CISMHE

UPDATED
EXECUTIVE SUMMARY
MAY, 2013

ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT PLAN FOR JELAM TAMAK H.E. PROJECT, UTTARAKHAND

Prepared for :
THDC India Limited

CENTRE FOR INTER-DISCIPLINARY STUDIES OF
MOUNTAIN & HILL ENVIRONMENT
UNIVERSITY OF DELHI, DELHI

PREFACE

Jelam Tamak H.E. Project proposed by THDC Ltd. is located on the Dhauliganga river in Joshimath sub-division of Chamoli district, Uttarakhand. The project is run-of-the-river scheme, envisages a 28 m high barrage, a reservoir with an surface area of nearly 38 ha and 4.4 km long head race tunnel. The installed capacity of the project is 108 MW. Total land required for the various project components is 96.27 ha. The project would affect 4 revenue villages by acquiring their private naap land, van panchayat land and grazing land.

EIA report has been prepared in two volumes, the first volume essentially covers project description, baseline data on land, water, biological, air and social environments and assessment of the impacts. The second volume deals with all mitigation measures and covers various Environmental Management Plans, viz. Catchment Area Treatment plan, Biodiversity Management plan, Resettlement & Rehabilitation plan, Rehabilitation Muck Dumping Area, etc. All the mitigation measures to be undertaken by the project developers have been dealt with in detail along with cost estimates for each plan. All the chapters prepared for EIA and EMP reports have been prepared by CISMHE through primary and secondary sources except Environmental Flow Assessment study.

December, 2012 **Principal Investigator**

CISMHE

CENTRE FOR INTERDISCIPLINARY STUDIES
OF MOUNTAIN & HILL ENVIRONMENT
UNIVERSITY OF DELHI

UNDERTAKING

This is to certify that the EIA/EMP report of Jelam Tamak H.E. Project is based on the original work carried out by Centre for Interdisciplinary Studies of Mountain & Hill Environment (CISMHE), University of Delhi. We also certify that the work has not formed the part of other EIA report and/or has not been copied from other published or unpublished reports. The information taken from the secondary source is well referred to in the report.

Principal Investigator

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NABET/ EIA/ 02/ 12/52

February 27, 2012

The Director
Centre for Interdisciplinary Studies of Mountain & Hill Environment
3rd Floor, ARC Building, University of Delhi,
Patel Marg, Delhi - 110007
(Kind Attention: **Prof Maharaj Krishan Pandit**)

Dear Sir,

QCI – NABET Scheme for Accreditation of EIA Consultant Organization

This is with reference to your application for QCI – NABET Accreditation as EIA Consultant Organization.

We are pleased to inform you that based on Document & Office Assessments, the Accreditation Committee has recommended conditional accreditation of **Centre for Interdisciplinary Studies of Mountain & Hill Environment** as per the scope given in **Annexure I (A & B).** Also find attached herewith the following:

a. Detailed terms & conditions of accreditation **(Annexure II).**
b. Results of various aspects of assessment of your organization **(Annexure III).**
c. The format which is to be followed for mentioning the names of the experts involved in the EIA reports prepared by you **(Annexure IV).**

Please confirm the correctness of spellings of the names of the experts mentioned in Annexure I B. Please check the QCI website for the Minutes of the Accreditation Committee Meeting held on February 07, 2012 for observations related to your application for compliance. You are also advised to visit QCI website to check clarifications on the Scheme issued from time to time for necessary actions at your end.

The accreditation of your organization will be for a period of three years starting January 10, 2012. The annual renewal of the accreditation will be confirmed after surveillance assessment every year. Surveillance assessments will be conducted to ensure compliance with NABET Scheme including the details mentioned in your Quality Manual and the terms & conditions mentioned in Annexure II.

May we request you for an early payment of the annual fees and your confirmation of acceptance of the terms and conditions attached. This will enable us to issue you the requisite accreditation certificate.

We thank you for your esteemed support in making this scheme successful and for your participation in this national cause.

Thanks and best regards,

Yours sincerely,

(Vipin Sahni)
Director

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Annexure I-A

Name of the Consultant: **Centre for Interdisciplinary Studies of Mountain & Hill Environment**

3rd Floor, ARC Building, University of Delhi,
Patel Marg, Delhi - 110007

Sectors Approved – 01 Nos.

Sl. No.	Sector No.	Name of Sector	Category A/B
1	3	River Valley, Hydel, Drainage and Irrigation projects	A

Total = 01 Sector*

****Sectors allocated to individual EIA Coordinators are mentioned in Annexure I-B***

(Vipin Sahni)
Director

TEAM COMPOSITION AND EXPERTISE

S.No.	Name of Expertise	Field	Areas Approved By NABET
1.	Professor M.K. Pandit	Ecology & Biodiversity (Flora and Impact Assessment)	Coordinator
2.	Dr. J.P. Bhatt	Ecology & Biodiversity (Fauna, Impact Assessment) Water Pollution & Aquatic Ecology	Coordinator EB & WP
3.	Dr. D.C. Nautiyal	Ecology & Biodiversity (Flora)	EB
4.	Dr. Sanjay Pattanayak	Geology	
5.	Dr. Vikrant Jain	Geology & Hydrology & Ground Water	Geology, HG
6.	Dr. Dorje Dawa	Land Use/ Land Cover, Hydrology & Ground Water Risk Hazardous Management	LU & ISW
7.	Mr. R. Mehta	GIS-Remote Sensing (Land Use/ Land Cover)	LU
8.	Mr. Basudev Singh Bisht	Socio-Economic	SE
9.	Ms Sudha Tiwari	Laboratory work & Aquatic Ecology	EB
10.	Mr. Aniket	Laboratory work	EB

* All analysis work associated with CISMHE laboratory under the University of Delhi.

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1. INTRODUCTION

Jelem Tamak H.E. Project is proposed to tap hydropower potential of Dhauliganga between Jelam and Tamak villages in district Chamoli (**Fig.1**). The water of Dhauliganga river is proposed to be diverted by a water conductor system located on its right bank for power generation. Three units each of 36 MW (108 MW) located in underground powerhouse on the right bank of Dhauliganga have been proposed based on the DPR. Project involves a 28 m high and 83 m long barrage at altitude 2623.50 m, a horse shoe concrete lined head race tunnel of 4.40 km length, an underground power house and 308 m long trail race tunnel. The scheme envisages the utilization of design discharge of 57.58 m^3/sec and the drop of about 207.54 m for power generation. The annual energy generation in a 90% dependable year is 505.12 GWh. Detailed salient features of Jelam Tamak H.E. Project are given in Table 1.

Table 1. Salient features of the proposed project Jelam Tamak H.E. Project

1.	**Project Location**	
	State	Uttarakhand
	District	Chamoli
	River	Dhauliganga
	Diversion Site	Near Jelam Village
2.	**Hydrology**	
	Catchment area	1666 km^2
	Area under snow	879.00 km^2
	Rain fed area	787.00 km^2
	Elevation of Snow Line	4900 m a.s.l.
	Standard Project Flood	1906 m^3/s
3.	**Reservoir**	
	Full Reservoir Level (F.R.L.)	2648.5 m
	Minimum Draw-down Level (M.D.D.L.)	2638.8 m
	Length of Reservoir at FRL	3.3 km

	Area of Reservoir at FRL	37.92 Ha
	Gross storage	5.50 million m^3
	Live storage	3.218 million m^3
4.	**Barrage**	
	Coordinates	Lat. 30º 37’ 35.4” N; Long. 79 º 49’ 39.5” E
	River Bed Level	EL 2623.50 m
	Barrage Top Level; Barrage Height	EL 2651.50 m; 28m
	No. & Size (W x H) of bays	5 barrage bays and 1 under-sluice bay, 8.0 m x 6.0 m each
	Sill Level – Barrage bays	EL 2624.50 m
	Sill level – Under-sluice bay	EL 2623.50 m
5.	**Radial Gates and Stoplogs**	
	Gate Type	Radial
	No & size (W x H)	6 Nos., 8.0 m x 6.0 m
	Hoist Type	Twin Hydraulic Cylinders
	Stoplogs Type (common for barrage & under sluice gates	Vertical Lift Slide type
	No & size	1 Set, 8.0 m x 8.30 m
	Hoist Type	Gantry Crane using a lifting beam
6.	**Intake**	
	Configuration	Twin intake on right bank, each feeding a desanding chamber
	Invert level	EL 2630.40 m
	Crest level (top of skimmer wall)	El 2632.30 m
	Gates	One service and one bulkhead gate in each intake
	Size (W x H)	3.8m x 3.8m, for both gates
	Hoist Type	Electrically operated rope drum hoist
7.	**Trash racks**	
	Type and Number	Fabricated steel panels; 8 Nos.
	Size of opening (W x H)	3.0 m x 6.8 m
	Size of trash rack panels (W x H)	3.0 m x 1.828 m

	Sill level	2632.30 m
	Inclination of trash rack	10º (with vertical)
8.	**Intake Ducts**	
	Nos.	2
	Size of each duct (W x H)	3.8 m x 3.8 m, rectangular
	Length of each duct	24.9 m
9.	**Feeder Tunnels**	
	Nos.	2
	Size of each tunnel	3.8 m, D-shape
	Length	146.0 m & 125.0 m
10.	**De-sanding Chambers**	
	No. & Size (L x W x H)	2 Nos., 200.0 m x 12.0 m x 13.6 m
	Size of particles to be removed	>0.2 mm
	Discharge for each chamber	38 m^3/s
	Flushing discharge for each chambers	5.80 m^3/s
11.	**Headrace Tunnel**	
	Design Discharge	57.58 m^3/s
	Finished Size and shape	5.2 m; Horseshoe
	Length	4404.58 m
	Thickness of lining	300 mm
12.	**Surge Shaft**	
	Type	Restricted-orifice; Underground
	Diameter – Shaft/Orifice	12.0 m/2.3m
	HRT invert at surge shaft	2603.80 m
	Surge shaft bottom (Top of orifice slab)	2611.0 m
	Surge Shaft Top	2671.0 m
	Total Height	60.0 m
	Upsurge/Down surge levels	2668.4 m / 2614 m
13.	**Pressure Shaft**	
	Configuration	One no. main pressure shaft with trifurcation at

		machine centerline level
	Grade of Steel	ASTM A537, Class II
	Main Pressure Shaft – Length Diameter	245.1 m 4.0 m
	Intermediate Branch – Length Diameter	11.0 m 3.25 m
	Unit Penstocks – Lengths Diameter	41 m, 28.30 m and 33.0 m 2.3 m
14.	**Penstock Valve**	
	Number and Type	One no.; Lattice type Butterfly Valve
	Elevation of Valve Centre Line	2605.80 m
	Diameter	4.00 m
15.	**Powerhouse Complex**	
	Installed Capacity	108 MW (3x36MW)
	Location	Underground, about 1 km upstream of Tamak village
	Coordinates	Lat: 30º 36’ 45” N; Long: 79 º 47’ 15” E
	Powerhouse Cavern (L x W x H)	101m x 19.5m x 39.7m
	Transformer Hall Cavern (L x W x H)	79 m x 13.5m x 22m
	Collection Gallery – Length; Width Invert/Crown El.	58.45 m; 12 m 2422.0 m / 2444.50 m
16.	**Main Inlet Valve**	
	Type	Spherical
	Number and Diameter	3 Nos.; 1.65m
	Elevation of Valve Centre Line	2420.50 m
17.	**Turbine**	
	Number and Turbine Type	3 Nos.; Vertical Axis Francis
	Turbine Centre Line El.	2420.50 m
	Rated Discharge per Unit	19.19 m^3/s
	Turbine Speed	428.57 rpm
	Rated net head	207.54 m
	Maximum tail water level	2432.77 m (HFL)

	Minimum tail water level	2426.57 m
	Normal Tail Water level	2427.73 m
18.	**Generator**	
	Number and Type	3 Nos.; Suspended Type
	Generator Output and Voltage	40.00 MVA; 11 kV ± 10%
	Generator Frequency	50 ± 5% Hz
	Power factor	0.9
19.	**EOT Cranes**	
	P.H. crane: Nos. and capacity	1 No.- 100 T / 20 T / 10T
	GIS crane: Nos. and capacity	1 No. – 10 T
	Penstock valve crane: Nos. and capacity	1 No. – 60 T / 16 T
20.	**Tailrace Tunnel**	
	Length	308.0 m
	Size (W x H)	7m X 9m
	Tailrace Outlet Gate - Type Size (W x H) Hoist	Vertical lift fixed wheel type 7m X 6m Rope Drum
	Outfall weir sill elevation	2426.8 m
21.	**Switchyard**	
	Type and Location	Surface; On the right bank of the river, in front of construction adit portal
	Area (L x W)	85.0 m x 30.0 m
22.	**Estimated Cost(In Rs)**	
	Civil works	696.87 Cr
	E & M works	177.94 Cr
	Total basic cost	874.81 Cr
	Interest during construction & Financing Charges	243.31 Cr
	Total (Generation works) excluding Transmission	1290.25 Cr
	Cost per MW installed	11.95 Cr
	Construction Period	52 months, excluding 6 months for pre-

	construction activities
23. Power Benefits	
90% dependable energy	505.12 MU
50% dependable energy	519.13 MU
24. Financial Aspects	
1st year tariff	Rs. 6.05
Levellised Tariff (with 12% free power to the State)	Rs. 5.22

The main objective of the present study is to carry out the Comprehensive Environmental Impact Assessment (EIA) for the proposed Jelam Tamak HE project and based on the impacts, to prepare various mitigative plans and also to meet the Environmental clearance criteria of Ministry of Environment and Forests (MoEF), Government of India.

