	common
5	White-capped Bunting	*Emberiza stewarti*	Common
6	Pink-browed Rosefinch	*Carpodacus rodochrous*	Uncommon
7	Common Rosefinch	*Carpodacus erythrinus*	Uncommon
8	European Goldfinch	*Carduelis spinoides*	common
9	Alpine Accentor	*Prunella collaris*	Uncommon
D	**Upupidae**		
10	Hoopoe	*Upupa epops*	Occasional
E	**Paridae**		
11	Black-throated Tit	*Aegithalos concinnus*	Fairly Common

S.No.	Family / common name	Scientific Name	Abundance
12	Green-backed Tit	*Parus monticolus*	Common
F	**Dicrurinae**		
13	Ashy Drongo	*Dicrurus leucophaeus*	Common
G	**Sylviidae**		
14	Hume's Warbler	*Phylloscopus humei*	Common
15	Crowned Leaf Warbler	*Phylloscopus occipitalis*	Common
H	**Muscicapidae**		
16	Dark-sided Flycatcher	*Muscicapa sibirica*	Fairly Common
17	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	Common
18	Verditer Flycatcher	*Eumyias thalassina*	Fairly Common
19	Asian Paradise Flycatcher	*Terpsiphone parasisi*	Uncommon
20	*Chat Pied Bush*	*Saxicola caprata*	Common
21	Indian Blue Robin	*Luscinia brunnea*	Fairly Common
22	Blue-fronted Robin	*Cinclidium frontale*	
23	Indian Robin	*Saxicoloides fulicata*	
24	Plumbeous Water Redstart	*Rhyacornis fuliginosus*	Common
25	Common Redstart	*Phoenicurus phoenicurus*	
26	White-capped Water Redstart	*Chaimarrornis leucocephalus*	Common
27	Little Forktail	*Enicurus scouleri*	common
28	Brown Dipper	*Cinclus pallasi*	Fairly Common
29	White throat dipper	*Cinclus cinclus*	
30	Blue Whistling Thrush	*Garrulax sp*	Common
31	Streaked Laughing Thrush	*Garrulax lineatus*	Common
32	Variegated Laughing Thrush	*Garrulax variegatus*	Common
I	**Psittacidae**		
33	Slaty-headed Parakeet	*Psittacula himalayana*	Common
J	**Megalaimidae**		
34	Great Barbet	*Megalaima virens*	Uncommon
K	**Picidae**		
35	Himalayan Woodpecker	*Dendrocopos himalayensis*	Common
36	Brown-fronted Woodpecker	*Dendrocops auriceps*	Uncommon
L	**Columbidae**		
37	Oriental Turtle Dove	*Streptopelia orientalis*	Common
38	Blue Rock Pigeon	*Columba livia*	common
39	Hill pigeon	*Columba rupestris*	common
40	Snow Pigeon	*Columba leuconota*	common
M	**Corvidae**		
41	Yellow- billed Blue Magpie	*Urocissa flavirostris*	Common
42	Large-billed / Jungle crow	*Corvus macrorhynchos*	Common
N	**Accipitridae**		
43	Himalayan Griffon	*Gyps himalayensis*	Common
44	Sparrow hawk	*Accipiter nisus*	Common
O	**Phasianidae**		
45	Chukar	*Alectoris chukar*	Fairly Common
46	Kalij Pheasant	*Lophura leucomelanos*	Uncommon
47	Koklass Pheasant	*Pucrasia macrolopha*	Rare
48	Himalayan Monal	*Lophophorus impejanus*	Higher reaches

S.No.	Family / common name	Scientific Name	Abundance
P	**Phasianidae**		
49	Snow Partridge	*Lerwa lerwa*	Common
50	Tibetan Partridge	*Perdix hodgsoniae*	Fairly Common
Q	**Sturnidae**		
51	Myna common	*Acridotheres tristis*	Common
52	Jungle Myna	*Acridotheres fuscus*	Common
R	**Strigidae**		
53	Owl	*Bubo bubo hemachalana*	Un common
54	Jungle Owlet	*Glaucidium radiatum*	Common

6.4.4 Molluscs, Amphibian and Reptiles:

Some common mollusks species which are distributed in Kashmir Himalayas are reported from the literature (Rajagopal & Subba Rao, 1968, 1972; Dhar et al. 1985; Engblom& Lingdell 1999). These are represented by land (terrestrial), aquatic and amphibious types which belong to gastropods and bivalves groups. Similarly, the information was collected from secondary source to find out occurrence of amphibian & reptiles of Kashmir Himalayas from the locals & from the literature (Biodiversity of the Kashmir Himalayas by GH. Dar et al. 2002). The occurrence of common species of molluscs, amphibian and reptiles are enlisted in **Table 6.5**.

Table 6.5: Common Species of Molluscs, Amphibian and Reptiles

Sl.No	SCIENTIFIC NAME
MOLLUSCS : Terrestrial	
1	*Ena spp.*
2	*Khasiella spp.*
3	*Syama spp.*
4	*Vellonia spp.*
MOLLUSCS :Aquatic Gastropods (snails)	
5	*Gyraulus spp.*
6	*Lymnaea spp.*
7	*Bithynia spp*
8	*Indoplanorbis spp.*
9	*Radix spp.*
10	*Stagnicola spp.*
11	*Acroloxus spp.*
MOLLUSCS : Bivalves	
12	*Corbicula spp.*
13	*Pisidium spp.*

AMPHIBIANS : Frogs & Toads		
Sl. No	**Common Name**	**Scientific Name**
1.	Himalayan Frog	*Staurois himalayanum*
2.	Himalayan Toad	*Bufo viridis*
REPTILES : Lizards & Snakes		
Lizards		
1	Common Garden Lizard	*Calotes versicolor*
2	Kashmir Rock Agamid	*Laudakia tuberculata*
3	Skinks	*Lygosoma himalayana*
Snakes		
1	Himalayan pit viper	*Agkistrodon himalayanus*
2.	Mountain keel back	*Amphiesoma platycips*
3.	Himalayan trinket snake	*Elaphe hodgsoni*
4.	Rat snake	*Ptyes mucosus*

6.4.5 Domestic Animals:

The domestic animals are mainly mammals. The domestic animals found in the study area are listed in the **Table 6.6.**

Table 6.6: List of Domestic Fauna in the Study Area

S. No.	Common Name	Zoological Name
1.	Yak (Female-for milk rearing and Male-ploughing fields)	*Bos grunniens*
2.	Cow	*Bos indicus*
3.	Dog	*Cains familieris*
4.	Goat	*Capra hircus*
5.	Horse	*Equus cabilus*
6.	Ass	*Equus hermionus*
7.	Cat	*Felis domesticus*
8.	Sheep	*Ovius polic*

6.4.6 RET Species Flora/ Fauna (IUCN/ Indian Wildlife Act, 1972)

Flora under RET

The project influenced area consists of sparse and patchy vegetation which is general in occurrence. No herb, shrub and tree species is falling in the list of Rare/threatened/endangered of Red Data Book of Indian Plants and IUCN.

Fauna under RET

No rare or threatened species are falling in the project influenced area. However, at higher elevation and hills with snow covered peaks with dense forests including pasture land are having some wildlife. The list of threatened species is given in **Table 6.7**.

Three species namely Himalayan Tahr, Asiatic Black Bear and Himalayan Brown Bear come under the vulnerable category. All the species of mammals have been listed in various schedules of the Indian Wildlife (Protection) Act 1972 but 'commonly' occur in the region.

Table 6.7: List of RET Fauna

Sl No.	Common name/ Scientific name	Red Data List IUCN*	RET under Indian Wild Life Act 1972*
1.	Himalayan Tahr, *Hemitragus jemlachicus*	Vulnerable	Schedule I (Part 1)
2.	Asiatic Black Bear, *Ursus thibetanus*	Vulnerable	Schedule II (Part 1)
3.	Himalayan Brown Bear, *Ursus arctos*	Vulnerable	Schedule I (Part 1)

* All these species occurs at higher elevation especially towards hill tops where dense forest is present as per the Working Plan of Forest Department however none of the species is present in the project influenced area

6.5 SPECIES OF CONSERVATION PRIORITY

6.5.1 Reservoir Area

Amongst the fauna surveyed in the reservoir area none of the species of bird and mammal falls under threatened list as per IUCN Red List 2008. Most of the bird species to be affected in this zone prefer aquatic fresh water habitat, but these are of common occurrence and distributed all over the Chenab River *e.g.* White-capped Red start, Plumbeous Water Redstart, Brown Dipper, Little Forktail, Grey and White Wagtail. Amongst the species of mammals none of the species is totally dependant or restricted to this area.

