

# **Tehri Hydro Development Corporation Ltd**

## **Environmental Studies for Vishnugad-Pipalkoti Hydro Electric Project**

### **EXECUTIVE SUMMARY**

- **Analysis of Alternatives**
- **Environmental Screening & Analysis  
for Advance Construction Works**
- **Archaeological Survey Report**
- **Terrestrial Biodiversity Report**

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## ANALYSIS OF ALTERNATIVES EXECUTIVE SUMMARY

### 1.0 INTRODUCTION

The 444 MW Vishnugad – Pipalkoti Hydro Electric Project (VPHEP) on the River Alaknanda in Chamoli district of Uttarakhand is being implemented by Tehri Hydro Development Corporation Limited (THDC). As part of the Environmental Studies of this project, an analysis of alternatives at macro and micro level was carried out. The objective was to study the various alternatives considered by the project proponents at various stages to arrive at the chosen alternatives and their environmental implications in terms of compliance with the relevant safeguard policies of the World Bank. The study includes the overall scenario of hydro projects in India and in the State of Uttarakhand to have a proper perspective and understanding of the analysis of alternatives.

### 2.0 HYDRO POWER SCENARIO IN INDIA

Considering the fact that hydro power is a renewable source of energy and is environment-friendly compared to coal based thermal power plants, and also the fact that India has huge hydro power potential, policy decisions were taken at national level to develop hydro power to meet the country's growing energy demand.

A systematic survey of hydro power potential in India was first undertaken during the period 1953 to 1959 by the erstwhile Central Water and Power Commission. According to this survey, hydro power potential of the country was assessed to be about 42,000 MW from a total of 250 schemes. This survey provided the base for development of hydro power projects in the country for the next two decades. During the period 1978 to 1987, a re-assessment of hydro power potential was undertaken by the Central Electricity Authority (CEA) on the advice of the Planning Commission. The scope of the re-assessment study included assessment of Gross Theoretical Potential, Secondary Energy contribution and Identification of possible sites for Pumped Storage development in addition to assessment of economic potential and computation of annual energy contribution in dependable and average flow conditions.

The re-assessment study assessed the hydro power potential of the country at about 84,000 MW from a total of 845 schemes. In addition, 56 sites for development of pumped storage schemes with total likely installed capacity of about 94,000 MW were also identified in various regions of the country.

#### **Demand Supply Scenario**

According to the CEA, the installed generating capacity of power in 2003 was 107,973 MW, of which share of hydro power was 25 % at 26910 MW. The projections of CEA show a peak demand of 115,705 MW by the end of 10<sup>th</sup> Plan and 157,107 MW by the end of 11<sup>th</sup> Plan. It was estimated that a capacity addition of 41,110 MW would be feasible in the 10<sup>th</sup> Plan, and efforts would be made to close the gap in demand and supply by the end of the 11<sup>th</sup> Plan. Further, it has been assessed that a mix of hydro power and thermal / nuclear power in the ratio of 40 : 60 is required in the country to have a flexibility in system operation. The ratio of 25 : 75, therefore, requires immediate correction to meet peak load requirements, as well as, system and frequency stability.

As mentioned earlier, the hydro power potential in India has been estimated at 150,000 MW which corresponds to 84,044 MW at 60 % load factor. With harnessed capacity at

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26,910 MW in 2003, it has been planned to add 14,393 MW in the 10<sup>th</sup> Plan and another 20,000 MW in the 11<sup>th</sup> Plan period in the hydro power sector.

### 3.0 HYDRO POWER SCENARIO IN UTTARAKHAND

The reassessment study revealed that the State of Uttarakhand in the Ganga basin has substantial potential for development of hydro power. The whole of Uttarakhand practically comes under the Ganga Basin, particularly, Upper Ganga Sub-Basin. The River Ganga is known as Bhagirathi in the upper reaches till it joins its major tributary Alaknanda. Gangotri glacier in the Himalayas, is at an altitude of about 7,000 metres in the District of Uttarkashi, and is the source of Ganga. The river descends down the valley and is joined by Jadnganga near Bhaironghat, Bhilangana near Tehri and Alaknanda at Dev Prayag. Alaknanda originates from the Kamet glaciers. After the confluence with Alaknanda, the river is known as Ganga and flows down the valley for about 160 km. After passing through Shivalik range of hills, it emerges in the plains of Haridwar.

#### Hydro Power Potential

In the reassessment study for hydro power potential carried out by CEA in 2001, 96 schemes have been identified in Uttarakhand, all of which come under the Ganga Basin. Out of these, 16 schemes were in operation and another 7 were under construction at the time of the study. These are given in the following table.

**Table: Hydropower Potential of Uttarakhand**

SL. NO.	IN OPERATION		UNDER CONSTRUCTION	
	Name of Scheme	Actual Installed Capacity (MW)	Name of Scheme	Actual Installed Capacity (MW)
1	Chibro	240	Lakhwar Vyasi-I	300
2	Khodri	120	Lakhwar Vyasi-II	120
3	Dhakrani	33.75	Maneri Bhali-II	304
4	Dhalipur	51	Tehri Dam	1000
5	Kulhal	30	Koteswar	400
6	Khara	72	Vishnu Prayag	400
7	Maneri Bhali-I	90	Srinagar	330
8	Garhwal Rishikesh	144		
9	Ramganga Dam	208		
10	Matatila	30		
11	Rihand	300		
12	Obra	99		
13	Khatima	41.4		
14	Ganga Canal	45.2		
15	Tanakpur	120		
	<b>TOTAL</b>	<b>1624.35</b>	<b>TOTAL</b>	<b>2554</b>

### 4.0 THDC in Hydro Power Development

Tehri Hydro Development Corporation Ltd. (THDC) was incorporated in 1988 as a joint venture of the Government of India and the Government of Uttar Pradesh (U.P.) for the development, operation and maintenance of the Tehri Hydro Power Complex and other hydro projects. In the past two decades, THDC has firmly established itself as a major

player in the development and generation of hydro power, specially after commissioning of the 4 x 250 MW Tehri Hydro Power Project, which involved highly innovative design and technological sophistication, in a difficult terrain.

The projects under implementation by THDC include Tehri Hydro Power Complex (2400 MW), on the river Bhagirathi, 444 MW Vishnugad Pipalkoti Project on River Alaknanda, and 6 Hydro Projects in Bhagirathi, Alaknanda and Sarada Valleys in Uttarakhand having total capacity of 800 MW. THDC is also updating the DPRs of two Projects in Bhutan, namely Sankosh Hydro Electric Project (4060 MW) and Bunakha Hydro Electric Project (180 MW), as well as, two Pumped Storage Schemes in Maharashtra. Thus, THDC is handling a large number of hydro projects, which are in various stages of DPR preparation, construction or operation. They include eleven projects in Uttarakhand besides the ones in Bhutan and Maharashtra.

### Site Selection for VPHEP

In 1984, Uttar Pradesh (U.P.) Irrigation Department identified Vishnugad – Pipalkoti Hydro Electric Project (VPHEP) for development with an installed capacity of 340 MW. Several alternative sites were considered in the identification report which included barrage at Helong and underground power house at Birhi on the right bank. The report also considered construction of a high dam and creation of a large storage. Two alternatives were considered. In the first case, an underground power house at Birhi on right bank was considered, and in the second alternative, a surface power house near village Hat, on the left bank, was proposed. However, no detailed investigations were carried out at the time.

In a subsequent development, the Government of Uttarakhand assigned the THDC the task of investigating and developing Vishnugad Pipalkoti site for hydro power generation.

In order to decide on a barrage or a dam, investigations were carried out by THDC at several locations in the area. The various alternatives considered are given below. While assessing the alternatives for final site selection, a lot of emphasis was laid on environmental and social aspects. The objective was to avoid or minimize impacts on physical environment, terrestrial and aquatic biodiversity and human settlements not only due to the dam but also due to the construction and operation of HRT, spillways, power house, sedimentation chambers, tail race tunnels and other facilities like approach roads, project township, labour colony, etc. For unavoidable impacts, appropriate mitigation measures were taken into account.

A summary of the findings of various alternatives is given below.

**Table 5.1: Summary of findings of various Alternatives**

Alternatives	Location	Environmental, Social & Technical issues	Remarks
D-1 site	Near Pipalkoti	<ul style="list-style-type: none"> <li>• Pipalkoti town and 6 villages will submerge</li> <li>• Huge forestland under submergence</li> <li>• NH-58 below pond level, will need realignment in 20/30 km stretch</li> </ul>	Not suitable

Alternatives	Location	Environmental, Social & Technical issues	Remarks
		<ul style="list-style-type: none"> <li>Main Central Thrust close to the site</li> <li>Calcareous rock-not suitable for storage dam</li> </ul>	
Upper Barrage Site	Just d/s of Animath nala - Alakhnada confluence	<ul style="list-style-type: none"> <li>Overburden depth too much-much excavation required</li> </ul>	Not suitable
Lower Barrage Site	Near Helong	<ul style="list-style-type: none"> <li>Close to MCT</li> <li>Full head not able to utilize</li> </ul>	Not suitable
D-2 Site	120 m d/s of D-1	<ul style="list-style-type: none"> <li>Overburden depth too much</li> </ul>	Not suitable
D-3 Site	200 m d/s of D-2	<ul style="list-style-type: none"> <li>Rockfall prone</li> <li>20m thick river borne material terrace above water level on both bank</li> </ul>	Not suitable
D-4 Site	1.5 km of d/s of D-1	<ul style="list-style-type: none"> <li>Least environmental and social problem</li> </ul>	Found suitable
D-5	50 m d/s of D-4	<ul style="list-style-type: none"> <li>Most Appropriate from environmental, social and technical aspects</li> </ul>	<b>Finally selected</b>

Taking into consideration the studies carried out by THDC, detailed investigations were carried out by the DPR consultants. On the basis of these investigations, a new site has been selected for construction of a diversion dam with low height spillway. This site is 50 metres downstream of the site selected in the feasibility study stage by THDC.

### Upstream and Downstream Linkages

The Project is envisaged as a run off river scheme to harness hydro potential of river Alakhnanda available between tail water level of Tapovan – Vishnugad Hydro Electric Project and Bowala Nandprayag Hydro Electric Project. The scheme envisages utilization of 228.86 cumecs discharge and design head of 237.0 m to generate 444 MW of hydropower.

There are several hydro projects expected to come up upstream and downstream of the VPHEP. The projects up-stream are as follows:

- 1) Tapovan Vishnugad (Dhaulti Ganga River)
- 2) Lata Tapovan (Dhaulti Ganga River)
- 3) Vishnu Prayag Scheme (400 MW) Alakhnanda River
- 4) Markura Lata (Dhaulti Ganga River)

The projects in the down stream section are as follows:

- 1) Bowala Nand Prayag Hydro Electric Project (Alakhnanda River)
- 2) Karn Prayag (Alakhnanda River)
- 3) Uvasu Dam (Alakhnanda River)
- 4) Srinagar Hydro Electric Project (330 MW) Alakhnanda River

## 5.0 Project Components

Selection of dam site is the key issue in the establishment of a hydro power project. While selecting the location of the dam, due considerations are also given to the various other project components with respect to suitability of their locations, in terms of the geology and topography of the area, accessibility, construction technology to be adopted, so on and so forth. Based on detailed investigations of all such issues, it has been decided in this project to construct underground power house with HRT and TRT. This will have minimum disturbance on the surface features of the area. A brief discussion on the project components is given here.

### Head Race Tunnel (HRT) Alignment

The 13.4 km long 8 m dia modified horse shoe shaped head race tunnel has been proposed on right bank of the river. The geological profile of the rock structure in the tunnel are completely folded and faulted. The alignment of the tunnel is crossed by several perennial and ephemeral nallas and Maina nadi, which is an important drainage and intersects the tunnel at a distance of about 9 km from the dam. The alignment of the tunnel has been optimally fixed to provide adequate rock cover below the nalla crossings. As the most critical stretch of the HRT passes through Maina nadi which required proper rock cover, detailed and adequate site investigations were carried out for finalizing and selecting the layout of the alignment.

The construction of HRT will not have any significant impact on environment as it is an underground tunnel. The HRT traverses through sparsely vegetated area with scattered Pine trees. It does not involve clearing of land. Hence the flora & fauna of the area will not have any adverse impact. It does not involve acquisition of land hence the individual and community will not be affected.

