GMR BAJOLI-HOLI HYDRO ELECTRIC PROJECT (180MW)

HIMACHAL PRADESH

Site office Add.

Kartik Guest House, VPO- Kuleth,Sub-Tehsil- Holi,

Tehsil – Bharmour, Distt- Chamba, (H.P.) 176309.

CATCHMENT AREA TREATMENT PLAN

(As per new guidelines of Himachal Pradesh State Forest Department)

ACKNOWLEDGEMENT

This proposal on Catchment Area Treatment Plan of the proposed GMR Bajoli-Holi Hydro-electric Project (180 MW) located in District Chamba, Himachal Pradesh, provides and account of degraded areas in the free drainage catchment of the project and suggests various measures for their treatment. The main theme of the exercise is to mitigate and reduce various degradation processes thereby minimizing soil erosion in the free draining catchment of the proposed project in order to reduce silt in the Ravi river water. The plan also aims at treating and stabilizing various degraded areas in the catchment with activities to reduce pressure on forests with active participation of human population dwelling in the area.

The proposed CAT plan envisages undertaking biological as well as engineering treatment measures for prevention of soil erosion. It provides an insight into the quantum and variety of activities to be undertaken in the programme as per the proposed plan and will go a long way in achieving the goal of prevention of catchment degraded and soil erosion in Ravi river basin. The physical and financial targets have been spread over a period of 11 years. As per the new guidelines issued by State forest department Himachal Pradesh.

GMR Bajoli- Holi Hydro Pvt. Ltd. record their sincere appreciation and gratitude towards various functionaries of HP Forest department as well as other Govt. department and public representatives for their blessings, cooperation and guidance in developing this CAT Plan for Bajoli- Holi HEP (180 MW) in Bharmour Forest Division Chamba.

We are indebted to Dr. Suresh Kumar, Conservator of Forests, Chamba, Shri R.K Puri, DFO Bharmour Division,Shri Rajkumar Sharma (ACF) Bharmour Forest Division and his staff for their valuable association and support to the company officials.

Rk Singh.

(R.K Singh)
Associate Vice-President

INDEX

BAJOLI-HOLI HYDRO ELECTRIC PROJECT (180 MW)

HIMACHAL PRADESH

CATCHMENT AREA TREATMENT PLAN

Pertinent details of project are as follows:

State	Himachal Pradesh
District	Chamba
Location of Dam site	Near Bajoli village
Latitude	32° 16' 49" N
Longitude	76° 40' 36" E
River basin	Ravi/Indus
River	Ravi
Catchment area	902 km^2
Installed capacity	180 MW
River bed elevation	EL.1975 m
Full Reservoir Level	EL.2018.25 m
Hydraulic structure for diversion	Dam
Height of dam from river bed	46 m

Bajoli Holi HEP (3x60= 180 MW) in H. P.
By M/s GMR Bajoli Holi Hydropower Pvt. Ltd
-Salient features

Project Location	
State	Himachal Pradesh
District	Chamba
River	Ravi
Vicinity	Holi Village
Hydrology	
Catchment area	902 km^2
Area under snow	296.00 km^2
Rain fed area	606.00 km^2
Elevation of Snow Line	4500 m a.s.l.
Probable Maximum Flood	7419 m^3/s
Reservoir	
Full Reservoir Level (F.R.L.)	2016.25 m a.s.l.
Minimum Draw-down Level (M.D.D.L.)	2012.00 m a.s.l.
Length of Reservoir at FRL	2.42 Km
Diversion Tunnel	
Nos.	01
Size	5.6 m Diameter Modified Horse shoe
Length	472 m
Dam-Spillway	
Latitude	32° 16' 49" N
Longitude	76° 40' 36" E
Top of Dam	2020.0 m a.s.l.

Dam Height from Foundation Level	66.00 m
Dam Length	178.0m
Spillway Crest Elevation	1985.0 m a.s.l.
Gate Type and Size (W x H)	4 Nos. Radial; 10.0 m x 15.21 m
Hoist Type and Capacity	Twin Hydraulic hoist (4 sets, 2x150 MT)
Intake (On Left bank)	
Numbers	02
Intake Crest elevation	2000 m a.s.l.
Nominal Discharge	83.42 m^3/s
Gate Type	Vertical lift fixed wheel type
Gate Size (W x H)	2 No., 3.5 m x 4.25 m
De-sanding Chambers	
No. & Size (L x H x W)	2 Nos., 240m x 14.5m x 10.8 m
Size of Particle to be Removed	>0.2 mm
Average Discharge for each Chamber	38.24 m^3/s
Silt flushing tunnel (W x H) & length	2.5m x 3.0m (after two Flushing ducts combines), 428.7 m
Number & size of Gates	04 nos, 1.2m x 1.5m
Flushing Tunnel Gate Type	Vertical lift slide type with bonneted cover
Headrace Tunnel	
Excavated Shape	Modified Horse shoe
Finished Size	5.6 m Diameter Modified Horse shoe
Length	15.538 km
Design Discharge	69.52 m^3/s
Surge Shaft	
Type	Open to sky gated Vertical Shaft
Diameter	12 m

Gate size	3 m (w) X 3.8m (H)
Total Height	122.00 m
Pressure Shaft	
Number and Diameter	1 Nos., 3.8 m dia
Length of main Pressure Shaft	865.50 m(Vertical Reach 238.60 m)
Design Discharge through Pressure Shaft	69.52 m^3/s
Intermediate Shaft after bifurcation	
No. & Dia	1 Nos., 3.1 m
Length	25 m
Unit Penstock	
No. & Dia	3 Nos., 2.2 m
Combined Length	137.24 m (39.58 m -Unit-I, 33.08 m -Unit-II, 64.58 m -Unit-III)
Penstock Butterfly Valve	
Type	Lattice
Number	1
Diameter	3.65 m
Main Inlet Valve	
Type	Spherical
Number	3
Diameter	1.75 m
Surface Powerhouse	
Latitude	32° 20' 52" N
Longitude	76° 31' 58" E
Dimensions (W x H x L)	19 m x 41.2m x 82.5 m
Turbine Type	Vertical Axis Francis Turbine
Number of Units	3

Turbine Setting Elevation	1699.80 m a.s.l.
Turbine Speed	428.57 rpm
Max./Min. Gross Head	311.5m / 309.94 m
Net Head	285.32 m
Installed Capacity per Unit	60 MW
Total Installed Capacity	180 MW
EOT Crane capacity	1 No. 160 T / 32 T
Maximum Tail water Level	1707.06 m a.s.l.
Minimum tail water level	1706.75 m a.s.l.
Normal Tail Water Level	1707.06 m a.s.l.
Generator	
Type	Suspended type
Number	3
Nominal speed	428.57 rpm
Generator Voltage / Frequency	11 kV / 50Hz
Load factor (Cos Ø)	0.9
Design energy	769.39 MU
Tailrace Channel	
Length/Slope	60.69 m; 1:4.8
Shape	Trapezoidal
Width of channel	Varying from 40 m to 33 m at outfall
Switchyard	
Type	Out door
Area (L x W)	35 m x 50 m
Power evacuation	Power evacuated over 220 kV D/C line with twin moose conductor upto 400/220 KV Lahal pooling station.
Construction Period	5 Years including 6 months for pre-construction activities from 0-date 1.1.2012 Unit I – 58 months Unit II - 59 months Unit III – 60 months

BAJOLI-HOLI HEP (180 MW)

ABSTRACT OF COST OF TOTAL WORKS

S. No	Description	Amount Rs.(in Crores)
i)	Civil works	1005.41
ii)	E & M works	271.47
iii)	Interest during construction	412.87
iv)	Financing Charges	7.18
	Total Project Cost	**1696.93**
v)	Local Area Development charges @ 1.5 % of Project cost	25.45
vi)	CAT Plan charges @ 2.5% of the Project cost	43.00
	Grand Total	**1765.38**

INTRODUCTION

Project Specific

Bajoli- Holi hydro Power Project has been allotted to M/S GMR Bajoli-Holi hydro Power Pvt. Ltd. For implementation of 180 MW hydro power project. The implementation agreement has been signed on 29 April, 2011 with H.P government. Environmental clearance has been issued on 24th Jan, 2011 by Ministry of Forest & Environments, New Delhi. Copy of the same is annexed in **Annexure- A**. Central Electricity Authority, New Delhi has been granted the **TEC Clearance** vide their letter No. 2/HP/34/CEA/09-PAC/690-720 dated 30.12.2011. Copy is enclosed in **Annexure- B.** The **Total** expenditure granted under TEC Clearence are as under. The Toposheet of the Catchment Area for Holi- Bajoli Project is attached in **Annexure- C.**

S. No	Description	Amount (in Crores)
i)	Civil works	1005.41
ii)	E & M works	271.47
iii)	Interest during construction	412.87
iv)	Financing Charges	7.18
	Total Project Cost	**1696.93**

Catchment Area Treatment Plan has been prepared based on the Site specific requirements & the guidelines laid down by Forest department H.P. The Total Cost under CAT implementation works out to be **Rs. 4300.03 Lacs**. The detailed **Physical & Financial abstract of CAT plan** is enclosed in **Annexure-D.**

General

Bajoli Holi Hydro Electric Project located in Himachal Pradesh is a run of river scheme harnessing the hydro electrical potential of river Ravi in its upper reaches. The project will have power benefits mainly, as the scope for irrigation is negligible in these reaches.

The project will feed power in the Northern Region which comprises the states of Himachal Pradesh, Haryana, Punjab, Delhi, Jammu & Kashmir, Uttaranchal, Utter Pradesh and Union Territory of Chandigarh.

Northern Regional Power Grid comprises the power system controlled by the electricity Boards of the above States / Union territory & Bhakra Beas Management Board.

The power system in the region is operated in an inter-connected and co-ordinated manner. Even after the co-ordinated operation of existing hydro, thermal, & nuclear power stations, the Northern Region is experiencing an acute power shortage during the last many years.

It is obviously not possible to meet the rapidly growing power demand of industrial, agriculture, commercial & domestic sectors from the existing power stations. Viewed in this context, an early exploitation of the available vast hydro power potential assumes a greater significance.

Power Sector Development

Since independence, there has been sizeable growth in the power sector. At the time of independence the generating capacity in the country was merely 1750 MW which has since increased to 143311MW as on 30.04.08. The annual generation has grown from about 5 billion units to 669.5 billion units during 2006-07. However, correspondingly the per capita consumption has increased from a mere15 kwh to 665 kwh in 2006-07 and is expected to be 1000 kwh by 2011-12. In-spite of the growth in power sector and capacity addition there is still an average deficiency of 10% in Energy demand and about 17% average in peak demand. Region wise deficiency is indicated in the table 0-1 below:

Table 0-1: Region wise Energy and Peak demand availability/deficit

Region	Energy				Peak			
	Require - ment	Availab - ility	Surplus / Deficit (-)		Demand	Met	Surplus / Deficit (-)	
	(MU)	(MU)	(MU)	(%)	(MW)	(MW)	(MW)	(%)
Northern	219,797	196,147	-23,650	-10.8	32,462	29,495	-2,967	-9.1
Western	247,173	208,228	-38,945	-15.8	38,277	29,385	-8,892	-23.2
Southern	187,743	181,820	-5,923	-3.2	26,777	24,368	-2,409	-9.0
Eastern	75,831	72,099	-3,732	-4.9	12,031	10,699	-1,332	-11.1
North-Eastern	8,799	7,713	-1,086	-12.3	1,742	1,347	-395	-22.7
All India	739,343	666,007	-73,336	-9.9	108,866	90,793	-18,073	-16.6

Schemes in Operation in Northern India

Installed Hydro Generating capacity in the country and in the Northern region as on 30.04.2008 is 35909 MW and 13001 MW respectively, as per report of Ministry of Power Govt. of India.

Need for Promoting Hydro Power

Hydro power is the richest renewable and environmentally benign source of energy. Hydro power stations have the inherent ability for instantaneous starting, stopping and managing load variations which helps in improving reliability of the power system. Hydro stations are the natural choice for meeting the peak demand. The generation cost is inflation free and in fact reduces over time. A hydro electric project has a useful life extending to well over 50 years and helps in conserving scarce fossil fuels. Development of hydro power projects also provides the added advantage of opening up avenues for development of remote and backward region of the country. Despite being recognized as a relatively benign and renewable source of energy, the share of hydro power in the overall generating capacity in the country has been steadily declining since 1963. The hydro share has declined from 44 percent in 1970 (beginning of 4th Plan) to 25 percent in 2007 (end of 10th Plan).

Several constraints have affected the pace of hydro power development. These have been technical such as inadequate geological investigations, outdated tunneling methods, financial such as non availability of long term financing and viability of tariff. Most hydro projects have been adversely affected by geological surprises especially

during underground tunneling in the relatively young Himalayan mountains. Other problems arising out of the inaccessible and remote locations of the site, delays in land acquisitions and in resettlement of project affected families have also slowed down the pace of hydro power development in the country.

Now the Government has accorded a high priority to the development of the hydro potential and have taken a number of policy initiatives to address the issues impeding the hydro power development. In accordance with latest hydro power policy the Government is encouraging substantial private investment in hydro power development.

Hydro Share

To meet the present demand of peaking and non peaking power, it is estimated that a hydro–thermal mix of 40:60 would be an ideal mix. As on 30.04.2008, the total installed capacity in the country is 143311 MW and hydro share accounts for 35,909 MW (25%) as below:

Type	Installed Capacity
Hydro	35909 MW
Thermal	92157 MW
Nuclear	4.120 MW
Renewable energy Sources	11125 MW
Total	**143311 MW**

Hydro Power Capacity Addition Envisaged During 11th and 12th Plan Periods

To meet the ever increasing power requirement, the Government has planned a capacity addition of 78,577 MW during 11th plan period (2007-2012) .comprising 39,865 MW in central sector, 27,952 MW in state sector and 10,760 MW in private sector. Out of this a capacity of 16,553 MW is proposed to be added from hydro projects comprising 9,685 MW in Central sector, 3,605 MW state sector and 3263 MW private sector.

Summary of Capacity Addition Proposed During 11th Plan

Sector	Hydro	Thermal	Nuclear	Total
CENTRAL	9,685	26,800	3,380	39,865
STATE	3,605	24,347	0	27,952
PRIVATE	3,263	7,497	0	10,760
ALL INDIA	16,553	58,644	3,380	78,577

Capacity Addition Proposed during 12th Plan (2012-2017)

As per the studies carried out by CEA to assess the requirement of additional capacity during the 12th plan (2012-2017), the requirement of installed capacity to meet the all India peak demand and energy requirement at the end of 12th plan would require a capacity addition of 82,200 MW, out of which 30,000 MW is proposed to be added through hydro projects.

Long Term Plan for Hydro Development

As per the reassessment of hydro electric potential carried out by CEA, the hydro potential of the country has been estimated about 150,000 MW. The hydro installed capacity at the end of 10th plan (2002-2007) was 34,654 MW .Anticipated hydro capacity addition during 11th plan (2007-2012) is 16,553 MW and during 12th plan (2012-2017) is 30,000 MW as mentioned above It is also expected that in the next 20 years the entire feasible hydro potential would be exploited in the country .

Hydro Power Potential in Himachal Pradesh

Total Hydropower potential of Himachal Pradesh is estimated at about 21,000 MW, out of which about 6370 MW has been developed. 5744 MW capacity addition is planned to come up by 2012, and another 5600 MW by 2017. The state Government has taken several initiatives to attract Private participation in development of these projects. The basin wise distribution of the potential is indicated below:

a) Beas 4564 MW
b) Ravi 2294 MW
c) Satluj 9211 Mw
d) Yamuna 1011 MW
e) Chenab 3287 MW
f) Mini / Micro 530 MW

HPSEB have identified several Projects in Ravi Basin, some of which are under operation. Total Power potential of the basin is assessed at 2294 MW, out of which 1043 MW is under operation. A list of projects identified in Ravi Basin is reproduced hereunder at Table-0-2:

Table 0-2: List of Projects identified in Ravi Basin

Sl. No.	River / Nallah	Project	Capacity MW
1	Gharola Nallah	Gharola	0.05
2	Sal Nallah	Sal Stage-II	2
3	Sal Nallah	Bhuri Singh P/H	0.45
4	Baira Suil	Baira-Suil	198
5	Ravi River	Chamera Stage-I	540
6	Ravi River	Chamera Stage-II	300
7	Holi Nallah	Holi	3
8	Ravi River	Bajoli Holi	180
9	Ravi River	Chamba	126
10	Ravi River	Bara Bhangal	200
11	Budhil Nallah	Harsar	60
12	Budhil Nallah	Bharmour	45
13	Budhil Nallah	Budhil	70
14	Ravi River	Sai-Kothi	17
15	Sal Nallah	Sal Stage-I	6.5
16	Ravi River	Chamera Stage-III	231
17	Siul Nallah	Siul	13
18	Ravi River	Kuther	260
19	Chanju	Chanju-I	36
20	Chanju	Chanju-II	17
		Total	**2305**

Himachal Pradesh blessed with vast hydro power potential, has a significant role to play in overcoming the power shortage in Northern Grid.

Necessity and Justification for Implementing the Project

Keeping in view the increased requirement of peak and off peak demand and anticipated increase in generating capacity on the basis of new projects and / or under construction/ consideration during 11th & 12th five year plans, it is evident that there is dire need to provide additional power to the Northern Grid starved of power. Till the end of 11th plan Govt. of India plans a total installed capacity of Hydropower as 51207 MW, which is about 34% of the total installed capacity of the country. In the recent years, the Govt.of India has committed quantum jump, in the financial allocation and also by way of other supports so that hydroelectric projects not only get right priorities but also contribute in an increased way to the future capacity addition programmes of the country. This has provided the private sector with opportunities to invest in the hydroelectric energy sector and also releases the government of the burden of locking up capital for long periods of time while it can be used in other development projects.

New schemes have to be taken up immediately and implemented to derive timely benefits. Eco friendly and renewable source of power development in the Northern Region is hydro electric power plants located in Himachal Pradesh. Thus implementing and execution of Bajoli Holi Hydro Electric Project in Chamba district of Himachal Pradesh is obviously and clearly justified. Power of the project shall be fully absorbed in the power starved Northern Grid.

Bajoli Holi Hydro electric Project with recommended installed capacity of 180 MW is one of the most attractive scheme in Himachal Pradesh and as such merits immediate clearance and execution.