6.5.2 Project Influenced Area

The mammals reported from the area are important from the conservation point of view of these species are listed in **Table 6.8.**

Table 6.8: Important Species for Conservation

S. No	Species	IUCN 2008 status	Area Utilized
1	Himalayan Tahr *Hemitragus jemlachicus*	Vulnerable	Higher slopes on the right bank of Chenab above the reservoir
2	Asiatic Black Bear *Ursus thibetanus*	Vulnerable	Forested slopes on the left bank of Chenab
3	Himalayan Brown Bear *Ursus arctos*	Vulnerable	Higher reaches on the ridge on the right bank of Chenab. Forested slopes on the left bank of Chenab

6.6 AQUATIC ECOLOGY

Aquatic ecosystem harbors a variety of plants and animals varies from primary producers to large consumers forming different trophic levels. These animals and plant communities are considered as the best indicators of the environment which responds not only to one environmental factor but also to an interacting group of factors. Any change with respect to environmental factors could results threats to the existing the aquatic biological diversity. Therefore to assess the possible impact of such high dam (3x150 MW HE Project) of on the aquatic environment, the study was conducted in the influence zone and to evolve appropriate mitigation measures. Baseline data was generated for aquatic fauna, habitat structure and river morphology. The total area has been sub-divided into the following areas;

- Pressent Dam site (Reservoir site)
- Upstream of the dam
- Downstream of dam/power house site

6.6.1 Objective

The aquatic environment studies of the area were made to understand the ecological status, and to predict the probable impacts due to the proposed project. Therefore, survey was carried out on existing aquatic environmental conditions of Chenab river basin for following objectives:

- Inventorization of different aquatic species of invertebrates and vertebrates (benthos, fishes);
- Inventorization of plankton, phyto-benthos and zoo-benthos;

Fig.6.2: CHENAB RIVER AT PROJECT SITE

- To identify the feeding and breeding grounds of economically important fishes;

The Chenab river basin in India is spread over two states viz., upper part in Himachal Pradesh and lower part in Jammu & Kashmir in India. The river is mainly snow fed. The main drainage channel of the basin is Chenab river, which is named after the confluence of two streams namely Chandra and Bhaga river near Tandi (2,573 meters) in the districts of Lahaul & Spiti (H.P.). Chandra River rises in the snows lying at the base of the main Himalayan range in the Lahaul and Spiti district. The picturesque lake of Chandra Tal forms at this rivers source site. This river originates from the southeast slope of the Baralacha La and turns abruptly west after traveling 48-km to flow another 64-km to meet with the Bhaga River at Tandi. The Bhaga River rises in a small tarn called Suraj Tal. The river pursues a southwesterly course for about 64-km and joins Chandra at Tandi. After sweeping the Lahul and Spiti valley in Himachal Pradesh it enters the Kishatwar and Ramban districts in Jammu & Kashmir.

At project site, the river flows here through deep gorges cutting through the stable and rocky hills of high mountains in the project site. Thus flows through narrow valley.

6.6.2 Methodology

Assessment of Aquatic Fauna

Samples for planktons, benthos and other aquatic fauna were made by using standard methods. Water sample were also collected from surface of the stream with minimum disturbances. The collected samples were assessed for plankton, periphytons, phyto- and zoo benthos samples using standard methods (APHA 1992, 1998).

Plankton samples were collected using a tericot ring net and the periphyton were obtained by scraping of 3 cm^2 area of the boulders and preserved in 1 ml of Lugol's solution. **Benthic macro-invertebrates** were collected from the pebbles, cobbles and gravels form the surface collected up to 15 cm sediment depth at different elevations. All collected specimens were preserved in 8% formalin solution or 70 % alcohol and were identified up to generic level by using Pennak (1953), Ward and Whipple (1959), Needham and Needham (1962), Trivedy and Goel (1984), Edington and Holdren (1995) and APHA (1992, 1998).

Fishes occurrence were determined by visual method and collecting samples using different fishing gears like cast net, scoop net, hand net, hook-line, pot and open local devices methods. Fishes were identified up to the species level with the help of keys of Jayaram (1981), Menon (1987) and Talwar and Jhingran (1997). IUCN red data list (2008) was compared to assess threatened, endangered and vulnerable species in the study area.

6.6.3 River Morphology & Habitat Structure

The river /stream morphology contributes to the biological integrity of the aquatic ecosystem, which has been assessed based on the criteria described by Rosgen (1996). River Chenab traverses through the deep gorges in the influence area of proposed Baglihar Hydroelectric project-II. The peaks of surrounding hills are found snow clad in winter season. The side slope of the hills in the area >60^{o}. The vegetation is sparse and river bank is devoid of riparian cover. The diversity in aquatic environment as well as on surface was found low. River flows through a stable and confined valley. The substratum is rocky which constitute large rocks, boulders with lesser amount of cobbles, pebbles and sand at banks. The geomorphology of the river and streams in the project area are predicted in the photographs.

River has torrent flow with bubble formation where rapids and cascade habitat is occur quite frequently. Some place scour pools, side and pocket pools also formed by the presence of rocks and boulders. Thus, the river has high gradient at dam site (4-10%) and fluvial morphology. The valley is narrow and confined with steep slope and stable rocky hills ('V' shape Plate-1). The glacial melt water is flowing in the Chenab and its streams where the water temperature recorded was varies between 8.5^{o}- 12.5^{o}C and velocity is found >1m/sec that may be due to high gradient of the river and streams (>7% slope). The channel is receiving spring water in the area. The observation has shown the presence of very few species of plankton and benthos. These were found present in the slow moving water zone, water seepage site and shallow places with side /pocket pools whereas benthos were mainly present in the streams and along the banks beneath the cobbles and gravels. Fishes are not found present in the Chenab waters. It can be inferred from the study that the area is represented by poor aquatic biodiversity. None of the species is found listed in the IUCN record (2006).

6.7 RESULTS

Aquatic faunal diversity at the influence zone showed a diverse range of species from zooplankton to fishes. The planktonic population of the stream is inherently poor due to constant change in water flow and habitat structure. Therefore, it has insignificant role to play in ecological niche. It is the benthic micro-flora and fauna, which play an important role in propagation of benthic fauna and fish.

Baseline information on aquatic flora and fauna was collected within catchments area through extensive field survey and from secondary sources is illustrated in **Table 6. 8**.

Table 6. 8: Baseline data of aquatic flora & fauna in the Impact Zone of the Study Area

S. No.	Species	Sampling Sites for aquatic Fauna and Flora				
		I	II	III	IV	V
Phytoplankton						

S. No.	Species	Sampling Sites for aquatic Fauna and Flora				
		I	II	III	IV	V
	Blue Green Algae					
1	*Oscillatoria* sp.	+	-	++	+	+
2	*Phormidium* sp.	-	+	-	-	-
3	*Schizothrix* sp.	-	-	-	-	+
	Green Algae					
1	*Chlamydomonas* sp.	-	-	-	-	-
2	*Trachelomonas* sp.	-	-	-	-	+
3	*Hyalotheca* sp.	-	++	-	-	-
4	*Microspora* sp.	+	-	-	-	-
5	*Zygnema* sp.	+++	+	++	+	-
6	*Batrachospermum* sp.	+	-	-	--	-
	Diatoms					
1	*Diatoma* sp.	+	-	-	-	-
2	*Synedra* sp.	-	+	-	-	-
3	*Meridion* sp.	+	-	-	-	-
4	*Nitzschia* sp	-	++	+	-	-
5	*Gomphonema* sp.	+++	-	++	+	-
Zoo-planktons						
	Protozoan					
1	*Arcella* sp.	-	-	+	+	+
2	*Peridiinium* sp	+	-	+	-	-
3	*Euchlanis* sp	-	+	-	+	-
4	*Ceratium* sp.	-	+	-	+	-
	Crustacean					
	Rotifers					
1	*Keratella* sp.	+	+	+	-	+
2	*Philodina* sp.	-	+	-	+	-
3	*Notholuca* sp.	-	-	-	+	-
Benthos Invertebrates						
	Ephemeroptera (May flies)					
1	*Baetis* sp.	++	+	++	+	++
2	*Ephemeralla* sp	+	-	-	+	+
3	*Stenonema* sp.	+	+	+	+	+++
	Plecoptera (Stoneflies)					
1	*Isoperla* sp.	+	+	+	+	+
2	*Perla* sp.	+	+	+	+	+
3	*Acroneura* sp	++	-	++	+	+
	Dipterans (Crane flies)					
1	*Chironomous* sp	+	+	+	++	+
2	*Ablabesmiya* sp	+	-	+	+	+
3	*Tipula* sp.	-	+	-	-	++
4	*Bibliocephala sp.*	**+**	**+**	**+**	**+**	**+**
	Trichopteran-(Caddis flies)					
1	*Rhycophilla* sp.	+	+	+	+	+
2	*Ochrotricha* sp	+	-	++	-	+
3	*Antocha* pupa	+	-	-	-	-
4	*Narpus* larvae	**+**	**+**		**+**	
Fishes						
	Endemic species					
1	Schizothorax richardsonii	-	-	-	-	-