### Spillway & Energy Dissipation

For optimal utilization of the head and water available from the different streams joining the river the site an ogee spillway with vertical gates is proposed to pass the design flood of  $108050\text{m}^3/\text{sec}$  corresponding to PMF. Four openings, each with clear opening of size 6.6m x 15m (height) are proposed to cater to design flood discharge which is inclusive of one gate for additional factor of safety as per BIS Code. Radial Gates will be operated by means of hydraulic hoists. Provision of stop log gates with gantry crane has also been made.

Energy dissipation is proposed through a trajectory type of bucket which throws the feet of water through the air and into the plunge pool. Protection works in term of concrete apron are proposed immediately downstream of bucket.

### Power House

Underground Power House site is proposed on right bank of Alaknanda river downstream of Haat village covering an area of 2.00 ha. The detailed topographical study of the area and the geological investigations carried out revealed that the power house complex was suitable for accommodating tunnels such as cable tunnel, ventilation tunnel, adit tunnel to penstock. Therefore the orientation of the power house has been decided on the basis of in-situ stress and foliation direction.

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The under ground power house complex will comprise of two separate caverns. The main machine hall cavern is 127m long, 21.3m wide and 44m high. It will have a 35m long service bay and 20m long control room and space for 4 units of 111 MW. The transformer cavern will be 112m long, 16m wide & 22m high to accommodate transformer and Gas Insulated Switchgear (GIS) etc. The draft tubes shall be provided with a draft tube gate.

The construction of under ground power house site is likely to reduce the impact on surrounding environment. The area is sparsely vegetated and floral species found at the site are common in occurrence and are found extensively throughout the degraded areas. The site is located on right side of the river hence the traffic on NH -58 on left bank will not be impacted significantly.

### Approach Roads

Four (4) approach roads covering a total length of 25.578 km length. are proposed to be constructed in the project area to provide good accessibility to various work fronts i.e. Dam Site, Power House, Adits, Quarry & Borrow Area, Muck Disposal Sites, Pot Yard Area etc. The various components of the project will be connected by project road diverted from National Highway no. 58 (NH-58). They are as follows:

- (i) Approach Road to dam site ( Animath to Dam)
- (ii) Approach Road to Langsi Adit (Gulabkoti to Dwing)
- (iii) Approach Road to Maina Adit (Pipalkoti to Maina Nadi)
- (iv) Approach Road to Power house & colony site (Koriya to Siyasain)

The road to dam complex will be diverted from the existing PWD road (from Helong to Karamnisha) and will be connected to dam top, bridge, and various work fronts up to river bed etc and will be of permanent nature. The site does not have any rare/endangered or threatened species of flora. It traverses through the Van Panchayat area and the species found at the location are common and planted. The construction of road does not involve disturbance to any wildlife habitat and human settlement. There is no settlement located at the site hence no impact on local people due to the road construction.

- Construction of approach road to Langsi Dwing Adit does not involve any road cutting on left bank. The existing PWD road which was an old road route to Badrinath will be utilized from Langsi up to the Bridge on Alaknanda. The section will be updated and connected to the adit portal opposite Patal Ganga. It will avoid cutting of trees, cutting of hill and land acquisition on the left bank. Therefore the impacts on environment and social aspects are minimized by the utilizing the old abandoned road
  - The approach from National Highway near Pipalkoti will be diverted to the adit portals on Maina Nadi and will be of permanent nature. It will provide connectivity to the villages on the right bank Tenduli, Math and Guniyala. The villagers have to frequently/ daily walk and reach Pipalkoti for marketing, hospital, school etc. The construction of road will save time and energy of the villagers.
  - The approach road near Kodia village will be of permanent nature and diverted to connect power house, switch yard, surge shaft top & bottom, TRT outfall and residential/non residential complex will be of dual carriage way. The alignment traverses
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through open area with some agricultural land. There is no forest present in the area. The vegetation is dominated by thorny bushes and all species found are common in occurrence.

### **Project Township**

The proposed project township is in Siyasain which is located on the right bank of Alakhnanda River approx. 20 km downstream from the dam site. The proposed township site is a flat patch of land with gentle slope of approx. 13 ha. Within this township residential/ non-residential building's, Post office, Bank, Fire station, Guest houses, Market, Police station etc., will be provided for the officers and staff for operation and maintenance of the plant. Water treatment plant/ Sewage treatment is also planned to be provided for a clean living environment. The complex is planned to be located on the right bank of Alakhnanda, D/S of the power house road bridge near village Jaisal/Siyasain.

This site has been selected as it has good accessibility with the surrounding facility area, power house, dam site of THDC and the nearest commercial complex i.e. market, community center, guest houses, hotels, offices etc. located at Pipalkoti. The local town of Pipalkoti is located approx. 4km away from this proposed project township. Secondly all construction activities related to the dam construction are located on the right bank of the Alakhnanda River. The major portion of the land is barren with a minimal covering of grass, few scattered trees, a school and few houses of the Jaisal/Siyasain village.

Sites on the left bank were not considered as NH-58 transverses on the left bank of Alakhnanda River. But proper approach roads for various work areas for construction and operation and maintenance of the project would be provided and diverted from National Highway at different locations by bridges across Alakhnanda River for various approach roads.

### **Contractors Accommodations**

The proposed contractors accommodation including the labour camps and construction workers camps are to be located in Gulabkoti, Langsi, Guniyala and Batula. The contractors accommodation, labour and construction workers camps at Gulabkoti, Langsi (Dwing) and Batula are located on the left bank of the river as topography on the right bank are steep as there is paucity of space and flat land on the right bank. These site has been selected by project authority as they have good accessibility with the surrounding facility area, power house, dam site of THDC and the nearest commercial complex These labour camps and construction workers camps and the various components of the project will be connected by the 4 project roads diverted from National Highway no. 58 (NH-58) by bridge crossing over Alakhnanda River at four points at Haat, Tenduli, Hyna and Tapan Nala. Presently all these bridge crossings are foot bridges. Four new bridges are also under construction over Alakhnanda River at Birahi, Haat, Pipalkoti, Tapan Nala and Halong.

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## Quarry and Borrow Areas

The Quarry Areas sites are located at Gulabkoti, Patalganga and Gari gaon. Gulabkoti Quarry area is located around 1.5 km downstream of the proposed dam site and adjacent to National Highway (NH-58). The Patalganga Quarry area with terrace deposits to be used as coarse aggregate in concrete for non-wearing surfaces is located at about 2 km downstream of the dam site. The third site of Garigaon near Birahi River for coarse aggregate to be used in concrete for non-wearing surfaces is located at 5 km away from the proposed power house.

All these Quarry areas have been selected as they are near the proposed construction sites for the various components of the project like Power House, Dams, Head and Tail Race Tunnels and Surge Shafts. The proposed quarry sites also have good accessibility and are well connected with the surrounding facility areas of power house and dam site of THDC by the four approach roads from Animath to dam site, Gulabkoti to Dwing, Pipalkoti to Maina Nadi and Koriya to Siasin.

The Quarry site is represented by open barren area dominated by common shrubs such as *Colebrookea oppositifolia* and *Euphorbia royleana*. The impact on biodiversity is insignificant.

The Borrow Areas are located at Bajipur, Haat and Bhagisera villages. Korla village borrow area having fine aggregate is located at about 10 km down stream of confluence of Birhi and Alakhnanda Rivers. The quarry area at Haat village with fine aggregate is located along River Alakhnanda. The third site at Korla village with terrace sand deposits is located 1.5 km away from the proposed power house at Bhagisera.

All these Borrow areas have been selected as they fall within the proposed construction sites for the various components of the project like Power House, Dams, Head and Tail Race Tunnels and Surge Shafts. Borrow area material sites has been selected near the construction sites for project to cut down the cost of construction and maintain the ecological balance of the area by using indigenous material found locally.

## Muck Disposal Sites

For dumping of the muck Four Muck Disposal Sites viz. (i) Haat, (ii) Jaisal, (iii) Gulabkoti and (iv) Guniyala have been identified adjacent to project components in which dumping will be done and further they will be restored and revegetated with proper landscaping.

The identified sites of muck disposal has been selected in such a way that they are in conjunction with various characteristics viz. landscape, cost effectiveness, nearness to source of generation, groundwater/blockage to surface water, relief and scope of afforestation and erosion control/sediment arrest.

The muck disposal sites are degraded areas. The vegetation found on the area constitutes of *Eupatorium adenophorum*, *Colebrookea oppositifolia*, *Plectranthus coesta* and *Rumex hastatus*. *Parthenium hysterophorus* is dominant grass species occurring in the area. The impact on flora and fauna will be insignificant. No impacts on local people as the sites are away from settlement area.

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## 6.0 No-Project Scenario

The demand for power in the agricultural, industrial and domestic sectors in Uttarakhand and other States in the northern region of India, is increasing. Most of the States in the region are experiencing power shortage. In order to overcome this shortage, it is felt necessary to increase generation of hydro power, for which there is huge potential in Uttarakhand. The Central Electricity Authority (CEA), in its 16<sup>th</sup> Electric Power Survey, projected the growth in demand in the northern region at the rate of 7 % during the 10<sup>th</sup> Plan and at the rate of 6.9 % during the 11<sup>th</sup> Plan. The current deficit in power supply in Uttarakhand is 2.8 % and in the northern region as a whole, 9.1 %.

VPHEP is one of the important projects to improve the power generation. In the 'No-Project-scenario', that is, if VPHEP does not materialize, the present environmental status in the area may not change, but this may lead to other problems like:

- Non-availability of electricity affecting households, hospitals, tourism and other commercial activities, industry and agriculture.
- Dependence on diesel generators and firewood to meet local requirements, leading to GHG emissions and other environmental and health related problems.

Taking all these aspects into consideration, it may be stated that environmental and health related problems would be there in the 'No-Project-Scenerio' and, at the same time, power shortage problems will aggravate. It is, therefore, concluded that VPHEP is required to be implemented with adequate safeguards for environmental and social concerns due to the project.

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## **ENVIRONMENTAL SCREENING & ANALYSIS FOR ADVANCE CONSTRUCTION WORKS**

### **EXECUTIVE SUMMARY**

#### **1.0 INTRODUCTION & BACKGROUND OF THE STUDY**

The Vishnugad Pipalkoti Hydroelectric Project (VPHEP) is a run-of-the river hydro power project proposed on River Alaknanda in district Chamoli in Uttarakhand. The project envisages construction of a diversion dam near village Helong (79°29' 30 E and 30°30'50" N). An underground power house is proposed at village Hat (79°24'56" E and 30°25'31"N), 3 km from Pipalkothi. The installed capacity for power generation is 444MW.

#### **2.0 OBJECTIVE OF THE STUDY**

The present study consists of screening of advance construction sites. The advance sites comprises of construction of approach roads to various work fronts of the project. Four approach roads are taken under the environmental screening study with the objective as given below:

- To provide information about general baseline environmental setting of the advance construction site
- To provide information on potential impacts of the road construction and the characteristics of the impacts in terms of pre- construction, construction and operation phase of the project
- To provide appropriate mitigation measures to minimize the potential adverse impacts and enhance positive impacts.
- To provide basic information for formulating management and monitoring plan

#### **3.0 ADMINISTRATIVE AND LEGAL FRAMEWORK**

The Government through specific legislations regulates the environmental management system in India. The statutory bodies responsible for ensuring environmental compliances are:

- The Ministry of Environment and Forest (MoEF), Government of India
- Central Pollution Control Board (CPCB)
- State Pollution Control Board (SPCB)

The Environment (Protection) Act, 1986, is the most comprehensive law on the subject. The law grants power to the Central Government to take all measures necessary to protect and improve the quality of environment and to prevent pollution of the environment. Following Acts, Laws, Rules and Guidelines are applicable for the study:

- Environment (Protection) Act, 1986
  - EIA Notification, 14<sup>th</sup> September 2006
  - Air (Prevention & Control of Pollution) Act, 1981
  - Water (Prevention & Control of Pollution) Act, 1974
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- Noise Pollution (Regulation & Control) Rules, 2003 and its amendments
- Forest (Conservation) Act, 1980 and its amendments
- Forest (Conservation) Rules, 2003 and its amendments
- Wildlife (Protection) Act, 1972
- Wildlife (Protection) Amendment Act, 2002
- Environmental Guidelines for Rail, Road & Highways Projects, 1989 (MoEF)
- EIA Manual published by Ministry of Environment & Forests, 2002

The present study is conducted in compliance with the MoEF and World Bank Guidelines.