2. METHODOLOGY

Standard methodologies of Environment Impact Assessment were followed in the EIA study of Jelam Tamak H.E. Project. The present study has been based on the guidelines for EIA reported by several workers and institutions including CISMHE. All the methods were structured for the identification, collection and organization of environmental impact data. The information thus, gathered has been analysed and presented in the form of a number of visual formats for easy interpretation and decision-making. The study was carried out in catchment area, influence zone (10 km radius) and project areas. Spatial database on physiographic features were taken from various sources including Survey of India (SOI), satellite data and analyzed with the help of Geographic Information System (GIS) tools.

The soils of the catchment area, influence zone (10 km radius) and project sites (proposed barrage site to power house site) are classified by using the standard method of NBSS (1998). The samples were taken from different locations and analysed for physical (moisture content, water holding capacity, bulk density and pore size measurement), chemical (pH, conductivity, chloride,

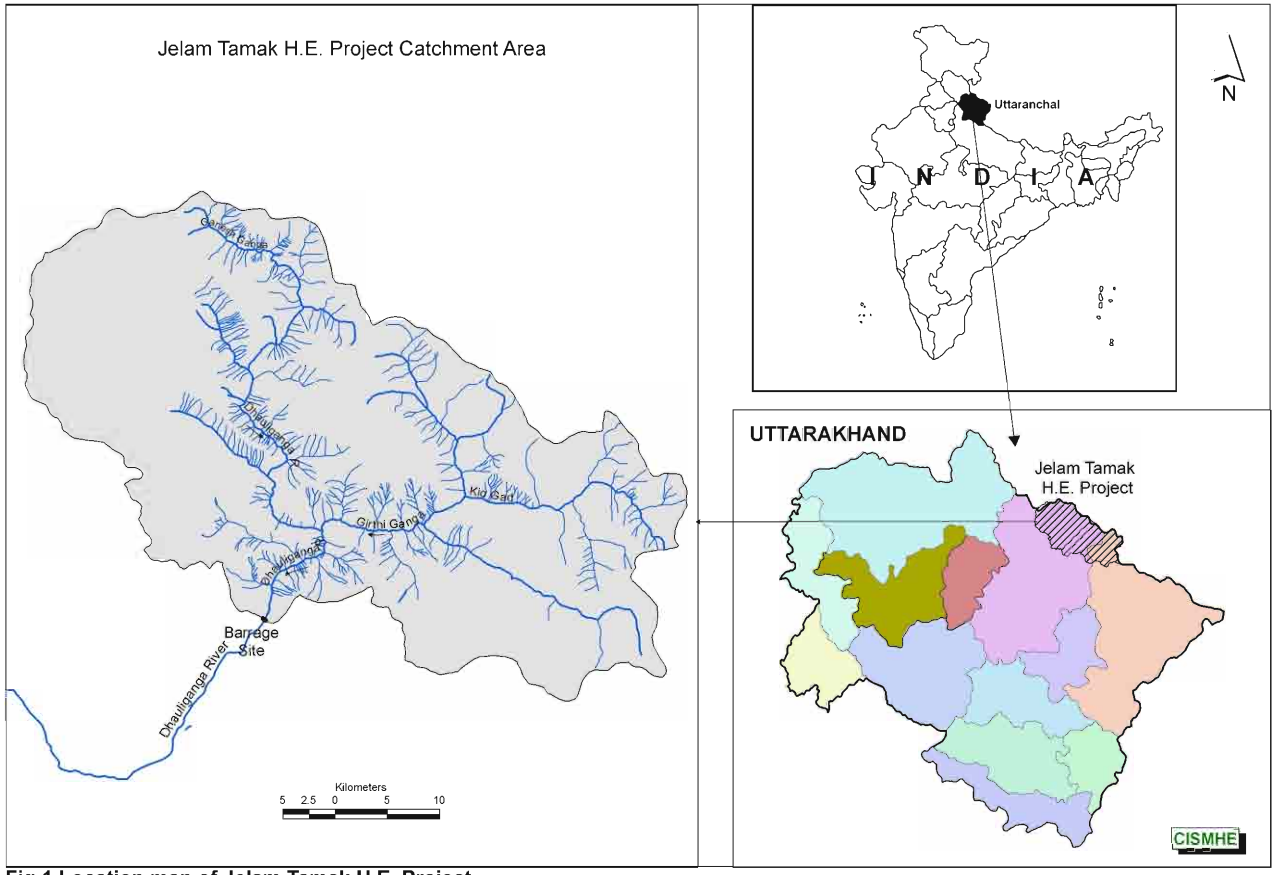

Fig.1 Location map of Jelam Tamak H.E. Project

phosphate, nitrate and organic matter) and biological characteristics (fungi and bacteria) using standard methodology.

Forest types and plant species were recorded during the field visits. Besides the primary surveys in the project areas, the floristic data for the catchment study were sourced from the published literature. To understand the community structure, vegetation sampling was carried out at different locations in the project area. For sampling various strata of vegetation the area was divided into six sites viz., powerhouse site, proposed barrage site, submergence site, upstream site, downstream of barrage site and downstream of powerhouse site. Based on the quadrat data, frequency, density, basal cover, importance value index (IVI) of each species were calculated using standard methods.

In order to collect the information on the fauna (mammals, birds, herpetofauna, butterflies) in the catchment area of Jelam Tamak H.E Project, primary as well secondary sources were utilized.

The water sampling was conducted at different locations in the 30 km river stretch of Dhauliganga river. The sampling was carried out for three seasons (Post-monsoon, Pre-monsoon and Monsoon). A total of 15 physical and chemical parameters and 5 biological parameters were studied to assess the river water quality.

The ambient air characteristics (SPM, NOx and SO_2 were recorded with the help of Respirable Dust Sampler (Envirotech APM 460 BL) with gaseous sampling attachment (Envirotech APM 411 TE). The sampler was run in nearby areas like Malari village and Joshimath. In addition, noise level and vehicular movement were also analysed in and around project areas.

Socio-economic profile includes brief description of Uttarakhand, district Chamoli and sub-division Joshimath, where the project components are located. History, cultural aspects and ethnic values of local life of Uttarakhand are mentioned. A detailed account on the demography, education, occupation, land use/land cover and other amenities of the villages located in 10 km radius and project affected villages is discussed in EIA report. In order to collect the baseline data for preparation of R & R plan a door to door survey for project affected families was carried out for the proposed project. A detailed questionnaire was prepared for this purpose .

The vulnerability of an ecosystem to various impact resulting from an activity or multiple activities was identified and accordingly impacts were predicted.

3. PHYSIOGRAPHY

The physiography of a river basin refers to topographic features like hills, mountains, peaks, slopes and their geographical disposition as well as drainage network. It also includes glacier cover, recent depositional and erosional landforms. In the present study, various physiographic parameters were analyzed through remote sensing and GIS techniques. A comprehensive database of different physiographic aspects was formulated for all constituent sub-watersheds of Dhauliganga river catchment.

3.1 Drainage Network

There are large numbers of small and large tributaries in the Jelam Tamak catchment (see **Fig. 2**). The head water of the main river channel Dhauliganga originates from the glacier clad and snow capped peak of Ganesh Parvat, which is elevated at a height of 6531 m. Initially the river is called as Ganesh Ganga when it originates from Ganesh Parvat from Greater Himalayan range in the northern part of the catchment. It is called as Dhauliganga river after Shepak Kharak. Some of the prominent rivers in the catchment area are Amrit Ganga, Girthi Ganga, Jainti Gad, Chuba Gad, Kosa Gad, and Siraunch Ghar. The influence area from the barrage site and power house is extended up to 43235.25 ha. The two major tributaries that flow into the Dhauliganga river up to the barrage site are Kosa Gad and Pangti Gadhera.

From the downstream of the barrage site up to power house site there are large numbers of tributaries joining the main river channel of Dhauliganga. Along the left bank Dunagiri Gad is one of the largest tributary system that drains into the main river channel. Downstream of the power house is featured with more tributaries. Streams along the left bank are Phagati gadhera, Gankwi Gadhera and Tolma Gadhera. The head water region of Gankwhi Gadhera is characterized with permanent glaciers. Along the right bank Wauti Gadhera, Gadi Gadhera are the main tributary systems that joins the river channel.

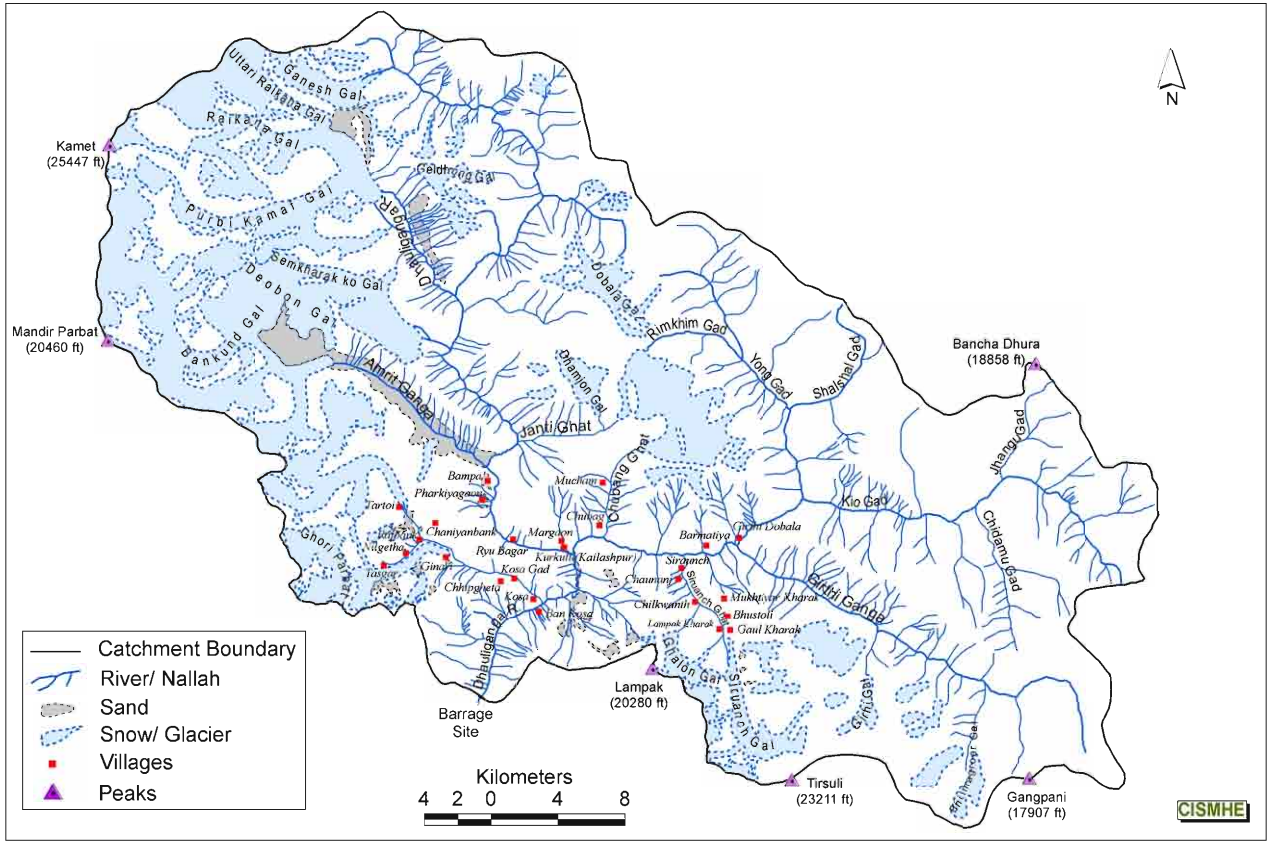

Fig.2 Drainage map of Dhauliganga river up to the proposed barrage site of Jelam-Tamak H.E. Project

3.2 Slope

There are seven slope classes classified in the catchment area. The most predominant slope class in the Jelam Tamak project area is Steep and very steep. Steep and very steep slope classes are widely spread across both the banks of Dhauliganga river. Moderately sloping is spread on an area of 17.7% of the total catchment area. The very steep slope class amounts to 36.09% of the total influence area and is susceptible to soil erosion. Other slope classes and their area coverage are given in **Figure 3**.