S. No.	Species	Sampling Sites for aquatic Fauna and Flora				
		I	II	III	IV	V
	Introduced/Exotic spp.					
1	Salmo trutta fario	-	-	-	-	-
2	S. gairdnerii gairdnerii	-	-	-	-	-
3	Salvelinus alpines	-	-	-	-	-

Note: - Present (+), Dominant (++), Abundant (+++), Absent (-)

Figure 6.3: Benthos Invertebrates Collected from Water in the Study area

Figure 6.4: Rainbow trout collected from river Chenab

Two categories of planktons i.e., green algae (Chlorophyceae) and blue green algae (Cyanophyceae) were recorded. The stream being a freshwater body, the presence of Chlorophyceae was more prominent. The variation in occurrence of phytoplankton taxa may be due to the water quality, channel morphology, elevation, geomorphology that occurs in the project site in river Chinab and its tributaries. The macrophytes that remain attached to the rocks, boulders; stones, etc. belong to various genera of bryophytes (mosses). These mosses grow on stone and boulders that protrude a few centimeters above the surface of water.

Zooplanktons belonging to Protozoa, Rotifera, Cladocera and Copepode were recorded. However, these are poorly represented group due to torrent water flow and low water temperature. The group shows minimum species richness that could be due to the presence of rapid habitat.

The variation in the aquatic faunal communities are due to water velocities, ice chilling temperature during winter, floods due to snow melts in summer and rolling of stream bottom material consisting such as boulders, stones, gravels etc. The faunal communities have developed an inherent capability to adapt to the tough hydrological conditions of fast flowing riverine conditions. The zoo benthos invertebrates are very important part of the food chain and also act as cleaning agents of river and stream waters. Hence, their presence or absence plays very important role to sustain the integrity of aquatic ecosystem.

The macro benthic fauna/Zoo benthos recorded in the project sites represents five orders of insects. The most dominant order among insects comprises of mayflies or ephemeroptera that observed common in all the sample sites. Among invertebrates recorded naids, larvae and imago of various insects contributed to about 90 % of the total aquatic fauna. The poor occurrence of benthos during study period could be due to low water temperature, high turbidity, torrent flow and rapids and runs habitat in river Chenab and cascade and falls in side streams.

6.8 FISH DIVERSITY

Jammu & Kashmir has vast resources of lentic and lotic water bodies, harboring a large number of indigenous and exotic fish species. River Chenab is one of the most important river of Indus river systems. During the visit fishing was undertaken to know the type of fishes available in Chenab river. Local people were also consulted for the availability of fish in the river.

Fish fauna in the part of Chenab river in the area and its tributary streams is determined by the water temperature, the flow velocity and the water depth. The species found here have to be either endowed with strong

locomotion like Snow trout and Mahseer or have developed special organs of attachment like *Garra* spp.

The typical cold water fishes that inhabit in downstream of the Chenab river and tributary streams are Mahseer (*Tor* spp.), minor carps (*Labeo dero* and *L. dyocheilus*), lesser barils (*Barilius bendelisis*), Sucker head (*Garra gotyla*), Snow trout (*Schizothorax* spp.) and Loaches (*Nemacheilus* spp. and *Botia birdi*). Mainly four groups of fishes which are of economic significance are found in study area stretch of Chenab river and are as follows:

1. Mahseer (*Tor* spp.); 2. Snow trout (*Schizothorax* spp.); 3. Catfish (*Garra* spp.); 4. Minor carps (*Labeo* spp.)

There are number of fisher men in the project study area, fishing is mainly performed in the tributaries and the Chenab at calm sites during the dry season. Snow trout dominates the catches. The perennial tributaries are assumes to be the main breeding habitats for economically important fish species in Chenab River. The lower reaches of perennial tributaries in the submergence area are flooded after establishment of the reservoir and are now the breeding and feeding ground for migrating fish and fish population.

6.9 ASSESSMENT OF IMPACTS DUE TO THE PROPOSED PROJECT

The proposed activity will not pose any adverse impact on hydrology and water quality as there is no proposal of dam construction. The dam has already been constructed for the stage-I, will be used in this project. The present survey reveals that there is occurrence of fishes in the river in the downstream of the dam. However, the ecological conditions of the catchments area provide scope for introduction of trout in the reservoir. The stream flows with many abrupt falls and cascades leaving lesser chances for migration of fish upstream.

The impacts due to constructed dam are as follows:

(i) Fish migration
(ii) Loss of habitat
(iii) Modification of discharge
(iv) Water temperature and water quality changes

Benefits

1. Water temperature changes have often been identified as a cause of reduction in native species but in this case it may prove beneficial for introduction of endemic snow trout or exotic trout.

6.10 MITIGATION MEASURES

The most effective mitigation measure to maintain the aquatic ecology is to ensure compensatory flow (15-30 %) and regular implementation and monitoring of environmental plan to maintain the water quality. The compensatory flow may be designed based on the habitats and future fishery. Since, the stage I of the proposed project already has a dam; it is recommended that optimum periodic release of water should be maintained to minimize adverse environmental impact.

CHAPTER-7

DEMOGRAPHY AND SOCIOECONOMIC

7.1 DEMOGRAPHIC PROFILE OF THE STUDY AREA

The Baglihar Hydro Electric Project (Stage-I & Stage-II) is located in the Ramban district of Jammu & Kashmir state. The nearest railhead is Udhampur, 65 km from Jammu. The project is about 18 km from Batote and 150 km from Jammu on Jammu-Srinagar National Highway 1-A on Nasri bypass road. The nearest airports are Jammu and Srinagar. A study was undertaken with respect to demography, occupational pattern, literacy rate and other important socio-economic indicators of village likely to be affected by the project within 10 km radius from the dam site.

1) Approach Adopted

Secondary Data: Socio-economic profile has been compiled from latest census data (Primary Census Abstract, 2001). For detailed socio-economic analysis administrative block has been taken as the minimum unit.

2) Administrative Set-up

There are 68 villages that fall under the study area of 10 KM radius from the dam site. These project affected villages are covered under community development block Ramban in Tahsil Ramban and community development block Assar in Tahsil Doda under district Doda. Ramban became an independent district in the year 2007 prior to which it was a part of district Doda. Doda district is one spread over an area of 11,691 Sq. Kms. The district shares common border with Anantnag District of Kashmir in the north; south-west and south are bordered by the Districts of Udhampur, Kathua and Chamba areas of Himachal Pradesh. From east and south-east is located the Leh District of Jammu & Kashmir. It is the 3rd largest district of Jammu & Kashmir in terms of area after Leh and Kargil. The features of district Doda at a glance are shown in **Table 7.1** and District Ramban in **Table 7.2**.