#### 4.0 PROJECT LOCATION

The project is located in District Chamoli in Uttarakhand. The location of dam site is at village Helong in Joshimath tehsil and power house site is at village Hat in Chamoli district. The nearest railway station is at Rishikesh about 225km from project site

##### **Advance Construction Location**

The National Highway No. 58 is on the left bank of the river whereas all the project components are located on the right side. All material and equipment for the project will be transported from the existing road network of NH-58. There is no road to reach the various work fronts. Approach road leading to work fronts is required to be constructed. Four approach roads are proposed under the project which will be taken under advance construction works.

- i. Approach Road to Dam site
- ii. Approach Road to Langsi adit
- iii. Approach Road to Maina adit
- iv. Approach Road to Power house & Colony site

#### 5.0 BASELINE ENVIRONMENTAL STATUS

The topography is by and large rugged, the entire region is mountainous.

**Land Use :** The main land use in the area is Agriculture. All the project roads mainly passing through Open type of forest land or barren land. Few patches of Agricultural land and Community plantation can be also observed. There are agricultural fields located at the following locations along the proposed road:

- Proposed Road to Langsi Adit - On the left side of river Alaknanda agriculture fields are located along old road route to Badrinath and on right hand side of river agriculture fields are near Tapon and Dwing Village.
- Proposed road to Maina Adit - Near, Tenduli, Math and Guniyala village
- On the proposed road Power house site - agricultural field were observed on left side of river (before crossing the river, starting from the NH-58)
- There are no agricultural fields along the approach road to Dam site.

**Geology:** The project area forming a part of Alaknanda valley exposes rocks belonging to Garhwal Group and Central Himalayan Crystalline and are composed mainly of calc arenaceous rocks with basic intrusive and migmatite bodies, while around Helong low to medium grade metamorphic rocks are exposed.

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**Seismology:** The project area lies within seismic zone V. The north dipping Main Central Thrust (MCT) lies about 2 km northeast of the proposed dam site and the seismic status of this thrust is not properly known. The Alaknanda fault and Srinagar thrust are located about 32 km and 45 km southwest respectively of the proposed dam site.

**Soil:** The soil in the region varies according to altitude and climate. Soil on the slope are generally shallow and usually have very thin surface horizons. Such soils have medium to coarse texture. Valley soils are developed from colluvium and alluvium brought down from the upper slopes and thus, are deposited in the valleys and low-lying tracts or river terraces as a process of aggradation. In general north facing slopes support deep, moist and fertile soils. The south facing slopes are exposed to denudation.

**Meteorology:** The climate of the project area can be divided into four main seasons i.e. winter season from Dec-Feb followed by pre-monsoon or mild summer season from March to May. The monsoon season begins in June and continues upto middle of Oct. The period from second half of the October to November is the post-monsoon season. The temperature in the area varies with elevation, rises rapidly after March and the month of July is the hottest month of the year with mean daily maximum temperature going up to 27-28°C. The months of December and January are the coolest months of the year, with mean daily minimum temperature as low as 4-5°C. The average annual rainfall is about 125 cm per annum.

**Hydrology:** The river Alaknada is the main river of the area. The hydrology of the project area is marked with small streams which are basically rainfed and become violent during rainy season. These streams are major concern in the approach road as they are susceptible to flooding during rain causing soil erosion and landslides. The approach road to Dam site has water out let below the road. There are no streams along the approach road. On the approach road to Langsi there is Tapon stream enroute to the adit site on Right Bank of the River. The stream has flooding nature and causes destruction of the adjoining areas. The bridge over the Tapon Nala has been washed away several times by the stream.

Flood was reported in River Alaknanda in 1970, Village Belakuchi settled on the left bank of the river was washed away. The road route to Badrinath was also washed away during the flood and new road route is laid from Pakhi to Langsi.

The approach road to Maina adit on right side at Math village, it is prominent one flowing throughout the year. The approach road to power house site has three small streams on left hand side. The road crosses the river Alaknanda and bifurcate Colony site and surge shaft area. One stream is located at the end of conlony area other is near the power house site.

**Ambient Air quality:** Ambient air quality is quite good in the area. There are no industries in or along the roads in project area hence any source of atmospheric air pollution is not expected.

**Water Quality:** Water quality is good. The major sources of water in the project area are streams or nallahs which flow adjacent to the habitations.

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**Ambient Noise Level:** Noise is not a problem in the project area. The noise levels were monitored continuously for 12 hours at each location. The noise level at various sampling stations ranged from 32 to 40 dBA, which were very well within permissible limits specified for residential area.

**Agriculture:** The cropping pattern in this zone is built around two major cropping seasons, viz. kharif (April-October) and rabi (October-April). Paddy, maize and pulses are the major kharif crops. During rabi season, crops such as wheat, barley, mustard, peas are grown.

**Flora:** The approach road to dam site passes through the forest area belonging to Van Panchayat. Flora of the area is dominated by Forest Trees tree species. Dominant species comprise of Pine (*Pinus roxburghii*), Utis (*Alnus nepalensis*), Bhandir (*Albizia lebbek*), Surai (*Cupressus torulosa*), Bakel (*Princepia utilis*) and Kilmora (*Berberies aristata*). All the species found at the site are common in occurrence

On the approach road to Langsi adit Fruit trees of Aru (*Prunus persica*), Dalim (*Punica granatum*) Akrot (*Juglans regia*) Lemon (*Citrus limon*) and Banana (*Musa paradisiaca*) were observed near Tapon and Dwing villages on agricultural land. All species found are common and found abundantly in the area.

On the approach road to Maina Adit vegetation on Left side of river is sparse with some scattered bushes. The flora of the area constitute of Pine forest, fruit trees, thorny and shrubs. **On the right side there is a dense forest after Guniyala villages as the road approaches the Maina Adit site. Three herb species *Berginia ligulata* (Silpara), *Hedychium spicatum* (Banhaldi) and *Thalictrum foliolosum* (Mamiri) are reported in the forest area near Maina adit, these species fall in vulnerable category as per IUCN Red list.** However these species are common in India in Himalayan region and are found in altitudinal range from 1000 to 3000 m. These species are in common category and does not fall in threatened list of Red Data Book of Indian Flora.

On the approach road to powerhouse and colony site all the species are common in occurrence as found at other sites. *Ficus palmata* (Bedu), *Melia azaderach* (Dhenkan) *Phoenix humilius* (Khajoor), *Sapium insigne* (Khinna) are common trees, *Adhatoda vasica* (Basinga), *Agave Americana* (Rambans) *Cannabis sativa* (Bhang) *Eupatorium adenophorum* (Kala bansa) and *Euphorbia royleana* (Sullu) are dominant shrubs in the area. The herbs are represented by *Argemone mexicana* (Satyanasi), *Cassia tora* (Chakunda), *Cestrum verutum* (Kanjalu) *Parthenium hysterophorus* (Gajar ghas) and *Polygonum chinensis* (Syaru)

**Fauna:** The Advance construction site starts from NH-58 and passes close to settlement and track routes to villages on the Right bank. The wildlife is not found near the highway. However across the river on right bank wildlife movement has been reported. Public consultation was carried in the villages and incidence of domestic animals (cows & dogs) lifting by Leopard and Bear has been reported.

Fauna of the project area is represented by reptiles, birds and mammals. The common wildlife reported were the Leopard, Bear, Monkey, Deer etc. The common birds recorded during the survey were Myna, Magpai, Pigeon, Black Drongo, Grey Shrike and White Cheek Bulbul

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## 6.0 IMPACT ASSESSMENT & MITIGATION MEASURES

### Hill Cutting

The construction of new roads involve hill cutting which leads to soil erosion & landslides, generation of solid wastes in the form of debris, dust pollution, disturbance of local drainage, siltation in nearby water bodies and noise & disturbance to wildlife due to blasting. The hill cutting is also likely to trigger landslide in the area.

### Mitigation Measures

- The proposed project will utilise the existing road of PWD, the road is part of approach road to Dwing Adit. The old PWD road will be utilised from NH- 58 to River Alaknanda hence no new road cutting will be involved in left side for this section. This will reduce the impact of road construction
- Minimize hill cutting by following restricted RoW (Right of Way)to the maximum extent,
- Use of full cut method, use of debris as construction material based on their suitability and unused material should be disposed at pre-identified disposal sites.
- Appropriate bio-engineering techniques will be used immediately after hill cutting to maintain stability of slope above and below ROW.
- Work may be restricted during rainy season.

Controlled blasting techniques will be used. Warning will be given to the inhabitants to stay away from the site to avoid any mis-happening

### Impact on Flora

The proposed project roads are passing through community forest, dense forest(only near Maina Adit) and open area. The construction activities affect forest by loss of vegetation due to tree cutting. Three herbaceous species *Berginia ligulata* (silpara), *Hedychium spicatum* (Banhaldi) and *Thalictrum foliolosum* (Mamiri) are found in the advance construction area on the approach road to Maina adit these species fall in vulnerable category in IUCN Red list and requires proper conservation.

Other dominant species which are affected are *Pinus roxburghii* (Pine), *Cedrela toona* (Tun), *Bauhinia variegata* (Kachnar), *Melia azaderach*(Dhenk), *Ficus palmata* (Bedu), *Sapium insigne* (Khinna), *Phoenix humilis* (Khajoor) and *Mallotus philippinensis* (Kamela), Shrubs such as *Berberies aristata* (Kashmoi), *Eupatorium adenophorum* (Kala bansa) *Euphorbia royleana* (Shuru), *Princepia utilis* (Bhekal) *Zanthoxylum alatum*(Timru) and *Rubus ellipticus* (Hinsar), *Colebrookia oppositifolia* (Bindu), *Calotropis gigantea* (Aak), *Lantana camera* (Lantana) *Urtica parviflora* (Kandali) and *Rumex hastatus* (Bhilmora) etc.

### Mitigation Measures

Loss of vegetation can be minimized by carefully designing RoW and by implementing compensatory afforestation programme as per the State Forest Department Govt. of Uttarakhand regulations.

- Double no. of trees may be planted in lieu of trees felled. Implementation of approved Compensatory Afforestation Plan in accordance with Forest (conservation) Act 1980 and Uttarakhand Forest Policy.



- The vulnerable species *Berginia ligulata* (silpara), *Hedychium spicatum* (Banhaldi) and *Thalictrum foliolosum* (Mamiri) found in the area will be developed in separate herbal garden. **THDC will undertake development of Herbal garden at suitable place in consultation with Forest Department.** Besides the three species other species of medicinal value may be also encouraged.
- Proper protection measures should be taken for the plantation work carried under the project. Van Panchayats may be involved in afforestation activity and monitoring of the plantation work. Compensation will be given to Van Panchayats for the land, standing crops and fruit bearing trees per R&R policy. Compensation will be provided before initiating construction activity
- Trees falling outside the ROW should not be felled

### Impact on Fauna

The wildlife is likely to be disturbed during construction phase due to various activities.

- The construction activity is likely to affect the movement of the animal
- Increase in noise may affect the feeding, breeding and movement of wildlife near forest area. Felling of trees is likely to affect the avifauna.
- Fragmentation of the habitat is not envisaged as the road does not divide any habitat area.

### Mitigation Measures

- Poaching will be strictly banned in the Forest area. It may be ensured by the Contractor that no hunting is practiced at the site by any of the worker and that all site personnels are aware of the location, value and sensitivity of the wildlife resources
- The project area is located in the transitional zone of Nanda Devi Biosphere reserve. Movement of wildlife is reported in the area therefore monitoring units be established in the project sites in consultation with Forest Department.
- Plantation of tree species which are major sources of fodder for wildlife in consultation with Forest Department in degraded and open areas.
- Awareness program on Environment and Wildlife Conservation should be provided to the work force. Forest Act and Wildlife Act may be strictly adhered to.

### Impact on Land and Soil

The construction activities may lead to soil erosion and landslide. Extraction of rocks and sand for the construction work from quarry sites will degrade the area.