3.3 Aspect

The area covered under different aspect categories, all the facet are uniformly spread in the catchment area (**Fig. 4**). Three facets NW-N-NE, NE-E-SE and SE-S-SW are uniformly spread in the catchment, all these three classes accounts (~34000-36000 ha) of land under the corresponding aspect classes.

3.4 Relief

Relief thematic layer is classified into 17 bands (Fig. 4) with 300 meter band width. Band width 4800-5100 m is predominantly spread in an area of 32627.40 ha which accounts to 19.14% of the total catchment area. In addition the elevation band classes 4200-4500 m, 4500-4800 m, 5100-5400 m and 5400-5700 m are also predominantly spread in the catchment area. All these classes together account ~60% of the total catchment area.

4. HYDROMETEOROLOGY

Hydrometeorology of a river basin is controlled by rainfall, temperature, direction of wind, evapo-transpiration, drainage network etc. These factors are guided by geographical position and topography of the basin, which in turn controls the vegetation, rock and soil covers.

The rainfall of the project area is controlled by two geoclimatic factors viz. its location in high altitude and seasons of the Himalayan belt. Maximum rainfall was received during the month of August and September with a precipitation of 187 mm and 170 mm respectively. Winter months are characterized with lower precipitation with maximum of 54.8 mm in January. With the onset of March the rainfall decreases and it increases by the onset of monsoon.

The water discharge for the Jelam Tamak basin was unavailable. Therefore d/s water discharge data was used. The water flow pattern for 37 years in the Jelam Tamak catchment was developed. The maximum and minimum 10-daily discharge was recorded in the middle of July (184 cumec) and end of February (3.1 cumec) respectively. With the onset of monsoon, the maximum discharge in the river was more than 149.40 cumec and reaches the peak in the month of July. The other peak discharges in the river are observed in middle of August (181.90 cumec) and beginning of July (174.60 cumec). From end of the September onwards, the water discharge in the river gradually decreases. During the monsoon period, average 10-daily discharge varies from 164.80 cumec in the month of August to 115.23 cumec in the month of June. In lean season, mean 10-daily discharge varies from 3.1 cumec in the month of January to 50.10 cumec in the month of December.

The sediment yield in a catchment area is controlled by several factors including landslide and flooding. Seismically triggered landslide may result in natural damming of tributaries. The breaching of such dam would supply huge sediment load into a reservoir. Of the total silt load the proportion of coarse silt is high in all the months and that of medium silt is low and the fine silt is lowest. The average annual suspended load at Tamak works out to be 0.433 g/l of which coarse, medium and fine constitute 0.338 g/l, 0.038 g/l and 0.055 g/l respectively.

5. GEOLOGY AND SEISMICITY

In the Catchment area of Jelam Tamak, the rocks of the Central Crystalline are predominant and intrusive undifferentiated biotite granite (ca 500 Ma) and tourmaline granite (ca 21 Ma) are exposed. North part of Central Crystalline group is followed by Martoli Group (Rilkot/Dar formation), Sumna Group and Kanawar Group, Upper Lilang Group and Lagudarsi Group. Central crystalline is the basement over which litho-sequences ranging in age from Mesoproterozoic to Quaternary were deposited. The gneisses, migmatites, crystalline schist, thick quartzite with conspicuous horizons of calc-silicates with psammite gneisses in the upper part form bulk of metasediments. The Central Crystalline is well exposed in the Alaknanda valley from Helang (south of Joshimath) to Badrinath. The Martoli Group is composed of the Rilkot, Bilju and Milam Formations. The Rilkot, also called as the Dar Formation, is made up of meta-sediments represented by kyanite-, sillimanite-, staurolite-, garnet- and mica-schist, calc-schist with bands of marble and quartzite.

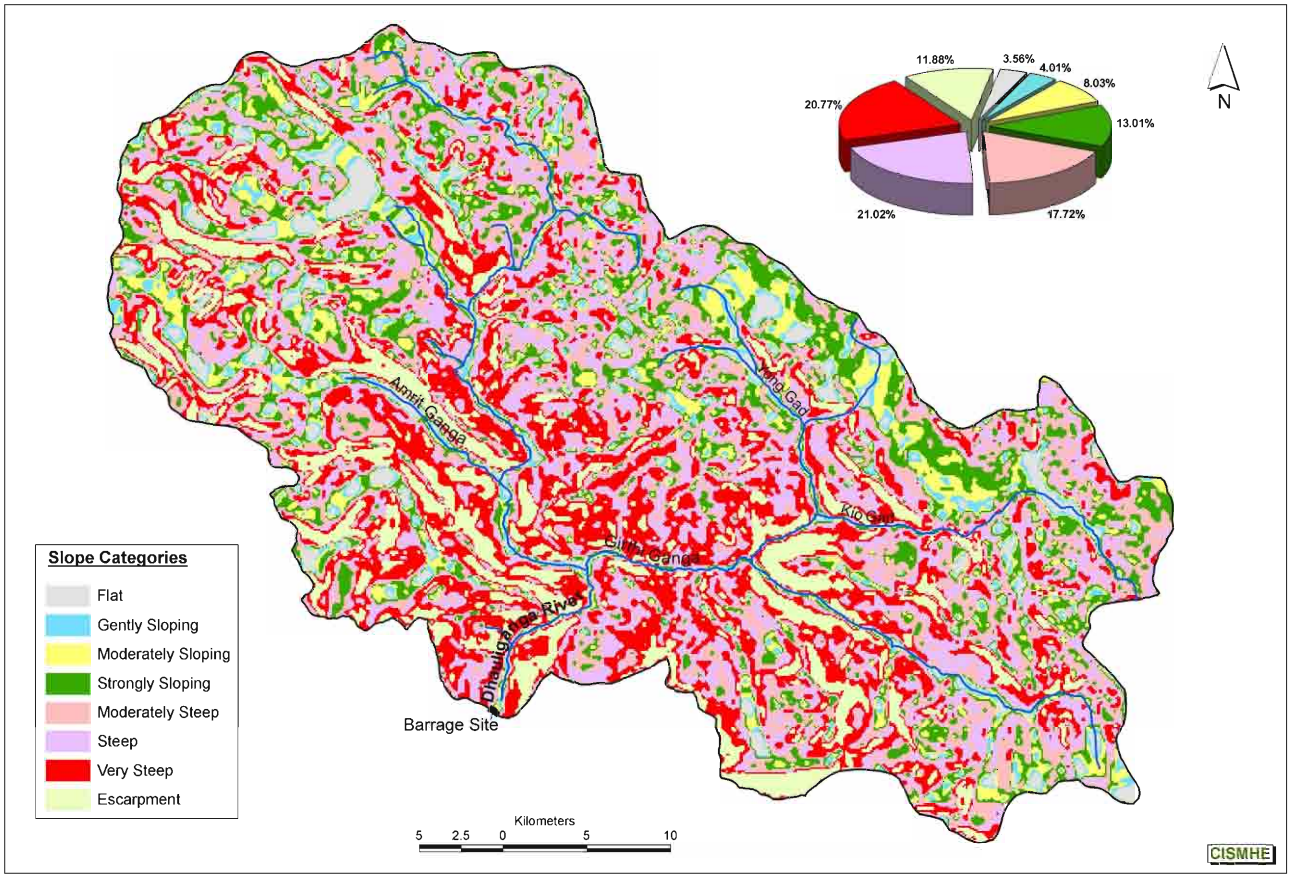

Fig.3 Slope map of Dhauliganga river catchment up to the proposed barrage site of Jelam Tamak H.E. Project

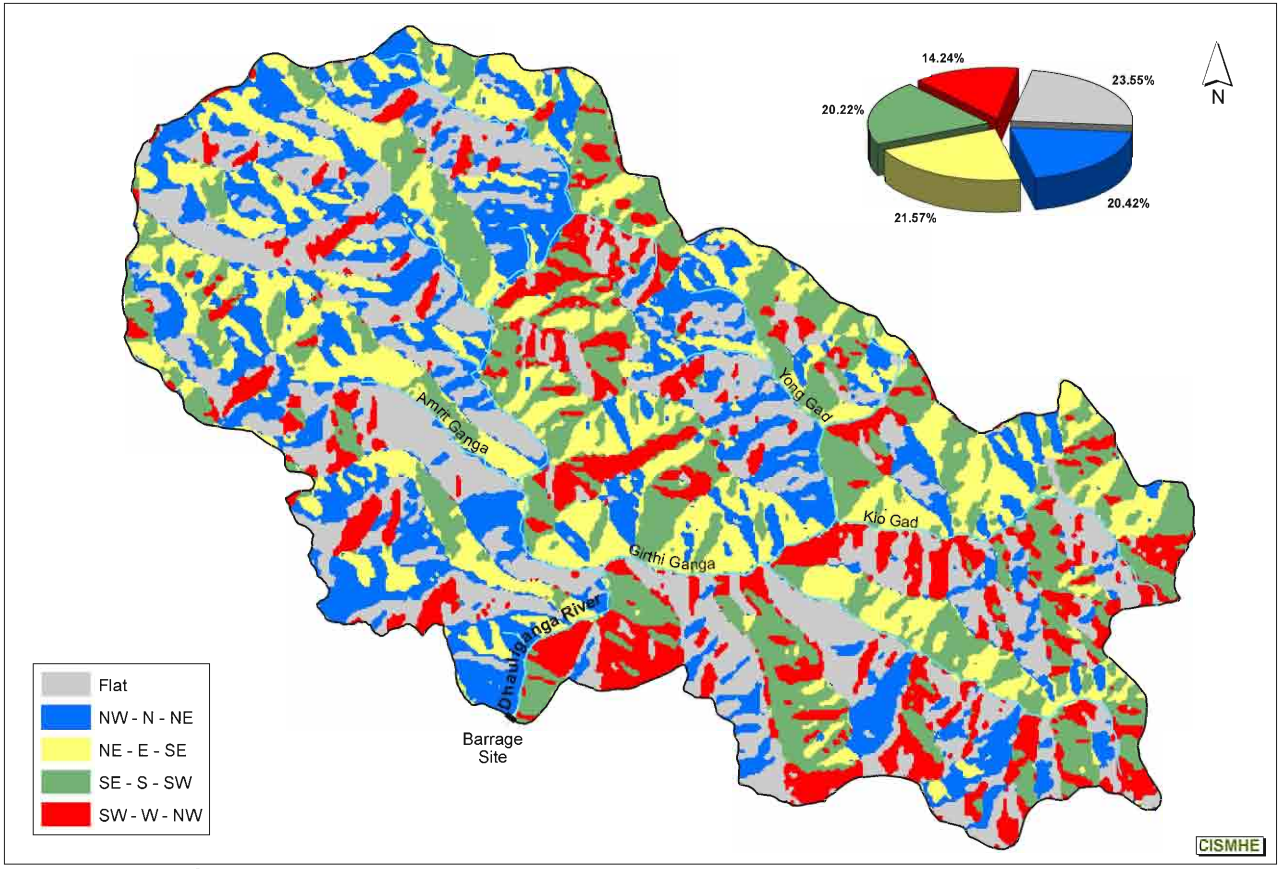

Fig.4 Aspect map of Jelam Tamak H.E. Project up to the proposed barrage site

The MCT is a steep north dipping major tectonic plane. It represents the contact between the Garhwal Group (Supersequence-II) and the Central Crystallines (Supersequence-I). It is traced from Helang in the Alaknanda valley to Munsiari in the Goriganga valley and farther east. The MCT is nearly 40 km towards south of proposed barrage site. In the Niti valley, the Dar Formation and Martoli Group (Mesoproterozoic to Early Cambrian) are not exposed but Sumna Group (Ordovician to Early Carboniferous) comes in direct contact with the Central Crystalline indicating the presence of a fault. The rocks exposed around the project area are regionally metamorphosed high grade metasediments, migmatites with Paleoproterozoic intrusive granite gneiss and younger granites. Heim and Gansser (1939) referred to this sequence as Central Crystalline zone or crystalline series. Bhimgora Quartzite Formation conformably overlies the Ragsi Formation. It is traceable from Tapoban in Dhauliganga valley.

The area lies in the seismically active zone–V of the seismic zoning map of India and is in proximity with the MCT zone along which micro-seismic activity is witnessed in this part of Himalaya. Therefore, it is essential to adopt suitable seismic coefficient in the design for various appurtenant structures of the project.

6. SOIL

Soils of the catchment area of Jelam Tamak H.E. Project comprises of 6 soils associations (**Fig. 5**). Soil association Lithic Cryorthents – Lithic Cryorthents is predominant in the catchment, covering an area of 24.9% of total catchment. A large area of the catchment is covered with glacier associated soils. Soils of influence zone comprise of 5 soil association with an area of 41195 ha. Typic Cryorthents – Lithic Cryorthents is most predominant soil group in the influence zone, covering an area of 48.8% of the total area. Nearly 22% area of influence zone is covered with the glaciers.