Table-7.1: District Doda at a Glance

AREA	**11,691 Sq. Kms**
AREA UNDER FOREST	**5400 Sq. Kms**
POPULATION	**6, 90,474**
POPULATION DENSITY	**36/km² (1991 census)**
SEX RATIO	**904 females per 1,000 males**
LITERACY RATE	**46.92%**
NO. OF VILLAGES	**655**
NO. OF PANCHAYATS	**262**
NO. OF CD BLOCKS	**19**
NO. OF TAHSILS	**07**
NO. OF ASSEMBLY SEATS	**06**
AVERAGE RAINFALL	**35 inches per annum**

(Source: Primary Census Abstract – 2001)

Table-7.2: District Ramban at a Glance

Profile		
1.	Area	**1346 (Sq. Kms.)**
2.	No. CD Blocks	**04**
3.	No. Tehsils	**02**
4.	No. Niabats	**07**
5.	No. Villages	**116**
6.	Road length ending 2007-08	
7.	Road length per 100 Sqkms of area	
8.	Estimated Population 2008 (in Nos)	**258253**
9.	BPL Population (in Nos)	**89482**
10.	%age of total population	**37.73%**
1. Sex Ratio (Female'000')		
i)	District Avg.	**973 (Survey 2008)**
ii)	State Avg.	**892 (2001 census)**
iii)	National Avg.	**933 (2001 census)**
2. Literacy rate		
i)	District Avg.	**47.37% (Survey 2008)**
ii)	State Avg.	**55.50% (2001 census)**
iii)	National Avg.	**64.80% (2001 census)**
3. Education		
A	**School Education.**	
i)	Primary Schools	**320**
ii)	Middle Schools	**112**
iii)	High Schools	**27**
iv)	Higher Sec. Schools	**13**
B	**Higher & Technical Education**	
i)	College	**01**
ii)	ITI	**03**
4. Health Infrastructure		
i)	Distt.Hospital	**01**
ii)	Sub-Distt Hospital	**03**
ii)	PHCs	**09**
iii)	MACs	**17**
iv)	Ads	**16**
v)	Sub Centres	**39**
5. Other Infrastructure		
i)	Hydro Power Project	**01**(Baghliar)

(Source: Planning and Development Department – J & K Govt)

7.2 POPULATION OF VILLAGES IN THE STUDY AREA:

The total population of these 68 villages as per Census of 2001 is 88,848. The percentages of male, female population and sex ratio are 52.61%, 47.39% and for 1000 (Males): 900 (females) respectively. There are about 13,645 households in the study area. The average family size is about 7

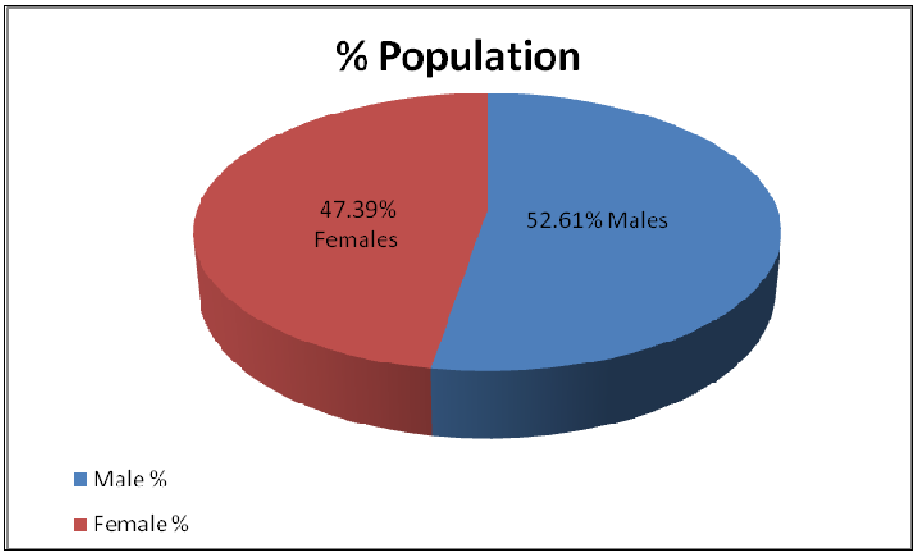
persons per house. Tahsil wise Population and Sex Ratio is shown in **Table-7.3** and in **Figure-7.1**

Table-7.3: Tahsil viz Population and Sex Ratio

Tahsils	No of Villages	Data					Sex Ratio	
		Total Population	Total Males	% Males	Total Females	% Females	Males	Females
Doda	26	39371	20314	51.60%	19057	48.40%	1000	938
Ramban	42	49477	26429	53.42%	23048	46.58%	1000	872
Grand Total	**68**	**88848**	**46743**	**52.61%**	**42105**	**47.39%**	**1000**	**900**

(Source: Primary Census Abstract – 2001)

Figure-7.1: Percentage Population



7.2.1 SOCIAL STRUCTURE IN THE STUDY AREA

The Scheduled Caste (SC) population within the study area is 19.09% of the total population out of which male SC population is 51% and female SC population is 49%. The Scheduled Tribe (ST) population within the study area is 15.15% out of which male population is 51% and female population is 49%. Tahsil wise break-up of social structure is exhibited in **Table-7.4** for SC population and **Table-7.5** for ST population.

Table-7.4: SC population break-up:

Tahsils	SC Population Break-up in the Study Area							
	No of villages	Total Population	Total SC Population	% SC Population	Total SC Males	% SC Males	Total SC Females	% SC Females
Doda	26	39371	9360	18.92 %	4798	51.26 %	4562	48.74 %
Ramban	42	49477	7605	19.32 %	3866	50.83 %	3739	49.17 %
Grand Total	**68**	**88848**	**16965**	**19.09 %**	**8664**	**51.07 %**	**8301**	**48.93 %**

(Source: Primary Census Abstract – 2001)

Table-7.5: ST population break-up:

Tahsils	SC Population Break-up in the Study Area							
	No of villages	Total Population	Total ST Population	% ST Population	Total ST Males	% ST Males	Total ST Females	% ST Females
Doda	26	39371	6954	14.06%	3600	51.77%	3354	48.23%
Ramban	42	49477	6507	16.53%	3296	50.65%	3211	49.35%
Grand Total	**68**	**88848**	**13461**	**15.15%**	**6896**	**51.23%**	**6565**	**48.77%**

(Source: Primary Census Abstract – 2001)

7.2.2 Literacy in the Study Area

The literacy rate in the study area is very poor especially female literacy. The total number of literates in the villages within the study area is 30,342 (34.15%). The percentage literates in the study area are much less than the state average of 55.50% (Census 2001). The percentage of male and female literacy to the total literate population is 74.38% and 25.62%, respectively. Tahsil wise literacy break-up is shown in the **Table-7.6:**

Table-7.6: Literacy break-up in the Study Area

Tahsils	Literacy Break-up in the Study Area							
	No of villages	Total Population	Total Literates	% Literates	Total Male Literates	% Male Literates	Total Female Literates	% Female Literates
Doda	26	39371	17015	34.39%	12635	74.26%	4380	25.74%
Ramban	42	49477	13327	33.85%	9932	74.53%	3395	25.47%
Grand Total	**68**	**88848**	**30342**	**34.15%**	**22567**	**74.38%**	**7775**	**25.62%**

(Source: Primary Census Abstract – 2001)

7.3 SOCIOECONOMIC OF THE STUDY AREA (BASED ON 2001 CENSUS)

7.3.1 Occupational structure

The occupational structure of the population in villages in the study area has been studied with reference to main workers, marginal workers and non-workers. The main workers, Marginal workers and Non workers in the study area are 31.80% (28,250), 12.79% (11,366) and 55.41% (49,232) respectively of the total population. The Tahsil wise Occupational Structure is shown in the **Table-7.7:** Main workers have been grouped into four categories namely: cultivators, agricultural labourers, household worker and other workers. These are discussed in the following sections. The percentage break-up of Main workers is shown in **Figure-7.2:**

Table-7.7: Occupational Structure in the Study Area

Tahsils	Occupational Structure of the study area (Villages)							
	No of villages	Total Population	Total Main Workers	% Main Workers	Total Marginal Workers	% Marginal Workers	Total Non Workers	% Non Workers
Doda	26	39371	18582	37.56%	6873	13.89%	24022	48.55%
Ramban	42	49477	9668	24.56%	4493	11.41%	25210	64.03%
Grand Total	**68**	**88848**	**28250**	**31.80%**	**11366**	**12.79%**	**49232**	**55.41%**

(Source: Primary Census Abstract – 2001)

7.3.2 Cultivators

A person who is engaged either as employer; single worker or family worker in cultivation of land owned is termed as cultivator. Total cultivators in study area are 15,167 (53.69% of main workers).