Project Proposal

General

The Bajoli Holi Hydroelectric project is proposed for development on Ravi river in Chamba district of Himachal Pradesh. The project is envisaged as a run-of-the-river scheme in the upper reaches of Ravi with project area lying between longitudes 76°40'36" and 76°27'30" E and latitudes 32°16'-49" and 32°20'-37" N. The project is proposed to harness the head available between Bajoli and Holi villages upstream of the under investigation Kutehr hydroelectric project and is accessible via Chamba-Holi road. The proposed diversion site is located between Bajoli and Nayagram villages and is about 15 km upstream of Holi, a large village in the area. The powerhouse site is located near Barola village, which is about 2 km downstream of Holi.

The project area is connected by a metalled road from Chamba, which itself is connected to Pathankot through National Highway 33. In the project area, the Chamba-Holi-Nayagram road runs on the left bank of Ravi river.

As per a recent agreement between GMR Energy Ltd. (GEL) and the Government of Himachal Pradesh, concession for development of the project has been awarded to GEL who intend to develop the project on Build, Own, Operate and Transfer (BOOT) basis.

Project Background

Ravi is one of the major rivers in the Indus basin which is joined by four major tributaries in it's head reach, namely Kalihan, Budhil, Tundah and Suil. The Bajoli Holi project is located just upstream Kutehr H.E.P (240 MW).

Pre-feasibility studies, followed by studies for preparation of Detailed Project Report, for Bajoli-Holi project had been undertaken by Himachal Pradesh State Electricity Board in recent past (the Project Report is dated June 2007), wherein an installed capacity of 180 MW was proposed by harnessing a gross head of about 288.5 m available in a 15 km stretch of river between Bajoli and Barola villages. The proposed scheme envisaged a right bank development with a powerhouse proposed at Barola village.

The scheme proposed in the Project Report comprises:

- A diversion barrage located near Bajoli at an elevation of about 1972 m with upstream pond level (FRL) as 1996.5 m.
- Underground desilting arrangement comprising 2 longitudinal chambers 250 m(L) x 13 m (W) x 19 m (H);
- 5.6 m diameter, modified horseshoe shaped HRT, 14.1 km long on the right bank of river culminating in an 88.48 m high 12 m diameter restricted orifice type surge shaft open to sky;
- About 400 m long, 4.25 m diameter pressure shaft trifurcating into three number 2.5 m diameter penstocks feeding three vertical axis Francis units;
- A pit-type surface powerhouse 49.6 m (L) x 15 m (W) x 29.6 m (H) on the right bank of Ravi River with 3x60 MW units. (An underground powerhouse was envisaged in the pre-feasibility stage);
- A RCC box-type tailrace channel, 6m x 5m in size and about 100 m long was proposed to discharge the water back into Ravi.

Since the available Project Report was prepared in June 2007, it requires to be updated to suit the latest hydro policy guidelines of state and central governments. Moreover, the project costing has to reflect the current material and equipment costs so that a realistic estimate of project cost is available with the Owner. With this objective, M/s GMR Energy Ltd have engaged SNC-Lavalin Engineering India Pvt. Ltd. (SLEI) to prepare a Detailed Project Report utilizing the data available and developing optimal project layout and design so that the project can be completed in time in an efficient manner.

HPSEB in its project report of June 2007 has taken the project's headwater and tailwater levels as 1996.5 m and 1708 m respectively. However, M/s GMR have been authorized to utilize head upto EL. 2015. Recently on 20.03.2009, the headwater and tail water elevations were modified to 2018.25 and 1706.75 m respectively, vide letter no HPSEB/SECTT/CE (PSP)/GOI(H)/Bajoli Holi/2009-3844-50 dated 20.03.09 issued by Government of Himachal Pradesh. In the present study and report, the modified headwater and tailwater elevations have been adopted and the project layout has been proposed for left bank development primarily because the accessibility of all project components becomes considerably simpler with the access road to and within the project area lying on the left bank of the river.

The detailed studies indicated that with keeping the diversion structure at the downstream site adopted for same by HPSEB, it was possible to align water conductor system on left bank and locate powerhouse either underground or on surface upstream of confluence of Kee Nala with Ravi. In this scheme, different alignments of HRT on left bank and alternative locations of powerhouse, possibility of locating adequate intermediate construction adits with minimum requirement of development of infrastructure were considered, studied and optimised. The detail study of all the alternative components have been discussed in their respective sections.

Finally the layout adopted includes a 66m high concrete gravity dam as diversion structure with slightly curved axis with the objective of regulating the spillway discharge located about 20m upstream of axis selected by HPSEB; a 15.563km long HRT aligned on left bank of Ravi; 12m diameter and 111.50 m high surge shaft located near Sutkar village, 857m long pressure shaft and 180MW installed capacity surface powerhouse located on left bank of Ravi just upstream of confluence of Kee Nala with Ravi. Keeping in view the length of HRT, five intermediate construction adits have been provided to facilitate the construction activities.

Access:-

Due to its rugged terrain and harsh climate conditions, most areas in the hill state of Himachal Pradesh have limited means of transport with a very sparse rail network and air transport connectivity to only a few places, the Bajoli Holi project area is no exception. As in the other parts of the state, the principal means of communication and transport is through a network of roads, which are continuously being improved. Recently, however, accessibility to the project area has improved with the development of hydroelectric projects such as Chamera I, Chamera II and Chamera III.

The project area is located about 200 km from Pathankot in Punjab state, and 85 km from Chamba, the district headquarters of Chamba district in Himachal Pradesh. The nearest broad gauge rail head as well as airport are in Pathankot. The road from Pathankot to Chamba is connected through national highway (NH- 20) and state highway (SH-33). The road from Chamba to the project site is an all weather road, major portion of which is covered under Major District Road (MDR-52)

Demographic details, Landuse & Socio Economic aspects

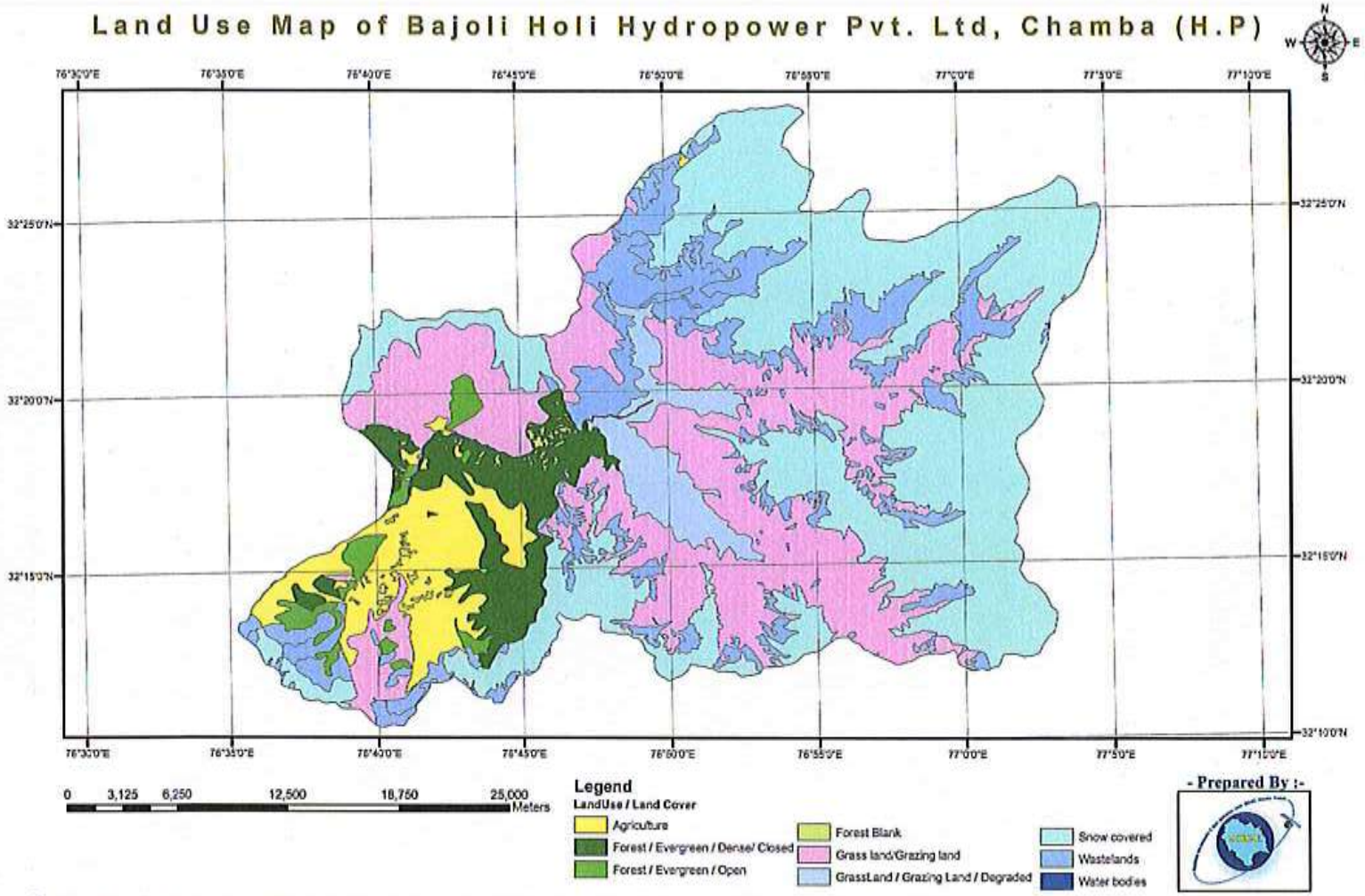
The state of Himachal Pradesh lies between 32° 22' 40" to 33° 12' 40" N latitudes and 75° 45' 55" to 79° 04' 20" E longitudes. It is bounded by Jammu & Kashmir in the north, Tibet in the east, Uttarakhand in the south-east and Punjab and Haryana in the south. The state has geographic area of 55,673 sq km demarcated into 12 districts, 109 tehsils/sub-tehsils and 57 urban areas with a human population of 6,077,248 (Census of India, 2001). The district Chamba is comprised of 10 tehsils/sub-tehsils viz. Chamba, Dalhousie, Brangal, Bharmaur, Saluni, Sihunta, Chuari Khas, Tisa, Holi and Pangi with district headquarters located at Chamba town situated at 996m. This district covers an area of 6,528 sq km with a human population of 4,60,499 (Census,2001) and population density of 71persons/sq km.(109 persons/sq km in the state and 324 persons All India average).

The population structure of district Chamba shows that the population is predominantly Hindu (92.31%), followed by Muslims, Sikhs, Christians and Jains. The Hindu population is comprised of Brahmins, Rajputs, Scheduled Castes and Scheduled Tribes. The Scheduled Castes population constitutes 19.75% of the total human population while Scheduled Tribes constitute 28.35% of the total population of the district. Gaddi, Gujjar and Pangwal are the Scheduled Tribes in the district. Gaddis are found mainly in Bharmaur tehsil and foothills of Dhauladhar in Kangra district. In addition to their primary occupation of priesthood, they have also taken to agriculture. Gujjars are notified as Scheduled Tribes in the state and they lead a pastoral life, migrating from high altitudes

to low hills in winters. Their main occupation is grazing cattle and supply of milk, ghee, etc. to people in towns. Pangwals are also Scheduled Tribes in the state mainly in Pangi valley with agriculture as their main occupation.

Chambiali is the main spoken language of the district in rural areas while in urban areas Hindi, Urdu and Punjabi is spoken commonly. Maize and wheat are the staple food of the people here in addition to millets that are consumed in Bharmaur and Pangi tehsils. Besides agriculture, livestock rearing is an important occupation of villagers which plays an important part in their economy. Cows, buffaloes, sheep, goats, etc. are the common animals reared by the rural communities for milk, ploughing of fields, dung, meat and wool. The district is entirely mountainous with altitudes ranging from 600 m to 6,200 m. The climate varies from sub-tropical to sub-arctic. Forests and forest produce along with tourism sustain the economy of the district. Horticulture also plays an important part in the economy of the district with production of temperate fruits like apple, citrus fruits, nuts and dry fruits.

Land Use Map of Bajoli Holi Hydropower Pvt. Ltd, Chamba (H.P)



This map has been prepared from thereferences(Latitude, longitute, height) and base map provided by the user agency and the AGISAC owes no responsibility of the correctness and accuracy of the same.

25(a)

Topography and Catchment

Topography

Lying mostly astride the main Himalayas and touching the Shivaliks on the southern fringe, the catchment area of the river Ravi is rugged and covered with the spurs of the high ranges. The Dhauladhar range separating the basin of river Beas from that of the river Ravi, the Pangi or Pir Panjal range dividing the water shed between the river Ravi and the river Chenab and Zaskar range bifurcating the basins of Chenab and Indus are three well defined snowy ranges, constituting the main topographical features of the area.

The Dhauladhar range running in North-West direction forms the boundary between Mandi and Kullu Districts, at the point where it gives off Bara-Bangahal branch to join the mid Himalayas. It makes a sudden bend westward and for the first time touches the boundaries of District Chamba, on the southern border. From this point, it continues for about 50 kms. forming the boundary between District Kangra and District Chamba.

The Zanskar range is the most direct continuation of the main Himalayan axis. It runs in North-West direction, dividing Ladakh from Lahaul-Spiti and then touches District Chamba, for a short distance along its northern border, separating Chamba and Lahaul-Spiti from Zanskar.

The Pir Panjal range known as the Pangi range within District Chamba after separating District Kullu from District Lahaul-Spiti, enters District Chamba on the western border of the Bara-Bangahal and traverses the district from South-East to North-West for more than 100 km. On the North-Western border, where the Pangi range leaves the territory, it gives off a branch to the South-West called the Daganidhar which forms the boundary between Chamba and Bhadrawah of Jammu and Kashmir. At its western extremity, this branch is connected by a short ridge, in which are the Padri and the Chatardhar passes. Topographically, the Dagnidhar and the Chatardhar are different sections of one continuous offshoot, forming with the Pangi Range, the water shed between the Ravi and the Chander-Bhaga (Chenab).

River Ravi and Its Tributaries :-

River Ravi originates from Bara-Bangahal at an elevation of 4229 m above mean sea level, approximately 150 km North-East of historical Chamba town. It flows in steep gradient with series of loops and bends. In between, main tributaries like Kalihan, Budhil, Tundah, and Suil & Sewa contribute lot of run-off to the Ravi. Bara-Bangahal comprises of snow covered slopes at heights ranging from 3050 m to 5800 m, above mean sea level. The total length of the course of the river Ravi is about 720 Kms.

The basin represents some remarkable physical features. The river flows in a North-West direction for most of its course, rises in Baira-Balsio and continues through Traila and Chanota to Ulans, where it is joined by two of its major tributaries in the head reaches viz. Budhil and Tundah. Beyond this, upto Chhatrari, river flows through a narrow gorge whereafter it opens out. After passing through Churi, Bagga, Mehla, Chamba and Udaipur, the river approaches Rajnagar, and then flows in narrow gorge to Sherpur. The Suil river, its largest tributary, joins the river Ravi upstream of Chamera Stage-I dam site. The Sewa river flowing from the north joins the river Ravi near Khairi. It then bends to the South-West and striking the terminal spurs of the Dhauladhar range, separates Chamba from Jammu and Kashmir and finally leaves the territory of Himachal Pradesh up stream of Ranjit Sagar Dam (Punjab).

Budhil nallah has its origin on the slopes of the mid Himalays near Kugti pass. At Harsar, it receives on its left bank the small stream from sacred lake of Mani-Mahesh, situated beneath the peak called the Mani-Mahesh, Kailash at an El. 3952 m. It passes village Bharmour downstream and soon afterwards meets the Ravi near village Kharamukh.

Tundah nallah rises at Kalichtop pass, flows through Tundah valley and joins the Ravi near Kharamukh. The right bank tributaries are bigger and have more discharge as compared to the left bank tributaries except Kalihan, which originates in Dhauladhar range on the left bank and contributes a good discharge. Both Budhil & Tundah are about 54 km in length.

CATCHMENT:-

The entire project catchment comprises of mountainous terrain with steep hill slopes and is thinly populated. The catchment area of the proposed project lies between Longitude 76°35'15" E and 77°3'35" E and Latitude 32°10'20"N and 32°28'7" N; the proposed diversion structure is located at Longitude 76°40'36" E and Latitude 32°16'49"N.

The total catchment area of river Ravi up to the proposed diversion site is 902 km^2. The rain fed catchment area and the snowfed area for the snowline elevation at EL. 4600 is 659 km^2 (73%) and 243 km^2 (27%) respectively, the shape of the catchment above the diversion site at Bajoli resembles an elongated leaf. Total length of the river from its origin upto its confluence with Indus River is nearly 720 km. The length of the river upto the proposed dam site is 40 km. The equivalent slope of the river upto dam site has been evaluated as 42 m/km. The river bed elevation at the diversion site is 1975.00 m.

a) Precipitation

The precipitation in the catchment takes places in the form of snow and rain. The catchment receives good rains from June/July to September due to the South-west monsoon. In this basin, little rainfall is observed during winter (November.-February) and spring season (March-April). The precipitation during winter falls as snow, primarily due to western disturbance that pass over the North-West part of the country during this period.