Proposed barrage site is located on the Typic Cryorthents – Typic Cryorthents soil group (see **Fig. 5**). Soil is moderately shallow, excessively drained, sandy-skeletal on moderate slopes with sandy surface, moderate erosion and strong stoniness; associated with Rock Outcrops. Proposed power house and HRT are located on the Typic Cryorthents – Lithic Cryorthents soil association. The soil is moderately shallow, excessively drained, coarse loamy soils on steep slopes and loamy

skeletal soils on very steep slopes with loamy surface. Soils are prone to severe erosion to very severe erosion.

No definite pattern was observed in the soil profile; medium sand, very coarse, coarse sand and very fine sand are predominant at all sites. Fine silt with clay ranged from 0.83% to 4.4.3% with maximum at site S1 and minimum at S3. The optimum range of water holding capacity was recorded at all sites with maximum in monsoon season. Soils were slightly acidic in nature; the available range of the pH is adequate to hold the maximum concentration of nutrients. Soils are characterized by the low organic carbon, organic matters and nutrients.

7. LAND USE AND LAND COVER

The land use and land cover of the Dhauliganga catchment area include snow, forest lands, scrub/alpine scrub, moraines, alpine meadows, cultivation/settlements, barren/rocky land and water body. Large area of the catchment (37.97%) is covered by snow (**Fig. 6**). Dense forest and open forest amounts to 10% and 10.31% of the catchment respectively. However, barren land and moraines together amounts to 26.21% of the total catchment area much larger than the total forest area.

The influence zone with 10 km radius, dense forest and open forest covers maximum area of 22.61% and 31.24% respectively. Moreover these land covers are spread along the left bank of the river. Second predominant land cover is Snow which is spread on an area of 14.2% of the influence zone and it is spread on the higher reaches along the right bank of the river.

8. FOREST TYPES & FLORISTICS

Uttarakhand is reported to have 45.80 per cent of its total geographic area under forest cover, which includes very dense, moderately dense, open forest and Scrub (FSI, 2009). The forest in the state can be divided into sixteen types which are characterized by Northern tropical dry deciduous forests (Dry sal-bearing forest and dry plain forest), Himalayan sub-tropical pine forests (Himalayan chir-pine and sub-tropical scrubs and Euphorbia scrub), Himalayan moist temperate forests (Lower Western Himalayan temperate and Upper west Himalayan temperate forests), Sub-alpine forests (West Himalayan birch/fir forest and pastures) and Moist and dry alpine scrub forests. The catchment area of the proposed Jelam Tamak H.E. Project covers Dry temperate coniferous forests,

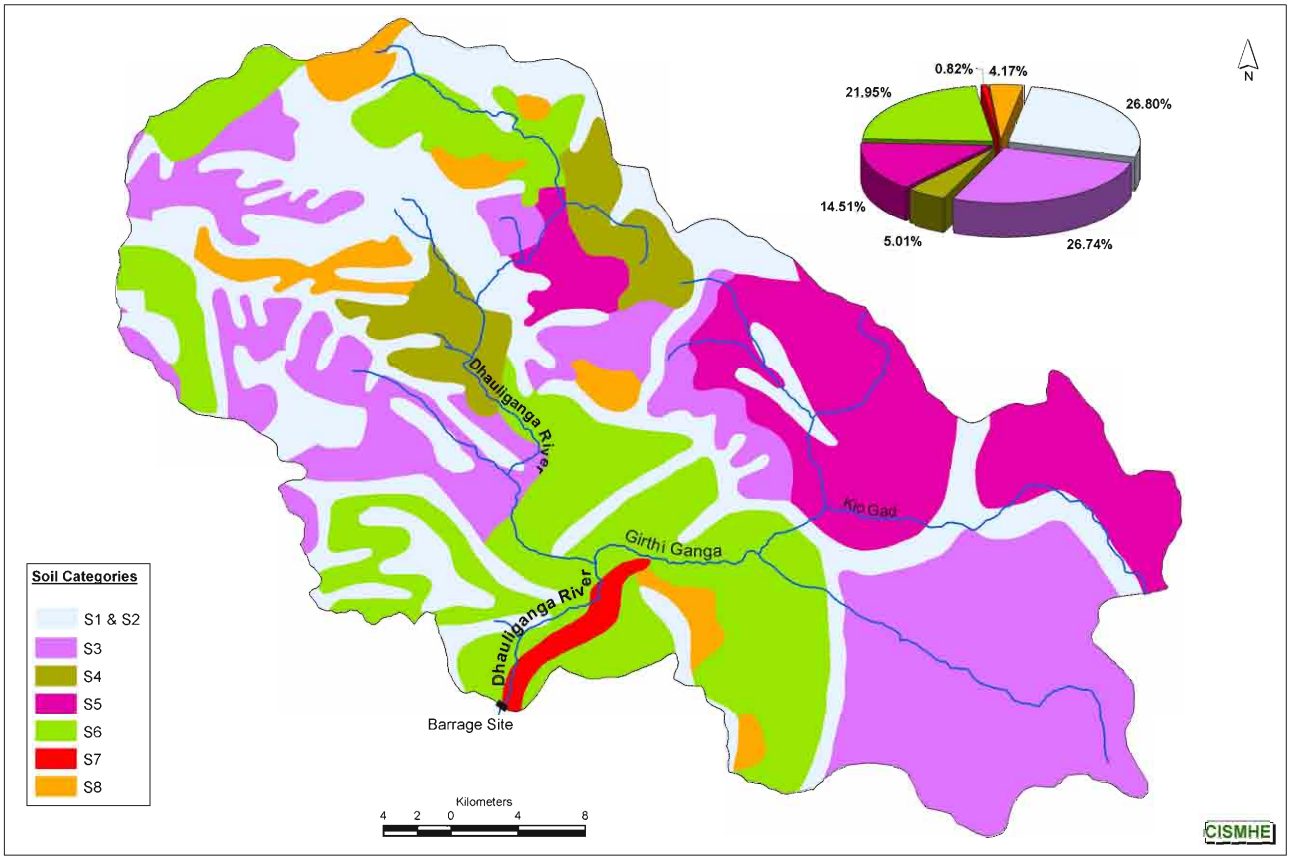

Fig.5 Soil map of catchment area up to the barrage site of Jelam Tamak H.E. Project

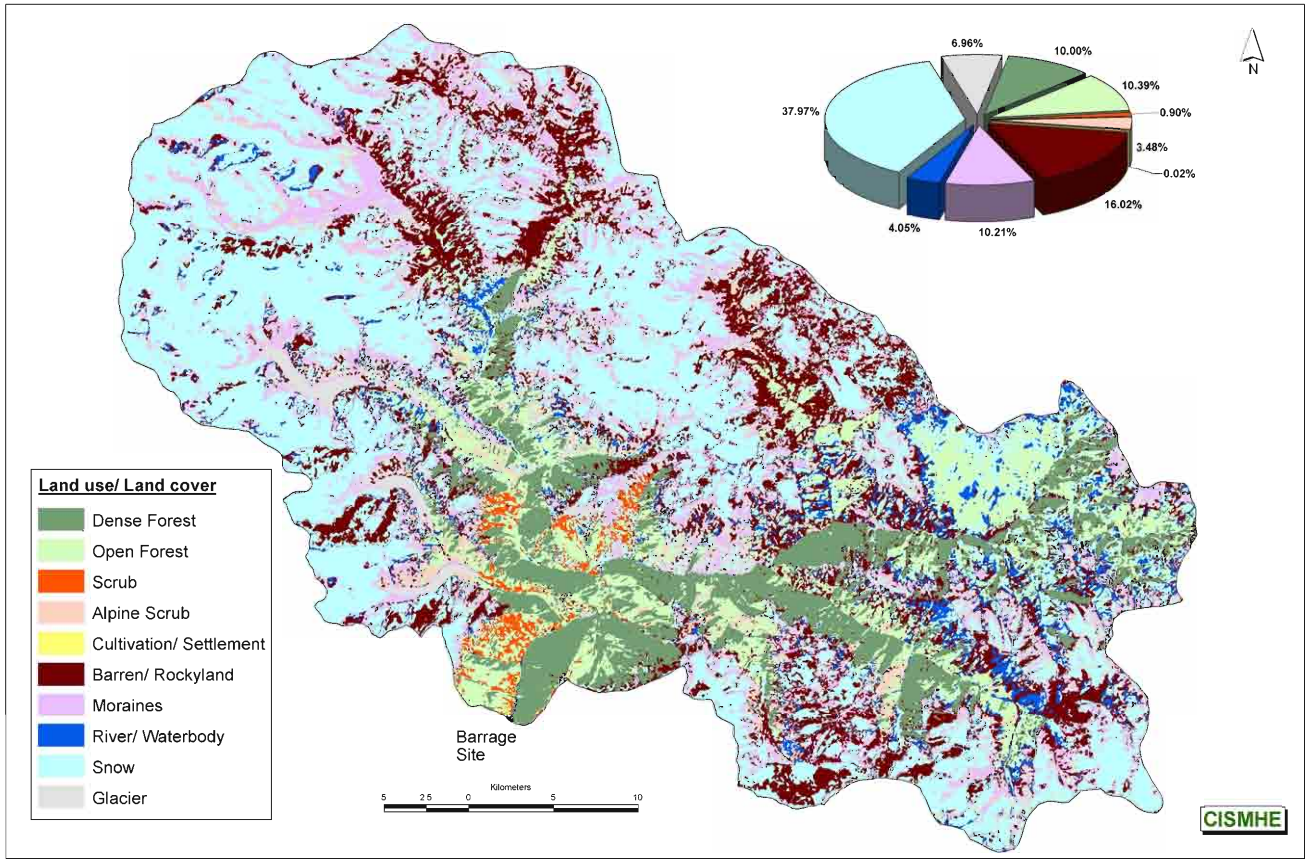

Fig.6 Land use/ land cover map of the Jelam Tamak H.E. Project up to the proposed barrage site

West Himalayan dry juniper forests and West Himalayan birch/fir forests. The area falls in the buffer zone of Nanda Devi Biosphere Reserve.

The ecological study in the project area of Jelam Tamak HEP was undertaken with the objectives of preparing a checklist of flora in the submergence area and locations where project components are proposed; listing of rare/endangered, economically important and medicinal plant species; determination of frequency, density and IVI of different vegetation components.

In the study area (within 10 km radius), angiosperms are represented by 196 species belonging 147 genera and 59 families. Out of 59 families, 50 are dicots and 9 are monocots. The dicotyledons are represented by 146 species belonging to 110 genera 50 families, while the monocotyledons are represented by 37 genera and 50 species. Gymnosperms are represented by 4 families, 7 genera and 7 species. Poaceae with 25 genera and 27 species and Asteraceae with 12 genera and 14 species are the largest families of monocots and dicots, respectively. Among gymnosperms Pinaceae is the dominant family represented by 3 genera and 3 species. The diversity of vegetation in Jelam Tamak and its adjacent areas was assessed in terms of the physiognomy of its floral elements. The herbaceous species (72.90%) constitute bulk of the flora followed by shrubs (15.76%), trees (7.88%), climbers (2.46%) and parasites (0.98%).

There are reports of nearly 116 endemic species of flowering plants found in Uttarakhand. Some of these endemic species are found in the catchment as well. Species like *Arenaria ferruginea*, *Berberis petiolaris, Calamagrostis garhwalensis, Carex nandadevensis,* etc. were reported from the catchment area (Nanda Devi Biosphere Reserve). As per Red Data Book of India, only two species (*Allium stracheyi* and *Taxus baccata*) are recorded from the project and catchment area. Some threatened plants like *Arenaria curvifolia, Cypripedium himalaicum, C. cordigerum, Nardostachys grandiflora* and *Picrorhiza kurroa* are reported from the core and buffer areas of Nanda Devi National Park and Valley of Flowers The possibility of wiping out of any species from the ecosytem is not expected, since aerial distance of proposed project from nearest point of these pristine areas is around 16-17 km. As far as forest area (92.44 ha) proposed for the direct project activities are concerned only *Allium stracheyi* could be located in submergence area and barrage area.

The region is rich in medicinal plant diversity. Some of the medicinal plants like *Artemisia gmelinii, Astragalus candolleanus, Berberis aristata, Ephedra gerardiana, Saussurea costus,* etc are quite common in the temperate and sub-alpine part of the project area. Parts of many plants are used by local people as vegetables or eaten raw. These include fruits of *Prunus armenica, P. persica, Pyrus malus, Rosa sericea*,etc which are eaten raw. Leaves of certain wild plant species provide good source of minerals in the diet of the local people. *Amaranthus paniculatus*, *Chenopodium album, Rumex nepalensis,* and *Urtica dioica* are important plant source of minerals.