7.3.3 Agricultural Labourers

Persons working on the land of others for wages or share in the yield have been treated as agricultural labourers. The total workers of this category are about 683 (2.42% of main workers).

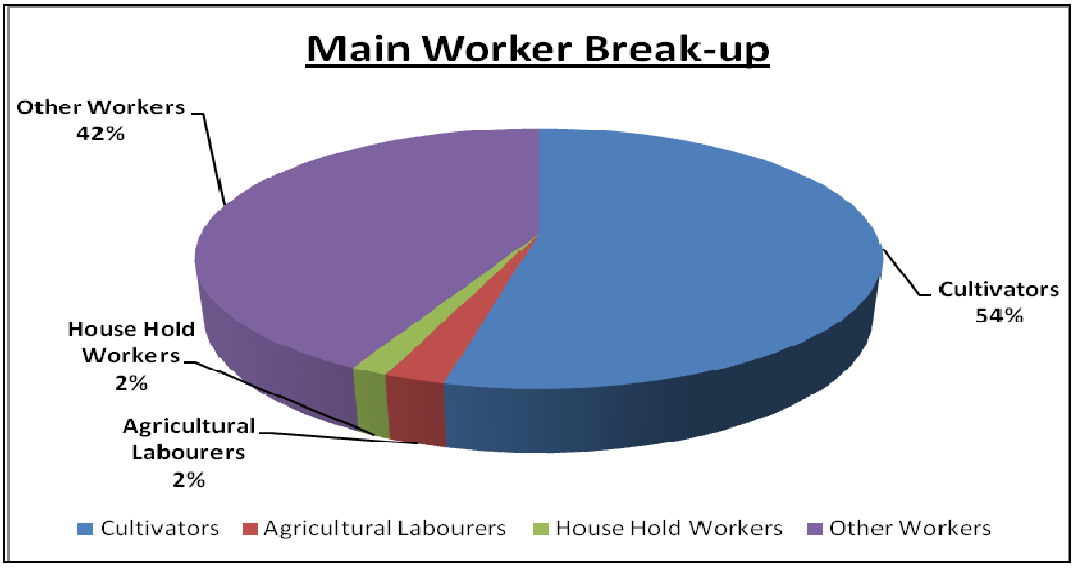
7.3.4 Household Worker

Persons working in others house hold for wages are treated as House hold Worker. Total workers of this category are about 419 (1.48% of main worker)

7.3.5 Other workers

The workers other than cultivators or agricultural labourers, who have been engaged in some economic activity, include plantation workers, commerce, business, transport, mining, construction worker etc. There are about 11,981 workers constituting 42.41% of main worker

Figure-7.2 Break-up of Main Workers



7.3.6 Marginal Workers

The marginal workers are those, who are engaged in some work for a period of less than six months, during the reference year. Total number of marginal workers in study area is 11,366 which is approx. 12.79% of the total population.

7.3.7 Non Workers

The non-workers include those engaged in unpaid household duties, students, retired persons, dependants, beggars etc. The total number of non-workers is 49,232, which is 55.41% of the total population.

7.3.8 INFRASTRUCTURAL FACILITIES AND AMENITIES IN THE STUDY AREA

A review of infrastructural facilities and amenities existing in the area has been done on the basis of the information given in census data of 2001. Infrastructural facilities and amenities like education, health, drinking water, electrification, and transport and communication network are though existent yet their number is not lucrative.

7.3.8.1 Educational Facilities

In the 68 villages in the study area, there are 143 primary/elementary schools, 58 middle schools, 14 secondary school, 1 senior secondary schools, 3 adult training centre and 2 other educational facilities. There are however, no colleges, industrial school or training school found. The educational facilities within the study area are presented in **Table-7.8**.

Table-7.8: Educational Facilities within the Study Area

Educational Facilities	No. of Institutions
Primary/Elementary School (P)	143
Middle school (MSCH)	58
Secondary School (S_SCH)	14
Senior Secondary school (SS_SCH)	1
College	NIL
Industrial School (IND_SCH)	NIL
Training School (TR_SCH)	NIL
Adult Training Center (ADLT_LT_CT)	3
Other Educational Facilities (OTH_SCH)	2

(Source: Village Directory of J & K for 2001)

7.3.8.2 Medical Facilities

The status of medical facilities in the study area is given in **Table 7.9**.

Table-7.9: Medical Facilities within the Study Area

Medical Facilities	Number
Allopathic Hospital	NIL
Ayurvedic Hospital	3
Unani Hospital	3
Homeopathic Hospital	NIL
Allopathic Dispensary	24
Ayurvedic Dispensary	7
Unani Dispensary	NIL
Homeopathic Dispensary	1
Maternity and Child Welfare Centre	6
Maternity Home	NIL
Child Welfare Centre	7
Health Centre	4
Primary Health Centre	3
Primary Health Sub Centre	1
Family Welfare Centre	2
T.B. Clinic	NIL
Nursing Home	NIL
Private Medical Practitioners	1
Subsidized Medical Practitioners	NIL
Community Health workers	1
Total Numbers	**63**

(Source: Village Directory of J & K for 2001)

7.3.8.3 Drinking Water

The major source of drinking water in the study area is tap water and spring water (i.e.) ground water. 65 villages out of the 68 in the study area have tap water supply and 63 villages use spring water. In addition, well water, hand pump, tank water, river water and canal water is used by the people of the villages in Ramban tahsils. The number of wells, hand pumps, tube-wells and tap water supply in the study area is shown in **Table 7.10**.

Table 7.10: Drinking Water Facility within the Study Area

Drinking Water Facilities	Number
Well Water (W)	03
Hand Pump (HP)	01
Tube-Well (TW)	00
Tap Water	65
Tank (TK)	03
River Water	07
Canal Water	07
Spring	63
Other Water Source	05

(Source: Village Directory of J & K for 2001)

7.3.8.4 Power Supply

Out of the 68 villages in the study area, 65 villages have power supply. The number of villages having electricity for domestic, agricultural and for all purposes is shown in **Table 7.11**.

Table-7.11: Electricity Facility within the Study Area

Categories	Villages
For domestic use	65
For agricultural use	01
For all use	57

(Source: Village Directory of J & K for 2001)

7.3.8.5 Post and Telegraph

Out of the 68 villages in the study area, 18 villages have post office facility. The post and telegraph facilities in the study area is depicted in **Table 7.12**.

Table-7.12: Post & Telegraph Facility within the Study Area

Facilities	Villages
Post Office (PO)	18
Telegraph Office	01
Post and Telegraph office	01
Phone	14 Connections

(Source: Village Directory of J & K for 2001)

7.3.8.6 Transport

The mode of transport in the study area is mainly state transport / private bus services. There is no railway line and air field in the study area. As per census of 2001, 45 villages out of the 68 in the study area has bus services.

7.3.8.7 Banking Facility

According to the census of 2001, 4 villages in the study area has banking facility.