The annual rainfall records are available for the 13 non-recording rain gauges of Chamba District. The normal annual rainfall and year wise annual rainfall has been recorded in millimeters at all these stations for the period 1960-2002 by the office of Director, Land Records, Revenue Department, Govt. of Himachal Pradesh.

b) Hydrological Characteristics

Hydrological inputs play a vital role in planning, execution and operation of any water resources development project. Hydrological studies are carried out at all stages of project developments starting from the pre-feasibility stage and are continued even during the operation of the project. Hydrological studies for a river valley project are carried out with a view to:

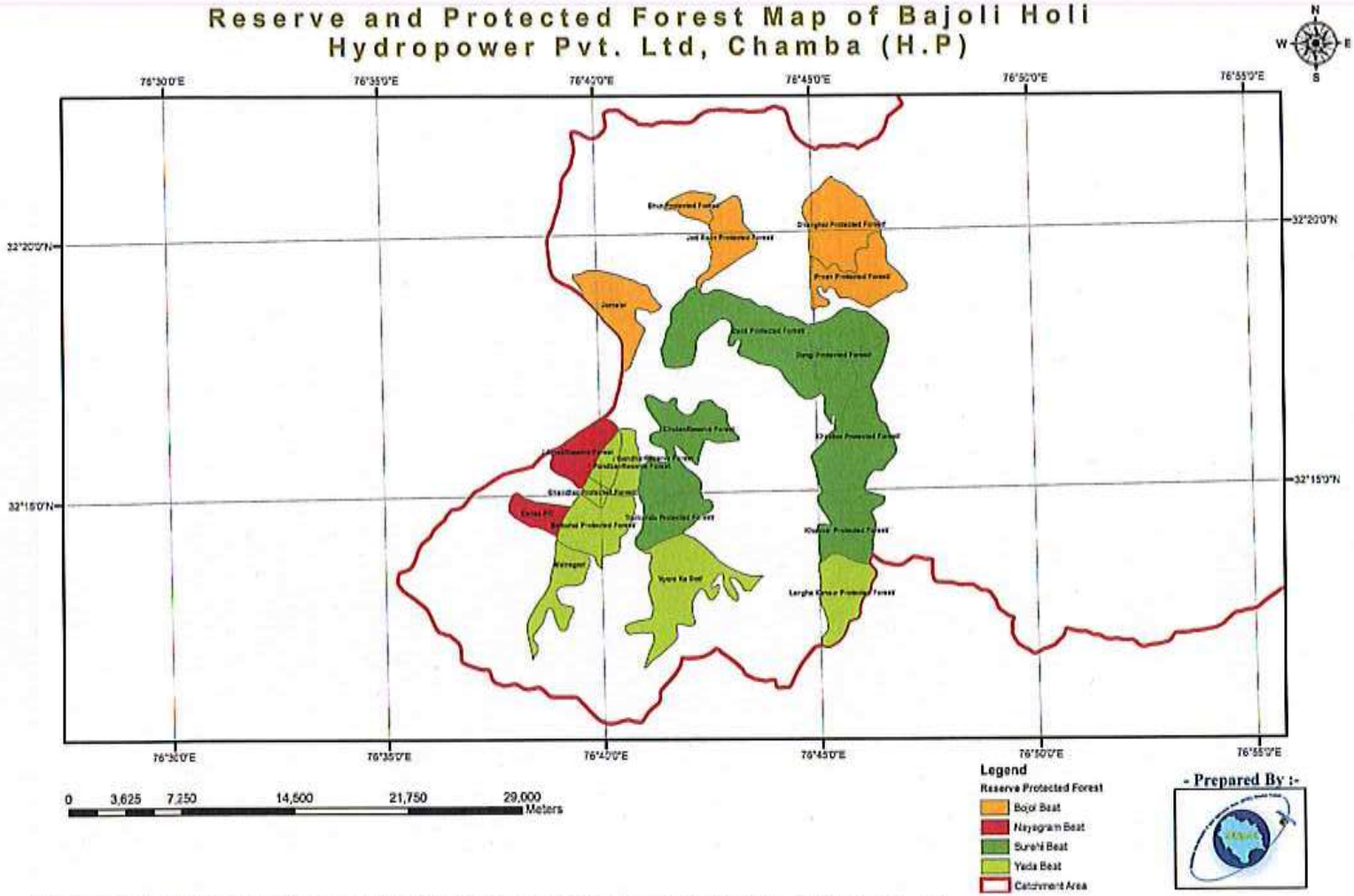
- Assess quantities of available water in the river for power generation and its variations with time.
- Estimate design flood and diversion flood required for the hydraulic design of spillways and temporary diversion structure as well as for safety of the structure.
- Determine reservoir capacity and the submergence area at FRL and MDDL
- Assess reservoir sedimentation rate as well as its effect on the live storage with reference to life of the reservoir.

The Bajoli Holi Hydro-electric Project is a run of the river scheme proposed on the Ravi River in Chamba district of Himachal Pradesh. The project envisages construction of a concrete gravity dam approximately 950 m downstream of Channi nallah near Bajoli village. The diverted water shall be carried through a water conductor system planned on the left bank of Ravi river. A surface powerhouse is proposed on the left bank near Holi village.

Pertinent details of project are as follows:

State	Himachal Pradesh
District	Chamba
Location of Dam site	Near Bajoli village
Latitude	32° 16' 49" N
Longitude	76° 40' 36" E
River basin	Ravi/Indus
River	Ravi
Catchment area	902 km^2
Installed capacity	180 MW
River bed elevation	EL.1975 m
Full Reservoir Level	EL.2018.25 m
Hydraulic structure for diversion	Dam
Height of dam from river bed	46 m

Reserve and Protected Forest Map of Bajoli Holi Hydropower Pvt. Ltd, Chamba (H.P)



This map has been prepared from thereferences(Latitude, longitute, height) and base map provided by the user agency and the AGISAC owes no responsibility of the correctness and - accuracy of the same.

29(a)

Adopted Conventions

The following conventions have been adopted for the hydrological assessment in this chapter:

- The hydrological year runs from June to May of the following calendar year;
- The monsoon season is defined from June to September;
- The non-monsoon season is defined from October to May of the following calendar year.

Area under permanent snow cover

Satellite imageries of last 5-6 years for summer month were requested from NRS for the study of area under snow cover in the project catchment. It is confirmed that satellite imageries for the monsoon months are not clear due to presence of cloud cover over the catchment area. Most of the images could not be processed to get desired information. However two satellite imageries for the month of April and October were procured and processed to delineate the snow line. The April image shows the entire catchment above 3500 m elevation under snow cover. In October image the snowline is found to be around 4600 m elevation.

It is obvious that the Snowline shifts from 3500 m in April to 4600 m in October with the melting of snow in the summer. It again comes down with the fresh snowfall during winter (Nov-Mar).

Climatology

The climate of Ravi basin is affected by the tropical weather systems during the summers and the cold weather systems known as Western Disturbances during winter and pre-monsoon months. The Western disturbances have their origins near the Mediterranean Sea and as mentioned above move in the westerly wind regime along Himalayan latitudes during the winter season. These disturbances may be in the form of a depression or a low-pressure area formation or an upper air cyclonic circulation or a trough in lower isobaric levels. They shift to more northerly latitudes as the summer season approaches.

Summer precipitation in the Ravi basin area is mainly associated with the Southwest monsoon which is dominant from June to September; most of the precipitation is in the form of rainfall. Extreme rainfall floods are mostly experienced during this season.

Based on the information available from different sources, the project basin broadly gets affected by the following seasons:

Winter	:	Dec to Mar
Summer/Pre-monsoon	:	Apr to Jun
Monsoon	:	Jul to Sept
Post-monsoon/Autumn	:	Oct to Nov

Data Availability

Rainfall data

There are 12 (Twelve) RG stations located in the Chamba district of Ravi River basin. The normal annual and annual rainfall records for most of the stations are available since 1960. Further, all weather station (AWS) has been installed at site by M/s GMR in April' 2009 and data recording is in progress.

Table 0-3: Period of rainfall data availability

S. No.	RG Station	Elevation (m)	Period
1.	Chamba	920	1960-2000 *
2.	Chhatrari	1800	1960-1997 *
3.	Bhandal	1750	1960-2003 *
4.	Chowari	1050	1960-1998 *
5.	Bathri	1350	1960-1983 *
6.	Kala top	2400	1960-2007 *
7.	Bharmour	2150	1960-2005 *
8.	Tissa	1550	1960-2003 *
9.	Bhanota	920	1960-1989 *
10	Killar	2550	1961-1989 *
11	Sahoo	1200	1981-1998 *
12	Holi	1850	1999-2007 *
13	Holi	1850	2009 – In Progress

* With Gaps

Discharge Data

A gauge-discharge (G&D) station on Ravi river was established at Bajoli in 1997 and measurements have continued since then. Then, eleven year of continuous observed flow data are available at project diversion site. Durgathi is the other G&D station near the project catchment where long term historic flow records are available (1972- 2000). The other G&D station located near the project site with short term flow records is at Kutehr (1995 – 2001). Both these G&D stations are located downstream of the proposed project site. Although the observed flow records of Kutehr, Bajoli and Durgathi share only a small common period, these common period flows have become useful for consistency check and verification of the basic data for finalization of flow series at the Project site.

Details of the G&D stations to be utilized for the present studies and their data availability are shown in Table 0-4 below:

Table 0-4: Details of G&D site on River Ravi

S. No.	G&D Station	Catchment Area (km^2)	Period of Record	Period	Owner Agency
1.	Durgathi	2205	1972-00 #	28 years	HPSEB
2.	Banthu	984	1971-76 #	5 years	HPSEB
3.	Tiyari	1112	1986-91 #	6 years	HPSEB
4.	Kutehr	1155	1995-01	6 years	HPSEB
5.	Bajoli	902	1997-08	11 years	HPSEB

with gaps

Geology of Project Area

The proposed Bajoli Holi Hydroelectric Project is envisaged in Ravi Basin in the Chamba area in western part of Himachal Pradesh, located between Pir Panjal and Dhaula Dhar mountain ranges. According to Srikantia and Bhargava (1998), the Chamba Basin is located in Tethys Himalayan tectogen in which a thick sequence of Proterozoic and Upper Paleozoic – Mesozoic rocks is exposed. These formations are co-related with similar rock types of Bhadarwah in Jammu & Kashmir in the northwest and the Proterozoic rocks are considered extension of similar rocks exposed in Lahaul in southeast. Based on the works of Geological Survey of India and several other workers, Srikantia and Bhargava (1998) have established the stratigraphic sequence in the area and are given in **Table-0-5.**

Table-0-5: Geological Succession in Chamba Area

Formation	Age	Lithology
Khalel	Triassic	Grayish blue, gray and yellow limestone and dolomite with inter-bedded gray orthoquartzite in the upper part and gray calcareous shale with inter beds of limestone in basal part
Salooni	Permian	Dark gray or black carbonaceous & pyritous slates with thin lenticles of limestone. Thin discontinuous bands of amygdaloidal and massive lava flows of basaltic to andesitic composition are observed at places.
Batal or Katarigali	Terminal Proterozoic	Black carbonaceous phyllite with inter beds of quartzite. Local limestone bed at the base with magnesite and gypsum.
Manjir	Neoproterozoic	Polymictic diamictite – poorly sorted, lithologically heterogeneous, laminated or banded.
Chamba Formation	Neoproterozoic	Mainly laminated chloritic slate with greywacke and intercalated carbonaceous slate
	Neoproterozoic	Mainly greenish grey or dark grey meta greywacke with slate and subordinate quartzite

The rocks belonging to Chamba Formation, which belong to the upper part of Proterozoic Salkhala Group, appear prominently in the core of an anticline in the Northwest corner of Chamba and also as a long and narrow band along the southwestern part. The rocks belonging to Salkhala Group are delimited by the Vaikrita group of Central Crystalline zone below, the Manjir – Batal (Katarigali) formations in Chamba area and Batal Formation of Haimanta Group in Lahaul – Spiti – Kinnaur,

above. It encloses outliers of Late Paleozoic – Early Mesozoic Salooni – Khalel formations in Chamba area and also granitoids in frontal zone.

The Chamba formation comprises a thick sequence of meta-greywacke, slate and phyllite with strong flyschoid characteristics. It is surrounded by Manjir formation which succeeds it along an unconformity followed by a broad belt of the Batal formation, also known as Katarigali formation in Bhadarwah – Bhalesh in Jammu & Kashmir and in Chamba area of Himachal Pradesh.

The studies carried out by Geological Survey of India have brought out that the formation earlier known as Salooni Formation in Chamba is actually the extension of the terminal Proterozoic Batal Formation of Lahaul area and Manjir is its basal unit. The Chamba Formation of Salkhala Group in Chamba area is unconformably overlain by Manjir Formation. Manjir Formation borders Chamba Formation in northwest, west and southwest parts and continues in southeast towards Karsog, turns around and extends into Kulu area. The Manjir formation comprises dominantly lenticular thick bedded or massive diamictite along with sandstone and intercalated argillites. However, due to metamorphism, these consist of grey and purple thinly bedded slate that at places contain pebbly horizons (Sharma & Bhola, 2004) and the rocks of this formation include grey and purple metamorphosed pebbly mudstones, para conglomerate with intercalated bands of grey slates. The clasts comprise dominantly quartzite, limestone, volcanic rocks and occasionally phyllite. These are poorly sorted and range from grit to boulder in size. The clast matrix ratio is highly variable.

The Manjir Formation is succeeded by Batal formation, also known as Katarigali Formation in Chamba, without any perceptible break. It forms the basal part of Tethyan Phanerozoic succession and has conformable contact with crystallines. The Batal formation in lower part comprises gray – green phyllites, grey quartzite and carbonaceous phyllite. Occasionally, migmatites and para-gneisses with garnetiferous biotite schist are also observed in this formation in south Lahaul. The middle part of the sequence comprises quartzites alternating with pyritous carbonaceous phyllites that are well exposed in Billing Lungpa and Kaylong. The upper part of the sequence comprises green coloured chlorite phyllite, carbonaceous phyllite and quartzitic phyllite. At places, lenticular bands of dolomite are observed in the basal part of Batal (Katarigali) Formation closer to its contact with Manjir Formation.

Salooni formation is infolded within the Batal (Katarigali) and comprises black shale, slates, calcareous slates and lenticels of limestone and has been assigned Permian age by Datta and Bhattacharyya (1975) on the basis of fossil assemblage.

Salooni formation is overlain by Khalel Formation that comprises mainly grey blue, grey and yellow limestone and dolomite with inter-bedded grey quartzites in upper part. The Salooni and Khalel represent major Permo – Triassic marine transgression in Himalayas and same is common to Bhadarwah area of Jammu and Tandi Belt of south west Lahaul. Chamba basin is considered as an extension of Bhadarwah Basin.

In the Bajoli-Holi project area, the rock type is phyllites and its variants like quartzitic phyllites, carbonaceous phyllites with bands of quartzites belonging to Katarigali Formation, Manjir Formation and Chamba Formation.

SOCIO-ECONOMIC ASPECTS

1.1 INTRODUCTION

Development projects are planned based on the availability of utilizable natural resources and on commissioning they act on growth foci. This attracts flow of finances, investments, jobs and other livelihood opportunities, which brings in people from different cultural and social background. Such planned activities not only provide impetus to the local economy but also bring about a multi-dimensional economic, social and cultural change. Most often it has been observed that such development projects are commissioned in economically and socially backward areas, which are inhabited by some of the indigenous populations. Commissioning of development project invariably brings about a number of desired and undesired impacts along with it.

Himachal Pradesh has one of the highest per capita incomes states inIndia. Due to the abundance of perennial rivers and having hydroelectric power plants, it sells electricity to other states such as Delhi, Punjaband Rajasthan. The economy of the state is mainly dependent on three sources like hydroelectric power, tourism and agriculture resources. Himachal Pradesh is surrounded by Jammu & Kashmir on north, Punjab on west and south-west, Haryana and Uttar Pradesh on south, Uttarakhand on south-east and by Tibet on the east. The literal meaning of this state is region of snowy mountains.

The state of Himachal Pradesh lies between 32° 22' 40" to 33° 12' 40" N latitudes and 75° 45' 55" to 79° 04' 20" E longitudes. The state has geographic area of 55,673 sq km demarcated into 12 districts, 109 tehsils/sub-tehsils and 57 urban areas with a human population of 6,077,248 (Census of India, 2001). The district Chamba comprises 10 tehsils/sub-tehsils viz. Chamba, Dalhousie, Brangal, Bharmaur, Saluni, Sihunta, ChuariKhas, Tisa, Holi and Pangi with district headquarters located at Chamba town situated at 996m. This district covers an area of 6,528 sq km with a human population of 4,60,499 (Census,2001) and population density of 71 persons/sq km (109 persons/sq km in the state and 324 persons All India average).The state is divided into twelve districts (Bilaspur, Chamba, Hamirpur, Kangra, Kinnaur, Kullu, Lahaul&Spiti, Mandi, Shimla, Sirmaur, Solan and Una). The districts are further sub-divided into sub-divisions, tehsils and sub tehsils. The people are predominantly Hindus (95.43%) with sprinkling of muslims (1.97%), Christians (0.13%), Sikhs (1.19%), Buddhist (1.25%) and jains (0.02%). The population presents an admixture of

Gaddis, Gujjars, Kinnars, Lahaulis and Pangawals. Hinduism is the predominant religion followed in this state.

According to the 2001 census, the population of Himachal Pradesh is 60.8 lakh, in which the male population has 30.9 lakh and the female is 29.9 lakh (Table 3.32). The population of Scheduled Tribes and Scheduled Castes is 2.4 lakh and 15 lakh, respectively. The total inhabited villages in state are 17,495 whereas number of towns and cities is 57 only. The state has 12 districts, 51 sub-divisions, 75- tehsils, 34 sub- tehsils and 75 blocks.

The prominent rivers arising from mountainous areas of Himachal are Sutlej, Beas, Parbati and Ravi – all south and southwest flowing rivers. The perennial availability of water and the geographic terrain have allowed harnessing of hydro-energy from these rivers. The present project proposed by GMR is one such scheme in the state. The BajoliHoli H.E. Project is located on RaviRiver in district Chamba with proposed dam near village Bajoli. The total catchment area of the RaviRiver is about 902 sq km up to dam site. The river is proposed to be diverted through a head race tunnel on the left bank from dam to the power house near Kutehr to generate 180 MW of electricity. For making an assessment of the socio-economic status of the area field surveys were conducted in the villages around the proposed project. This information was supplemented with secondary sources like Primary Census Abstracts and Statistical Handbook of District Chamba.

1.1.1Chamba District

Chamba town, the district headquarters, is connected by a metalled road of about 120 km from Pathankot via Bannikhet. Chamba town is connected to the proposed project site near Nayagram village via Kharamukh and Holi. According to the 1991 census, total human population of district Chamba was recorded to be 3,93,286 persons. Of this population 51.3% are males and 48.6% females. The district population has, however, increased to 4,60,499 (Census, 2001) with a decadal growth of 17.09% (Tables 7.1&7.2). The rural population of the district accounts for 92.4%, while the urban population is only 7.6%. The literacy rate in the district is low (63.73%) as compared to other districts of Himachal Pradesh (Average for the state - 77.13%), but it is higher than other neighbouring Himalayan states. The population structure of district Chamba shows that the population is predominantly Hindu (92.31%), followed by Muslims, Sikhs, Christians and Jains. The Hindu population comprises Brahmins, Rajputs,

Scheduled Castes and Scheduled Tribes. The Scheduled Castes population constitutes 19.75% of the total human population while Scheduled Tribes constitute 28.35% of the total population of the district. Gaddi, Gujjar and Pangwal are the Scheduled Tribes in the district. Gaddis are found mainly in Bharmaur tehsil and foothills of Dhauladhar in Kangra district. In addition to their primary occupation of priesthood, they have also taken to agriculture. Gujjars are notified as Scheduled Tribes in the state and they lead a pastoral life, migrating from high altitudes to low hills in winters. Their main occupation is grazing cattle and supply of milk, ghee, etc. to people in towns. Pangwals are also Scheduled Tribes in the state mainly in Pangi valley with agriculture as their main occupation.