9. FAUNAL ELEMENTS

The fauna of Western Himalaya shows its affinities partly with oriental fauna and partly with palaearctic forms. The fauna of Dhauliganga basin largely affected by the palaearctic features which increase towards north-west Himalaya. However, some of the oriental elements also make their presence in the region especially in the lower reaches and southern part of the basin. Of 390 mammalian species in India, the catchment area harbours about 17 species of mammals belonging to 8 families. Rhesus macaque (*Macaca mulatta*) and Common langur (S*emnopithecus entellus*) are widely distributed in the region. Wild boar (*Sus scrofa*), Musk deer (*Moschus chrysogaster*), Barking deer (*Muntiacus muntjak*), Sambar, (*Cervus unicolor*), Goral (*Naemorhedus goral*), Blue sheep (*Pseudois nayaur*) and Argali (*Ovis ammon*) represent order Artiodactyla in the region. Argali and Blue sheep are found over 4000 m. between tree line and trans-Himalayan tracts. Nanda Devi Biosphere Reserve is well known habitat of Blue sheep and Argali in the basin. Common leopard (*P. pardus*) is very common in the region, distributed between lowermost reaches to 3000 m. They sometimes, enter in the human habitation and kill domestic animals. Snow leopard (*P. uncia*) inhabits upper part of the basin (above 3000 m). Dog family includes Wolf (*Canis lupus*), Asiatic Jackal (*C. aureus*), Red fox (*Vulpes vulpes*) and Indian wild dog (*Coun alpinus*).

The avifauna in the catchments and project vicinity of proposed project is comprised of hawks, vultures, falcons, eagles, partridges, pheasants, pigeons, doves, cuckoos, swifts, barbets, drongoes, mynas, tits, sparrows, tree pies, magpies, thrushes, laughing thrushes, bulbuls, flycatchers, finches, wagtails, forktails etc.. Most of the species are common in influence zone while a few of them like Snow partridge (*Lerwa lerwa*), Himalayan snowcock (*Tetragallus himalayensis*), Monal pheasant (*Lophophorus impejanus*), Cheer pheasant (*Catreus wallichii*), Wood pigeon (*Columba hodgsonii*), Yellow billed chough (*Pyrrhocorax graculus*), Common chough (*Pyrrhocorax*

Pyrrhocorax) and Rock bunting (*Emberiza cia*) are restricted in the catchment area inhabiting areas above 2500 m.

Catchment area of Jelam Tamak H.E. Project is very poor in harbouring the herpetofauna. Influence zone (lower reaches) is expected to harbour nearly 4 species of amphibian, viz. *Rana annadalei*, *R. blandordii*, *R. leibigii* and *R. minica*. Reptiles comprise of *Hemidactylus brooki*, *H. flaviviridis*, *Agama tuberculata*, *Japalura major*, *Scincella himalayanum*, *Amphiesma stolata*, *Xenochrophis piscator*, *Ptyas mucosus* and *Vipera russelli.* Based on the IUCN criterion a total of 4 species of mammals are threatened in the catchment area. In the bird species four species namely *Gypaetus barbatus*, *Catreus wallichii, Lophophorus impejanus* and *Pucrasia macrolopha* have been identified as threatened species as per criterion of ZSI (1994).

During the pre-monsoon season Goral (*Nemorhdaedus goral*) was spotted between proposed barrage and powerhouse sites (left bank of river Dhauliganga) of the project. Local inhabitants confirmed the presence of Himalayan tahr (*Hemitragus jemlahicus*) near the proposed project activities area. In monsoon season Himalayan weasel (*Mustella sibirica*) was spotted near the proposed power house while Asiatic Jackal (*Canis aureus*) was sighted upstream of barrage site (right bank). Group of Rhesus Macaque (*Macaca mulatta*) was observed for all seasons in the surroundings. Pellets and tracks of deer were recorded at bank of river near proposed barrage site in winter season.

A total of 34 species of birds (including three unidentified species) were observed in and around the project areas during three seasons. Rock pigeon, Common myna, White cheeked bulbul, Tree sparrow, Greenish warbler and Rock bunting were most common and abundant species in the project area. Majority of the species were widespread and sparse resident. None of the species was threatened and scheduled.

Rana annadalei, *Hemidactylus brooki*, *H. flaviviridis*, *Agama tuberculata* and *Vipera russell* were common herpetofauna in the surroundings of the proposed project. A carcass of *V. russell* was observed downstream area of proposed power house confirming its presence in the region. *Hemidactylus* spp. were common in households near the project area. *A. tuberculata* was most abundant species among the herpetofauna in and around the project area.

A total of 17 species of butterflies were recorded belonging to 6 families with maximum (17) in monsoon season. During the winter season only 4 species (Himalayan Fivering, Indian Red Admiral, Dark Clouded Yellow and Sapphire) were observed far below the project area. Majority of the species were sighted in the lower reaches of influence zone. Common Fourring, Cabbage White and Indian Red Admiral were most common species of butterflies around the project areas.

10. PROTECTED AREAS

The proposed project lies within the buffer zone of Nanda Devi Biosphere Reserve. Nanda Devi National Park forms one of the core zones of the biosphere Reserve having a total area of about 624.62 sq km. The other core zone subsequently added to it is the Valley of Flowers National Park (VONP), which covers an area of 87.50 sq km. The total area of Nanda Devi Biosphere Reserve is 5,860.69 sq km. The area covered under buffer zone is 5148.57 sq km. Core zones do not fall within 10 km radius of the proposed H.E. project. A detail Map of Nanda Devi Biosphere Reserve is given in **Figure 7.**

People living in the 47 villages of the buffer zone of Nanda Devi Biosphere Reserve belong to two ethnic groups viz., Indo-Mongoloid (Bhotiya) and Indo-Aryan with their indigenous culture, tradition and religious beliefs. The Bhotia reside in the higher mountains near the area of the reserve. No human habitation exists in the core zones of the Nanda Devi Biosphere Reserve. Out of 47 villages, 34 villages are in Chamoli, 10 in Pithoragarh and 3 in Bageshwar districts. The principal occupation is agriculture and sheep rearing although tourism is coming up as an important industry in the region.

Core zones are predominated by Silver fir (*Abies pindrow*) and birch (*Betula utilis*) forests. Buffer zone follows more or less broad pattern of forests types of north-west Himalaya. They are temperate forests, upper West Himalayan temperate forests, sub-alpine birch-fir and moist and dry alpine scrubs and pastures. Nanda Devi Biosphere Reserve is represented nearly by 739 species of angiosperms belonging to 378 genera and 98 families. In addition to this, there are 11 species of gymnosperms and 51 species of pteridophytes in the area. Among the angiosperm dicotyledons are represented by 600 species belonging to 301 genera and 86 families, while the monocotyledons are

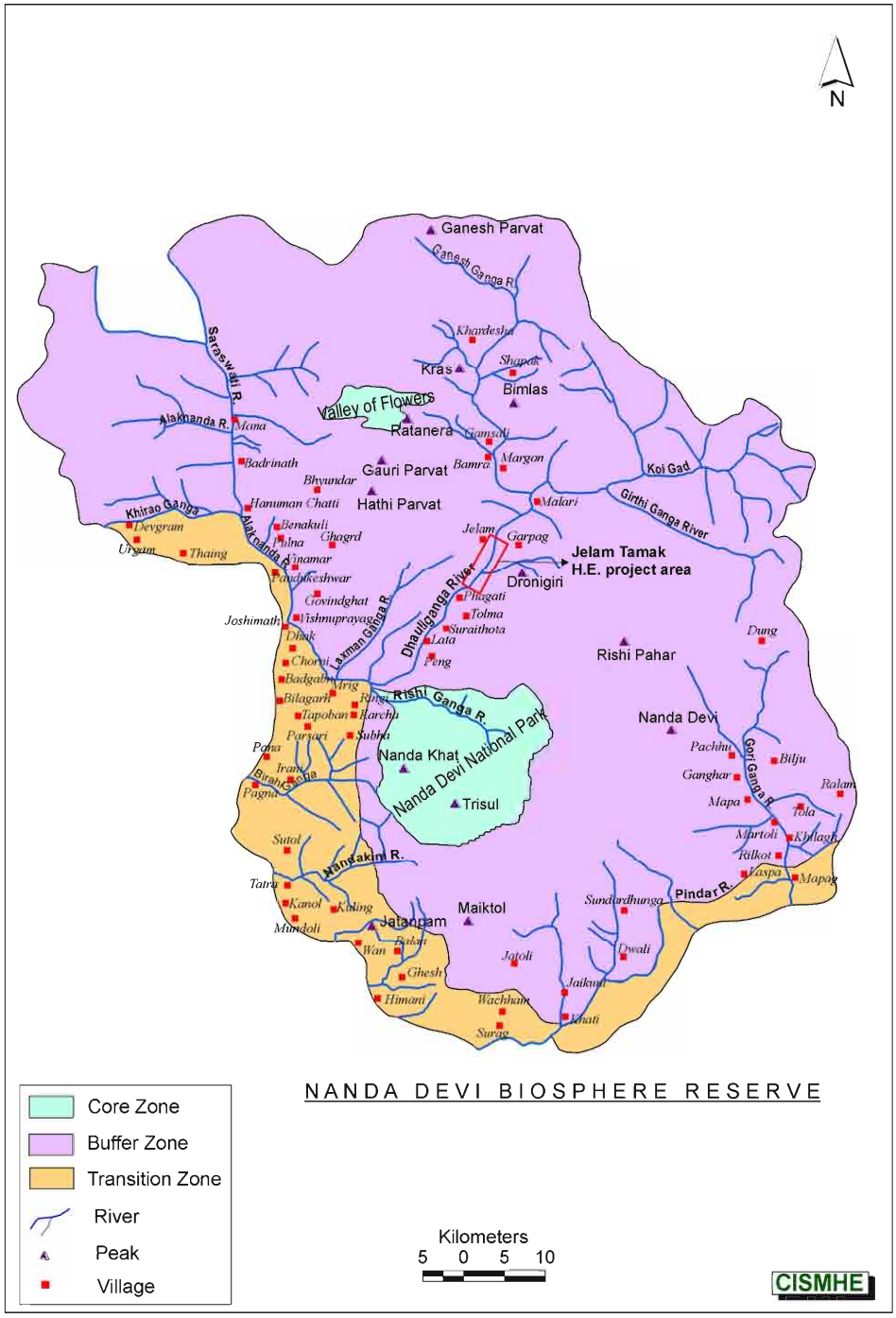

Fig.7 A map showing Jelam Tamak H.E. project vis-a-vis Nanda Devi Biosphere Reserve

represented by 139 species belonging to 77 genera and 12 families. Gymnosperms are represented by 4 families, 8 genera and 11 species.

Mammalian fauna of Nanda Devi Biosphere reserve is comprised of more than 18 species belong to 9 families. In the Nanda Devi National Park an account of the 14 known species of mammals has been reported by Tak and Lamba (1985) Himalayan musk deer (*Moschus chrysogaster)*, mainland serow (*Capricornus sumatrensis*), and Himalayan tahr (*Hemitragus jemlahicu*) are common but density is not plentiful. Bharal (*Pseudois nayur*) and Snow leopard (Panthera uncial) inhabit high altitude and are not common species. Among the primates Hanuman langur (*Semnopithecus entellus*) and Rhesus macaque (*Macaca mullata*) are very common species in the parks, especially in buffer zones. Mammalian fauna of other core zone -Valley of Flowers National Park is more or less similar to the Nanda Devi National Park. A total of 13 species have been recorded from the Valley of Flowers National Park. Blue sheep, Himalayan tahr, Musk deer, Serow, Snow leopard, Common leopard and Red fox are 'threatened' species.

Himalayan monal (*Lophophora impejanus*), Koklas pheasant (*Pucrasia macroplopha*) Snow partridge (*Lerwa lerwa*), Himalayan snowcock (*Tetraogallus himalayensis*) and Chukar partridgte are important Galliformes of the core zones. Among the Falconiformes Himalayan golden eagle (*Aqiula chrysaetos*), Himalayan griffon (*Gyps himalayensis*) and Lammergeier (*Gypaetus barbatus*) are the most common species. Crested black tit (*Parus melanolophus)*, Yellow-bellied fantail flycatcher (*Rhipidura hypoxantha)*, Orange-flanked bush robin (*Erithacus cyanurus*), Bluefronted redstart (*Phoenicurus frontalis*), Indian tree pipit (*Anthus hodgsoni*), Vinaceous breasted pipit (*A. roseatus*), Common rosefinch (*Carpodacus erythrinus*) and Nutcracker (*Nucifraga caryocatactes)* are abundant species of these national parks.

About 80 species of butterflies are known to inhabit NDBR (Arora *et al*. 1995). The important species of core and buffer zones are: Dark clouded yellow (*Colias electo fieldii*), Painted lady (*Cynthia cardui*), Indian tortoiseshell (*Aglais cashmirensis*), Indian fritillary (*Argyreus hyperbius*), Queen of Spain fritillary (*Issoria lathonia*), Comma (*Polygonia album*), Common sailer (*Neptis hylas varmona*), Himalayan sailer (*Neptis mahendra*), Chocolate soldier (*Precis iphita iphita*), Blue admiral (*Kaniska canace*), Large silverstripe (*Childrena childreni*), Common tiger (*Danaus genutia*) and Plain tiger (*Danaus chrysippus*).