7.3.9 LAND USE PATTERN OF THE STUDY AREA BASED ON CENSUS OF 2001.

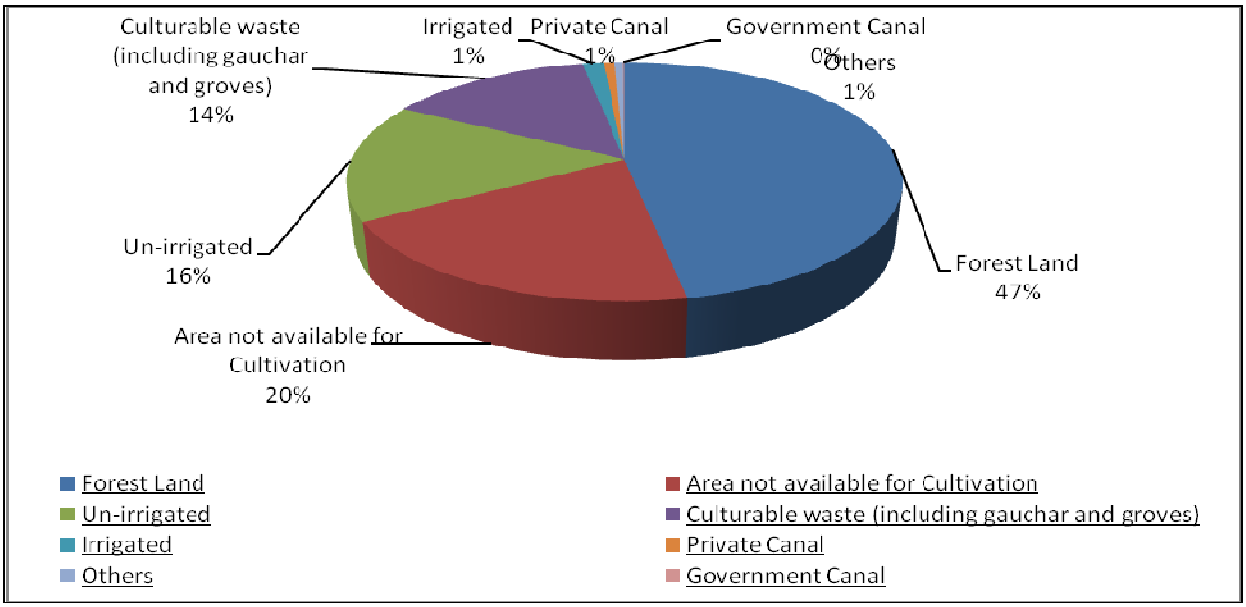
The land use pattern based on census of 2001 for the villages falling under the study area was done. The total area (in Hectares) falling under the study area is 51,382.41 Hectares. Land use pattern of the study area based on the Census of 2001 is shown in **Table-7.13** and **Figure-7.3**:

Table-7.13: Land Use Pattern of the study area based on the census of 2001 (Area is in Hectares)

Type of Land	Total Land (Ha)	% to Total
Forest Land	24,150.40	47.00%
Area not available for Cultivation	10,177.26	19.81%
Un-irrigated	8,264.94	16.09%
Culturable waste (including gauchar and groves)	7,276.77	14.16%
Irrigated	756.52	1.47%
Private Canal	416.01	0.81%
Others	298.53	0.58%
Government Canal	41.98	0.08%
Grand Total	**51,382.41**	**100.00%**

Source: Village Directory of J & K for 2001)

Figure-7.3: Land use pattern of the villages in the study area



7.4 AGRICULTURE PRACTICES / CROPPING PATTERN

Agriculture is the main occupation of the rural people of Doda. Topography, climate and soil are the main factors affecting agriculture in the District. The main variety of crops of this region can be classified under the following categories:

1. *Food Crops : Rice, wheat , maize , millets and pulses.*
2. *Commercials: Crops : Zera , Potato etc*
3. *Horticulture Crops: Apple etc.*
4. *Other Crops : Potato, Chillies etc.*

CROP CALENDER

S. No.	Crops	Sowing	Harvesting	Peak Marketing
1	Rice/Paddy/Maize	May to June	Sept. to Oct.	No marketing system
2	Wheat/Barely	Oct. to Nov.	May to June	-do-
3	Small Millets/Pulses	May to June	Sept. to Oct.	-do-
4	Chilies	May to June	Oct. to Nov.	-do-
5	Tobacco	June to July	Oct. to Nov.	-do-
6	Sugarcane	March	Oct. to Nov.	-do-
7	Grape & Mustered	Oct. to Nov.	June to July	-do-
8	Potatoes	May to June	Sept. to Oct.	-do-
9	Onions	Oct. to Nov.	June to July	-do-

(Source: Chief Agriculture officer, Doda)

7.5 ETHNOGRAPHIC PROFILE

The racial composition of the state was largely influenced by the immigrants from the territories of Turkmenia, Tadzkistan, Uzbaikistan, Kazakistan, Georgia, Azerbaijan (USSR) Turkey, Iraq and Afghanistan.
The various ethnic groups of the Jammu and Kashmir State though intermingled have their areas of high concentration. For example, Kashmirs are mainly concentrated in the Valley bottom, Dards occupy the valley of Gurez, Hanjis are confined to water bodies of Kashmir, Gujjars and Bakarwals are living and oscillating in the Kandi areas, Dogras occupy the outskirts of the Punjab plain, while Chibhalis and Paharis live between Chenab and Jhelum rivers. Moreover, there are numerous small ethnic groups like Rhotas, Gaddis and Sikhs which have significant concentration in isolated pockets of the state.

In the study area Kashmiris, Grujhars and Bakarwals constitute the pre-dominant ethnic groups. Kashmiris are well spread in various parts of the state but their major concentration lies in the valley of Kashmir, Kishtwar, Bhadarwah, Doda and Ramban areas of the Jammu Division. There is a close bearing of the Indo-Aryans on the racial composition of the Kashmiris. In fact, the Indo-Aryan religions and languages have substantially affected the mode of life of the Kashmiris. 'Kashmiri' is a wide term which has loosely been applied for several streams of immigrated mainly from Turkey, Iran, Central Asia and Afghanistan and settled in the valley.

Gujjars and Bakarwals constitute a significant proportion of the population of Padder block. In general, they have nomadic character and largely depend on flocks and cattle keeping for their livelihood. The arrival of Gurjjars in Jammu and Kashmir is attributed to the outbreak of devastating droughts and famines in Rajasthan and Gujarat. Although, some of the Gurjjars have started developing land connections, they are essentially cattle rears and a section of them – Backarwals regularly oscillates between the southern slopes of the Siwaliks and the Margs (Alpine-pastures) of the Central Himalayas.

The Gurjjars and Bakarwals are the followers of Islam, excepting a few who are settled in Bimber, Mirpur and Rajouri. The Gujjars, because of their strict religious adherence, have emerged as the most outstanding tribe who are trusted for their honest. So far as the dress is concerned, the males wear a long shirt and a trouser as per the tenets of Islam. Besides, they wear a turban of peculiar style. The ladies usually wear a long shirt and shalwar with a cap of dupatta on their head. Though purdah system among ladies is not observed, they avoid facing the strangers.

7.6 LIVESTOCK

The inhabitants of the area are basically dependent upon agriculture and animal husbandry. In view of lesser cultivable area and mountainous topography, sloppy lands, problems of soil erosion and high altitude the farmers can not solely depend upon agriculture and have to resort to rearing of animals. Some areas are inhabited by Gurjjars and Backarwals who are known for their hard work in the form of rearing of cattle. Rearing of cattle, horses, goats and sheep is their main occupation. Animal husbandry is also being practiced by persons other than Gurjjars who indulge in rearing of domestic animals like cattle, buffalos and goats besides poultry birds.

7.7 ARCHAEOLOGICAL / RELIGIOUS / HISTORICAL MONUMENTS

No archaeological monument of national importance either lies in the project area or in its submergence area. There is also no structure of national heritage in the area.

7.8 MAJOR INDUSTRIES IN THE STUDY AREA

Ramban and Doda District is industrially backward because of its topography and non-availability of raw material, technical and skilled persons so that resources available could be exploited / utilized. However, District Industry center Doda must be envisaging developing the industrial sector. As per data available or provided to the statistical agency only three factories were registered. Besides 1528 S.S.I units were registered formally with DIC ending 3/2006. 28 SSI units were formally registered providing employment to 116 persons during the year 2005-2006.

There are 30 Handicraft and 10 Handloom training centers in the Districts. As many as 492 trainees were trained by the Handicraft and 90 trainees trained in the Handloom training centers during the year under reference i.e. 2005-06.

(Source: Economic Review of Doda Dist; for year 2005-06 by Dist Statistical and Evaluation Industry, Doda)

7.8.1 COMMERCIAL ESTABLISHMENTS.

315 numbers of commercial establishments were registered during 2005-06 in the district by providing employment to 656 persons in addition to the shops already running. There are 4861 shops which include 4285 shops run by owners and 576 shops run by others .Besides there are 911 Hotel and Restaurant with employment of 386 persons.

(Source: Economic Review of Doda Dist; for year 2005-06 by Dist Statistical and Evaluation Industry, Doda)

7.9 SENSITIVE AREAS

No National Park, Sanctuary, Archeological Monuments, Notified Eco-sensitive areas or protected area under Wild Life (Protection) Act exists within the project area or within 15 km distance from it.