Chambiali is the main spoken language of the district in rural areas while in urban areas Hindi, Urdu and Punjabi is spoken commonly. Maize and wheat are the staple food of the people here in addition to millets that are consumed in Bharmaur and Pangi tehsils. Besides agriculture, livestock rearing is an important occupation of villagers which plays an important part in their economy. Cows, buffaloes, sheep, goats, etc. are the common animals reared by the rural communities for milk, ploughing of fields, dung, meat and wool. The district is entirely mountainous with altitudes ranging from 600 m to 6,200 m. The climate varies from sub-tropical to sub-arctic. Forests and forest produce along with tourism sustain the economy of the district. Horticulture also plays an important part in the economy of the district with production of temperate fruits like apple, citrus fruits, nuts and dry fruits. The project study area is spread across two districts viz. Chamba and Kangra.Majority of the project study area falls within Holi Sub-tehsil of Chamba district. The Chamba is the second largest (6,528 sq km) among the twelve districts ofHimachal Pradesh having the population of 4,60,887 persons according to Census 2001. The sex-ratio is 959. The density of population in the district is 71 persons per sq km. It consists of 6 sub-divisions, 7 tehsils and 3 sub tehsils namely Bhaillai, Sihunta and Holi. There are 270 gram panchayats in the district. It has 6 development blocks.The population of Scheduled Castes and Scheduled Tribes are 92,359 and 1, 17,569 respectively. Total literacy rate in the district is 62.9% in which male has76.4% and female has 48.8%.

1.1.2 Kangra District

Dharmshala is the headquarters of District Kangra. Kangra is spread over an area of the 5,739 sq km. Total population of district is 1339030 persons according to Census 2001. The sex ratio is 1025. Population density in the district is 233 persons/sq km. Kangradistrict consists of 8 sub – divisions, 16 tehsils, 4 sub – Tehsils and 15 development blocks. Major river of the district is Beas. Only a small portion of the project area, mainly the catchment upstream of dam site falls within Multhan sub-tehsil of Kangra district.

1.1.3 Holi Sub-tehsil

Most of the study area of the proposed BajoliHoli H.E. Projectlies within the Sub-tehsil Holi, which covers an area of about 1793.30 sq km while only the upper catchment falls within Multhan sub-tehsil of Kangra district. Holi is the headquarters of the sub-tehsil and is located about 80 km away from Chamba town. The area is bounded byChamba tehsil in west, sub-tehsil Multhan of district Kangra in east, tehsil Tisa in north-west and district Lahul and Spiti in northeast. Total number of villages in Bharmaur and Holi tehsils is 252 of which only 99 are inhabited with 6611 households. Holi tehsil has population density of 13.82 persons/sq km.

a) Demographic Profile

Total population of Holi has increased to 14514 in 2001 with only 3.9% decadal increase. The sex ratio of male to female is 928.The age group of 0-6 years constitutes only 18.3% (6,225) of the total population.The proposed project and its components fall in the sub-tehsil Holi. Its development block is Bharmourwhich has 29 panchayats. Total population of Holi sub-tehsil is 14,514 which belong to 3,032households (Tables 1.1 & 1.4). The population of Scheduled Castes (SC) and Scheduled Tribes (ST) is 2,500 and 10,880 respectively. The population in the age group of 0-6 years accounts 2,049.

Table 1.1 Demographic profile of Chamba district vis-à-vis Himachal Pradesh state

	Himachal Pradesh			District Chamba			Sub-Tehsil Holi			Sub-Tehsil Multhan of Kangra District		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
POPULATION												
Total	60,77,900	54,82,319	5,94,581	4,60,887	4,26,345	34,542	14,514	14,514	-	7498	7498	-
Male	30,87,940	27,56,073	3,31,867	2,35,218	2,16,704	18,514	7,525	7,525	-	3809	3809	-
Female	29,89,960	27,26,246	2,63,714	2,25,669	2,09,641	16,028	6,989	6,989	-	3689	3689	-
Pop. (0-6 yrs)	7,93,137	7,30,628	62,509	69,579	65,902	3,677	2,049	2,049	-	1137	1137	-
SC	15,02,170	14,03,050	99,120	92,359	86,150	6,209	2,500	2,500	-	985	985	-
ST	2,44,587	2,37,060	7,527	1,17,569	1,15,701	1,868	10,880	10,880	-	0	0	-
LITERACY												
Total	40,41,621	35,67,456	4,74,165	2,46,169	2,18,546	27,623	7,592	7,592	-	4266	4266	-
Male	22,78,386	20,04,134	2,74,252	1,52,533	1,37,067	15,466	4,609	4,609	-	2815	2815	-
Female	17,63,235	15,63,322	1,99,913	93,636	81,479	12,157	2,983	2,983	-	1454	1454	-
Lit. Rate (%)	76.5	75.1	88.9	62.9	60.6	89.5	60.9	60.9	-	56.9	56.9	-
SEX RATIO												
Total Pop.	968	989	795	959	967	866	929	929	-	939	939	-
SC	968	976	864	968	976	864	973	973	-			-
ST	996	1002	809	996	1002	809	946	946	-			-

No. of HH	12,21,589	10,79,797	1,41,792	87,029	79,618	7,411	3,032	3,032	-			-

Source: Census, 2001

Table 1.2: Population structure in Chamba District

District/State		Population			Decadal Growth (%)
		Total	Male	Female	1991-2001
Chamba	Total	460,499	234,812	225,687	+7.09
	Rural	425,981	216,393	209,588	+17.22
	Urban	34,518	18,419	16,099	+ 15.49
Himachal Pradesh	Total	6,077,248	3,085,256	2,991,992	+17.53
	Rural	5,482,367	2,754,251	2,728,116	+16.11
	Urban	594,881	331,005	263,876	+32.43

Table 1.3: Population, child population in the age-group 0-6 of years and their sex-ratio in sub-tehsil Holi

Year	Population			Sex ratio	Child population in the age-group of 0-6 yrs			Sex ratio of child population
	Total	Male	Female		Total	Male	Female	
1991	13966	7278	6688	919	–	–	–	–
2001	14514	7526	6986	928	2049	1036	1013	978

(Source: Census, 2001)

Table 1.4: Population Density & Demographic profile of sub-tehsil Holi

Sub-tehsil	No. of villages	No. of inhabited villages	No. of households	Area (ha)	Population density (persons/sq km)
1991	140	47	2,816	105,044	13.30
2001	140	47	3,032	105,044	13.82

b) Education and other amenities

The literacy rate in sub-tehsil Holi is about 60.9%. In Multhan sub-tehsil it is 56.9% only.

Table 1.5: Literacy rate in sub-tehilHoli and sub-tehsil Multhan

	Literacy Rate (%)			No. of Educational Institutions				
	Total	Male	Female	PS	MS	SS	SSC	Colleges
Chamba District	62.9	76.4	48.8	852	290	128	44	2
Holi Sub-tehsil	60.9	71.2	49.8	40	10	3	3	0
Kangra District	80.1	87.1	73	2026	749	344	141	9
Multhan Sub-tehsil	56.9	73.9	39.4	137	51	21	6	1

PS=Primary School, MS=Middle School, SS=Secondary School, SSC=SeniorSecondary School(Source, Census of India 2001)

There is only one Primary Health Centre located in the entire Holi sub-tehsil while there is one allopathic hospital each in the 2 sub-tehsils. There is only one ayurvedichospital in Holiand no homeopathic hospitals (Table 1.6). There are 7 Primary Health Sub Centers, only one Child Welfare Centre located in the village Kuarsi.

Table 1.6: *Distribution of different amenities in villages and total population in* sub-tehsil Holi and sub-tehsil Multhan

Sub-tehsil	Hospitals			Health Centers		
	Allopathic	Ayurvedic	Homeopathic	PHC	PHSC	CWC
Holi Sub- tehsil	1	0	0	1	7	1
Multhan Sub – tehsil	1	1	0	5	26	1

PHC= Primary health centre, PHSC= Primary health sub centre, CWC= Child welfare centre.
(*Source*: Census, 2001)

c) Occupation Pattern

Agriculture has traditionally been the major feature of Himachal Pradesh's economy. Besides this the economy of the villages in the area depends mainly on the government and non-government services. The major cash crops like paddy, maizes, rajmas, potato, apple, etc., are found in this area.

About 40% of the total population falls in the main workers category in Holi sub tehsil (Table 1.7). Marginal workers contribute 19% of the total work force, dominated by females. About 42% of the total population is in the non-worker category.

Table 1.7: Occupation pattern in sub-tehsil Holi and sub-tehsil Multhan

Sub - tehsil	Work Force			Main Workers			Marginalworkers			Non workers		
	T	M	F	T	M	F	T	M	F	T	M	F
Holi	8524	4514	4010	5771	3775	1996	2753	739	2014	5990	3011	2979
Multhan	4454	2184	2270	3849	1927	1922	605	257	348	3044	1625	1419

(T = Total, M = Male, F = Female (*Source*: Census, 2001)

a) Houses and Equipment

In the area, majority of houses are single storeyed, the roofs are sloping designed for the snowfall resistance and made of slates or shingles. The walls of houses are generally built of stone and wood. The timber mainly comprises of Toon, Kail and Deodar. Proper modern designed houses have also seen in Holi village.Charpais (cots), mats of paddy straws, Kharchas and Asans are the common items of household furniture in the interior villages. Wooden boxes and steel trunks are found in each house for valuable things and clothes. However, these items are nowadays being replaced by chairs, tables and sofa sets.

b) Places of Religious Importance and Tourist Interest

Bharmaur is located at an altitude of 2,195m, where snowfall occurs during the winter season. Due to snowfall and beautiful landscape it provides an aesthetic place for the tourists. Chaurasia temples (84 shrines) in Bharmaur also attract the pilgrims and tourists. Moreover, Bharmaur is a base for the ManimaheshYatra, which is an important place of pilgrimage located at a distance of about 35 km from Bharmaur. People from Himachal and adjoining states visit Manimahesh in the month of August and September for the main pilgrimage yatra.

1.2 SOCIO-ECONOMIC STATUS OF THE STUDY AREA

The main objective of the present study was to assess the socio-economic status of the villages located in the study area i.e. within 10 km radius of various project components. It is based upon information collected from the primary and secondary sources (Figure 1.1).

Secondary data/information has collected from published sources mainly from Census of India – Census Data, 2001 and also from district gazetteers and statistical handbooks. Primary data was also collected from Gram Panchayat Records and by Village level survey conducted using a customized questionnaire for the purpose. Interactions with the local people especially with the village Pradhan and eminent persons was undertaken to collect first hand information

and response to the project. It mirrors the present social and economic status of the people living in and around the project area and their perspective towards the project. The different perceptions of people towards the project have also been collected and documented. Not just that, a number of suggestions for the improvement and enhancement in the availability of the amenities to people were also collected and discussed.

The project study area is spread across 5 panchayats namely Holi, Kuleth, Deol, Nayagram and Bajol which incudes 38 villages falling under the Holi sub-tehsil.

A census survey of the population residing in the vicinity villages of the project area was carried out. This section deals with the overall village summary of the socio-economic standards and the amenities available to the local people living therein.

1.2.1 Demographic Profile

The numbers of households are 1741 and the total human population of these villages is 9278 of which 927 belong to Scheduled Castes and 8306 belong to Scheduled Tribes; which constitutes the maximum population. The maximum number of households is in Sutkar village under Holipanchayat having the total population of 836 and the least number of households is in DeosharVillage. The number of BPL families in the study area is 545. The Table 1.8 shows the demographic profile of villages in study area.

i) People and Culture

The people living in the villages are predominantly Hindus. They are generally co-operative to each other and the society is characterized by simplicity and egalitarian values. Women enjoy a high status and old people are given due respect and reverence. Fairer skin and hazel-colored eyes are commonly seen among the people. The maximum of the people are Gaddi tribe.Their main languages are a mixture of Hindi and Pahari, also known as Gaddi language. The word Gaddi is a generic name and under it included Brahmins, Rajputs, Khatris, Thakurs and Rathis.

Generally, Gaddis are mainly inhabitants of Bharmaur, Chamba and Kangra district. The most agreed interpretation is that the name Gaddi derive from the Sanskrit word Gadar which means Sheep. Gaddis are very simple and honest people. They are God fearing people. Thus, crimes like murder, abduction and theft are rare in the study area.

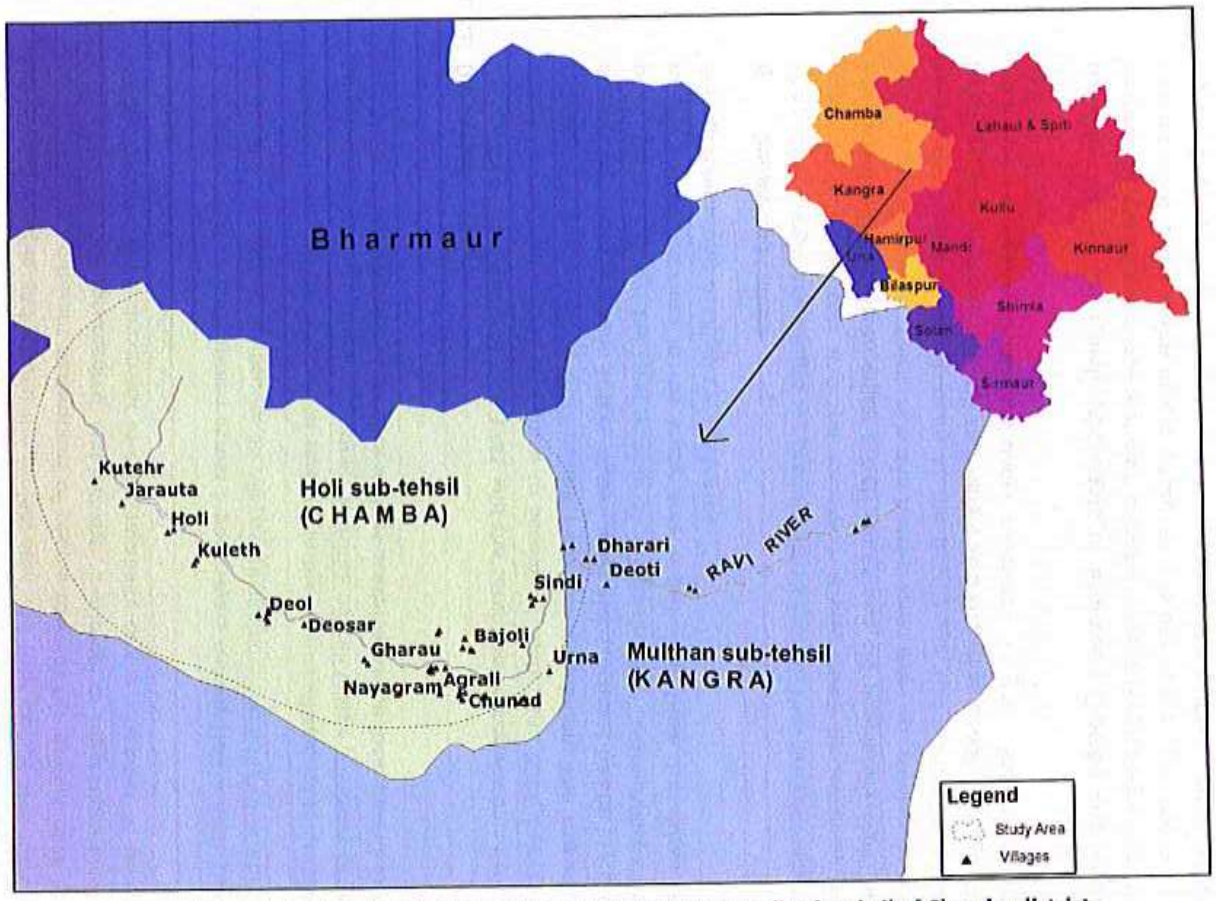


Figure 1.1: Map showing villages in the study area in Holi sub-tehsil of Chamba district

The culture of the people is same as the Hinduism culture. As fairs and festivals symbolizes the whole meaning of life, even in the toughest condition of existence people forget all their worries and tensions to make most of the festivity. Especially in the mountainous region festival adds extra charm and beauty to nature. A large number of fairs and festivals are organized in the HoliValley. Apart from the regular Indian festivals the people of this place celebrate some of the famous local festival based on their local gods and goddesses namely Kullethjatra, Lohary, Shaar, Gontari, etc.

1.2.1 Educational Profile

The educational profile of the people in the study area is average. There are 18 primary schools, 5 middle schools; only one senior secondary schools (Holi Village) in the entire study area. There is no college in the entire study area. The average literacy rate in the study area is 48%; Banoonvillage has the highest literacy rate. Table 7.9 shows the educational profile of villages in study area.

1.2.2 Health Care Facilities

Health care facilities are few in numbers in the study area. Local people are forced to travel long distances for their basic medical needs. Commonly the seasonal diseases like colds, cough, thyroid problems and certain respiratory diseases are reported in the area. There are no allopathic, ayurvedic, homeopathic hospitals and Child Welfare Centre in the study area. There is only one Primary Health Centers (PHC) in Kuleth village and 3 Primary health sub centre (PHSC).

1.2.3 Transport Facilities

The Chamba to Holi roads are metalled road, but the villages roads are kuchha roads. Mostly the roads of the villages in the Bajoli and Nayagrampanchayat are long foot track routes. The nearest railway station and airport is in Pathankot, which is in 235 km from Holi. There is only one helipad in Holi.

1.2.4 Sanitation and other Facilities

People use the spring water source in all household purposes and are independent from the river, as their domestic water source. Every house does not have own septic tank. All the villages are electrified; however, there is shortage of electricity especially in the winter season. There are 5 veterinary dispensaries, 4 co-operative societies in the study area. In Holi, there is only one

PWD circuit house. There are two Bank Branches namely PNB (Punjab National Bank) and Himachal Pradesh State Co-operative Bank.

1.2.5 Economy

a) Agriculture

Terrace farming was the common agricultural practice in the study area, due to hilly terrain region. The region is covered with patches of barren land. The local economy of the people depends mostly on the agriculture. The villagers grow various types of crops for both subsistence and for selling it to the local markets. The commercial crops grown are mainly maize, wheat, barley, rajmah, rice, soya beans etc. And the main horticulture crops are apple, walnut, etc. All the villages were practicing organic farming.