### Mitigation Measures

- Bioengineering measures will be applied for slope stabilization. Plantation of grasses, shrubs and trees will be undertaken for slope stabilization. Plant Species recommended for slope stabilization and rehabilitation of quarry and borrow areas are *Agave americana* (Rambans), *Eupatorium adenophorum* (Basinga), *Euphorbia royleana* (Shuru) *Opuntia dilleni* (Nagphani), *Carissa spinarium* (Karonda), *Zizyphus mauritiana* (Ber), *Rumex hastatus* (Bhilmora) *Colebrookea oppositifolia* (Bindu) and *Bauhinia variegata* (Kachnar)
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- Provision for culverts will be given in design near water bodies and proper drainage will be provided along the road
- The extraction of material will be done from the identified quarry site only. The quarry area will be reclaimed back. The pits formed will be backfilled by construction waste and site will be stabilized. Top soil removed during excavation work will be stored separately in bunded area and may be utilized during plantation or refilling of excavated area.
- Construction work may be avoided during rainy season to evade erosion and spreading of loose material.

### **Impact on Air Quality**

The construction activity is likely to impact the air quality due to generation of dust and emission from equipments and vehicles. However the impact will be temporary and limited to construction site.

#### ***Mitigation Measures***

- Regular water sprinkling on construction sites, haul & unpaved roads particularly near habitation will be undertaken to control fugitive dust
- Trucks carrying soil, sand and stone may be duly covered to avoid spilling.
- Plants, machinery and equipment will be handled so as to minimize generation of dust.
- All crusher, machineries, vehicles and equipments used in construction shall confirm to relative dust emission standards of CPCB.

### **Noise Level**

The noise level of the construction site is likely to increase due to various activities, which may cause disturbance to the inhabitants and fauna in the area. However this impact would be insignificant as the increase in noise shall be intermittent and temporary.

#### ***Mitigation Measures***

- The machineries, vehicles and equipments use in construction shall strictly confirm to CPCB standard.
- All vehicles equipment machinery used in construction shall be fitted by exhaust silencers. Equipments will be maintained regularly and soundproof gadgets should be used.
- Head phones, ear plugs will be provided to the workers at construction site.
- Blasting shall be carried out as per the statutory laws, regulation and rules pertaining to acquisition, transport, storage, handling and use of explosives

### **Water Quality**

The water bodies near the construction site are likely to be polluted due to runoff from the construction site or spilling of construction material and Turbidity of the water will increase. Four bridges are proposed over river Alaknanda, the quality of the river is

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likely to be affected during construction. However the impact will be temporary and reversible

### ***Mitigation Measures***

- Provision of temporary drainage arrangement due to construction activities will be made by Contractor and clause will be incorporated in General Conditions of Contract document for its effective implementation.
- Silt fencing may be provided near water bodies.
- Discharge of waste from construction/labour camp into water bodies may be strictly prohibited.
- Construction methodologies with minimum or no impact on water quality may be adopted, disposal of construction wastes at designated sites and adequate drainage system may be provided
- Construction activity may be prohibited during rainy season near water bodies.
- Water quality monitoring will be conducted during construction phase

### **Impact due to Establishment of Labour Camp**

During construction phase Construction / Labour Camp will be located along the project area. Large numbers of labour population is likely to influx in the project area. The establishment of labour camps is likely to have significantly affect on environment through improper waste (Solid & Garbage /Sewage) disposal, negative impacts on public health unfriendly use of community resources, poaching of wildlife and leaving dirty & waste material after shifting from one site to another site. Labours may cut trees for cooking purpose.

### **Mitigation Measures**

- Construction of camps will be located at least 500 meters away from habitation and forest areas.
  - Adequate supply of fuel in the form of kerosene or LPG may be provided to construction labours to avoid felling of trees for cooking and other household activities. A common community kitchen can be also established. No open fires should be allowed in camps.
  - Adequate sanitary facilities may be provided within every camp. The place will be cleaned daily and kept in strict sanitary condition. Separate latrine will be provided for women. Adequate supply of water will be provided. Health camp will be organized to bring awareness about communicable diseases.
  - Reference to the illegally cutting trees, hunting and other prohibited activities will be included in the contract document.
  - During construction labours/ workers may be hired from local communities also or other part of the villages as far as possible to avoid social conflict in the construction camp and thereby minimizing resources conflict.
  - On completion of work it will be ensured that clean area left behind.
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## 7.0 MANAGEMENT ISSUES - CONSTRUCTION AND OPERATION PHASE

The environmental issues during construction stage generally involve safety and public health issue. The construction agency is required to comply with the laws with respect to Environment protection, Pollution Prevention, Forest Conservation, Resettlement and safety and any other applicable law. Environmental pollution during the construction phase will be less but control of pollution during this phase is of considerable importance.

The EMP constitutes of Emission and Dust Management Plan, Construction / Labour Camp Management, Borrow Area Management Plan, Public Health and Safety, Green Belt Development. The mitigation measures during the operation phase will be implemented by Environmental incharge of THDC. Thus the overall responsibility for the implementation of mitigation measures will be with the Construction Contractor during the construction phase and THDC during operation phase. The various agencies responsible for implementation of mitigation measures are summarized below.

S.No	Environmental Issue	Mitigation measures Implementation Agency	Supervision Agency
<b>Construction Phase</b>			
1.	Hill Cutting	Construction Contractor	Site In-charge / Environmental in-charge, THDC
2.	Flora	Construction Contractor	Forest Dept/ Environmental in-charge, THDC
3.	Fauna	Construction Contractor	Forest Dept/ Environmental in-charge, / Project in charge
4.	Land & Soil conservation	Construction Contractor	Environmental in-charge, THDC
5.	Air Quality	Construction Contractor	Environmental incharge, THDC
6.	Noise	Construction Contractor	Environmental in-charge, THDC
7.	Water Quality	Construction Contractor	Environmental in-charge, THDC
8.	Solid Waste	Construction Contractor	Environmental in-charge, THDC
9.	Safety measures	Construction Contractor	Environmental in-charge / Project incharge ,THDC
<b>Operation Phase</b>			
1.	Maintenance of Plantation	Environmental in-charge THDC	Forest Dept
2	Safety System	Environmental in-charge THDC	Project In-charge THDC
3	Maintenance of Drainage	Environmental in-charge THDC	Project In-charge THDC

Water Quality, Air Quality and Noise level monitoring will be carried at construction location by the Construction Contractor as per CPCB guideline. The monitoring activities will be supervised by THDC/Supervision Consultant. Monitoring budget provided under consolidated EA Report.

Environmental Budget **Rs.9.0 million** has been estimated, tree plantation is included under Green belt development and Compensatory afforestation, provided under consolidated EA Report.

Item	Cost (Rs. million)
Clearing and grubbing	4.0
Provision of breast walls, construction of catch water and interceptor drains	3.0
Provision of drainage system along roads	2.0
<b>Total</b>	<b>9.0</b>

## ARCHAEOLOGICAL SURVEY REPORT

### EXECUTIVE SUMMARY

#### 1.0 HISTORICAL BACKGROUND

The Vishnugad Pipalkoti Hydroelectric Project (VPHEP) is a run-of-the river hydro power project proposed on River Alaknanda in district Chamoli in Uttarakhand. Archaeologically and culturally, the entire area from the foothills to the higher Himalayan mountain upto the source of Alaknanda is considered as the land highly sacrosanct. Moreover, because of its religious significance due to the great Himalayan shrines, it has remained culturally and historically inseparable from the rest of India

The archaeological researches in India since independence have brought forth a rich data of our cultural heritage. The extensive explorations and assiduous excavations undertaken throughout the country have succeeded in unearthing a plethora of new evidences. In the same way, regional studies in archaeology have also contributed in discovering India's past in no lesser terms. However, the region of the Garhwal-Himalaya has comparatively been less studied.

**Pre-History:** The prehistory past of the Garhwal-Himalaya is not known with certainty. The reasons are two fold, firstly, topographically it was a most difficult region and secondly, the extreme climatic cycles made it more inhospitable for the early man. Further more, the recurrence of the tectonic fluctuations resulting physiographic changes along with frequent landslides all around in the valleys and mountains disturbed the entire sequence everywhere an obliterated totally all evidence of the past.

**Paleolithic Tools:** Exploration for Stone Age artifacts were conducted at Srinagar and Dang in the Alaknanda Valley as far back as 1977, when a few flacks resembling the pebble tools were picked up from terrace 1(at village Dang). Exploration in 1980-81 however, brought to light a sizable collection of Paleolithic implements. The artifacts range from the pebble tools to the middle Paleolithic implement found from the river terrace

**Prehistoric Art:** Prehistoric art is yet one more significant aspect generally associated with the Prehistoric cultures. The discovery of prehistoric art in central Himalayan region furnishes a new evidence for it. The evidence of rock shelters having paintings, come from the Alakananda Valley of the central Himalayan region. A Rock shelter depicting painting was discovered by Nautiyal at Kimni in Karnaprayag-Gwaldam road in Chamoli district. The other Rock shelter is at Dungri village on the Chamoli-Badrinath road in Chamoli District. The cave is about 2 km away from Chhinka on the high Mountain towards Chamoli.

**Proto-History:** In the later phase of the proto history in the Alakananda Valley, the people who occupied the region were using painted Grey Ware as their principal pottery.

Archaeologically and culturally, the entire area from the foothills to the higher Himalayan mountain upto the source of Alaknanda is considered as the land highly sacrosanct. Moreover, because of its religious significance due to the great Himalayan shrines, it has remained culturally and historically inseparable from the rest of India. Unfortunately, the early history of the entire region of Uttarakhand is disjointed, as also that of this valley. There are, however, some stray materials, which need to be supplemented by future investigations.

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## 2.0 HISTORICAL ARCHAEOLOGY

The 6<sup>th</sup> century B.C. witnessed a cultural renaissance, giving birth to new ideas and traditions. However, the study of the cultural evolution in the Garhwal Himalaya region has not yet become an established fact of history. Therefore, archaeological discoveries in recent years through exploration and excavations are gradually bringing forth new evidences for the formulation of cultural background of this area. The recent discoveries brought out in this valley and elsewhere in the Garhwal-Himalayas, indicate that the area was serving as a meeting ground of various cultural waves flowing from different directions. The new material evidence has proved that this was a pivotal region and so almost every traveler from Fa-hien in the 4<sup>th</sup> -5<sup>th</sup> century AD to Heiun-tsang in the 7<sup>th</sup> century AD had visited either its heartland or places of peripheral zone.

### Some Important Explored and Excavated Archaeological Sites in the Region

a) **Ranihat:** It is an excavated site Ranihat (30° 12'N, 78° 47'E) is a small village about nine kilometers from the town of Srinagar on Srinagar-Badiyaragarh road. The cultural sequence of this site is as follows:

Period-I	:	<i>circa</i> 600 to 400 BC Painted Grey Ware Culture (PGW)
Period-II A	:	<i>circa</i> 400 to 200 BC Mauryan
Period-II B	:	<i>circa</i> 200 BC to AD 20 Sunga-Kushana
Period-III	:	<i>circa</i> 800 to AD 1200 Sultanate

b) **Thapli:** It is an excavated site Thapli (30° 12' N & 78° 47' E) is a small village about thirteen kilometers from the town of Srinagar on Srinagar - Badiyaragarh road. It is a single culture site of Painted Grey Ware (PGW) and is placed around 1100 BC to 800 BC.

c) **Mana:** The site, situated 3 km beyond Badrinath, is a big village of tribal Marchhas. A few sherds of fine plain grey ware and fine red ware can be placed in pre-Christian era. The rest of the finds from Mana are assignable to the post-Gupta period.

d) **Tapoban:** The site is situated about 15 km from Joshimath on the Malari road on the left bank of Dauliganga. It has several temples and the ancient pottery is scattered all around the fields. The pottery is assigned to the post-Gupta period, to which period the temples of the site also belong.

e) **Rein:** The site is situated about 18 km from Joshimath on Joshimath-Malari road on the left bank of Dhauliganga. This site is ascribed to the post-Gupta period.

f) **Subhaien:** The site is situated at a height of 7000ft about 23 km from Joshimath on Joshimath-Malari road on the left bank of Dhauliganga. This site is assigned to the post-Gupta period.

g) **Gopeshwar:** This site is situated 10 km west of Chamoli. This site is assigned to the post-Gupta period.

h) **Simli:** This site is situated 8 km from Karnaprayag on the Karnaprayag-Ranikhet highway. This site is assigned to the post-Gupta period.