CHAPTER 8

IDENTIFICATION, PREDICTION AND EVALUATION OF IMPACTS

8.1 INTRODUCTION

Baglihar HEP, Stage-II mainly involves construction of underground water conductor system and underground power house. The intake of the structure has already been built along with Stage-I work. It is expected that there will be certain changes in the overall environmental matrix of the area on d/s of the existing dam due to construction of underground works of Stage-II. The baseline data of the existing environment, in the absence of the proposed activity, provides the status of natural environment and with the proposed activity it further provides a mechanism for prediction of the changes that are likely to occur. In the present study, evaluation of land, water, air, noise, flora, fauna and socio-economics was undertaken to understand the baseline environmental status of the area and estimation were made as how this will change with the commencement of the proposed activities. Anticipating the quantum of change, efforts were also made to analyze the degree of alternations and strategies for suitable management to ameliorate the negative impacts project activities. This exercise has provided a sound basis for formulation of different management plans, which are presented in the EMP document of the project.

8.2 IMPACTS ON LAND ENVIRONMENT

The impacts on land environment due to construction of the project have been evaluated and it was found that terrain around project site is going to have permanent and temporary changes in the landscape. The major impacts are described below:-

- Alteration of terrain due to construction of approach and access roads.
- Generation of muck and localized increase in erosion due to excavation of tunnel, powerhouse and other appurtenant components.
- Generation of solid waste due to construction and deployment of construction workforce.

8.2.1 Impacts on the Microclimate of the Area

The major construction activities involve underground excavation and concreting works in underground water conductor system and power house, there shall not be any impact on microclimate of the area. The operation stage of a hydro electric project through an underground power house shall also not create any impact on the meteorology and climatology of the area.

8.2.2 Change in Landuse / Landcover

Construction Phase

- Excavation of surface and underground components of the project will generate 8.86 lac cum of muck out of which 4.43 lac cum is expected to be utilized as construction material. The remaining 4.43 lac cum of muck, which on swell basis works out to 6.29 lac cum, will be dumped in five designated dumping areas away from the main river, which will not bring change into the landscape of the area.

- The headrace tunnel, after entering into the bed rock, will have in general adequate rock cover. There are no settlements / houses above the tunnel alignment. The sufficient rock cover coupled with controlled blasting technique shall reduce the vibrations imparted to a minimal.

Operational Phase

- During the operation phase no significant change on land use is expected, however, the land cover will improve, due to implementation of landscape and restoration and balance catchment area treatment works. Many of the redundant areas having no further usage will be brought under plantation.

8.2.3 Soil Erosion and Siltation

Construction Phase

- Soil erosion due to excavation of different components of the project, construction of roads and dumping of muck into disposal yards will accelerate soil erosion during the construction period and this increase siltation for which precaution like siltation tanks shall have to be resorted to at aggregate crushing and processing plants, dewatering from tunnels etc.

Operational Phase

- Soil erosion due to project activities will not exist in the operation phase as the construction would be completed and landscape restoration work would also be implemented. In addition to this under catchment area treatment stabilization of landslides / slip prone areas will minimize erosion. The rate of siltation of Chenab in the free draining catchment shall substantially reduce.

8.2.4 Impact on Geology

Construction Phase

Geological investigation for the project was carried out and details of the geology of the project area have been discussed in Chapter 3 of this report. As per site observations, the rock formations in the area are inherently loose and prone to landslides at various locations. However, as per site specific investigations, the geological formations in the selected

project sites are judged stable and will be able to withstand the impacts of drilling and blasting. However, at any unstable formation encountered during tunneling, blasting may lead to high vibrations, which in turn may result in soil erosion, subsidence and loss of vegetation. Hence, controlled blasting with use of multi-second delay detonators is to be adopted at such geologically fragile locations.

Intensity of anticipated environmental impacts will be low based on environmental value and degree of disturbance. Therefore, intensity of anticipated environmental impact on geology of the area will be weak and extent of anticipated impact will be local. Duration of impact will be medium leading to low significance of the impact.

Operation Phase
No impact is anticipated on the geology of the area during the operation phase.

8.2.5 Impact on Hydrology

Construction Phase
Construction of proposed project may lead to two types of impact on the hydrology of the area i.e. surface water and ground water hydrology. These impacts have been described below:

Impact on the Surface Water Hydrology
The water requirement during construction of the tunnel from other adits will be met from local sources. Hence, this divided water source will ensure that there is no excessive water demand on any single water resource. Moreover, if any groundwater is encountered during tunneling operations, it will be used for construction requirements to reduce surface water requirement. Further the existing drainage system in the area will not be modified or affected during the construction phase.

As a matter of fact the Stage-II involves abstraction of water for peaking and firm generation in monsoon period and when river discharge is in excess of the requirement of Stage-I. The water diverted for Stage-II is that quantum of water which would have otherwise been passed through the spillways. Hence, the intensity of anticipated environmental impacts is judged as low, based on environmental value and degree of disturbance. Therefore, intensity of anticipated environmental impact on hydrology of the area will be weak, anticipated impact local in extent and duration short leading to low significance of the impact.

Impact on Ground Water Resource
The ground water levels in the region could not be established, as is often the case in mountainous terrain. Since the water usage will be mainly from the local khad water for construction purposes, no adverse impact on groundwater availability is expected. Dumping of wastes shall also be

undertaken at specified exposed surface locations only and hence, no negative effect is envisaged on the groundwater quality of the area.

Some seasonal surface streams shall cross the tunnel alignment with the stream bed well above the crown of the tunnel at the point of crossing. Hence, there shall not be any disturbance to ground water regime consequent to blasting for tunneling. Moreover, the underground tunnel shall be aligned deep in the mountain below the ground profile. The ground water position of the area shall not change due to existing steep slope of surface and water tight lining of the tunnel.

Operation Phase

Impact on Surface Water Hydrology

During operation phase, the water (maximum 430 cumec) from the Chenab will also be diverted for power generation through HRT of Stage-II. Following guidelines issued by the Ministry of Environment & Forest, Govt. of India, the minimum flow based on average lean weather flow that will be maintained in the river will be 13.6 cumecs down stream of dam. Besides, about 1.4 cumec of water shall be added through regeneration below dam, discharge pumped out from drainage gallery of the dam, sweating and seepage from banks and also through Nichari nala, Pira nala and Gajpat nala, which confluence with the Chenab about 0.7 km and 1.3 km d/s of plunge pool of the dam. Since, the water from the river is neither used by the villages along the river, nor is there any significant aquatic flora / faunal population; the reduced flow in 02 km. stretch d/s of dam is not likely to have any adverse impact. Thus no negative impact due to water withdrawal shall be experienced.

8.2.6 Environmental degradation due to labour immigration

Construction Phase

- During the construction phase congregation of approximately 1800 workers at peak construction activity is likely to take place in the project area, for which semi permanent / temporary accommodation would be required. Due to this, pressure on land and water resource would occur. The disposal of sewage, solid waste would be required. If the labour force is not provided with proper fuel arrangements, the pressure on adjoining forest for fuel wood may take place. In order to reduce the dependence on forest the project proponent / contractors will be asked to provide adequate boarding and lodging to the workforce. Conflict between the migrants and the local population may occur for employment.

Operation Phase

- In the operation phase the project will have full-fledged infrastructure to meet the requirement of the reduced strength of project workers. The labour force engaged in construction activity will also move away once the project work is completed; therefore no additional impact is expected.

8.3 IMPACTS ON AIR & NOISE ENVIRONMENT

Construction Phase

- Temporary changes in the ambient air quality during construction phase are expected due to emission of hydrocarbons from vehicles and gases from blasting operations in the surface and underground works. The present levels of NO_x, SO_2, SPM and RSPM indicate that the air does not contain abnormal concentration of the above. The driving of HRT and excavation of other under ground works by resorting to blasting shall instantaneously increase the level of SPM/RPM. The use of dumpers inside tunnel shall also result in increase in SO_2 level requiring proper air ventilation in the tunnel at the same time establishing of competent exhaust system. During construction monitoring of above parameters require to be carried out periodically to keep the levels within prescribed limits by adopting rectification measures.

- Temporary changes in noise levels are expected during construction phase only. In order to check the noise, pollution noise filters may be erected around crushing and batching plants and regular maintenance of heavy earth vehicles may be adopted to reduce noise levels.