Cultivation of medicinal plants like Dhoop (*Jurineamacrocephalla*), kuth (*Saussurealappa*), Ban Kakru (*Podophyllumemodi*), Kaur (*Picrorhizakurroa*), etc. are commonly practice in the study area mostly in the catchment area.

b) Animal husbandry

Animal husbandry is one of the major occupations which support the main income of the study area. Livestock include sheep, cows, goats and mule. Among them goats and sheep is the main economic support for them. They are used for wool, milk products and meat also. An adult goat is selling around Rs.1,800 to Rs. 2,000. Mules are commonly used for carrying loads. A mule can carry about 75kg maximum load. Other occupations like working in government services and sectors, crafts and weaving are also recorded. Mostly in the winter-season, people especially women weave rugs, carpets, clothes and bags from the locally produced wool.

CATCHMENT AREA TREATMENT PLAN

1 NEED FOR CATCHMENT AREA TREATMENT

It is a well-established fact that reservoirs formed by dams on rivers are subjected to sedimentation. The process of sedimentation embodies the sequential processes of erosion, entrainment, transportation, deposition and compaction of sediment. The study of erosion and sediment yield from catchments is of utmost importance as the deposition of sediment in reservoir reduces its capacity, and thus affecting the water availability for the designated use. The eroded sediment from catchment when deposited on streambeds and banks causes braiding of river reach. The removal of top fertile soil from catchment adversely affects the agricultural production. Thus, a well-designed **Catchment Area Treatment (CAT)** Plan is essential to ameliorate the above-mentioned adverse process of soil erosion.

Soil erosion may be defined as the detachment and transportation of soil. Water is the major agent responsible for this erosion. In many locations, winds, glaciers, etc. also cause soil erosion. In a hilly catchment area, as in the present case, erosion due to water is a common phenomenon and the same has been studied as a part of the CAT Plan. Soil erosion leads to:

- loss in production potential
- reduction in infiltration rates
- reduction in water-holding capacity
- loss of nutrients
- increase in tillage operation costs
- reduction in water supply

The CAT plan highlights the management techniques to control erosion in the catchment area of a water resource project. The life span of a reservoir is greatly reduced due to erosion in the catchment area. Adequate preventive measures are thus needed for the treatment of catchment for its stabilization against future erosion.

CAT Plan has been formulated for free draining catchment i.e. up to the proposed upstream Bara Bangahal H. E. Project on Ravi River. Free draining catchment area for this CAT Plan is 254.45 sq km. The total catchment area at proposed Bara Bangahal HEP site is 647.5 sq km while at proposed Bajoli Holi HEP is 902 sq km.The catchment area considered for the present study is given in Figure 1.1 as raw satellite imagery.

The catchment area treatment involves

- Understanding of the erosion characteristics of the terrain and,
- Suggesting remedial measures to reduce the erosion rate.

In the present study **'Silt Yield Index' (SYI)**, method has been used. In this method, the terrain is subdivided into various watersheds and the erodibility is determined on relative basis. SYI provides a comparative erodibility criteria of catchment (low, moderate, high, etc.) and do not provide the absolute silt yield. SYI method is widely used mainly because of the fact that it is easy to use and has lesser data requirement. Moreover, it can be applied to larger areas like sub-watersheds, etc.

1.1 APPROACH FOR THE STUDY

A detailed database on natural resources, terrain conditions, soil type of the catchment area, socio-economic status, etc. is a pre-requisite to prepare treatment plan keeping in view the concept of sustainable development. Various thematic maps have been used in preparation of the CAT plan. Geographic Information System (**GIS**) is a computerized resource data base system, which is referenced to some geographic coordinate system. In the present study, real coordinate system has been used. The GIS is a tool to store, analyze and display various spatial data. In addition, GIS, because of its special hardware and software characteristics, has a capacity to perform numerous functions and operations on the various spatial data layers residing in the database. GIS provides the capability to analyze large amounts of data in relation to a set of established criteria. In order to ensure that latest and accurate data is used for the analysis, satellite data has been used for deriving land use data. Ground truth studies, too, have been conducted.

The various steps, covered in the study, are as follows:

- Definition of the problem
- Data acquisition and preparation
- Output presentation

The above mentioned steps are briefly described in the following paragraphs:

1.1.1 Definition of the Problem

The requirements of the study were defined and the expected outputs were finalized. The various data layers of the catchment area to be used for the study are as follows:

- Slope Map
- Soil Map
- Land use Classification Map
- Current Management Practices
- Catchment Area Map.

1.1.2 Data Acquisition and Preparation

The data available from various sources has been collected. The ground maps, contour information, etc. were scanned, digitized and registered as per the requirement. Data was prepared depending on the level of accuracy required and any corrections required were made. All the layers were geo-referenced and brought to a common scale (real co-ordinates), so that overlay could be performed. A computer program using standard modeling techniques was used to estimate the soil loss. The formats of outputs from each layer were firmed up to match the formats of inputs in the program. The grid size to be used was also decided to match the level of accuracy required, the data availability and the software and time limitations. Ground truthing and data collection was also included in the procedure.

For the present study, IRS P6-LISS III digital satellite data was used for interpretation & classification. The data has been procured in raw digital format and has been geo-referenced using Survey of India topographical sheets with the help of standard data preparation techniques in standard image processing software. The interpretation of geo-referenced satellite data has been done using standard enhancement techniques, ground checks and experiences of qualified professionals. A detailed ground truth verification exercise has been undertaken as a part of field survey to enrich the image interpretation process. The classified land use map of the free draining catchment area, considered for the study, is shown as Figure 1.2. The land use pattern of the catchment area is summarized in Table 1.1.

Derived contours from topographical maps were used for preparation of Digital Elevation Model (DEM) of the free draining catchment area and to prepare a slope map. The first step in generation of slope map is to create surface using

the elevation values stored in the form of contours or points. After marking the catchment area, all the contours on the topographical maps were derived. The output of the digitisation procedure was the contours as well as points contours in form of x, y & z points. (x, y - location and z - their elevation). All this information was in real world co-ordinates (latitude, longitude and height in meters above sea level) and is provided in subsequent drawing from 1.2(a) to 1.2(c).

Table 1.1:Land use classification for free draining catchment at diversion site

Land use/Land cover	Area (%)	Area (ha)
River/Water Bodies	0.70	179.25
Open Areas	9.61	2444.91
Agricultural Areas	8.63	2196.61
Dense Forest	36.63	9321.57
Open Forest	15.07	3833.59
Shrubs/Bushes/Grasses	24.85	6323.72
Snow Covered Areas	4.13	1050.33
Settlement/Exposed rocks	0.37	95.12
Total	**100.00**	**25445.10**

A Digital Terrain Model (DTM) of the area was then prepared, which was used to derive a slope map. The slope was divided in classes of slope percentages. The areas falling under various standard slope categories have been tabulated below in Table 1.2. The slope map is enclosed as Figure-1.3.

Table 1.2: Area falling under different slope categories

Slope category (%)	Area (%)	Area (sq km)
0-10	17.10	43.51
10-20	4.55	11.57
20-30	8.95	22.77
30-40	21.77	55.39
40-50	30.73	78.19
> 50	16.91	43.02
Total	**100.00**	**254.45**

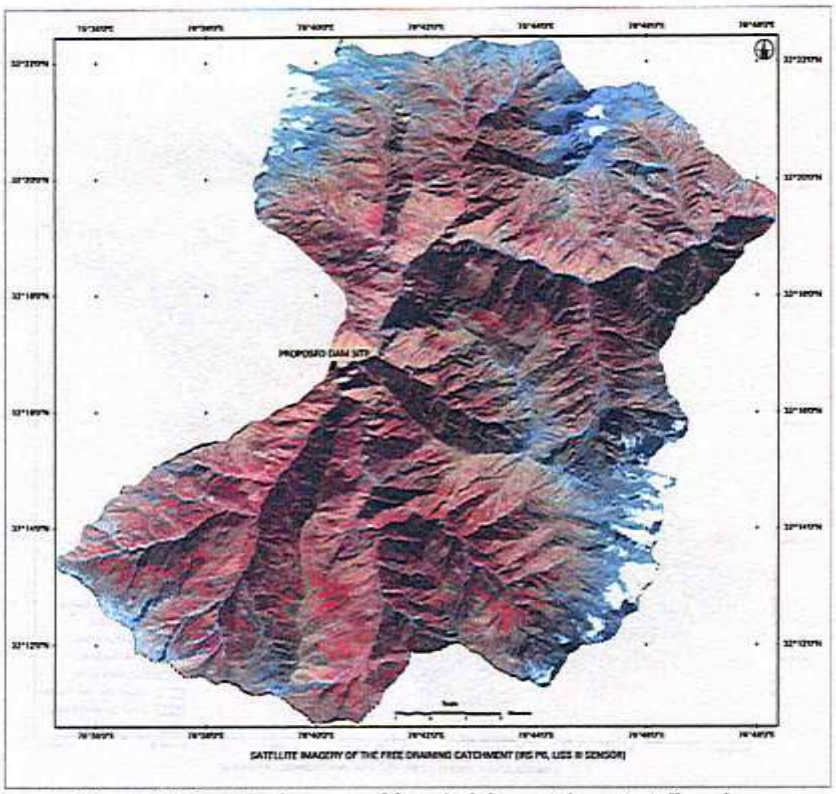


Figure 1.1: Satellite imagery of free draining catchment at diversion

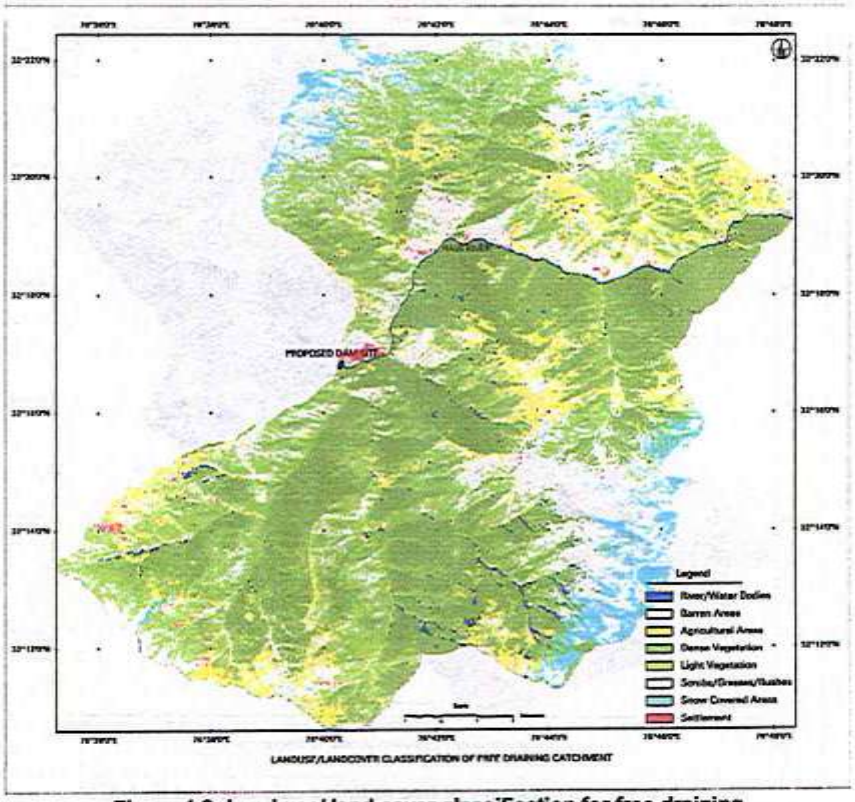


Figure 1.2: Land use/ land cover classification for free draining catchment at diversion site

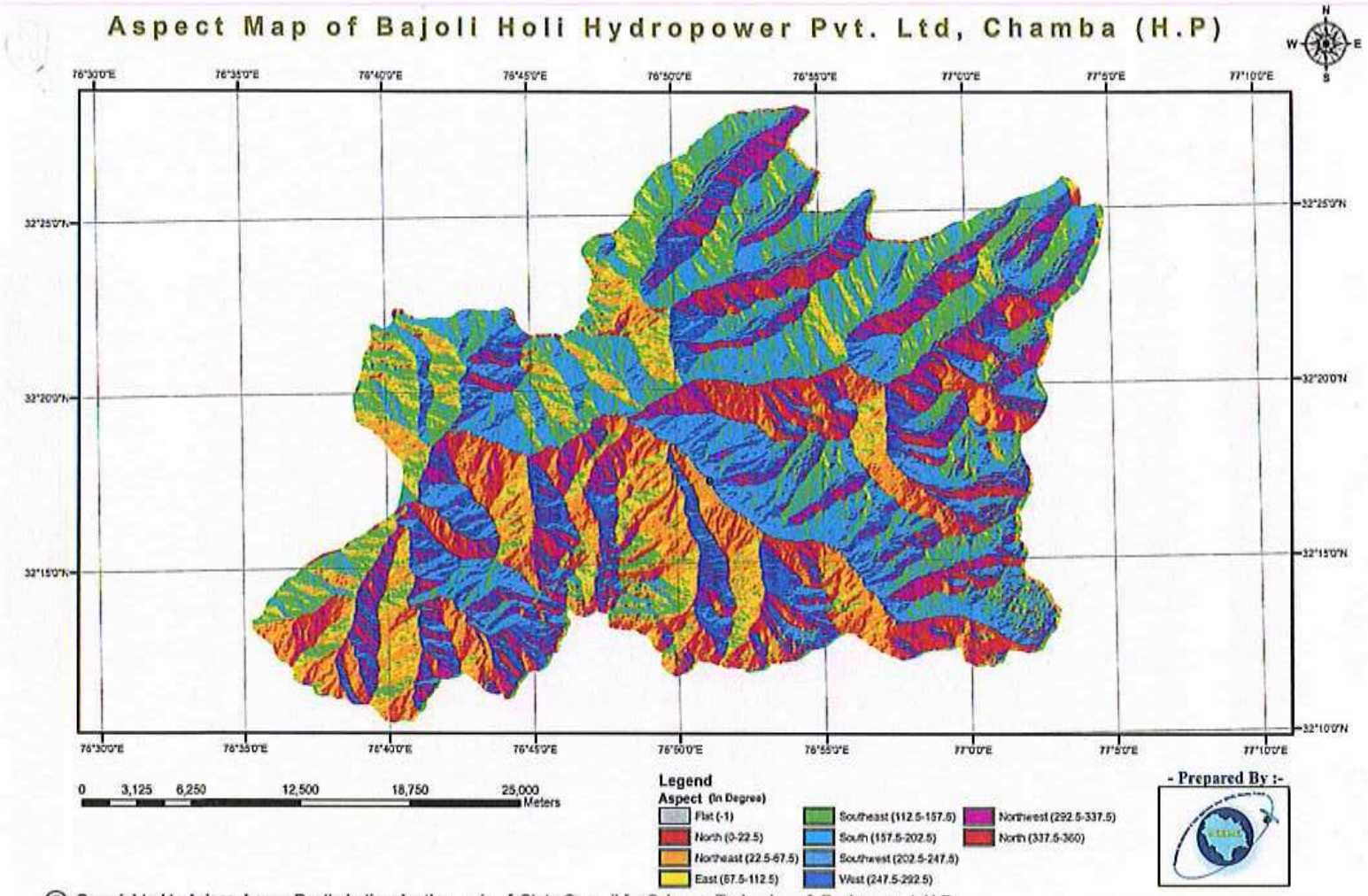


Figure-1.2(a)

Elevation Map of Bajoli Holi Hydropower Pvt. Ltd, Chamba (H.P)

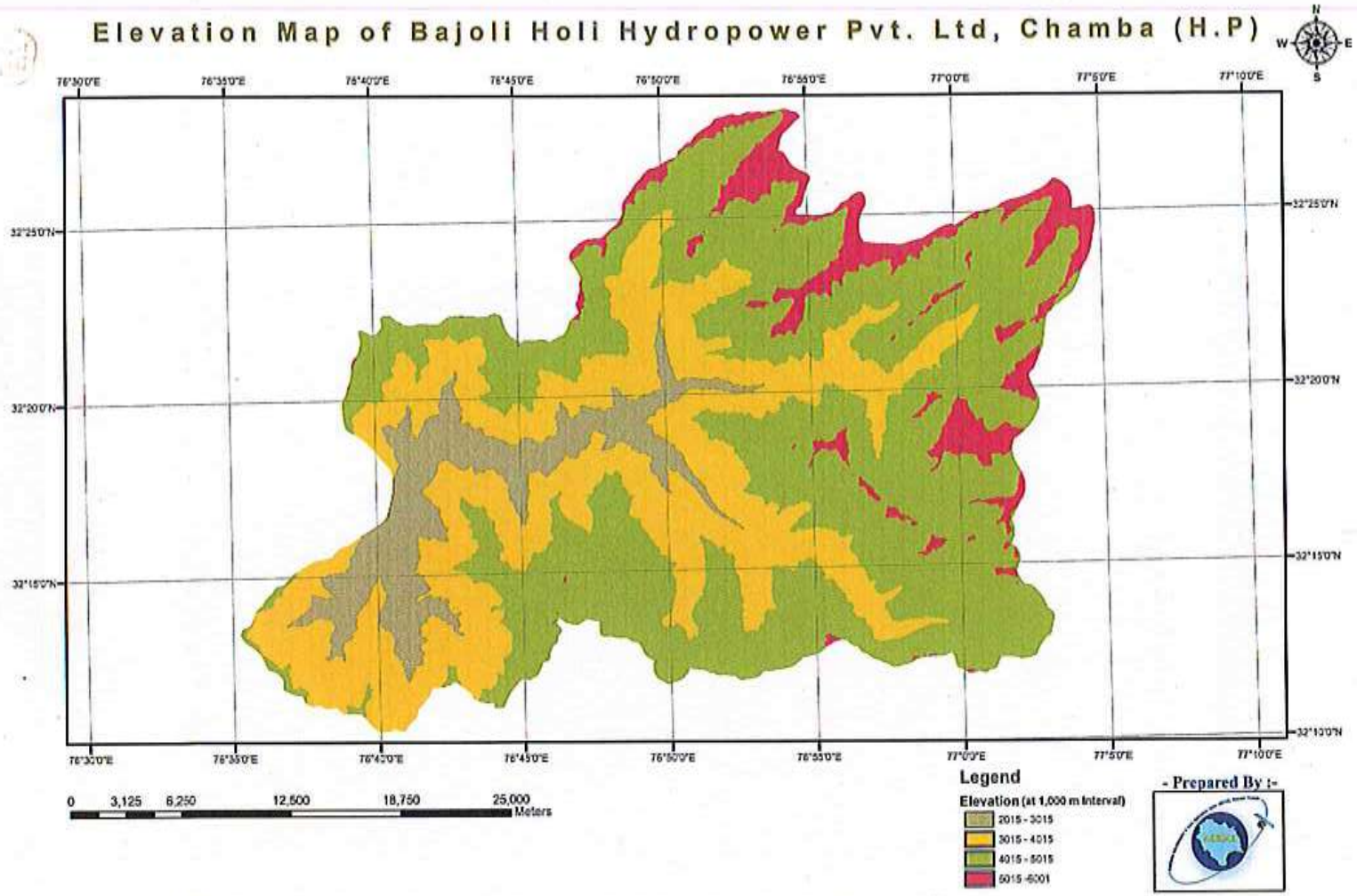


Figure (1.2 (b))