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- i) **Chandpurgarhi:** This site is situated 11 km from Karnaprayag on the Karnaprayag-Ranikhet highway. This site is assigned from about 4<sup>th</sup> century onwards and continued so up to the early medieval period.
- j) **Adibadri:** Like Chandpurgarhi, Adibadri is also a significant ancient site, yielding red ware of the post-Gupta period and early medieval period.
- k) **Kameda:** The site is situated 2 km east of the town of Gaucher on the left bank of Alaknanda. This site is assigned to the Sunga-Kushana period.
- l) **Ratura:** This site is situated on the left bank of Alaknanda, 7 km from Rudraprayag on the Badrinath highway. This site is assigned to pre-Christian era and post-Gupta period.
- m) **Ufalda:** This site is situated 4 km south of Srinagar town on the left bank of Alaknanda. This site is assigned to the post-Gupta period.
- n) **Dhandri:** This site is situated 8 km south of Srinagar town. This site is assigned to 4<sup>th</sup> -5<sup>th</sup> century AD.
- o) **Naithana:** This site is situated around 6 km of Ranihat on the right bank of Alaknanda. This site is assigned to the post-Gupta period.
- p) **Supana:** This site is situated around 7 km north of Ranihat on the right bank of Alaknanda. This site is assigned to the early historical period.

### 3.0 EXPLORATION RESULTS

On the basis of village to village Survey (Exploration), a list of 63 villages has been prepared in Joshimath tehsil, Distt. Chamoli. These villages falls under the area of Vishnugarh-Pipalkoti Hydro Electric Dam project area, covering an area of 7 km from river Alaknanda covering the stretch length of 28 km. from Chhinka village to 3 Km upstream towards Joshimath from Helong Dam site in district Chamoli tehsil Joshimath. Out of these 63 villages surveyed 10 villages have archaeological / heritage remains.

Besides archaeological remains such as cultural properties, sites, folklores, legends, buildings almost all 63 villages have preserved their paleontological, natural religious and sacred heritage in a very ritualistic and traditional manner. An overall idea of number of villages surveyed containing archaeological sites etc., is given in **Table below**.

**Table 1: Typological Distribution of Archaeological Remains discovered during Survey**

Type of Archaeological Remains	Number of Villages	Total
Pre-historic Rock-shelter	1	1
Megalithic Site	1	1
Historical Site	2	2



Type of Archaeological Remains	Number of Villages	Total
Temples (Historical)	5	5
Structural remains of Heritage Buildings	2	2

The Archaeological sites present in the Project Influence Area (PIA) - 7 km radius from project sites, Project Immediate Affected Area (PIAA) - 500m from project site and Project Affected Area (PAA) are given in the table below.

**Table 2: Archaeological Sites of Project Area**

S.No	Site	Archaeological Monument
1	Dungri - (PIA) N 30°25'30.97" E 79°22' 11.74" ± 11 m 1572 m above MSL	Pre-historic rock-shelter site. The rock-shelter is about 10 mts high and the paintings are drawn on huge, flat rock (4 x 6 mts) overlooking the deep valley towards the north-east. The paintings have been done in deep red ochre showing a hoard of animals. A few motifs represent human and animal forms.
2.	Amarpur - (PIA) N. 30°25'11.5" E. 79°26'15.6" ± 8 m 1353 m above MSL	Megalithic burial site consisting the types: a) Menhirs. b) Crain circles. c) Rectangular Crain burials
3.	Sirkot-1 and Sirkot-2 - (PIA ) N-30° 24' 37.3" E-79° 24' 41.3" ± 5 m N-30° 24' 27.1" E-79° 24' 36.0" ± 5 m 1307 and 1311 m above MSL	Pot sherds Historical period site consisting of red ware pot sherds (mid and rim part) and a stone pounder. These findings are from about 2-3 feet below the present working level of the field.
4.	Mahargaon-(Kyontha) - (PIA ) N - 30° 24' 35.5" E - 79° 25' 24.6" ± 6m 1364 m above MSL	Pot sherds Historical period site consisting of red ware potsherds in the agriculture fields.
5.	Darmi - (PIA) N - 30° 28' 37.2" E - 79° 23'14.2"± 9 m 1557 m above MSL	Narsimha Temple Temple is an archaeological monument. The plinth stone of the <i>garbhgrih</i> / sanctum sanctorum is intact and original, where as the part of <i>Shikhar</i> and <i>Mukha mandapa</i> is renovated / altered recently.
6.	Gulabkoti - (PIA) N- 30° 30' 15.8" E-79° 29'31.8"± 37 m 1507 m above MSL	Lakshmi Narain Temple Temple is made up of local dressed stones in dry masonry, the temple is intact and bears old paintings on the inner walls of the <i>mukha mandapa</i> . The wooden doors are also original and no

S.No	Site	Archaeological Monument
		structural addition and alterations to the temple architecture has been made. This village falls on the ancient route to Badrinath.
7.	Tangni Malli - (PIA) N- 30° 28' 36.7" E-79° 28'19.6"± 10 mts. 1547 m above MSL	Heritage building Profusely carved and decorated wooden balcony of Rajput art tradition. This master piece of local art is a very rare master piece.
8.	Pakhi - (PIA) N-30°27'50.0" E- 079°26'42.4" ± 8m 1372 m above MSL	<i>Garud</i> Temple. It is a living temple located just close to the Garud Ganga bridge. It has been totally renovated with cement plaster and white washed.  Godess Durga Temple It is a living temple located in the heart of the village. It has been totally renovated with cement plaster and white washed.
9	Haat Village - (PIAA) N - 30° 25' 18.8" E - 79° 24' 53.7" ± 8 m 1075 m above MSL	Lakshmi-Narayan Temple Lakshmi-Narayan temple is located in PIAA area at Hat. The temple can be dated to 9-10 <sup>th</sup> century A.D. This temple has gone under many structural alterations & additions, but the garbhgrih / sanctum sanctorum is in its insitu position, partly buried
10	<b>Siyasain - (PAA)</b> N - 30° 25' 18.8" E - 79° 24' 53.7" ± 8 m 1075 m above MSL	<b>Heritage Building</b> The Archaeological site consists of Heritage Building on the way to Seasain village. These are the remains and abandoned structures of Hat ( <i>Bazar</i> ) and transit camps of the pilgrimagers, who used to halt at this place en- route to Badrinath from Chamoli and vice-versa in early times. It can be dated to 1800 A.D.

Only one archeological site at village Siasain – heritage building and pilgrim path fall in project affected area, this site may be conserved by THDC.

#### 4.0 MITIGATION MEASURES AND RECOMMENDATIONS

These heritage structures are in a bad state of conservation and preservation, it is suggested for their proper documentation, conservation and preservation. ***Major portions of the heritage building are in a very dilapidated and poor condition, which makes them impossible to be restored or preserved. This is the reason why the local people are using the stones and other structural members of these Heritage Buildings for their modern structures, which have fallen apart. Therefore it is suggested to conserve and preserve those portions of the structural members of the Heritage Building which can be restored and preserved and for which the exact age can also be ascertained.***

It is suggested that the **temples falling in the villages on the Right Hand Side** of river Alaknanda may be considered for enhancement and beautification. The villages on RHS are **Tirosi, Tapon, Dwing, Kimana, Palla, Lanji, Pokhani, Hyuna, Guniyala, Biamaru, Surenda, Kanda, Bedumath, Bajani, Math Jharetha, Haat, Siyasain, Jaisal, Durgapur, Kunj, Bowala and Chhinka.**

An **Archeological museum** may be opened in the project area for display of Archaeological findings of the area, in consultation with Archaeological Survey of India.

#### **Archaeological Chance Find Procedure:**

Sites and properties that are buried or not identified by the survey undertaken by THDC may be discovered during project implementation, especially in the course of construction or excavation. Such unanticipated discoveries of remains of an archaeological and/or historical nature are termed archaeological chance finds. Most often they are concentrations of pottery, worked stone, and human and animal bones, without commercial value, but of significance to archaeologists, historians, anthropologists, and paleontologists.

The following archaeological chance find procedures are adopted in project design and construction contracts:

- The responsibility for preservation, maintenance and assessment of historical and cultural monuments rests with the Department of Archaeology, State Govt., and in specific cases, with the Archaeological Survey of India.
  - Whenever chance finds of cultural or historical artifacts (moveable and immovable) are made the Department of Archaeology of the state Government, the Archaeological Survey of India will be informed. Should the continuation of work endanger the historical and cultural artifacts, the project work will be suspended until a solution is found for the preservation of these artifacts, or advice from the Archaeological Survey of India is obtained.
  - Contractors, employees of the contractors and all project employees will be responsible for informing the Project Director immediately after discovery of the chance find, without any judgment on their own on the value of the chance find. The Project head will be responsible to inform the Department of Archaeology of the State Government, and the Archaeological Survey of India, local Office, within 48 hours of such discovery.
  - The Project Head will request for a representative of the State Department of Archaeology, Government of Uttarakhand, and/or the Archaeological Survey of India, local Office in Uttarakhand to make a site inspection.
  - Project Head will order cessation of work in the vicinity of the chance find until the visit of a representative (usually required within 48-72 hours of notification); and follow the advice by the State Department of Archaeology, and/or the Archaeological Survey of India on possible salvage or excavation (usually required within 48-72 hours of notification).
  - Failure to report a chance find within the 48 hours of discovery, is a punishable offence under the relevant Indian legislation. Similarly, (intentional) damage to a historical or cultural artifact is a punishable offence.
-

THDC will also seek the support of the Archaeological Survey of India, local Office to periodically inspect the sites of construction, excavation and muck disposal to detect any chance finds.

**Recommendations for management/conservation measures required to be taken by THDC.**

- A joint body may be formed either by involving local people i.e. (gram panchyat/sabha) or (state/ central govt.) with THDC for monitoring and execution of the work.
- Role of THDC in this respect:  
Conservation of cultural resources providing appropriate infrastructure for the:
  - a. Conservation of archaeological / heritage / sacred sites and objects in the project and its surrounding areas.
  - b. Display of the archaeological / heritage finds/objects collected/acquired in the local site museum.
  - c. Awareness among locals at school, college and village level

An Architect / Archaeologist may be employed in THDC management cell for suggesting conservation and architectural measures.

For Eco-view points Pakhi and Agthala village are selected which can be developed as tourist view point in the Project area.

A tentative budget of **Rs.25,00,000/- (Rupees Twenty Five Lakhs)** is proposed for Archaeological Management. For structural Conservation, Preservation and Restoration of Archaeological sites tentative budget of Rs 10,00,000/- (Rupees Ten lakhs) and Rs.15,00,000/- (Rupees Fifteen lakhs) for Archaeological museum.

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## TERRESTRIAL BIODIVERSITY REPORT

### EXECUTIVE SUMMARY

#### 1.0 INTRODUCTION

The Vishnugad Pipalkoti Hydroelectric Project (VPHEP) is a run-of-the river hydro power project proposed on River Alaknanda in district Chamoli in Uttarakhand. The project envisages construction of a diversion dam near village Helong (79°29' 30" E and 30°30'50" N). An underground power house is proposed at village Hat (79°24'56" E and 30°25'31"N), 3 km from Pipalkoti. The installed capacity for power generation is 444MW. The present study comprise of Terrestrial Biodiversity Study for the VPHEP.

#### 2.0 PROJECT BACKGROUND

River Alaknanda is a major tributary of river Ganga, originating from the glacial regions of Himalayas. The river has tremendous scope for development of hydro-power, which needs to be harnessed to meet the ever-growing demand for power. At present, various hydropower schemes are in different stages of development on river Alaknanda. Vishnugad Pipalkoti is one of the various hydropower schemes envisaged in this region. The river stretch under the project is about of about 27 km from village Helong to village Birahi. The operation of VPHEP is linked to the upstream projects on Vishnugad (by JP ) and of Topovan- Vishnugad (by NTPC). Downstream of this project, further run of the river power project are planned, which will also divert water from Alakananda through headrace tunnel.