The buffer zone, constituting the area immediately surrounding the core zone of Nanda Devi, is home to 19 communities. Lata and Reni situated near the West entrance of the reserve and the confluence of the Rishi and Dhauli Ganga, are the most prominent villages in the buffer zone. Other large settlements include Malari, Jelum, Jumma, Dronagiri, Gamshali, and Tolma. Furthest north along the Dhauli lies the village of Niti at the Indo-Tibetan frontier, from which the entire valley has traditionally drawn its name.

11 WATER ENVIRONMENT & AQUATIC ECOLOGY

11.1 Water Quality

The present study has been focused on the water quality in Dhauliganga river stretch from Jelam to downstream Vishnu Prayag Chamoli district of Uttarakhand. Water samples were taken during Post- monsoon, Pre- monsoon and Monsoon seasons from various locations. All the water samples were analysed for various physical, chemical and biological parameters to get an overview of water quality. Table 2 gives details of physico-chemical parameters of river water.

Total absence of coli form from the study area indicating good water quality in the present stretch. In the plankton communities, zooplanktons accounted for minor part (Table 3). Their density was higher in pre- monsoon season than in monsoon season. Density of suspended algae was highest in post- monsoon season and lowest in monsoon season. Minimum density of benthic macro invertebrates was recorded at W5 (33 Indiv./m^2) in monsoon season, while maximum density was recorded at W2 (5810 Indiv./m^2) in pre- monsoon season. Monsoon season recorded minimum density for all the biotic communities recorded, as the high discharge during the season washes away the suspended as well as benthic organisms. A total of 101 diatom taxa were found during the study, in which 44 taxa were common in both communities (benthic and suspended) while 30 were specific to the suspended form and 27 to benthic form. *Gomphonema* was the genera with maximum number of taxa (25 taxa) followed by *Achnanthidium* (24 taxa), *Cymbella* (22 taxa), *Fragilaria* (10 taxa) and *Diatoma* (6 taxa). Diatom assemblage composition of *Achnanthidium, Cymbella, Fragilaria* and *Diatoma* indicates good water quality, as these genera are generally characteristics of oligotrophic streams (Hieber, 2001). In suspended form, maximum numbers of taxa (32 taxa) were found at W3 and minimum numbers of taxa (17 taxa) were found at W2 in pre- monsoon season.

Table 2. Physico-chemical characteristics of Dhauliganga river near Jelam Tamak H.E. project area

	Post-monsoon				Pre-monsoon					Monsoon				
Parameters	**W1**	**W2**	**W3**	**Jn**	**W1**	**W2**	**W3**	**W4**	**W5**	**W1**	**W2**	**W3**	**W4**	**W5**
Physical Characteristics														
Water current velocity (m/s)	1.40	1.30	1.10	NR	0.92	1.34	1.28	2.72	1.25	2.24	3.27	2.43	2.89	2.40
Water discharge (Cusecs)	6.10	11.60	11.90	NR	19.97	21.51	30.67	41.61	44.79	70.32	86.57	98.83	174.8	263.55
Temperature (ºC)	6.00	5.00	6.00	6.50	5.83	6.00	6.00	9.00	9.00	10.00	10.00	12.00	10.00	13.00
Turbidity (ntu)	3.00	3.00	2.00	3.00	1.00	1.00	2.00	1.00	2.00	45.00	52.00	53.00	64.00	72.00
Chemical Characteristics														
pH	7.70	7.70	7.70	7.10	7.85	8.06	8.28	8.12	8.18	8.67	8.76	8.69	8.66	8.67
Dissolved Oxygen (mg/l)	11.2	12.60	11.50	NR	8.05	10.05	10.00	10.05	9.85	8.93	8.43	7.86	9.60	9.40
BOD (mg/l)	0.22	0.12	0.36	-	1.23	1.02	1.22	1.41	2.21	0.21	0.23	0.29	0.21	0.23
COD (mg/l)	1.25	1.29	1.25	-	2.56	2.43	2.68	3.21	1.21	1.12	1.34	1.21	1.46	1.53
E. Conductivity (µs)	136.6	135.00	139.00	58.66	354.70	353.00	362.00	330.00	269.30	152.00	146.00	131.00	169.00	76.00
Salinity (mg/l)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
TDS (mg/l)	156.60	160.00	160.00	30.00	226.70	198.00	220.00	201.30	162.00	112.70	185.66	102.33	116.30	81.00
Total alkalinity (mg/l)	76.00	80.00	78.00	24.00	92.00	86.00	84.00	84.00	68.00	56.00	68.00	66.00	60.00	52.00
Total hardness (mg/l)	208.00	224.00	220.00	40.00	138.00	134.00	128.00	112.00	94.00	136.00	136.00	136.00	148.00	128.00
Ca hardness (mg/l)	116.00	140.00	84.00	28.00	81.90	79.80	77.70	75.60	63.00	100.00	100.00	96.00	112.00	88.00
Ca++ (mg/l)	46.40	56.00	33.60	11.20	32.79	31.95	31.11	30.27	25.23	40.00	40.00	38.40	44.80	35.20

Mg hardness (mg/l)	92.00	84.00	136.00	12.00	56.40	54.20	50.30	36.40	31.00	36.00	36.00	40.00	36.00	40.00
Mg++ (mg/l)	22.35	20.41	33	2.91	13.7	13.16	12.22	8.84	7.52	8.74	8.74	9.72	8.74	9.72
Chloride (mg/l)	8.99	5.99	5.99	7.99	8.99	6.99	5.99	5.99	6.99	8.50	9.92	8.50	9.92	9.92
Nitrate as NO_3-N (µg/l)	0.33	0.91	0.73	0.00	0.82	0.63	0.86	0.56	0.13	0.00	0.00	4.52	2.98	3.52
Phosphate as PO_4-P (µg/l)	0.00	1.05	0.30	0.16	0.20	0.22	0.00	0.00	0.26	1.62	0.614	1.07	0.00	0.00
Iron (mg/l)	1.10	1.13	1.14	1.10	1.26	1.24	1.21	1.24	1.24	1.11	1.23	1.11	0.98	1.11
Heavy metal (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Heavy metal included Mercury (Hg), Cadmium (Cd), Lead (Pb), Chromium (Cr)

11.2 Fish and fisheries

None of the fish species was encountered during the fish surveys in Dhauliganga river. There are no traditional fishermen communities in region and local inhabitants also denied any possibility of fish species in the Dhauliganga river stretch between Raini to Malari villages. Also, fish fry and fingerlings from the pools and ditches were not observed.

12. AIR ENVIRONMENT

There is no point source of air pollutants in the region. However, the diffuse sources like forest fires in summer, construction works of roads, river valley projects, burning of fuel woods and vehicular movement are main agents of air pollution. Levels of SPM (RSPM, and NRSPM), NO_x and SO_2 were measured at different locations in the project area by using Respirable Dust Sampler (Envirotech APM 460BL) with gaseous sampling attachment (Envirotech APM 411TE).

Highest concentration of SPM was recorded in Malari village that can be attributed to the wind erosion of soils of steep slopes. At Joshimath the SPM levels were comparatively higher in August as compared to that recorded in March. In this region the main sources of SPM are vehicles, open degraded land areas and landslides. In monsoon season the SPM concentrations were lower due to the settling down of dust particles.

The only source of NO_x emissions in the project area is vehicles. Maximum levels of NO_x were observed at Joshimath (3.517 $\mu g/m^3$) in the monsoon season when the region undergo through heavy vehicular movement due to pilgrimage and tourism activities. The main source of SO_2 is burning of fuels such as oils and coal. In the entire Chamoli district there is total absence of power plants based on coal and oil. Levels of SO_2 were non-traceable in all the seasons which may be due to low traffic flow in the region.

The highest traffic density per hour was recorded in the summer season near Tapovan (32) which dropped to 21 in upper segment of the road. During the winter season vehicular density was minimum. Light vehicles (taxies) are main source of public transport in the region while heavy vehicles include trucks and dumpers. The traffic data implies that there is no major vehicular pollution in the region.

Table 3. Density of various biotic communities Dhauliganga river near Jelam Tamak H.E. Project area

	Post- monsoon				Pre-monsoon					Monsoon				
Biological Characteristics	**W1**	**W2**	**W3**	**Jn**	**W1**	**W2**	**W3**	**W4**	**W5**	**W1**	**W2**	**W3**	**W4**	**W5**
Total Coliforms test	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Zooplankton (indi./lit.)	NR	NR	NR	NR	164	94	672	196	288	23	34	12	26	21
Suspended algae (cells/ lit.)	40864	20229	7020	NR	82	225	244	42	72	22	31	10	9	16
Phytobenthos (cells/ cm^2)	96212	197900	34983	8801	680932	175897	842887	794722	170	5	0	21	NR	NR
Macro invertebrates (indiv / m^2)	266	465	154	NIL	3144	5810	3833	433	1344	177	122	221	NR	33

The average sound level ranged from 47.5±0.66 – 59.3±0.54, 53.6±2.7 – 58.1±3.1 and 53.2±1.6 – 62.3±0.54 during post monsoon, pre-monsoon and monsoon seasons, respectively. Upstream and downstream of Vishnupryag and Jhelam Nala recorded high sound level. It can be attributed to the construction works of hydro-electric projects.

13. SOCIO-CULTURE & ECONOMIC PROFILE

Proposed Jelam Tamak H.E Project is located on the Dhauliganga river in Joshimath sub division of Chamoli district in Uttarakhand. The total population of district Chamoli is 3,70,359 with a sex ratio of 1015 (Census 2001). About 86.3% of the total population inhabits the rural areas. Total literacy rate of district is 75.4% with maximum in males. The population structure is comprised of Brahmins, Rajputs, Scheduled caste (SC) and Scheduled tribe (ST). SC and ST population account for 18.2% and 2.8% of total population, respectively. The scheduled tribe population is composed mainly of Marchha bhutias and Tolchha bhutias.

A total of 14 villages are located in the influence zone of project. Total population of these villages is 2034 come from 517 households (Census, 2001). The sex ratio in these villages is 1007; is more than district, state and National averages. Age group 0-6 year accounts for 15.5% of the total population. Scheduled caste population forms small part of the population and restricted in 5 villages only. The influence zone is dominated with Scheduled tribe population, accounting for 78.86% of the total population. Tapovan and Joshimath are the centres of senior secondary education while Joshimath, Karanprayag and Srinagar are the centres of higher education. Average literacy rate in these villages is 66.9% with considerably higher in males (83.35%). Maize, millets, beans, potato and spices are main crop in the area.

A total of three villages are directly affected due to the various project activities. Jelam is nearest village of proposed barrage site, located on the right bank of Dhauliganga river. Total population of Jelam village is 315 comes from 85 households. The land of Jelam village has to be acquired for dumping areas and colony area is 4.28 ha. Total household affected in Jelam village would be 8 in number. Jumma village is located on the right bank of Dhauliganga river. Total population of Jumma village is 98 belong to 27 households. The land of Jumma village has to be acquired for dumping areas, contractor labour colony area is 3.34 ha. Total 06 households will be affected due to various project activities. Longsagari (Tamak) village is located on the right bank of

Dhauliganga river and is nearest village of proposed power house. The land of Longsagari (Tamak) village to be acquired for proposed power house complex is 0.36 ha. A total of 17 households will be displaced due to project activities while 16 are affected. Majority of the households are affected due to the project activities. In addition, Dronagiri village is affected due to acquisition of 9.8 ha Van Panchayat land. The village is not directly affected but needs to be compensated.

A total of 47 households from three villages are directly affected due to various project components of Jelam Tamak H.E. Project. Out of 47 households total 31 families of 17 households belonging to Longsagari village are displaced. Total population of affected families of proposed project is 217 with a sex ratio of 1028. All population comes from Scheduled tribe families.

The residents of villages Kosa, Jelam, Jumma, Kaga Laga Dronagiri and Garpak (located in influence area) descend in lower reaches of Chamoli district to cop peak winter. They are located in various hamlets and villages like Mangroli, Paunkhila, Kaleshwer, Karnprayag and Mathiyana Pursari of Karanprayag, Nandprayag and Chamoli sub divisions of the district. However, their revenue records are under the jurisdiction of Joshimath sub division. All villagers have *pucca* houses, mostly made up of stone masonry. Road network and transportation are poor and all villagers depend on a single State Highway. All villages of influence area have primary education facilities but lack secondary and senior secondary education facilities. Health facilities are also poor in the region. A total of 19 families of directly affected villages belong to BPL categories, 11 are widows and 32 come under the category of senior citizen. Indirectly affected revenue village Dronagiri comprises of 3 villages namely, Dronagiri, Garpak and Kaga. A total population of these villages is 807 belonging to 145 families as per family register.