41(b)

Slope Map of Bajoli Holi Hydropower Pvt. Ltd, Chamba (H.P)

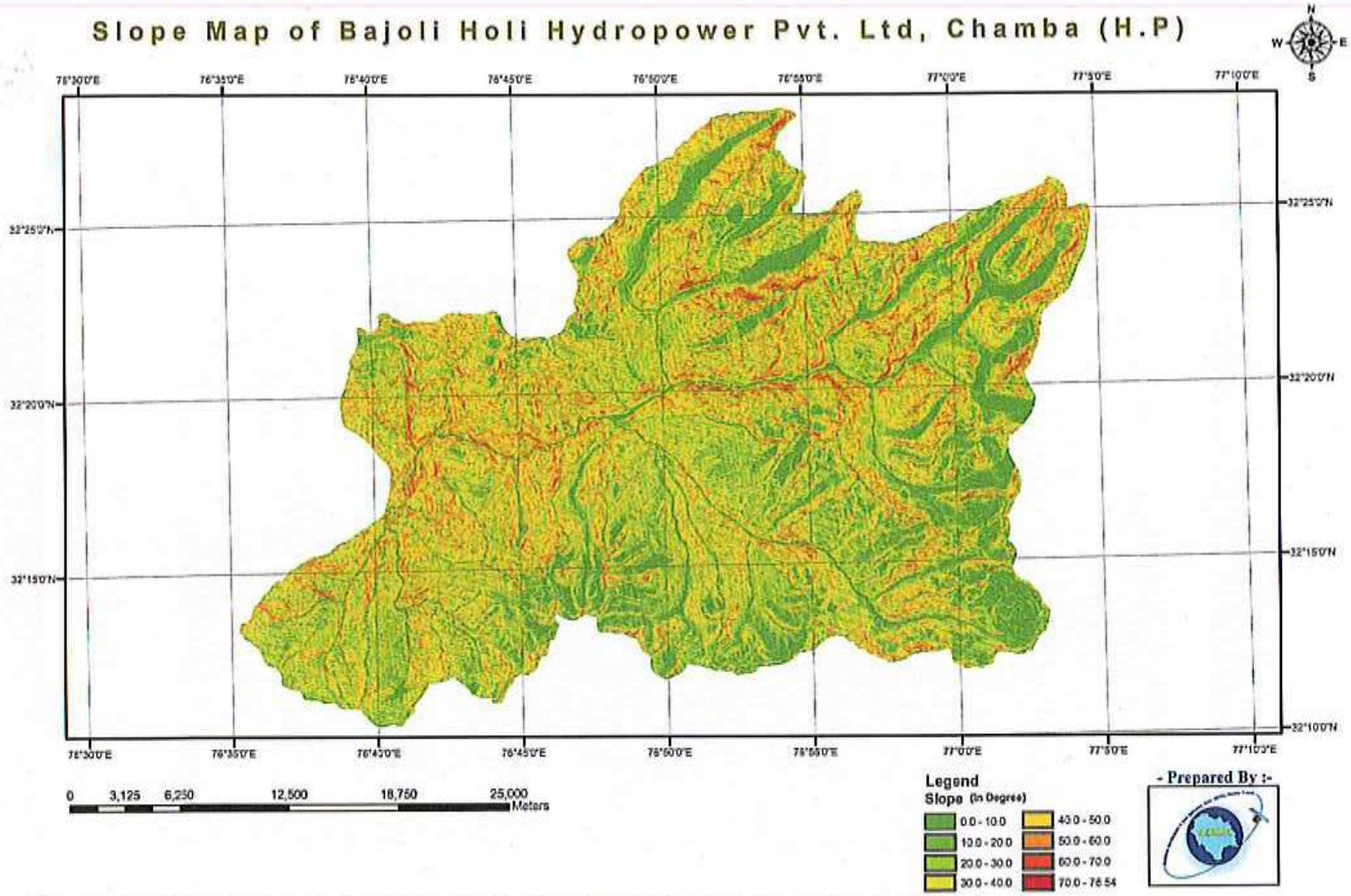


Figure – 1.2(c)

Soil map has been digitized and produced using soil maps collected from Natural Resources Atlas of Himachal Pradesh. Various layers, thus prepared, were used for Modeling. Soil map has been shown as Figure 1.4. The legend for soil classes has been given subsequently.

Soil series and their description

Soil Order	Description
Typic Cryorthents	Rock outcrops associated with medium deep to shallow, excessively drained, loamy-skeletal calcareous soils on very steep slopes with loamy surface, severe erosion and moderate stoniness.
Typic Udorthents	Rock outcrops; associated with shallow to deep, well drained mesic, coarse loamy-skeletal soils on very steep slopes with loamy surface, severe erosion and strong stoniness.
Lithic Udorthents	Shallow, well drained, mesic, loamy soils on steep slopes with loamy surface, very severe erosion and severe stoniness associated with medium to shallow deep, well drained, coarse-loamy soils with loamy surface and severe to very severe erosion.
Typic Cryochrepts	Deep, well drained, fine-loamy soils on steep slopes with loamy surface and severe erosion; associated with deep excessively drained, sandy-skeletal soils with sandy surface, very severe erosion and moderate stoniness.

Software was prepared using standard modeling techniques to calculate the soil loss using input from all the layers as described below:

Modelling: The river catchment area has been divided into small grids of 25m*25m. The vector layer so generated of 25 m grid size was updated by landuse/landcover details, soil information and slope values in GIS software using different maps as generated above. Soil loss has then been calculated for each grid using modelling techniques through information derived from updated grids with the help of a customized computer software/program.

A thematic map has been prepared using these calculated soil erosion values for delineating areas prone to soil erosion in the free draining catchment. The percentages of free draining catchment area falling in different soil vulnerability classes are given in Table 1.3 and shown in Figure 1.5

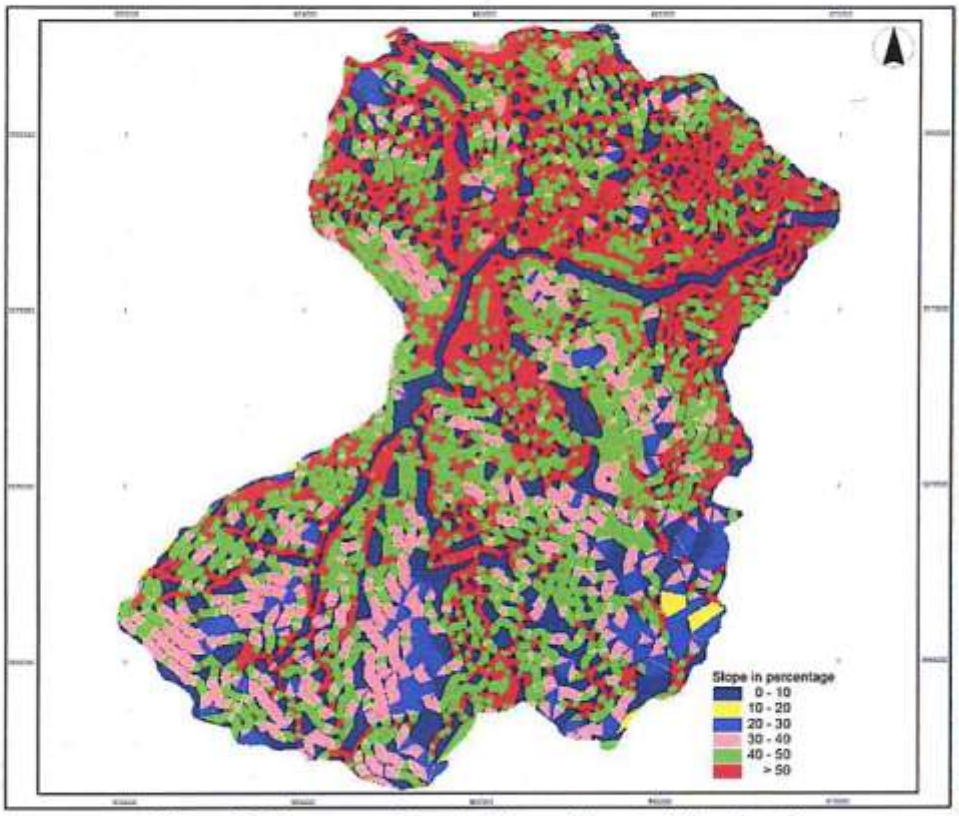


Figure 1.3: Slope map of free draining catchment at diversion site

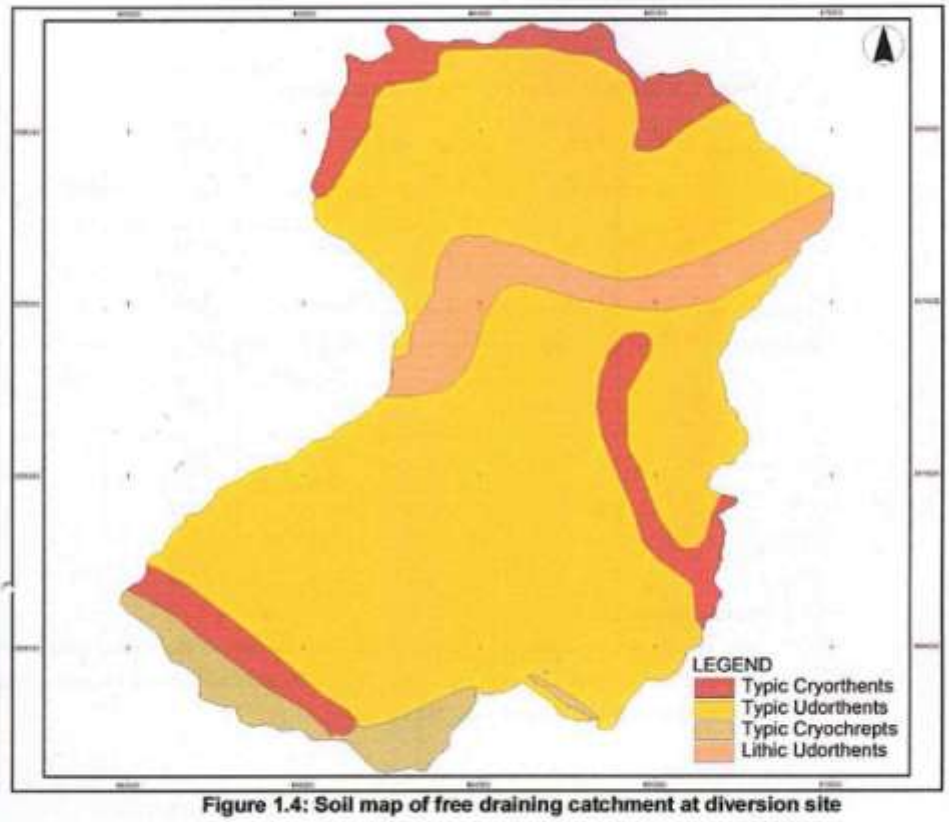


Figure 1.4: Soil map of free draining catchment at diversion site

Table 1.3: Soil loss ranges for the river catchment

S. No.	Soil loss range in tonnes/acre/annum	Area (sq km)	Area (%)
1	< 1	54.76	21.52
2	1 – 2.5	29.05	11.42
3	2.5 – 6.0	114.99	45.19
4	6.0 – 10.0	41.41	16.27
6	> 10.0	14.25	5.60
	Total	254.45	100.00

1.1.3 Output Presentation

The result of the modeling was interpreted in pictorial form to identify the areas with high soil erosion rates. The primary and secondary data collected as a part of the field studies were used as an input for the model.

1.2 ESTIMATION OF SOIL LOSS USING SILT YIELD INDEX (SYI) METHOD

In '**Silt Yield Index' (SYI)**, method, the terrain is subdivided into various watersheds and the erodibility is determined on relative basis. SYI provides a comparative erodibility criteria of catchment (low, moderate, high, etc.) and do not provide the absolute silt yield. SYI method is widely used mainly because of the fact that it is easy to use and has lesser data requirement. Moreover, it can be applied to larger areas like sub-watersheds, etc.

The SYI model, considering sedimentation as product of erosivity, erodibility and arial extent was conceptualized in the All India Soil and Land Use Survey (AISLUS) as early as 1969 and has been in operational use since then to meet the requirements of prioritization of smaller hydrologic units within river valley project catchment areas.

The erosivity determinants are the climatic factors and soil and land attributes that have direct or reciprocal bearing on the unit of the detached soil material. The relationship can be expressed as:

Soil erosivity = f (Climate, physiography, slope, soil parameters, land use/land cover, soil management)

Silt Yield Index

SYI is defined as the Yield per unit area and SYI value for hydrologic unit is obtained by taking the weighted arithmetic mean over the entire area of the hydrologic unit by using suitable empirical equation.

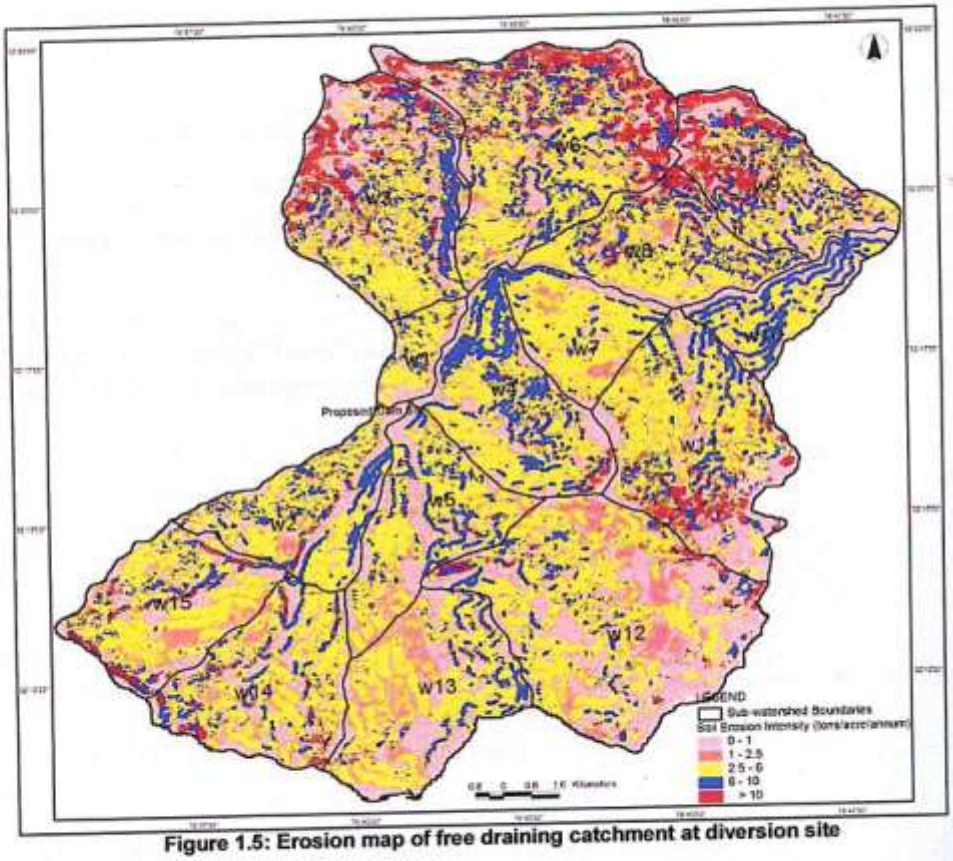


Figure 1.5: Erosion map of free draining catchment at diversion site

Prioritization of Watersheds/Sub-watersheds

The prioritization of smaller hydrologic units within the vast catchments is based on the SYI of the smaller units. The boundary values or range of SYI values for different priority categories are arrived at by studying the frequency distribution of SYI values and locating the suitable breaking points. The watersheds/ sub-watersheds are subsequently rated into various categories corresponding to their respective SYI values.

The application of SYI model for prioritization of sub-watersheds in the catchment areas involves the evaluation of:

a) Climatic factors comprising total precipitation, its frequency and intensity,
b) Geomorphic factors comprising land forms, physiography, slope and drainage characteristics,
c) Surface cover factors governing the flow hydraulics and
d) Management factors.

The data on climatic factors can be obtained for different locations in the catchment area from the meteorological stations whereas the field investigations are required for estimating the other attributes.

The various steps involved in the application of model are:

- Preparation of a framework of sub-watersheds through systematic delineation
- Rapid reconnaissance surveys on 1:50,000 scale leading to the generation of a map indicating erosion-intensity mapping units.
- Assignment of weightage values to various mapping units based on relative silt-yield potential.
- Computing Silt Yield Index for individual watersheds/sub-watersheds.
- Grading of watersheds/sub-watersheds into very high, high, medium, low and very low priority categories.

The area of each of the mapping units is computed and silt yield indices of individual sub-watersheds are calculated using the following equations:

a. Silt Yield Index

To calculate SYI, the methodology developed by All India Soil & Land Use Survey (Department of Agriculture, Govt. of India) has been followed, where each erosion intensity unit is assigned a weightage value. When considered collectively, the weightage value represents approximately the relative comparative erosion intensity. A basic factor of K = 10 was used in determining the weightage values. The value of 10 indicates a static condition of equilibrium between erosion and deposition. Any

addition to the factor K (10+X) is suggestive of erosion in ascending order whereas subtraction, i.e. (10-X) is indicative of deposition possibilities.

Delivery ratios were adjusted for each of the erosion intensity unit. The delivery ratio suggests the percentage of eroded material that finally finds entry into reservoir or river/ stream. Area of each composite unit in each sub-watershed was then estimated.

SYI was calculated using following empirical formula:

$$SYI = \frac{\Sigma (Ai * Wi) * Di * 100}{Aw}; \quad \text{where } i = 1 \text{ to } n$$

where

Ai = Area of i^{th} unit (EIMU)

Wi = Weightage value of i^{th} mapping unit

n = No. of mapping units

Aw = Total area of sub-watershed.