#### 3.0 POLICY AND LEGAL ASPECTS OF BIODIVERSITY CONSERVATION

In order to project biodiversity resources of the country Government of India (GOI) is actively involved in various conservation measures such as establishment of National Parks & Sanctuaries, Biosphere Reserve Program, World Heritage Sites, Specific Animal Targeted Project (Project Tiger 1973, Project Elephant 1991-92, Rhinoceros i.e. Sanctuary / National Park in North East and North West India), etc. There are many international treaties/regional treaties concentrate specifically on conservation and use of global biodiversity. Following are some of the international treaties relevant to biodiversity

- Convention on Biological Diversity, (1992)
- Convention Relative to the Preservation of Fauna and Flora in their Natural State. 8<sup>th</sup> Nov. 1993, London
- International Plant Protection Convention. 6<sup>th</sup> Dec. 1951, Rome
- Plant Protection Agreement for South East Asia and Pacific Region 27<sup>th</sup> Feb. 1956, Rome
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat 2<sup>nd</sup> Feb 1971, Ramsar
- Convention on the conservation of Migratory Species of Wild Animals, 23<sup>rd</sup> June 1979, Bonn
- Convention on International Trade in Endangered Species of Wild Fauna and Flora, 3<sup>rd</sup> March 1973, Washington
- International Tropical Timber Agreement 19<sup>th</sup> Nov. 1983, Geneva

International treaties to which India is a signatory:

- Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS)

- The United Nations Convention on Biological Diversity

There are 97 existing national parks in India covering an area of 38,199.47 km<sup>2</sup> which is 1.16% of the geographical area of the country (National Wildlife Database, June, 2008). Uttarakhand have 6 national parks covering an area of 4,731km<sup>2</sup> which is 8.85% of the geographical area of the state. Two national parks Nanda Devi National Park and Valley of Flowers national park fall in the Alaknanda basin.

#### Status of Protected Areas

Location	National Parks	Sanctuaries	Biosphere Reserve	Conservation Reserve	Community Reserve
India	97	508	14	7	2
Uttarakhand	6	6	1	2	0
Alaknanda Basin	2	1	1	0	0
Project Area	0	0	1	0	0

The Project area lies within the transitional zone of Nanda Devi Biosphere Reserve (NDBR).

#### 4.0 BIODIVERSITY ASSESSMENT METHODOLOGY

**Flora Assessment:** To characterize the vegetation under the project area study was carried out by using Standard Quadrat Method and Random Sampling approach was followed. Quadrat size of 10 x 10 m used for tree species and 5x5m for shrub species and 1x 1m quadrats for herbs & grasses. The properties of vegetation with reference to species composition and functional attributes are expressed on species basis. Frequency, density abundance and Importance Value Index (IVI) were calculated. Diversity was calculated using Shanon – Wiener Index

##### Shanon – Wiener Index

The number of species and number of individuals in a community is measure of species diversity which depends on stability of the habitat. Vegetation of the study area was assess by determining Shannon – Wiener diversity index.

$$H = -\sum (ni / n) \log_{10} (ni / n)$$

**ni** = Number of individuals of each species in the sample

**n** = Total number of individuals

**Faunal assessment:** The list of wildlife was obtained from Kedarnath Forest Division Gopeshwar and Badrinath Forest Division Gopeshwar, The domestic animals were listed based on direct observation during field survey.

Public consultation was conducted during survey of the project area to know about various aspects of forest. Information about uses of various plant species by local people as well as sighting of any wildlife species, uses, poaching etc were obtained.

#### 5.0 BIODIVERSITY STATUS

The forests vegetation of the Uttarakhand ranges from tropical dry deciduous forests in the foothills to alpine meadows above timberline. The Comparative Distribution of

Forests Types in the State, Alaknanda Basin, Project Influence Area (PIA)-7 km area of project sites, Project Immediate Affected Area (PIAA) - 500 m on either side of project sites and Project Affected Area (PAA) is given below.

#### Comparative Distribution of Forest Types

S. No	Forest Type	Uttarakhand	Alaknanda Basin	PIA	PIAA	PAA
1	Moist Alpine Scrub	+	+	-	-	-
2	Sub- Alpine Forests	+	+	-	-	-
3	Himalayan Dry Temperate Forests	+	+	+	-	-
4	Himalayan Moist Temperate Forests	+	+	+	-	-
5	Sub-tropical Pine Forests	+	+	+	+	+
6	Tropical Dry Deciduous Forests	+	-	-	-	-
7	Tropical Deciduous Forests	+	-	-	-	-
8	Littoral & Swamp Forests	+	-	-	-	-

#### Biodiversity of Alaknanda River Basin

The Alaknanda River is the major tributary of the river Ganga. The Alaknanda originates at a height of 3641 meters below Balakun peak 16 km upstream from Badrinath from the two glaciers of Bhagirath Kharak and Satopanth.

The unique geographical location climate and topography along with latitudinal variation of the area has endowed the Alaknanda basin with highly luxuriant and diverse flora. The following major forest types have been identified:

- i. Himalayan Sub tropical Pine (between 900 – 2000m)
- ii. Temperate Forest (between 2000-2800).
- iii. Sub alpine Forest (between 2800-3800m).
- iv. Alpines land (above tree line between 3800-4500m).
- v. Alpine meadows (above tree line in above 3800-4500m).

#### Nanda Devi Biosphere Reserve (NDBR)

The project site is located in the transitional zone of NDBR. The territory of Nanda Devi Biosphere reserve starts from Patal Ganga. The transitional zone in project area is approximately 5km from dam site to Patalganga. The land use pattern of this zone comprises of forests, agricultural land, waste land, settlements, cultivable waste land and orchards. The National Highway NH-58 is located on the left side of the Alaknanda river in the project area and is a pilgrim route.

Nanda Devi Biosphere Reserve (30° 05'-31° 02'N Latitude, 79° 12'-80° 19'E Longitude) is located in the northern part of west Himalaya and comprises of parts of Chamoli district in Garhwal, Bageshwar and Pithoragarh districts in Kumaun in the Uttarakhand State. It belongs to Himalayan Highland Biogeographic Zonation of India and among the World Heritage Sites. In order to undertake complementary activities of biodiversity conservation and development of sustainable management aspects, Biosphere Reserves are demarcated into three inter-related zones.

**Core zone:** The core zone is defined as absolutely undisturbed zone. It must contain suitable habitat for numerous plant and animal species, including higher order predators and may contain centres of endemism. The core zones also contain places of exceptional scientific interest. **A core zone secures legal protection** and management and research activities that do not affect natural processes and wildlife are allowed. In NDBR strict conservation measures are taken to preserve the core zone and no human activity except regulated tourism is allowed inside the core zone. Regular patrolling activity and monitoring activity is taken up in side the core zone The Core Zone of NDBR comprise of:

1. Nanda Devi National - total area 624.6 km<sup>2</sup>
2. Valley of Flower National Park - total area of 87.5 km<sup>2</sup>

The Valley of flowers is a trek of about 16 km from Govindghat which is about 25 km from Joshimath. The Nanda Devi National Park is situated at a distance of 25 km from Joshimath, the territory starts at a distance of 9 km trek from the Village Lata. The core zone of NDBR harbors high diversity of species, alpine communities, rare, endangered, native and endemic species of both flora and fauna. The core area has 17 species of mammals such as Snow leopard (*Panthera uncia*), Leopard (*P. pardus*), Himalayan black bear (*Selenarctos thibetanus*), Himalayan brown bear (*Ursus aretos*), Himalayan musk deer (*Moschus chrysogaster*) Blue sheep (*Pseudois nayaur*), Himalayan tahr (*Hemitragus jemlahicus*), etc. many species of birds such as Monal pheasant (*Lophophorous impejanus*), Himalayan snow cock (*Tetraogallus himalayensis*), Koklas pheasant (*Pucrasia macrolopha*), Snow pigeon (*Columba leuconota*), Himalayan golden eagle (*Aquila chrysaetos*), Himalayan griffon (*Gyps himalayensis*), Lammergeier (*Gypaetus barbatus*), etc. (Tak 1997) and 19 species of butterflies such as Common yellow swallowtail (*Papilio machaon*), Common blue apollo (*Parnasshis hardwickei*), Bath white (*Pontia daplidice*), Painted lady (*Cynthia cardui*), etc.

**Buffer Zone:** The buffer zone adjoins or surrounds the core zone. In the NDBR the whole buffer zone has mainly three types of lands. Vegetation in the buffer zone comprises of temperate, subalpine and alpine types. It supports over 800 species of plants including fungi, lichens and bryophytes and 520 species of fauna. Over 23 forest communities and over 62 alpine communities have been recorded from the buffer zone of the reserve. 254 species of plants in Pindari area and 193 species in Lata-Tolma-Malari area are used by the native communities for various purposes. The buffer zone supports 29 species of mammals. Forty seven (47) villages are located in buffer zone of the reserve. The villagers are totally dependent on the forests for fuel, fodder, medicinal and wild edible plants and various other purposes

Under buffer zone 57.92 km<sup>2</sup> land is under Forest Panchayat land. These areas are under the direct control of Village Panchayat Committee and are looked after by them under the supervision and guidance of the Divisional Forest Officer. The major chunk of the buffer comprises of the Civil Forest Lands and the total area of such land is 4,595.10 km<sup>2</sup>. The administrative control of these areas lies with the Revenue Department but the civil forest being protected forest lands the provisions of Indian Forest Act applies in these areas. The buffer zone of the NDBR has 490.17 km<sup>2</sup> of Reserve Forest areas. The Reserve Forest Areas are totally owned and managed by the Forest Department of Uttarakhand.

**Transition zone:** The transition zone surrounding the buffer zone covers 546.34 km<sup>2</sup> area and inhabited by 52 villages. The inhabitants belong to schedule tribes, schedule castes, Brahmins and Rajputs. The vegetation mainly comprises of temperate, sub-alpine and alpine types. The land use pattern mainly comprises of forests, agricultural land, waste land, settlements, cultivable waste land, orchards, etc. The inhabitants are



mainly dependent on horticultural and agricultural crops such as Apple (*Pyrus malus*), Walnut (*Juglans regia*), Apricot (*Prunus armeniaca*) Potato (*Solanum tuberosum*), Amaranth (*Amaranthus paniculatus*), Bee keeping, medicinal plants cultivation and sheep farming for income generation

### Biodiversity of Project Influence Area

The major forest type observed in the project area up to an elevation of 2000-2200m is Upper Himalayan Pine forest. At higher elevations within the study area, scrubs are observed. *Pinus roxburghii* (Pine) chiefly occurs between the altitudinal range of 750 m and 1,600 m. Within the wide altitudinal distribution, the optimum zone of Chir is between 900 m and 1500 m, beyond which, it is observed in association with other species up to an elevation of about 1600 m. The forest of the project area fall under Badrinath and Kedarnath forest division.

The forests of the project area mainly fall in the degraded category. The forest areas are dominated by pine. The pine crops comprise mostly of middle age to mature trees. Young trees are generally deficient, occurring scattered or in small patches. Open shrub occupy the ground. Formation of plant story such as top, middle and lower is absent. Middle story and ground flora is absent in the pine forest. Pine forests are generally pure; no other species reaches the top canopy.

In the areas near habitation felling of trees is done for fuel, fodder and construction. The forests are open and poor in regeneration. The factors contributing to the degradation of the forest are

- Annual fire in the area.
- Grazing and browsing
- Felling for fuel, fodder and pole
- Agriculture & Horticulture Activities
- Natural factors – Dry rocky and steep slopes.

The major vegetation characteristics in the project area are Himalayan Moist Temperate Forest and Himalayan Dry Temperate Forest. The people from surrounding villages depend on forest for various purposes the Table given below depict various uses of trees by local people. The major uses of trees falling under the project area are as given below:

**Uses of Major Species by Community**

Name of Tree	Local	Shade	Food	Fodder	Fuel	Timber	Manure
<i>Albizzia lebbek</i>	Siris	—	-	+	+	+	-
<i>Alnus nepalensis</i>	Utis	—	-	+	-	+	+
<i>Bauhinia variegata</i>	Kachnar	—	+	+	+	-	+
<i>Bombax ceiba</i>	Semal	—	-	-	+	+	+
<i>Cedrus deodara</i>	Deodar	-	-	-	+	+	-
<i>Cinnamomum tamala</i>	Tejpat	+	+	-	-	+	
<i>Celtis australis</i>	Kharik	+	—	+	-	+	+
<i>Dalbergia sissoo</i>	Shisham	+	-	+	-	+	-
<i>Mallotus philippinensis</i>	Ruin	-	-	-	+	+	+
<i>Morus alba</i>	Tut	-	-	+	+	-	+
<i>Pinus roxburghii</i>	Chir	+	+	-	+	+	+
<i>Populus ciliata</i>	Poplar	+	-	-	+	+	-
<i>Pyrus pashia</i>	Mehal	-	-	+	+	-	+
<i>Quercus incana</i>	Ban oak	-	-	+	+	+	+
<i>Rhododendron arboreum</i>	Burans	+	+	-	+	-	+
<i>Cedrela toona</i>	Tun	+	-	+	-	+	-

Source: Public consultation

\* + In Use - Not in use

The fauna of the study area is represented by reptiles, birds and animals. The variation in altitude, climate, topography, forests type and forest cover leads to variation in animals. The fauna can be characterized as domestic animals and wild life.