14. ENVIRONMENTAL FLOW ASSESSMENT

Due to absence fish fauna in the river stretch under investigation, the environmental flow has been designed for macro-invertebrate fauna and algal species. The average lean flow of 2.97 cumecs will be released from the barrage site of Jelam Tamak H.E. Project during lean season and non monsoon season while 5 cumecs will be released in monsoon season. In downstream section 4 perennial tributaries contribute to the discharge, thus, water discharge gradually increase in the downstream course. The simulation of these flows in different months seems adequate for the

survival of macro-invertebrates and algal species as average depth and water current velocity in the downstream would be more than 15 cm and 0.5 m/s, respectively throughout year.

15. IMPACT ASSESSMENT

15.1 Land Environment

The environmental impacts of the proposed Jelam Tamak H.E. Project are being forecast in the light of the activities that would be undertaken during the construction of barrage, drilling and blasting during tunneling for head race tunnel, adits, roads, construction of permanent housing and labour colonies, quarrying for construction material and dumping of muck generated from various project components. The likely impacts have been considered on ecosystems, both terrestrial and aquatic as a whole and also on individual critical species, if any. Impacts have also been assessed on the geophysical environment of the area which may lead to serious negative consequences.

The major impacts on the terrestrial ecosystem anticipated are habitat disturbance, degradation, fragmentation and destruction. Out of 96.27 ha of land to be acquired, 65.45 ha is forest land, 7.98 ha is nap land and 9.8 ha is Van panchyat land. The areas of direct activities like roads, barrage structure, dumping area etc. house very sparse forest and are dominated with scrubs. The predominant species of these areas are *Fraxinus xanthoxyloides*, *Sorbaria tomentosa*, *Berberis aristata*, *Ribes orientalis, Fragaria nubicolia*, *Alliums* sp., *Artemisia gmilinii, Anaphalis* sp. etc Sparse mixed coniferous forest (*Cedrus deodara*, *Pinus wallichiana*, *Fraxinus xanthoxyloides*, *Hippophae salicifolia*) are dominant in the areas of indirect activities (uphills and ridges). The species located on the areas of direct activities would be affected adversely. The impacts are negative and reversible, however, the major impacts on the species are not anticipated because these species are well distributed in the area and none of the species is threatened. The construction activities and influx of workers are anticipated to lead to the habitat degradation.

The proposed barrage site and upstream area have been identified as corridors of wildlife viz., *Pseudois nayaur*, *Nemorhaedus goral, Moschus chrysogaster*, *Muntiacus muntjak* etc. The project activities and human turmoil would likely hamper the movement of animals. Thus, the likely impacts on the wildlife are negative, local and irreversible. The area is inhabited by the animals like musk deer, Tahr, black bear, *Lerwa lerwa*, *Tetragallus himalayensis*, *Lophophorus impejanus* etc.

which are shy in nature and prefer a calm and relaxed environment. The project activities may affect them adversely especially breeding activities. The impacts on the wildlife due to project activities are negative, short term and irreversible.

15.2 Water Environment

The likely impacts on nearby water bodies during construction phase are anticipated due to the increased labourer, dumping of muck etc. The possibilities of sewage outfall from labourer colony, open defecation alongside the river and leaching of muck persist in the area if not managed properly. The additional population of around 2400 may exert the pressure on the river water due to sewage outfall, bathing and other activities. The annual estimated outfall of sewage due to additional population in Jelam Tamak H.E. Project would approximately be 8,76,00,000 litres, if not managed properly.

The impacts would be indifferent, irreversible and local. The river water does not house any endemic and threatened algal and macro-invertebrates. Therefore, significant negative and positive changes are not anticipated. Increasing water fringe due to reservoir may likely favour the vectors of water borne disease. However, climatic conditions in the region are not conducive for high concentration of the vectors.

None of the fish species has been recorded in 10 km radius of the project sites during the survey, therefore, negative impacts on fish population are not anticipated. Contrarily, increased water fringe due to the creation of reservoir would provide a fair possibility to culture some fish species. It is advisable that project authority would formulate a fishery management plan for indigenous species.

15.3 Air Environment

The process of excavation, tunneling, quarrying, dumping and transportation of muck and road construction would increase the level of suspended particulate matter many folds. The present concentration of SPM (about 95 $\mu g/m^3$) near project area might increase to 400 – 500 $\mu g/m^3$ during the construction phase. The significant increase in the vehicular movement and operation of a large number of equipments and machine would increase the level of NOx, SOx, CO and noise level in the surrounding area. The concentration of each of the pollutants might go beyond 10 $\mu g/m^3$. These pollutants would lead to adverse impacts on human health and the presence of wildlife in the

surrounding. The impacts are negative and short term, however, they are strategic in nature as would spread in a larger area of the valley.

15.4 Geophysical Environment

The project activities like road construction, tunneling, blasting, etc have many geophysical consequences. The road construction near proposed power house site might trigger the new land slides and may change the profile of existing drainage system in uphills. Excavation of HRT is prone to damage the water table. Notably, the area is rich in hot springs. However, HRT alignment does not passes through any hot spring and water table, therefore, adverse impacts on the water tables are not foreseen.

15.5 Human Environment

The influx of labourers and workers for construction activities is anticipated to influence the human environment negatively as well as positively. Nearly 2400 persons including labourers and project staff are expected to come in the area for the purpose of project work. Increasing population may put in additional pressure on the natural resources that may range from fuel wood collection to exploitation of medicinal plants. New settlements put in stresses on the existing water bodies and habitat. The project influence area is inhabited by the Bhotya tribe having different culture and tradition. There is possibility of social evils, cultural confliction and new disease with migrant labourers and workers.

15.6 Socio-economic Environment

Project authority takes up many activities with respect to the social upliftment and peripheral development. These activities play a positive role in the infrastructure development like roads, transportation facilities, education, employment opportunity, health facilities, etc. The project would provide a good share of jobs to local people. These impacts are long term and strategic. Tribal population is predominant in the project surroundings, the impacts of such types of activities would be of great importance in the region.

15.7 Downstream Impacts

The downstream impacts due to the barrage/dam are imperative to highlight, because it is directly related to the biotic communities of the river, riparian vegetation, channel deformation and

socio-cultural and economic aspects. Though, magnitude of downstream impacts would be small in Jelam Tamak H.E. Project because water will be diverted from a very small stretch, fish species are absent in this section, people in the area are not dependant on the river water for drinking, irrigation, etc. The problem of water availability would be more serious in downstream section, where most of the discharge would be diverted through HRT and this stretch would lost its purifying capacity. In the downstream 4 tributaries join river Dhauliganga at 0.52 km (Dunagiri Gad on left bank), 1.7 km (unnamed nallah on left bank), 3.6 km (Jumma Gad on right bank) and 4.04 km (Bhosing Gad on left bank). Considering 20% average discharge of lean months 2.97 cumec of water would be released from the barrage axis during non monsoon months while 5 cumec of water would be released in monsoon months (June to September). After the confluence of first Dunagiri nallah water discharge would increase to 4.14 cumec (February) to 15.24 cumec (July). Water discharge would gradually increase in downstream and before tailrace discharge it would be 4.44 cumec to 17.49 cumec in respective months.

Since fish fauna is absent in the river stretch, discharge is not relevant to fish species. However, after the diversion, flow of water would be confined to a small channel in downstream. It would lead to adverse effect on the riparian plant species, viz. *Hippophae salicifolia, Salix wallichiana, Sorbaria tomentosa,* etc.

15.8 Cumulative Impact Assessment

Cumulative impacts on the surrounding of both projects like Malari Jelam and Jelam Tamak H.E. Projects have been assessed on the land environment, water environment, geophysical environment, biological environment and socio-economic environment. Besides the impacts of Construction phase and Operation phase are described separately in Chapter 15.

15.9 Issues of Public Hearing

All the issues raised by the public during public hearing meeting have been addressed and included in the EIA report of the project.

II ENVIRONMENTAL MANAGEMENT PLAN

The baseline study of environmental aspects regarding the developmental project is aimed towards the identification and prediction of likely impacts of the various activities on environmental variables. In consequence of the predicted impacts, a comprehensive Environmental Management Plan (EMP) is formulated to avoid or mitigate negative impacts. An EMP relies on the implementation of the suggested measures and regular monitoring of various plan. Various mitigation measures have been suggested below

1. RESTORATION OF DUMPING AREAS

During construction phase total quantity of muck including swelling factor has been estimated to be 8,06,921 cum from different appurtenant structure like barrage, adits, HRT and power house complex. In order to dispose off and to rehabilitate the generated muck, there is a provision of 9.94 ha of land come from 6 dumping sites (DS-1 to DS-6). Capacity of these dumping sites to accommodate the muck is around 7,51,180 cum. Therefore, around 7,48,000 cum would be dumped at these sites (Table 2.1). Remaining muck of nearly 59,000 cum would be utilized for the construction of different components. All sites are located atleast 30 m away from the high flood level of the river Dhauliganga. Total cost for the restoration of dumping sites would be **Rs. 771.44 lakhs**.

2. WASTE MANAGEMENT

The project area is sparsely populated. A few families have proper sanitation facilities while most of them have not proper measures of disposal of waste. The construction of the project would require additional work force to execute the work. The additional work force would include labourers, technical staff, officers etc., some of them will be along with their families. The migrant population i.e. additional workers would generate 4,38,000 kg of solid waste annually. For a population of 2400 persons for the Jelam Tamak H.E. Project, the liquid waste generated annually would be approximately 8,76,00,000 litres. An appropriate management plan has been proposed for the disposal of all types of wastes including solid waste generated in the labour camps, project colonies, offices and other sites of the proposed project. In order to manage solid waste sanitary facilities, dumpers and wheel borrows, sanitary facilities, septic tanks, bathrooms and washing

places, sewage treatment plants and incinerators are suggested at various places in the project area. Total financial outlay for the waste management would be **Rs. 249.00 lakhs.**

3. FUEL WOOD & ENERGY CONSERVATION

The fuel wood is the main source of energy in the surrounding area of Jelam Tamak HE Project. Therefore, an additional pressure due to coming labourers is anticipated in the area, if not managed properly. The plan includes the provision of alternative fuel to local people and migrant population as well. Project authorities are suggested to provide alternatives not only to the workers of the project but project affected families. These facilities can be extended to the direct impact and influence zone. In order to conserve the fuel wood and energy, provision of solar water heater, LPG depots, Kerosne depots, community kitchens, distribution of improved chullahs and solar cookers is made. Total financial outlay for the fuel wood and energy conservation is **Rs**. **50.00 lakh.**

4. PUBLIC HEALTH DELIVERY SYSTEM

The proposed plan was prepared considering the poor health facilities of surrounding villages and their accessibility. A chunk of the population including project workers and local people would be exposed to pollutants due to construction activities. The health related problem may be caused by the migrant or additional population in the area. In order to provide adequate medical facilities in the region, the project authorities are suggested to strengthen existing medical facilities in the area, to open a new hospital and a primary health centre in the affected zone, to run immunization and vaccination programmes in the surrounding villages of project. Additionally, the project authorities are suggested to organize medical camps at least one in the year, to distribute first aid box and to run a ambulance the area. Total financial package for the health delivery system for the proposed project would be **Rs. 285.50 lakh.**

5. RESTORATION OF ROAD & OTHER CONSTRUCTION AREAS

The proposed Jelam Tamak HE Project would involve construction of colonies for staff and laborers, roads linking to various components of project, offices, workshops, etc. A total area of 13.31 ha of land will be disturbed due to construction of colony area, office complex, magazine building, workshop etc. During construction phase, some locales in the right bank area are likely to be prone to soil erosion. Construction of retaining walls would be necessary to stabilize the slopes. Biological measures would involve plantation of the tree species and shrubs in the colony area.

Local plant species should be preferred for plantations. In addition road construction in the proposed project will disturb the hill slopes and result in excavated material. Retaining walls are proposed in the region to avoid slippage and land slides. Biological measures would involve plantation of saplings of various tree and shrub species along the road sides.

Cost estimates for different components of the landscaping and restoration is **Rs.121.2 lakh.**

6. MANAGEMENT OF AIR & WATER QUALITY AND NOISE LEVEL

The project activities like excavation, blasting, drilling, road construction, dumping and transportation of muck etc. lead to the immense impacts on the water, soil and air quality. In addition, new settlements, increasing vehicular movement and increasing sound level due to heavy equipments result into generation of huge amount of wastes, depravation of soil, water and air quality and high noise level. The release of effluents from working sites, SPM, NOx and SOx from heavy machines, vehicles and transportation of muck deprave not only the water, noise and air quality but biodiversity and habitat in the surrounding and is hazardous to human health.

The mitigations measures are suggested to be followed during the construction of the project. The contractor will be responsible for maintaining properly functioning construction equipment to minimize exhaust. It is advisable to the project authorities to appoint an officer, not below the rank of Senior Manager to look after these precautionary measures in and around the project components' area. Monitoring will be carried out by State Pollution Control Board, which can hire a reputed institution/University for the purpose. The funds for the monitoring will be provided by the Project authorities. The allocation of funds for this plan is given under the chapter Environmental Monitoring in the report. Total financial outlay for the management of water, air and noise level quality would be **Rs. 100.00 lakh** only.