Di = Delivery ratio

Delivery ratios are assigned to all erosion intensity units depending upon their distance from the nearest stream. The criteria adopted for assigning the delivery ratio are as follows:

Nearest Stream	Delivery Ratio
0 - 0.9 km	1.00
1.0 - 2.0 km	0.95
2.1 - 5.0 km	0.90
5.1 - 15.0 km	0.80
15.1 - 30.0 km	0.70

The SYI values for classification of various categories of erosion intensity rates are given in Table 1.4.

Table 1.4: Criteria for erosion intensity rate

Priority categories	SYI Values
Very high	> 1300
High	1200-1299
Medium	1100-1199
Low	1000-1099
Very Low	<1000

The erosion category of various watersheds in the catchment area as per a SYI index has been estimated. The objective of the SYI method is to prioritize sub-watershed in a catchment area for treatment. The area under very high and high erosion categories is to be treated at the project proponent's cost. Hence, CAT plan shall be suggested for very high and high erosion categories, as a part of the EIA study, the expenses of which have to be borne by project proponents.

1.3 WATERSHED MANAGEMENT – AVAILABLE TECHNIQUES

Watershed management is the optimal use of soil and water resources within a given geographical area so as to enable sustainable production. It implies changes in land use, vegetative cover, and other structural and non-structural action that are taken in a watershed to achieve specific watershed management objectives. The overall objectives of watershed management programme are to:

- increase infiltration into soil;
- control excessive runoff;
- manage & utilize runoff for useful purpose.

Following Engineering and Biological measures shall be suggested for the catchment area treatment depending upon the requirement and suitability:

a. Engineering measures
- **Step drain**
- **Angle iron barbed wire fencing**
- **Stone masonry**
- **Check dams**

b. Biological measures
- **Development of nurseries**
- **Plantation/afforestation**
- **Pasture development**
- **Social forestry**

The basis of site selection for different biological and engineering treatment measures under CAT are given in Table 1.5.

1.4 Basis for Treatment

In the present report, CAT Plan as per the slope, land use pattern, soil characteristics has been suggested based on the prioritization of sub watersheds using SYI method (Table 1.6). The CAT plan has been suggested for Sub-watersheds with very high and high erosion categories as the cost for treatment for such watersheds is to be borne by the project proponents. The objective of the SYI method is to prioritize sub-watershed in a catchment area for treatment. The area under very high and high erosion categories have to be treated by the project proponents, which accounts for about 37.85% of the total free draining catchment area. Sub-watershed wise proposed treatment measures in these sub watersheds superimposed over SOI toposheets are given. It is proposed that treatment measures shall be implemented over 11 years and shall be co-terminus with the construction of dam.

Table 1.5: Basis for selection of catchment area treatment measures

Treatment measure	*Basis for selection*
Social forestry, fuel wood and fodder grass development	Near settlements to control tree felling
Contour Bunding	Control of soil erosion from agricultural fields.
Pasture Development	Open canopy, barren land, degraded surface
Afforestation	Open canopy, degraded surface, high soil erosion, gentle to moderate slope
Barbed wire fencing	In the vicinity of afforestation work to protect it from grazing etc.
Step drain	To check soil erosion in small streams, steps with concrete base are prepared in sloppy area where silt erosion in the stream and bank erosion is high due to turbidity of current.
Nursery	Centrally located points for better supervision of proposed afforestation minimize cost of transportation of seedling and ensure better survival.

The survey of AISLUS was done long back but now the conditions of the nallas have been changed due to the construction of roads, landslides and other, biotic interferences. Treatments are prescribed accordingly and will also be changed at the time of implementation of CAT plan.

Table 1.6: Erosion intensity categorization as per SYI classification

micro-watershed	Area (ha)	SYI	Priority Category
Tm2	1363.00	1237	High
Tm2d	2370.00	1204	High
Tm2g	2792.00	1254	High
Tm2j	1488.00	1248	High
Tk3m	1617.00	1225	High
Tk3	1304.00	1181	Medium
Tk3k	1467.00	1127	Medium
Tk3n	2327.00	1165	Medium
Tk3p	791.90	1198	Medium
Total	**15519.90**	-	-

- **Digital map of Watershed & Drainage Map is shown in fig 1.6(c)**

Figure 1.6(a): MAP SHOWING MICRO WATERSHED OF BHARMOUR FOREST DIVISION

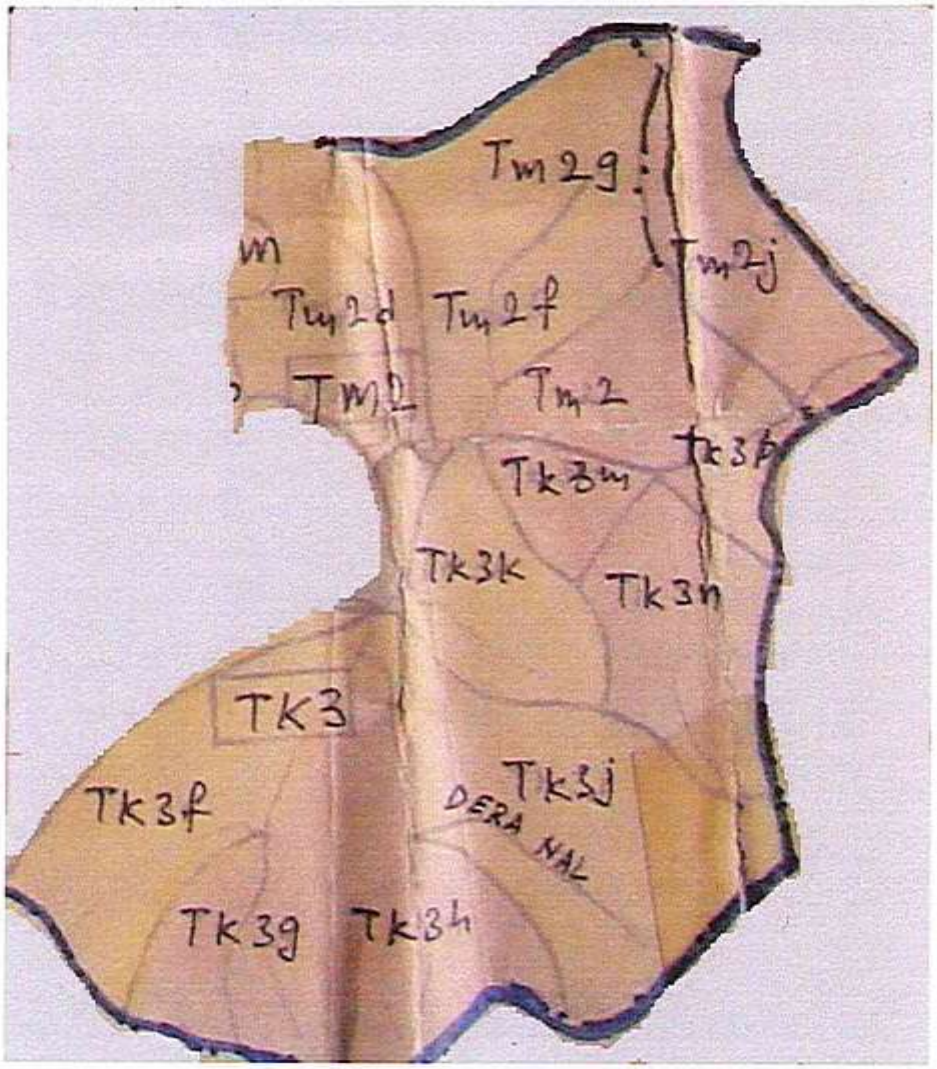
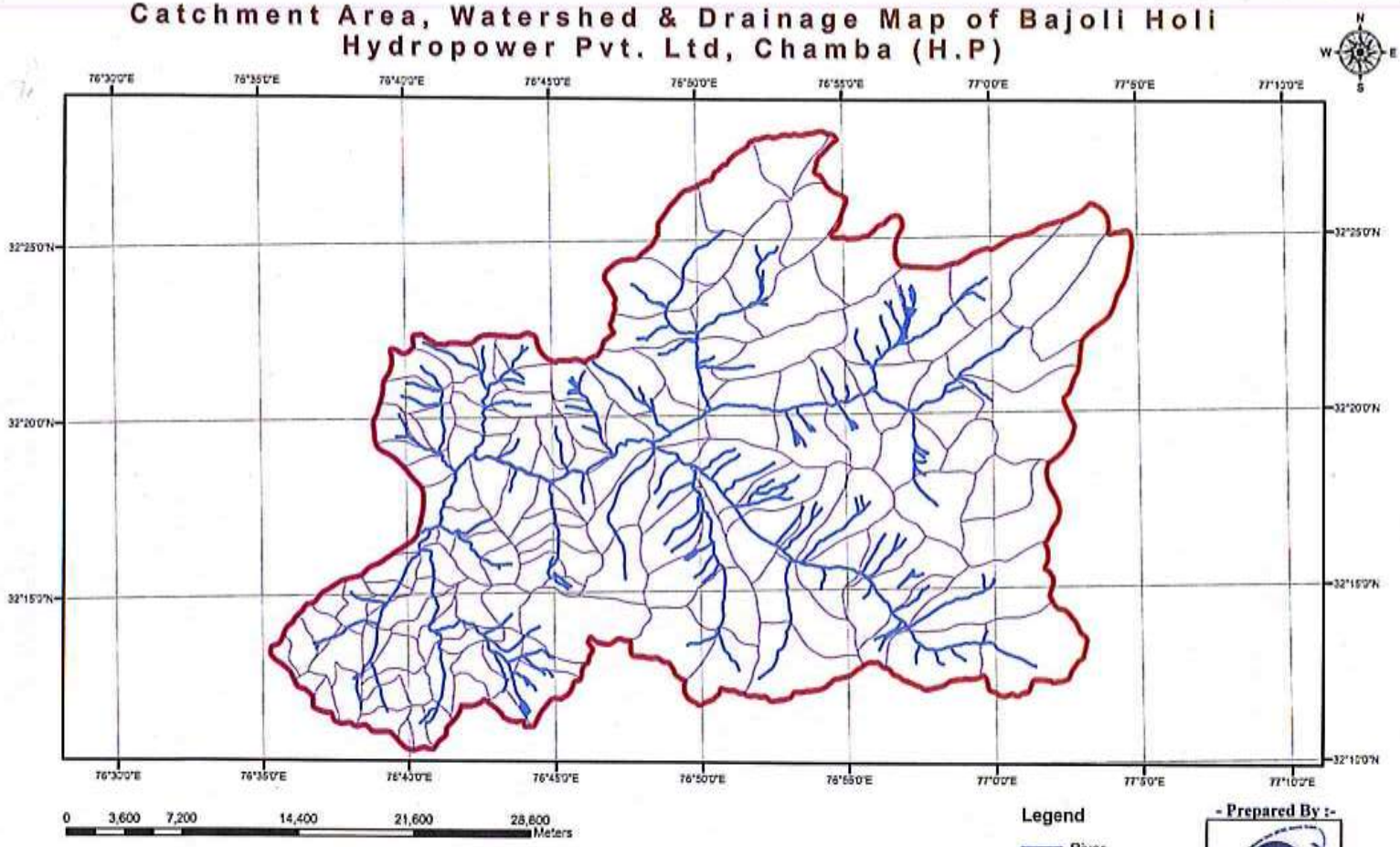


Figure 1.6(b): MAP SHOWING MICRO WATERSHED IN CATCHMENT AREA OF BAJOLI-HOLI HEP(180MW)

Catchment Area, Watershed & Drainage Map of Bajoli Holi Hydropower Pvt. Ltd, Chamba (H.P)



This map has been prepared from thereferences(Latitude, longitute, height) and base map provided by the user agency and the AGISAC owes no responsibility of the correctness and accuracy of the same.

Figure - 1.6(c)

BAJOLI-HOLI HYDRO ELECTRIC PROJECT (180 MW)

HIMACHAL PRADESH

CATCHMENT AREA TREATMENT PLAN

The following activities has been considered for the treatment of Catchment of the Project.

i) Afforestation measures.

ii) Soil & water conservation measures.

iii) Payment for Enviornmental services including Eco-tourism.

iv) Research,Training & Capacity build-up.

v) Infrastructural build-up & forest protection.

vi) Wildlife measures.

vii) Monitoring & Evaluation.

viii) Support for preparing Site specific work plan.

ix) Contingencies.

AFFORESTATION MEASURES

General

Since this is mountainous tract with moderate to steep slopes, gully formation due to water/snow flows in the depressions are bound to occur. Therefore, all the afforestation works will have to be supported by anti-erosion measures like gully plugging, check dams etc. in varying extent. The total amount of **Rs. 1094.01 lacs** has been kept for Afforestation measures. The following types of areas are proposed for afforestation aided by varying types and degrees of soil conservation measure and check dams:

(i) Evergreen forest blank detected through Remote Sensing.

(ii) Heavily grazed areas around habitations.

(iii) Blank area fit for bringing in vegetation and draining directly in the vicinity of diversion dam storage.

In the background of above criteria, limitation of extent of area which can be closed with the consent of local people (right holders) and in consultation with local field forest officers, it is proposed to do afforestation of 694 ha over a period of 5 years, starting from the 2nd year of CAT Plan implementation. The detail of Total expenses for Afforestation measures are as follows.

Sr. No.	Activities	Amount (in lacs)
I	Afforestation & maintenance	496.16
II	Energy plantation	270.30
III	Enrichment plantation & maintenance	88.75
IV	Nurseries development	89.30
V	Subsidiary Silvi-culuture	52.50
VI	Pasture management	97.00
	TOTAL	**1094.01**

A provision of maintenance of plantation for 5 years has been made as detailed below:

Plantation:-

Choice of Species

The choice of species depends on the various factors, such as climatic, edaphic, topographic and biotic but the surviving indigenous species give a clear indication of the most suitable species. Since most of areas included in this component, are situated at lower elevations, therefore, preference should be given to indigenous, fast growing, hardy, species which can survive under the adverse condition of the locality. Sincere and strenuous efforts should be made to bring the blank areas under forest cover as early as possible. In order to cover up the blank areas expeditiously, at the earliest, the maximum area has been suggested to be taken up during the 1st & 2nd years. Soil conservation works have also been prescribed along with afforestation measures where ever necessary.

Plantation Technique

a) Site Selection

Specific sites have been suggested and location of plantation is also indicated in the above statement. However, if the deviation is absolute necessary, some changes can be done by the Divisional Forest Officer after spot inspection.

b) Closure Notification

Each plantation area will be notified for closure and supervision of rights, one year in advance of plantation work. According to provision made in Forest Settlement, one third of total area of forest can be closed for thirty years, but it is normally not practicable. The area should remain closed effectively till the regenerated crop reaches the stage beyond any damage due to frost, drought, and weeds and needs no longer protection from animals. Hence the period of closure may be kept 10-20 years depending upon growth of species planted.

c) Fencing

Where necessary plantation areas will be effectively closed with 3-5 strands barbed wire fencing. Fence posts should be of durable species. These should be affixed in ground along the periphery of area to be closed at suitable spacing, deep enough to withstand weight and tension in barbed wire. It should be borne in mind that loose, zigzag and haphazardly aligned barbed wire fencing would provide least resistance to animals of vicinity and efforts so made in raising plantation will, surely, be unproductive and invite unnecessary criticism of local people. It would be better if some branches of fast growing species are reinforced in fencing to provide adequate tension in the strand of barbed wire. Non-palatable fast growing shrub species like Adhetoda, Vitex, Agave, Debregeasia, etc. shall be planted along the barbed wire fence at a close spacing of 50 cm to form a live hedge.

d) Preparation of Site

Pits on standard size 30 cm diameter for Deodar, Kail, Fir/Spruce and 45cm is diameter for broadleaved well in advance so as to provide an interval of 2-3 months between pit digging and planting for weathering of soil.

e) **Spacing**

Planting for coniferous at space of 2.5m X 2.5m and that of broad leaved 3m X 3m is general practice and it should be continued however while treating eroded portions suitable broad leaved may be planted at the space of 1.5m X 1.5m.

f) **Sowing and Planting**

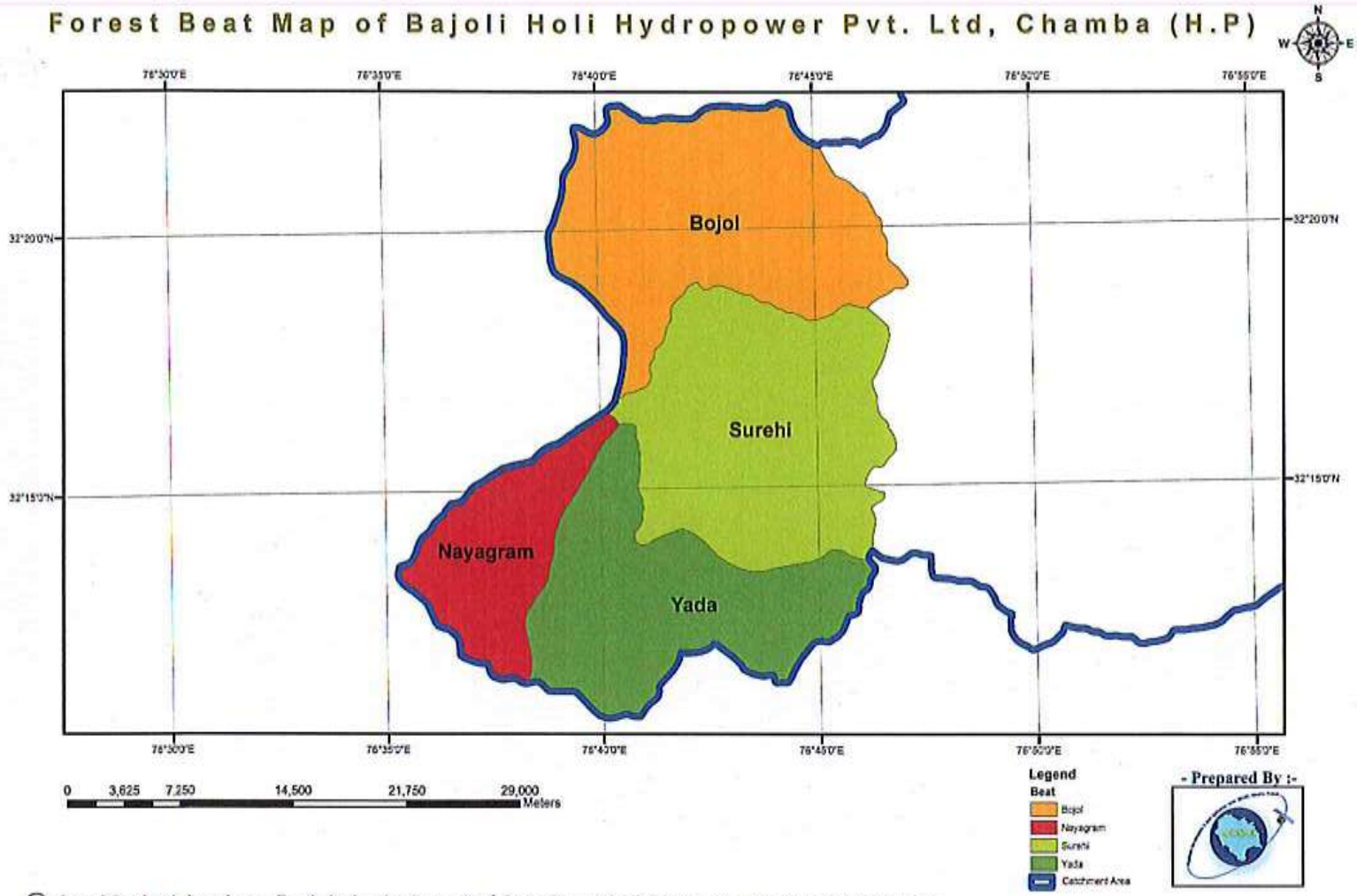
Planting should be preferred to sowing, though the later operation may be cheaper. Success is more certain and initial growth more rapid, in case sturdy nursery raised plants are used. Sowing may be carried out only on comparatively better sites, where these are expected to be easily successful. Piak (Alnus nitida) along nala and sowing of Deodar can be preferred. But certainly Piak dibbling / sowing must be carried out only in marshy lands/nallas.