### Biodiversity of Project Immediate Affected Area

The forest type of PIAA consist of Himalayan Chir Pine Forest and Himalayan Sub Tropical Scrub

Himalayan Chir Pine Forest

Major Associates: *Pinus roxburghii* – *Rhododendron* - *Albizzia*

Minor Associates: *Woodfordia* - *Berberis* - *Rubus*

*Artemisia* - *Desmodium* – *Plectranthus*

Himalayan Sub Tropical Scrub

Major Associates: *Debregeasia* - *Euphorbia* - *Woodfordia*

Minor Associates: *Berberis* – *Rubus* - *Prinsepia*

### Biodiversity of Project Affected Area

The flora of project affected area is represented by 87 species. Physio-gnomically vegetation has been categorized as trees, shrubs, herbs grasses, climbers, pteridophytes and epiphytes. The trees dominated by contributing maximum number of 34 species followed by 26 species of shrubs, 18 species of herbs , 3 climbers, 4 species of grasses, 2 species of pteridophytes and one species of epiphyte.

### Flora of Project Affected Areas

S. No.	Scientific name	Local name	Family
<b>Trees</b>			
1.	<i>Aegle marmelos</i>	Bel	Rutaceae
2.	<i>Albizzia lebbek</i>	Bhandir, Siris	Leguminosae
3.	<i>Alnus nepalensis</i>	Utis	Betulaceae
4.	<i>Bauhinia variegata</i>	Kachnar	Leguminosae
5.	<i>Bombax ceiba</i>	Semal	Malvaceae
6.	<i>Cedrela toona</i>	Toon	Meliaceae
7.	<i>Celtis australis</i>	Kharak	Ulmaceae
8.	<i>Citrus limon</i>	Nimu	Rutaceae
9.	<i>Citrus sp</i>	Malta	Rutaceae
10.	<i>Cupressus torulosa</i>	Surai	Cupressaceae
11.	<i>Dalbergia sissoo</i>	Shisham	Fabaceae
12.	<i>Emblica officinalis</i>	Amla	Euphorbiaceae
13.	<i>Ficus auriculata</i>	Timal	Moraceae
14.	<i>Ficus bengalensis</i>	Bargad	Moraceae
15.	<i>Ficus palmate</i>	Bedu	Moraceae
16.	<i>Ficus religiosa</i>	Pipal	Moraceae
17.	<i>Grevillea robusta</i>	Silver oak	Proteaceae
18.	<i>Juglans regia</i>	Akhrot	Juglandaceae
19.	<i>Mallotus philippinensis</i>	Ruin	Euphorbiaceae
20.	<i>Mangifera indica</i>	Aam	Anacardiaceae
21.	<i>Melia azedarach</i>	Dhenk	Meliaceae
22.	<i>Morus alba</i>	Tut	Moraceae
23.	<i>Musa paradisiacal</i>	Kela	Musaceae

S. No.	Scientific name	Local name	Family
24.	<i>Phoenix humilis</i>	Khajoor	Palmae
25.	<i>Pinus roxburghii</i>	Chil	Pinaceae
26.	<i>Prunus armeniaca</i>	Chuli	Rosaceae
27.	<i>Prunus communis</i>	Aloocha	Rosaceae
28.	<i>Prunus persica</i>	Aroo	Rosaceae
29.	<i>Punica granatum</i>	Aanar	Punicaceae
30.	<i>Pyrus pashia</i>	Mehal	Rosaceae
31.	<i>Sapindus mukorossi</i>	Ritha	Sapindaceae
32.	<i>Sapium insigne</i>	Khinna	Euphorbiaceae
33.	<i>Syzygium cumini</i>	Jamun	Myrtaceae
34.	<i>Toona serrata</i>	Kakuru	Meliaceae
<b>Shrubs</b>			
35.	<i>Adhatoda vasica</i>	Basinga	Acanthaceae
36.	<i>Agave Americana</i>	Rambans	Agavaceae
37.	<i>Berberis aristata</i>	Karmshal, Kashmoi	Berberidaceae
38.	<i>Calotropis gigantea</i>	Aak	Asclepiadaceae
39.	<i>Cannabis sativa</i>	Bhang	Cannabaceae
40.	<i>Carissa spinarum</i>	Karonada	Apocynaceae
41.	<i>Colebrookea oppositifolia</i>	Bindu	Lamiaceae
42.	<i>Coriaria nepalensis</i>	Makhoi	Coriariaceae
43.	<i>Debregeasia hypoleuca</i>	Sihanru	Urticaceae
44.	<i>Eupatorium adenophorum</i>	Kala bansa	Asteraceae
45.	<i>Euphorbia royleana</i>	Shuru	Euphorbiaceae
46.	<i>Jatropha curcas</i>	Arand	Euphorbiaceae
47.	<i>Lantana camara</i>	Lantana	Verbinaceae
48.	<i>Opuntia dillenii</i>	Nagphani	Cactaceae
49.	<i>Plectranthus coesta</i>	Chichiri	Lamiaceae
50.	<i>Princepia utilis</i>	Bhekal	Rosaceae
51.	<i>Pyracantha crenulata</i>	Ghingaru	Rosaceae
52.	<i>Ricinus communis</i>	Arandi	Euphorbiaceae
53.	<i>Rosa brunonii</i>	Kunja	Rosaceae
54.	<i>Rubus ellipticus</i>	Hinsar	Rosaceae
55.	<i>Rubus niveus</i>	Kala Hinsalu	Rosaceae
56.	<i>Rumex hastatus</i>	Bhilmora	Polygonaceae
57.	<i>Urtica parviflora</i>	Kandali	Urticaceae
58.	<i>Woodfordia floribunda</i>	Dhaura	Lythraceae
59.	<i>Zanthoxylum alatum</i>	Timbur	Rutaceae
60.	<i>Ziziphus mauritiana</i>	Ber	Rhamnaceae
<b>Herbs</b>			
61.	<i>Achyranthes aspera</i>	Aghada, Puthkanda	Amaranthaceae
62.	<i>Argemone mexicana</i>	Prickly poppy	Papaveraceae
63.	<i>Artemisia capillaris</i>	Pati	Asteraceae
64.	<i>Bidens bipinnata</i>	Kuru	Asteraceae
65.	<i>Bergenia ligulata</i>	Silphara	Saxiferaaceae
66.	<i>Cassia tora</i>	Chakunda	Caesalpinaceae
67.	<i>Cestrum verutum</i>	Kanjalu	Solanaceae
68.	<i>Chenopodium album</i>	Bathwa	Chenopodiaceae
69.	<i>Datura suaveolens</i>	Datura	Solanaceae
70.	<i>Euphorbia hirta</i>	Dudhi	Euphorbiaceae
71.	<i>Fragaria indica</i>	Bhumla	Rosaceae
72.	<i>Galinsoga parviflora</i>	Marchya	Asteraceae
73.	<i>Hedychium spicatum</i>	Banhaldu	Zingiberaceae
74.	<i>Oxalis corniculata</i>	Amrit Sak	Oxalidaceae
75.	<i>Polygonum chinense</i>	Jangli palak	Polygonaceae
76.	<i>Sonchus asper</i>	Dudhi	Asteraceae
77.	<i>Thalictrum foliolosum</i>	Mamiri	Ranunculaceae
78.	<i>Tridax procumbens</i>	Ground weed	Amaranthaceae

S. No.	Scientific name	Local name	Family
<b>Climbers</b>			
79.	<i>Bauhinia vahlii</i>	Malo	Leguminosae
80.	<i>Clematis connata</i>	Kanguli	Ranunculaceae
81.	<i>Ipomea purpurea</i>	Besharam	Convolvulaceaea
<b>Grasses</b>			
82.	<i>Apluda mutica</i>	Tachula	Gramineae
83.	<i>Cynodon dactylon</i>	Dhub	Gramineae
84.	<i>Chrysopogan fulvus</i>	Godia	Gramineae
85.	<i>Parthenium hysterophorus</i>	Congress grass	Compositae
<b>Ferns</b>			
86.	<i>Pteris sp</i>	Fern	Pteridaceae
87.	<i>Adiantum sp</i>	Fern	Pteridaceae

There is a dense forest after Guniyala villages as the road approaches the Maina Adit site. Three herb species *Berginia ligulata* (Silpara), *Hedychium spicatum* (Ban haldi) and *Thalictrum foliolosum* (Mamiri) are reported in the forest area near Maina adit, these species fall in vulnerable category as per IUCN Red list. However these species are common in India in Himalayan region and are found in altitudinal range from 1000 to 3000 m.

Assessment of diversity index of the project affected area shows that the diversity of the area is low for both trees & shrubs and grasses & herbs. All the value of diversity index is below 2.5. The diversity of the area is lowest in the quarry site. The diversity index of the project areas is given below.

#### Diversity Index of Project Affected Area

S.No.	Site	Biodiversity Index		
		Trees	Shrubs	Grasses & Herbs
1	Dam Site	2.29	2.13	1.71
2	Powerhouse & Colony site	2.41	2.48	1.92
3	Gulabkoti Adit	2.07 ( Trees & shrubs)		0.89
4	Langsi Adit	2.40 ( Trees & shrubs)		1.37
5	Quarry site Birahi	2.33 ( Trees & shrubs)		1.16
6	Quarry site Patalganga	1.13 ( Trees & shrubs)		1.06

#### Natural Fauna

The distribution of fauna is mainly dependant on availability and type of vegetation providing feeding, breeding, hiding & resting sites. As project, area is dominated by hilly tracks with less vegetation cover and interrupted by agriculture activities in the form of trench cultivation. Fauna of the project area is mainly represented by reptiles, birds and mammals.

#### Wildlife found in the Project Area

Scientific Name	Common Name	Family	Status	
			IWPA 1972	IUCN
<i>Panthera pardus</i>	Leopard	Felidae	Sch I	NT
<i>Ursus aretos</i>	Brown Bear	Ursidae	Sch I	LR/lc
<i>Macaca mulatta</i>	Monkey	Cercopithecidae	Sch II	LR/NT
<i>Mus booduga</i>	Field mouse	Muridae	Sch V	LR/lc

Scientific Name	Common Name	Family	Status	
			IWPA 1972	IUCN
<i>Caprolagus hispidus</i>	Hispid Hare	Cervidae	-	-
<i>Canis aureus</i>	Siyar	Canidae	Sch II	LC
<i>Muntiacus muntjak</i>	Kakad	Cercopithecidae	Sch III	LR/lc
<i>Vulpes bengalensis</i>	Fox	Canidae	Sch II	LC
<i>Suncus murinus</i>	Chuchunder	Soricidae	-	LC
<i>Presbytis entellus</i>	Langur	Cercopithecidae	Sch II	LR/lc
<i>Sus scrofa</i>	Wild Boar	Suidae	Sch III	LR/lc
<i>Lepus nigrocolis</i>	Khargosh	Leporidae	-	-
<b>Reptiles</b>				
<i>Varanus bengalensis</i>	Monitor Lizard	Varanidae	Sch I	LC
<i>Calotes spp</i>	Common Lizard	-	-	-
<b>Amphibians</b>				
<i>Bufo himalayanus</i>	Toad	-	-	-

LC: Least Concern, LR: Low Risk NT: Near Threatened

As per IUCN Red List most of the wildlife fall in “LC“ least concern category and only one species fall in vulnerable category. As per wildlife Protection Act (1972) three species *Panthera pardus* *Ursus aretos* and *Varanus bengalensis* fall in schedule I category and three species fall in schedule II category. Two species fall in schedule III and one in schedule V. Schedule I species are the species which are most critical and require appropriate protection measures. Birds were identified with binox. The common birds recorded during the survey were Myna, Magpai, Pigeon, Black Drongo, Grey Shrike and White Cheek Bulbul. All species present in the project area fall in the category of least concern, no species fall in threatened category.