7. CATCHMENT AREA TREATMENT PLAN

The catchment area treatment (CAT) plan for the free-draining catchment area has been formulated with the main objective of arresting soil erosion in the catchment area up to the dam site. The CAT has been limited to free-draining catchment because of an upstream river valley project, namely Jelam Tamak HE Project. Based on the topographic factors, soil type, climate, land use/vegetation cover in the catchment area, erosion susceptible areas have been identified. Analysis of these databases to assess the sediment yield index have been undertaken. The three sub-watersheds have been delineated

in the free-draining catchment area for the study of soil erosion. Sub watershed coded with Dg1 is the largest sub watershed in the free draining area with an area coverage of 10465.20 ha, it is followed by sub watershed Dg3 with an area coverage of 2742.77 ha and lastly Dg2 with lesser area coverage of 2557.4 ha. The total area of the free draining area is 15765.38 ha. Total area identified for the treatment is around 1137.26 ha which is 7.21% of the free-draining catchment area. Remaining 93% of the free draining catchment area is not suitable for treatment either due to very steep slopes (above 30%) or higher elevation or does not have the erosion very severe and severe intensity. Various engineering, mechanical and biological measures have been suggested for the treatment of catchment area. In engineering measures 147 Brushwood checkdams and 150 DRSM checkdams are suggested. In biological measures afforestation, assisted natural regeneration, pasture development and cultivation of local medicinal and useful plants has been suggested. The plan is to be executed by Forest Department, Uttarakhand in six years. The total budget for execution of the plan is **Rs. 773.43.**

8. GREEN BELT DEVELOPMENT PLAN

The purpose of the green belt development around the perimeter of various project sites of hydro electric power is to protect environmentally sensitive land as the project construction process emanates lot of dust due to excavation works, crushing of material and batching of aggregates. Some of the aims and objectives of a creating green belt around the project area are to prevent land degradation, to increase forest cover, to provide aesthetic view of project area and to supports tourism and cultural opportunities. The plantation along the reservoir periphery will serve many purposes, such as it will protect the reservoir from soil erosion and shall provide a shelter to birds and wildlife. The green belt is proposed to be developed within the project area at the following places viz., barrage site, power house site and around the periphery of reservoir. A list of indigenous tree, shrubs and herbs was prepared after identification of species suitable for development of greenbelt around the project area and along the periphery of reservoir. The overall cost of green belt development **Rs. 39.25 lakhs.**

9. RESTORATION OF QUARRY & BORROW SITES

Excavation related to quarry operations involves large degradation which results into the complete removal of vegetation cover and profound landform modifications. For construction of different components of Jelam Tamak H.E. Project substantial excavation in rock and soil would be

required. This would lead to formation of depression and craters. These areas at a later date will require proper management and restoration. Total area likely to be disturbed due to these activities is around 10.09 ha. Various biological, bio-engineering and engineering measures have been suggested for the restoration of the quarry sites. Proposed mitigation measures will also help to arrest soil erosion in the region. For the restoration of quarries, a budget of **Rs. 41.10 lakhs** is proposed in the management plan.

10. BIODIVERSITY MANAGEMENT & CONSERVATION PLAN

The catchment area and other components of Jelam Tamak H.E. Project fall in the Buffer zone of Nanda Devi Biosphere Reserve (NDBR) and is ecologically and socially very sensitive area. The region harbours relatively more unique, rare and threatened plant and animal species and inhabited predominantly by scheduled tribes of Uttarakhand having unique culture and customs. The present plan aims at the conservation of natural resources and to circumvent the stress on biodiversity. During the construction phase, various adverse impacts on the wildlife are anticipated in the surrounding areas of the proposed project in terms of increased noise levels, land vibrations during tunneling and blasting, release of air and water pollutants, etc. Mammals are the most vulnerable group affected by these negative impacts, which affect their movement, behaviour and breeding habit. The activities and development to be undertaken are Forest Resource Management, Documentation of Threatened, Endemic and Landraces species, Establishment of Botanical garden, removal of invasive species, Habitat Improvement plan and Forest protection plan. To avoid and minimize the negative impacts from these activities project authorities are advised to prepare strict guideline and action plan.

For the implementation of the above guidelines, the project authorities will provide the funds for Biodiversity Management Plan of Jelam Tamak H.E. Project of Uttarakhand for five years. The total estimated cost of the Biodiversity management and conservation would be **Rs**. **245.40 lakh**.

11. FISHERY DEVELOPMENT & DOWNSTREAM MANAGEMENT PLAN

Nearly 38 ha area of reservoir could facilitate the scope of development of reservoir fishery. The absence of fish species in that area can be attributed to the adverse climatic condition like low temperature. However, there are other indigenous Himalayan species especially schizothoracines which can thrive better in stagnant water and low temperature. These species can be introduced in

the reservoir for the fishery purpose. For the reason project authority would consult State fishery department. Total budget for this purpose would be **Rs.55.00 lakhs** only.

After the diversion of water about 4.5 km river stretch would suffer from the paucity of water. Though, diversity of ichthyofauna is nil or very low but the stretch is rich in algal and macro-invertebrates diversity. Thus, adequate flow would require to conserve above said aquatic life. Considering 20% average discharge of lean months 2.97 cumec of water would be released from the barrage axis during non monsoon months while 5 cumec of water would be released in monsoon months (June to September). After the confluence of first Dunagiri nallah water discharge would increase to 4.14 cumec (February) to 15.24 cumec (July). Water discharge would gradually increase in downstream and before tailrace discharge it would be 4.44 cumec to 17.49 cumec in respective months.

12. RESETTLEMENT & REHABILITATION PLAN

The aim of any Rehabilitation and Resettlement plan is to mitigate all unavoidable negative impacts caused due to the project and to resettle the affected persons and restore their livelihoods. The R & R plan of Jelam Tamak H.E. Project has been prepared based on socio-economic survey of the affected population and consultation with various stakeholders. Taking the regional issues, culture and custom into account a few states and some project developers have also developed their Rehabilitation and Resettlement policy with better packages. THDC has reviewed and modified its R&R policy to make it in line with the NPRR 2007 and in light of the experience gained over the years.

Total requirement for the land for various activities is 96.27 ha. Of 96.27 land forest land accounts for 65.45 ha and naap land is 7.98 ha belongs to Jelam, Tamak and Jumma villages. Van Panchayat land to acquired is 9.8 ha belongs to Dronagiri village. The maximum land of 38.33 ha including river bed area is required for reservoir (Table 4).

A total of 47 households from three villages are affected due to various project components of Jelam Tamak H.E. Project. As per the definition of NPRR (2007) total 94 families reside these households. Out of 94, total 31 families of 17 households belonging to Longsagari village are displaced. Total population of affected families of proposed project is 217 with a sex ratio of 1018. All population comes from Scheduled tribe families.

Table 4. Break up of the land required for various project components of Jelam Tamak H.E. Project

Particulars	Forest	RF	Van Panch land	Naap Land	Total
	(ha)	(ha)	(ha)	(ha)	(ha)
Reservoir area up to EL. 2650.00	29.29		9	0.04	38.33
Balance land for barrage	2.2		0.8	-	3
Land required above intake, desanders, HRT part etc,	2.92			-	2.92
Owners 'colony	4.83			-	4.83
Rock Quarry	0.31			-	0.31
RBM	4.76	5.02			9.78
Disposal area at barrage site	7.22				7.22
Disposal area near HRT	0.85				0.85
Disposal area near Jumma		1.17		0.34	1.51
Disposal area near Power house				0.36	0.36
Roads	9.38	0.82		-	10.2
Central workshop, fuel pump, auto repair shop	1.44			-	1.44
Area above power house complex & balance HRT		4.76		-	4.76
Explosive magazine area	0.03			-	0.03
Plant, store, etc. in barrage area	0.81			-	0.81
Plants, weir house, penstock, fabrication yard, etc in powerhouse area		1.27			1.27
Aggregate processing plant, stockpile area & river bed material.	1.41			-	1.41
Contractor's colony near Jumma nallah				7.24	7.24
	65.45	**13.04**	**9.8**	**7.98**	**96.27**

None of the family is rendered landless in affected area. However, 31 families are homestead oustess. Though, these families are displaced but a separate resettlement colony is not proposed for them due to inadequate group. The developmental plan for the affected area by the project authorities are capacity building, merit scholarship Scheme, incentive for adopting small family**,** adoption of village, free electricity, sports facilities, etc. In addition, project developers are expected to involve the local people in the project activities and prefer them jobs opportunities. For periphery development, project developers are expected to provide infrastructure facilities in existing schools, bus Stops/ rain Shelters, construction of footpaths and bridge repairing, provision of solar Green House, transportation facilities, assistance to Local NGOs, Community Welfare Centre(s), in the area. Total budget for the Rehabilitation and Resettlement Plan, Periphery Development and net

present value is **19,12,85,900 (Rupees Nineteen crores, twelve lakhs eighty five thousand and nine hundred only)**.

13. DISASTER MANAGEMENT PLAN

Disaster Management plan has been prepared in case of barrage breach scenario. Considering the worst case scenario, the effect of barrage breach of Jelam Tamak H.E. project was assumed in the downstream project, therefore, a comprehensive plan was formulated. The disaster Management plan includes surveillance, infrastructural development, emergency action plan, preparedness Plan, administrative and procedural aspects, development of communication System, awareness, response and recovery, evacuation Plan, mitigation and rehabilitation plan. Total financial outlay for disaster management plan would be **Rs. 352.00 lakhs** only.

14. GOOD PRACTICE

The activities put in the negative impacts on the environment are either avoided or minimized. In this regard, some of the impacts are mitigated through detailed management plan while other are avoided by taking the precautionary and safeguard measures into account. Some of measures for which a detailed plan can not be prepared are suggested as good practice viz., environmental training for the project workers, conservation of biodiversity, waste management, health aspects, landscaping, social aspects, storage, handling and emergency response for hazardous chemicals, explosives, etc.

15. ENVIRONMENT MANAGEMENT, IMPLEMENTATION AND MONITORING PROGRAMME

Various environmental variables like water, noise, air would require a regular monitoring to avoid deterioration of quality while others actions as mitigation measure need sound evaluation. Two committees are suggested for the evaluation and monitoring of environment in Jelam Tamak H.E. Project i.e. Third Party Monitoring Committee (TPMC) and Project Level Coordination Committee (PLCC). The project level coordination committee would coordinate the Third Party Monitoring Committee in various aspects. Total financial layout under this head would be **Rs. 300.00** only. There would be provision of a separate budget for the evaluation and monitoring environment and TPMC and PLCC. Many agencies like State Pollution Control Board, State Forest Department, Research institutions, etc would be involved in this work.

16. CONSTRUCTION METHODOLOGY & EQUIPMENT PLANNING

Construction methodology and selection of equipment have been planned with the aim to commission the project well within a total period of 52 months (excluding infrastructure works for 6 months). The construction of all other major components is proposed to be taken up after the availability of basic infrastructural facilities. A total of 44 different types of equipment would be used for the construction of various components like diversion tunnel, HRT, barrage, powerhouse, switch yard etc. in Jelam Tamak H.E. Project. These equipments would be deployed and run temporarily in the construction areas (for the period of construction).

17. COMPENSATORY AFFORESTATION PLAN

Compensatory afforestation has been prepared by the State Forest Department after conducting a detailed survey. The objective of the plan is to make up for the loss of forest land for construction of the proposed Jelam-Tamak Hydroelectric Project. The total forest land required for the project is 88.29 ha divided into Reserve forest, Civil soyam forest and Van panchayat land. Thus as per the Forest Department the estimated cost for Compensatory Afforestation of 176.29 ha is **Rs. 153.00 lacs**.

18. SUMMARY OF COST ESTIMATES

Cost estimate for different plans is given in Table 5. Total amount to be spent for implementation of Environmental Management Plan is **Rs 5449.17 lakhs.**

Table 5. Summary of cost estimates for various plans suggested in EMP report of Jelam Tamak H.E. Project

S. No.	Particulars	Amount (Rs. in lakhs)
1.	Restoration of Dumping Areas	771.44
2.	Waste Management	249.00
3.	Fuel wood & Energy Conservation	50.00
4.	Public Health Delivery System	285.50
5.	Restoration of Roads & other Construction Areas	121.20
6.	Management of Air & Water Quality and Noise Level	100.00
7.	Catchment Area Treatment Plan	773.43
8.	Green Belt Development Plan	39.25
9.	Restoration of Quarry & Borrow Sites	41.10
10.	Biodiversity Management & Conservation Plan	245.40
11.	Fishery Development & Downstream Management Plan	55.00
12.	Resettlement & Rehabilitation Plan	1912.85
13.	Disaster Management Plan	352.00
14.	Environment Management, Implementation and Monitoring Programme	300.00
15.	Compensatory Afforestation Plan	153.00
	Total	**5449.17**