Operation Phase

- The ambient air quality during the operation phase in power house is not expected to deteriorate.

- Noise level in the underground power house is expected to be higher and could be of the order of 85-90 dB(A). However, outside of the main access tunnel to power house, there will not be any appreciable increase in noise level.

8.4 IMPACTS ON WATER ENVIRONMENT

Construction Phase

- During the construction phase of Stage-II, the river water on d/s of dam is supposed to catch considerable amount of sediment from the underground works for which the water coming out from such area will be dislodged of sediment in the silt trapping tanks before being released to river.
- The silt laden water emanating from all other open air works and from the foundation works of power house, however will require sediment extraction before releasing the water into the river section.

- The muck disposal yards, quarry areas would be the areas of concerns for leaching of sediments during rains.

- The discharge coming out of batching and crushing plants would also bring considerable sediments in water due to washing of plants and aggregate material.

- The sewage generated at the labour camps and other residential areas may also bring considerable pollutants to river sections, if disposed off in the river section without treatment.

Operation Phase

- In the operation phase of the proposed project the water environment in general will not deteriorate as the water will be continuously used for power generation and will be released simultaneously.

- For downstream usages of river course will have a minimum environmental flow of 13.6 cumecs released downstream of dam site for downstream riparian use of d/s 2 km length.

- The regular flushing operation of reservoir during monsoon shall not let the development of unwanted heaps / shoal in the flow section of the river bed which cause change in the river regime.

8.4.1 Impact due to change in Hydrological Cycle

The abstraction of water (maximum 430 cumec) through Intake / HRT of Stage-II shall reduce the flow upto 02 km d/s of the dam to the extent discharge flowing through HRT, upto the point of outfall of TRT. This implies that there shall be less evaporation in the two km. reach d/s of the dam than before. Thus, the increase in evapo-transpiration due to creation of the reservoir shall be slightly reduced by the decline in the d/s river segment due to water being conducted through underground HRT. Since, the quantity of the water abstracted from the river for non-consumptive use of power generation is again returned to the system without any consumption, there shall not be any remarkable change in hydrological cycle in context to the project absolutely.

8.4.2 Ground and Surface Water Use

The water use of Chenab on u/s and d/s of the project has already been discussed in para-4.6. It has been brought out neither there is any industry making use of river water nor are there any surface / lift irrigation schemes withdrawing the Chenab water, through, some major hydro projects have been proposed on the river u/s of Baglihar HEP. Thus, the project shall get the regulated discharge of the Chenab from the proposed u/s projects.

8.4.3 Impact due to Ground Water Pollution

The baseline study of water quality in respect of surface water and ground water (spring) has revealed that both are of good quality and the various

water characteristics are within the tolerance limit as set-out under IS:2260. The surface water meets the standards of drinking water quality. Therefore, seepage of good quality surface water from reservoir shall least impair the obtaining quality of ground water.

8.4.4 Backwater Effect

The major tributaries of the Chenab directly draining into the reservoir in the study area are Desa nadi, Garsal nala, Chittigad, Jowarasha nadi, Dhoroh khad at its right bank and Bach, Raggi Kanderi, Akri nadi, Kilamund nadi and Chakwa nadi at its left bank. These shall have a relatively high water level at the confluence point due to back water.

8.4.5 Impact on Performance of Existing Projects

At present, immediately d/s of Baglihar HEP, Salal HEP is functional on the Chenab. In view of the proposed project with gross storage of 428.28 MCM needed for peaking as well as firm generation, the flow d/s shall not be affected though a regulated flow shall be maintained d/s of the proposed dam. Besides this, due to sediment control through works carried-out and undergoing against Catchment Area Treatment (CAT), Compensatory Afforestation and Green Belt Development, the water quality shall improve and d/s projects will receive comparatively lesser silt laden water which will have far reaching impact on their reservoir life.

8.4.6 Impact on Turbidity in Construction Phase

The impact of silt laden water, during construction phase, emanating from excavation of the open air works, from dewatering during underground excavation in HRT / Adits / Shafts and Power House Cavern and also from discharge coming out of batching and crushing plants bringing considerable sediments, have been discussed in para-8.2.3 and 8.4 of the report along with suggestive measures for redressing. The impact shall be felt during construction with the slight increase in turbidity in the river water d/s of dam despite resorting to de-silting of silt laden discharge coming from various excavation points, but the transparency of the water shall not be impaired to the extent that the available sunlight ceases to power the photosynthetic reactions.

8.5 IMPACTS ON FLORA

- It is evident from the study that in the study area of the project none of tree species, shrub, herb or any climber or grass species are either vulnerable or endangered.
- Interestingly the vegetation composition of the study area is also widely distributed in the influence zone in abundance and there will be no significant loss to the habitat.
- Floral characteristics especially in the areas where the project components are going to be underground would not change.
- The floral abundance of the project area in post construction phase will increase by many folds as the plantation under catchment area treatment, reservoir rim treatment, green belt, restoration and landscaping will be completed.

8.6 IMPACTS ON FAUNA

Construction Phase

- Increase in temporary stress levels of wildlife during construction phase due to noise, human interference and reduction in present habitat.
- Threat due to poaching might increase.

Operational Phase

- The river course beyond Dulhasti dam in the u/s and in the downstream upto Salal has already been affected due to cascade development of the Chenab River which has largely affected the propagation of fishes. The construction of projects like Baglihar HEP, therefore has no specific bearing on the migration of fish as the upstream and downstream river courses has already been affected by existing HEPs.

8.7 IMPACTS ON THE SOCIOECONOMICS

8.7.1 Impact Upstream of Dam

- No land shall be acquired for Stage-II work as acquisition has already been undertaken during the course of Stage-I.
- The project affected people may be provided training and financial help for entrepreneurship development.
- Preferential employment in semi-skilled and skilled categories will enhance the socio-economic status of project affected families.
- Pressure on the existing provincial / state road will increase.

8.7.2 Downstream Impacts

- Due to the construction of "Baglihar HE Project" the regulated flow of water will reduce flooding of downstream areas.
- Regulated water supplies will also be available for power generation in d/s projects.
- Due to project the quality of water in the downstream is not going to be affected as the water received by the project will be discharged in the downstream after power generation round the clock.
- Project colonies and roads will have well laid green belts.

8.7.3 Psychological, Cultural and Social Impacts

Muslims and Hindus constitute the pre-dominant religious community of the study area falling in Jammu region of district Ramban. The area is pre-dominantly inhabited by various ethnic groups like Kashmiris, Dogra, Gujars and Bakarwals who have distinct habits of food and clothing. They have deep religious faiths and celebrate festivals with great fervors and enthusiasm. During construction phase, migratory population though in limited numbers, is expected from other parts of the country having different cultural habits. However, no cultural conflicts are foreseen due to the migratory population, as they will be largely settled in separate conglomerates having all inbuilt facilities. Since major work force will be drawn from the local people and the people of J & K state, which by interaction with outside labour during course of construction, shall develop affinity and friendship with the outside workers, thus, minimizing the chances of conflict.

8.8 SUMMARY OF POSITIVE AND NEGATIVE IMPACTS

The positive impacts are enlisted below:-

- The clean and renewable source of energy
- Employment opportunities
- Benefits to economy and commerce
- Increased infrastructure
- Improvement in environment through implementation of CAT, Compensatory Afforestation, Green belt Development and different other plans

The negative impacts are:-

- The loss of agriculture land
- Likely decrease in agriculture and horticulture production due to air pollution in construction phase
- Temporary disturbance to the fauna of the study area

8.9 IMPACT MANAGEMENT

Based on the evaluation of baseline data and predicted impacts, suitable management plans should be worked out for implementation, in order to ameliorate the negative impacts in the sphere of land, water, air, noise, biological and socioeconomic environments. The implementation of all the management plans should commence concurrent to project execution so that all the environmental ambiguities going to arise may be resolved before the project is commissioned. Environmental ambiguities going to arise may be resolved before the project is commissioned. It would be appropriate to have strict monitoring of the mitigation measures at the level of MOEF for which a Monitoring Committee may be constituted to evaluate the progress made in implementation of mitigating measure and to suggest any improvement thereof. Strict monitoring will also be required to watch out the implementation of air, water and noise measures to be adopted by the contractors at various project sites by the Project Authorities /Project level monitoring committee.

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