#### Comparative Status of Natural Resources in the Project Area

Parameters	Uttarakhand	Alaknanda Basin	Project Influence Area	Project Immediate Influence Area	Project Directly Affected Area
Forests Type	8	5	3	1	1
Flora (total trees, shrubs, climbers, grasses, ferns etc.)	4048	800	154	96	87
Flora : Diversity Index	-	-	-	0.89 – 2.41	0.89 – 2.41
National Parks	6	2	0	0	0
Sanctuaries	6	1	0	0	0
Biosphere Reserve	1	1	1	1	1
Threatened / Protected fauna (no. of species)	22	15	5	3	3
Other Fauna	2248	-	33	32	32

## 7.0 IMPACTS AND MITIGATION MEASURES

The development of the project will not have any impact on the Core and Buffer zone of the NDBR. The Impact in the transitional zone NDBR of is not significant. The project sites are located along the river course. The area along the river consists of steep rocky slopes with scattered pine forest. The implementation of CAT plan and Afforestation plan will enhance the resources and environment of NDBR area. A detail CAT is

prepared by Forest Dept under which the interventions proposed for Nanda Devi include:

*Forestry Work*

- Afforestation work- 50ha
- Densification – 100 ha
- Medicinal plant plantation – 50 ha
- Assisted natural regeneration in the area 300 ha

*Soil & Moisture Conservation Engineering Work such as*

- Vegetative check dams- 250 No.
- Gully Plugging – 1500 No.
- Stone check dams - 500 No.
- Crate wire check dams -500 No.
- Spurs –200 No.
- Water percolation tanks – 500 No.

The total Budget for NDBR is Rs.4,39,80,500/- under CAT plan

The potential adverse impact of the project is considered to be loss of flora/ forests due to construction of dam/ reservoir. The forest land 104.611ha. Total 2,465 trees are to be felled/ cleared for the project. The impacts on biodiversity and the mitigation measure are given in the Table below

**Impact on Biodiversity & Mitigation Measures**

S. No	Project Phase	Activities	Impacts	Mitigation Measures
1.	Construction Phase	(i) Acquisition of Forest Land	Loss of Forests land is 104.611 ha.	<ul style="list-style-type: none"> <li>▪ Obtain Forest clearance from MoEF</li> <li>▪ Strict implementation of approved Compensatory Afforestation Plan in accordance with Forest (conservation) Act 1980 and Uttarakhand Forest Policy. Carry out compensatory afforestation in 209 ha area.</li> <li>▪ Strict compliance of MoEF stipulated condition for Forest clearance.</li> </ul>
		(ii) Felling of Trees	The clearing of project sites for construction requires felling of trees, a total number of 2,465 trees are be felled. The trees consist of plantation in forest land and vanpanchayat land. All the species are commonly distributed throughout the project immediate influence as	<ul style="list-style-type: none"> <li>▪ Compensatory Afforestation should be carried to compensate the loss of trees. Double no. of trees 4,930 trees may be planted in lieu of trees felled.</li> <li>▪ Compensation should be given as per R &amp;R policy.</li> <li>▪ Compensation for fruit bearing trees should be compensated</li> </ul>

S. No	Project Phase	Activities	Impacts	Mitigation Measures
			well as project influence area hence, the impact will be insignificant	<p>as per R &amp; R Policy.</p> <ul style="list-style-type: none"> <li>Under Road construction Trees falling outside the ROW should not be felled.</li> </ul>
		(iii) Clearing of Project sites for construction activity	The project site is dominated by Plantation species and weedy shrubs which are commonly distributed throughout the area. 3 vulnerable species were observed in the project sites.	<ul style="list-style-type: none"> <li>Compensatory Afforestation will be carried under the Degraded Forest Area Development scheme hence there will be increase in the forest cover</li> <li>The vulnerable species <i>Bergenia ligulata</i> (silpara), <i>Hedychium spicatum</i> (Banhaldi) and <i>Thalictrum foliolosum</i> (Mamiri) found in the area should be developed in separate herbal garden.</li> <li>THDC should undertake development of Herbal garden at suitable place in consultation with forest department and propagation of the species must be taken. Besides the three species other species of medicinal value may be also encouraged.</li> </ul>
	<b>Construction Phase -</b>	Impact on Fauna	<p>The wildlife is likely to be disturbed during construction phase due to various activities.</p> <p>The construction activity is likely to affect the movement of the animal</p> <p>Increase in noise may affect the feeding, breeding and movement of wildlife near forest area. Felling of trees is likely to affect the avifauna.</p> <p>Fragmentation of the habitat is not envisaged</p>	<ul style="list-style-type: none"> <li>Poaching should be strictly banned in the Forest area. It may be ensured by the Contractor that no hunting is practiced at the site by any of the worker and that all site personnel are aware of the location, value and sensitivity of the wildlife resources</li> <li>The project area is located in the transitional zone of Nanda Devi Biosphere reserve. Movement of wildlife is reported in the area therefore monitoring unit should be established in the project sites in consultation with Forest Department.</li> </ul>

S. No	Project Phase	Activities	Impacts	Mitigation Measures
			as the road construction and other construction works does not divide any habitat area.	<ul style="list-style-type: none"> <li>▪ Plantation of tree species which are major sources of fodder for wildlife in consultation with forest department in degraded and open areas.</li> <li>▪ Awareness program on Environment and Wildlife Conservation should be provided to the work force. Forest Act and Wildlife Act may be strictly adhered to.</li> </ul>
		(i) Generation of dust by movement of vehicles and construction work, crusher operation	<p>This may cause increase in SPM and RPM level in the area. Dust is also likely to settle on the surrounding flora.</p> <p>The impact shall be temporary, localized and reversible.</p> <p>No significant impact on Project Influence Area and Alaknanda Basin.</p>	<ul style="list-style-type: none"> <li>▪ All vehicles delivering materials to the site should be covered to avoid spillage of materials.</li> <li>▪ All exiting approach road used by vehicles should be kept clean and clear of dust</li> <li>▪ The roads surfaces should be host or watered using necessary equipments.</li> <li>▪ Plants, machinery and equipment should be handled so as to minimize generation of dust.</li> <li>▪ All earth work should be protected to minimize dust generation.</li> <li>▪ All crusher used in construction should confirm to relative dust emission devises</li> </ul>
		(ii) Generation of Noise	<p>The noise level of the construction site is likely to increase due to various activities, which may cause disturbance to the fauna in the area. However this impact would be insignificant as the increase in noise shall be intermittent and temporary</p> <p>No significant impact on fauna of Project Influence Area and</p>	<ul style="list-style-type: none"> <li>▪ The machineries, vehicles and equipments use in construction should strictly confirm to CPCB standard.</li> <li>▪ All vehicles equipment machinery used in construction should be fitted by exhaust silencers.</li> <li>▪ Equipments should be maintained regularly and soundproof gadgets should be used.</li> <li>▪ Blasting should be carried out</li> </ul>



S. No	Project Phase	Activities	Impacts	Mitigation Measures
			Alaknanda Basin	as per the statutory laws, regulation and rules pertaining to acquisition, transport, storage, handling and use of explosives
		(iii) Movement of Labour force and Technical Staff	<p>The labour force and technical staff may poach on occasionally invaded wildlife in the area.</p> <p>No significant impact on Project Influence Area and Alaknanda Basin</p>	<ul style="list-style-type: none"> <li>▪ The contractor should arrange alternative source of energy such as Kerosene or LPG</li> <li>▪ The Wildlife conservation Act should be strictly adhered.</li> <li>▪ Environmental awareness training should be provided to the Contractor and workers.</li> </ul>
		(iv) Quarry activities	<p>Extraction of rocks and sand shall be done for the construction work from quarry sites.</p> <p>No significant impact on Project Influence Area and Alaknanda Basin.</p>	<ul style="list-style-type: none"> <li>▪ The extraction of material should be done from the identified quarry site only.</li> <li>▪ The quarry area should be reclaimed back. The pits formed should be backfilled by construction waste and site should be stabilized.</li> <li>▪ The topsoil (150mm) from all areas should be preserved in stockpiles.</li> <li>▪ Stockpile should be utilized for redevelopment of quarry areas.</li> <li>▪ Grasses and shrub species should be planted.</li> </ul>
		(v) Soil Erosion	The construction activities may lead to the erosion of soil in catchments area of	<ul style="list-style-type: none"> <li>▪ Strict implementation of approved Catchment Area Treatment Plan for control of soil erosion.</li> </ul>

S. No	Project Phase	Activities	Impacts	Mitigation Measures
			Alaknanda Basin.	<ul style="list-style-type: none"> <li>▪ Work may be restricted in rainy season.</li> </ul>
		(vi) Muck Disposal	<p>The muck produced by the construction work shall be disposed at the dumping sites</p> <p>The disposal of muck shall destroy the flora at the sites. However the sites identified for muck disposal are open barren areas.</p>	<ul style="list-style-type: none"> <li>▪ The muck should be disposed at the identified sites only.</li> <li>▪ Before disposal of muck retaining walls should be constructed at the edges to retain the muck as the sites area just above the river Alaknanda</li> </ul>
3.	Construction Phase	(II) Influx of labour	Requirement of living places, hotels, filling stations, service stations and extra workers will arise. This will provide job opportunity to the local skilled and unskilled population.	<ul style="list-style-type: none"> <li>▪ Cutting of trees should be strictly prohibited in the area for other construction work.</li> <li>▪ Forest clearance should be obtained if there is any requirement for cutting trees.</li> </ul>
		(III) Induced Commercial development	<p>Development in Pipalkoti town and nearby places is likely to take place and land price may increase.</p> <p>New commercial development and adverse impacts are not envisaged</p> <p>The impact on Alaknanda Basin will be insignificant</p>	<ul style="list-style-type: none"> <li>▪ Any new colonies developed in area should have provision for plantation in the colony area.</li> <li>▪ As, Pipalkoti &amp; Chamoli are well equipped with the commercial development which are very near from proposed sites hence any new Commercial development not envisaged</li> </ul>

S. No	Project Phase	Activities	Impacts	Mitigation Measures
4.	Operation Phase	(i) Loss of flora	In operation phase no tree felling is anticipated.  Compensatory afforestation and avenue plantation is likely to increase the greenery in the area. Hence the impact will be positive during operation phase.	<ul style="list-style-type: none"> <li>▪ Proper protection measures should be taken for the plantation work carried under the project. Van Panchayats should be involved in afforestation activity and monitoring of the plantation work.</li> <li>▪ Fencing of plantation area should be done.</li> <li>▪ Watchman should be employed to take care of plantation for minimum 3 years.</li> </ul>
		(ii) Loss of fauna	Loss of fauna is not anticipated during operation phase as the wildlife is found in the upper reaches of hills far away from project area.  No impact on fauna of Project Influence Area and Alaknanda Basin during operation phase.	<ul style="list-style-type: none"> <li>▪ No impact is envisaged on fauna during operation phase.</li> <li>▪ Wildlife conservation program should be supported by the project</li> </ul>
		(iii) Biodiversity	No significant impact is envisaged on biodiversity in Project Influence Area and Alaknanda Basin	<ul style="list-style-type: none"> <li>▪ Awareness programs should be held for the stakeholders to develop concern for conservation of biodiversity in the area.</li> </ul>

## 8.0 Environmental Management Plan

A detail EMP is prepared defining mitigation measures, responsible agencies and budget for addressing environmental concerns. Implementation of management measures for impacts related to Forest and tree felling is the joint responsibility of THDC and State Forest Department. The State forest Department will be responsible for Implementing Catchment Area Treatment (CAT) plan, Compensatory Afforestation Plan, Wildlife

Conservation Program, Develop Herbal Garden in consultation with State Medicinal Plant Board (SMPB) and facilitate and guide Van Panchayats

The EMC (Environmental Management Cell) of THDC will be responsible for the technical planning, implementation and monitoring of all environmental mitigation and compensation measures. Muck /Quarry Area Redevelopment Plan, Avenue Plantation and Landscaping will be implemented by THDC. THDC will also undertake environmental awareness program in the area involving Van Panchayats, Gram Panchayats, Schools and Mahila Mangal Dals (Women's group).

Wherever contractors are involved, they will be responsible to implement mitigation measures and THDC will monitor the implementation program.

The Van Panchayat is an important institute in the area and should be involved to protect plantation sites, cultivation of herbal species and develop nurseries for plantation under the project area.

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