BaraBanchho Block:-

There are following Forest Beat coming into our Catchment area:-

a) **Nayagram Beat.**
b) **Bajol beat.**
c) **Surehi Beat.**
d) **Yada Beat.**

Forest Beat Map of Bajoli Holi Hydropower Pvt. Ltd, Chamba (H.P)



This map has been prepared from thereferences(Latitude, longitute, height) and base map provided by the user agency and the AGISAC owes no responsibility of the correctness and - accuracy of the same.

1. Nayagram Beat:-

i) Tunda Munda DPF(C- I) (Proposed area for plantation = 25 Ha)

Tunda Munda (C-I) DPF – 25 Ha

The aspect is Eastern. The slope is gentle steep and area is almost blank covered with grass growth. The species naturally growing around the area are Deodar, Kail & F/Sp. The proposed area is situated near Gandhir RF. Afforestation Plan scheme is at a distance of about 2 Km from the Nayagram nursery (Proposed). The Elevation of proposed area is 1920 m to 2805 m. Soil of the proposed area is shallow to fairly deep.

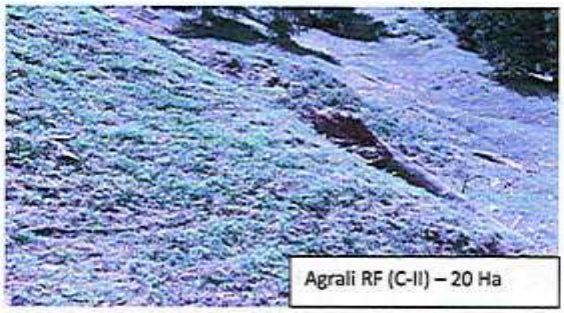
ii) Tunda Munda DPF (C- II) (Proposed area for plantation = 26 Ha)

The aspect is Eastern. The slope is gentle steep and area is almost blank covered with grass growth. The species naturally growing around the area are Deodar, Kail & F/Sp. The proposed area is situated near Thanater DPF. Afforestation Plan scheme is at a distance of about 2.5 Km from the Nayagram nursery (Proposed). The Elevation of proposed area is 2440 m to 4315 m. Soil of the proposed area is shallow and Rocky.

Tunda Munda (C-II) DPF – 26 Ha

iii) Agrali RF (C-II) (Proposed area for plantation = 20 Ha)

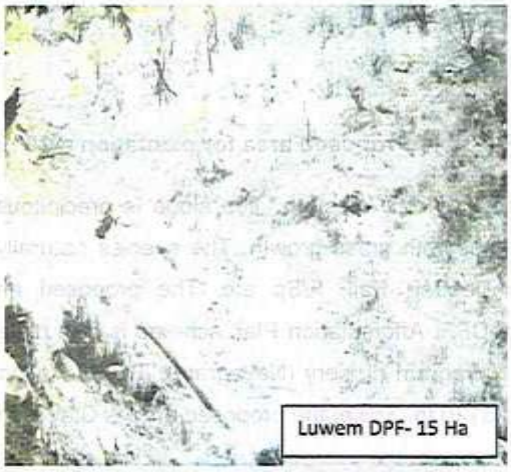
The aspect is North Western. The slope is gentle steep to moderately steep and area is almost blank covered with grass growth. The species naturally growing around the area are Deodar, Kail & F/Sp. The proposed area is situated near Nayagram DPF. Afforestation Plan scheme is at a distance of about 1 Km from the Nayagram nursery (Proposed). The Elevation of proposed area is 2060 m to 3120 m. Soil of the proposed area is Clay loamy, shallow & Rocky.



Agrali RF (C-II) – 20 Ha

iv) Luwain DPF (Proposed area for plantation = 15 Ha)

The aspect is Northern. The slope is gentle steep and area is almost blank. The species naturally growing around the area is Kail. The proposed area is situated near Nawai RF. Afforestation Plan scheme is at a distance of about 2 Km from the Nayagram nursery (Proposed). The Elevation of proposed area is 7600 m to 8300 m. Soil of the proposed area is Clay loamy, shallow to fairly deep and rocky.



Luwem DPF- 15 Ha

v) **Agrali DPF (Proposed area for plantation = 25 Ha)**

The aspect is Northern. The slope is moderately steep and area is almost blank. The species naturally growing around the area is Kail, Deodar. The proposed area is situated near Agrali RF-C1. Afforestation Plan scheme is at a distance of about 3.5 Km from the Nayagram nursery (Proposed). The Elevation of proposed area is 6500 m to 7500 m. Soil of the proposed area is Clay loamy, shallow to fairly deep.

Agrali DPF- 25 Ha

vi) **Agrali RF (C-II) (Proposed area for plantation = 25 Ha)**

The aspect is North Western. The slope is precipitous and area is almost blank covered with grass growth. The species naturally growing around the area are Deodar, Kail, F/Sp etc. The proposed area is situated near Nayagram DPF. Afforestation Plan scheme is at a distance of about 2.0 Km from the Nayagram nursery (Nayagram). The Elevation of proposed area is 2060 m to 3120 m. Soil of the proposed area is Clay loamy & shallow.

Agrali RF (C-II) – 25 Ha

vii) **Tunda Munda DPF(C- II) (Proposed area for plantation = 20 Ha)**

The aspect is Eastern. The slope is gentle steep and area is almost gentle to moderately steep blank covered with grass growth. The species naturally growing around the area are Deodar, Kail & F/Sp. The proposed area is situated near Thanater DPF. Afforestation Plan scheme is at a distance of about 3 Km from the Nayagram nursery (Proposed). The Elevation of proposed area is 2440 m to 4315 m. Soil of the proposed area is shallow and Rocky.

Tunda Munda DPF (C-II)- 20 Ha

viii) Kut DPF (C- I) (Proposed area for plantation = 18 Ha)

The aspect is Northern. The slope is moderately steep and covered with grass growth. The species naturally growing around the area are Deodar, Kail & F/Sp. The proposed area is situated near Pani Nalli RF. Afforestation Plan scheme is at a distance of about 1 Km from the Nayagram nursery (Proposed). The Elevation of proposed area is 2440 m to 2985 m. Soil of the proposed area is shallow fairly deep.

Kut DPF (C-I) - 18 Ha

2. BAJOL BEAT :-

i) Bajoli DPF (Proposed area for plantation = 20 Ha)

The aspect is Southern. The slope is moderately steep and covered with grass growth. The species naturally growing around the area are Kail. The proposed area is situated near Bajol DPF. Afforestation Plan scheme is at a distance of about 1.5 Km from the Bajol nursery (Proposed). The Elevation of proposed area is 2590 m to 3415 m. Soil of the proposed area is shallow to fairly deep.

Bajoli DPF – 20 Ha

ii) Bajol DPF (Proposed area for plantation = 31 Ha)

The aspect is Southern. The slope is moderately steep and covered with grass growth. The species naturally growing around the area are Kail. The proposed area is situated near Bajoli DPF. Afforestation Plan scheme is at a distance of about 3 Km from the Bajol nursery (Proposed). The Elevation of proposed area is 2440 m to 3355 m. Soil of the proposed area is Clay, Loamy to fairly deep.

Bajol DPF- 31 Ha

iii) Sindi DPF (Proposed area for plantation = 25 Ha)

The aspect is South eastern. The slope is steep to precipitous and covered with grass growth. The species naturally growing around the area are Kail, Deodar etc. The proposed area is situated near Bajoli DPF. Afforestation Plan scheme is at a distance of about 4.0 Km from the Bajol nursery (Proposed). The Elevation of proposed area is 2340 m to 3820 m. Soil of the proposed area is Clay, Loamy shallow to fairly deep and exposed rock at places.

Sindi DPF- 25 Ha

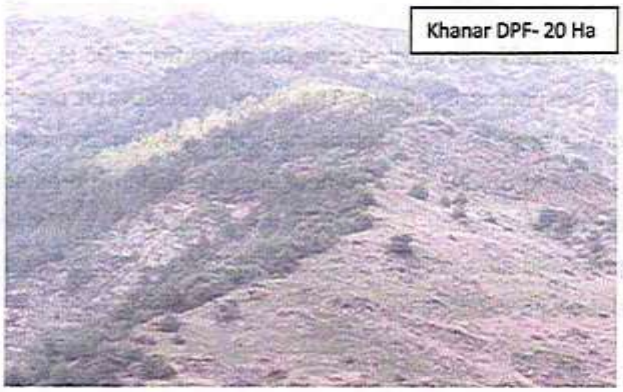
iv) Dhardi DPF (Proposed area for plantation = 25 Ha)

The aspect is South-Western. The slope is gentle to moderately steep and covered with grass growth. The species naturally growing around the area are Kail. The proposed area is situated near Drugna Dhar. Afforestation Plan scheme is at a distance of about 1.5 Km from the Garonda nursery (Proposed). The Elevation of proposed area is 2255 m to 4480 m. Soil of the proposed area is Clay Loamy to superficial and exposed rock.

Dhardi DPF- 25 Ha

v) Khanar DPF (Proposed area for plantation = 20 Ha)

The aspect is Southern. The slope is steep to precipitous and covered with grass growth. The species naturally growing around the area are Kail, Deodar. The proposed area is situated near Parosh DPF. Afforestation Plan scheme is at a distance of about 1 Km from the Khanar nursery (Proposed). The Elevation of proposed area is 2160 m to 2920 m. Soil of the proposed area is Clay Loamy to shallow deep and exposed rock.



Khanar DPF- 20 Ha

vi) Gronda DPF (Proposed are for plantation = 15 Ha)

The aspect is Southern and South-Eastern. The slope is steep to precipitous and covered with grass growth. The species naturally growing around the area are Kail, F/Sp. The proposed area is situated near Sindi DPF. Afforestation Plan scheme is at a distance of about 1 Km from the Garonda nursery (Proposed). The Elevation of proposed area is 2195 m to 3770 m. Soil of the proposed area is Clay Loamy to shallow deep and exposed rock.

Gronda DPF- 15 Ha

vii) Gowar DPF (Proposed area for plantation = 35 Ha)

The aspect is Southern. The slope is steep and precipitous and covered with grass growth. The species naturally growing around the area are Kail. The proposed area is situated near Dug Ka Nalla. Afforestation Plan scheme is at a distance of about 2 Km from the Bajol nursery (Proposed). The Elevation of proposed area is 1675 m to 3720 m. Soil of the proposed area is Shallow to fairly deep with exposed rock.

Gowar DPF- 35 Ha

3. Surehi Beat :-

i) Chaloon DPF (proposed area for Plantation = 15 Ha)

The aspect is South Western & Western. The slope is moderately steep and covered with grass growth. The species naturally growing around the area are Kail,F/Sp . The proposed area is situated near Surehi DPF. Afforestation Plan scheme is at a distance of about 2.5 Km from the Surehi nursery (Proposed). The Elevation of proposed area is 2135 m to 3665 m. Soil of the proposed area is fairly deep, Clay Loamy

ii) Chaloon DPF (proposed area for Plantation = 10 Ha)

The aspect is South Western & Western. The slope is moderately steep and covered with grass growth. The species naturally growing around the area are Kail, F/Sp. The proposed area is situated near Surehi DPF. Afforestation Plan scheme is at a distance of about 3.0 Km from the Surehi nursery (Proposed). The Elevation of proposed area is 2135 m to 3665 m. Soil of the proposed area is fairly deep, Clay Loamy.

iii) Urna DPF (Proposed area for plantation = 25 Ha)

The aspect is South Western & Western. The slope is gentle steep and covered with grass growth. The species naturally growing around the area are Kail, F/Sp. The proposed area is situated near Deoti DPF. Afforestation Plan scheme is at a distance of about 4 Km from the Surehi nursery (Proposed). The Elevation of proposed area is 2025 m to 3915 m. Soil of the proposed area is shallow and rocky.

Urna DPF – 25 Ha

iv) Chulan RF- I (Proposed area for plantation = 30 Ha)

The aspect is North Eastern. The slope is gentle steep to moderately and covered with grass growth. The species naturally growing around the area are Kail, Deodar & F/Sp. The proposed area is situated near Surehi DPF. Afforestation Plan scheme is at a distance of about 1.5 Km from the Surehi nursery (Proposed). The Elevation of proposed area is 1980 m to 2590 m. Soil of the proposed area is shallow and Clay Loamy.

Chulan RF-I – 30 Ha

v) Surehi DPF (Proposed area for plantation = 21 Ha)

The aspect is South Western. The slope is gentle steep to moderately and covered with grass growth. The species naturally growing around the area are Kail, Deodar & F/Sp. The proposed area is situated near Surehi village. Afforestation Plan scheme is at a distance of about 1 Km from the Surehi nursery (Proposed). The Elevation of proposed area is 2165 m to 3050 m. Soil of the proposed area is shallow and fairly deep loamy.

Surehi DPF – 21

vi) **Thana DPF (Proposed area for plantation = 20 Ha)**

The aspect is Southern. The slope is gentle steep to moderately steep and covered with grass growth. The species naturally growing around the area are Kail, Deodar. The proposed area is situated near Surehi DPF. Afforestation Plan scheme is at a distance of about 1 Km from the surehi nursery (Proposed). The Elevation of proposed area is 2135 m to 2285 m. Soil of the proposed area is shallow and rocky.

Thana DPF – 20 Ha

4. <u>Yada Beat</u>.

i) **Yada DPF (Proposed area for plantation = 35 Ha)**

The aspect is Eastern and Northern Eastern. The slope is gentle steep and covered with grass growth. The species naturally growing around the area are Kail, F/Sp. The proposed area is situated near Jalsu Nalla. Afforestation Plan scheme is at a distance of about 8 Km from the surehi nursery (Proposed). The Elevation of proposed area is 2450 m to 3530 m. Soil of the proposed area is clay loamy and fairly deep.

ii) **Batbaih DPF (Proposed area for plantation = 21 Ha)**

The aspect is Eastern. The slope is gentle steep and covered with grass growth. The species naturally growing around the area are Kail, F/Sp. The proposed area is situated near Pandvan DPF. Afforestation Plan scheme is at a distance of about 5 Km from the Surehi nursery (Proposed). The Elevation of proposed area is 2310 m to 3433 m. Soil of the proposed area is clay loamy and shallow to fairly deep & rocky.

HOLI BLOCK:-

1. **Deol Beat :-**

   (i) **Kiur DPF (Proposed area for Plantation-35 Ha)**

   The aspect is Eastern. The slope is gentle steep and covered with grass growth. The species naturally growing around the area are Kail, F/Sp. The proposed area is situated near Kiur Village. Afforestation Plan scheme is at a distance of about 06 Km from the Holi nursery. The Elevation of proposed area is 2250 m to 3200 m. Soil of the proposed area is shallow to fairly deep Clay.

Kiur DPF – 35 Ha

   (ii) **Deol RF :- (Proposed area for Plantation-10 Ha)**

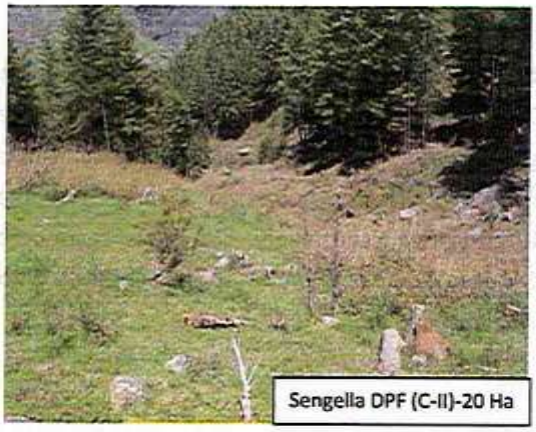
   The aspect is North Eastern. The slope is moderately steep. The species naturally growing around the area are Kail, Deodar. The proposed area is situated near Deol Village. Afforestation Plan scheme is at a distance of about 04 Km from the Holi nursery. The Elevation of proposed area is 2195 m to 2375 m. Soil of the proposed area is Clay loamy fairly deep.

(iii) Sengella C-I DPF:- (Proposed area for Plantation-20 Ha)

The aspect is Northern. The slope is gentle steep. The species naturally growing around the area are Kail, Deodar. The proposed area is situated near Deol Village. Afforestation Plan scheme is at a distance of about 05 Km from the Holi nursery. The Elevation of proposed area is 2590 m to 3475 m. Soil of the proposed area is Shallow to fairly deep, Clay loamy with exposed rock.

(iv) **Sengella C- II DPF:- (Proposed area for Plantation-20 Ha)**

The aspect is Northern. The slope is gentle steep. The species naturally growing around the area are Kail, Deodar. The proposed area is situated near Deol Village. Afforestation Plan scheme is at a distance of about 5 Km from the Holi nursery. The Elevation of proposed area is 2590 m to 3475 m. Soil of the proposed area is Shallow to fairly deep, Clay loamy with exposed rock.



Sengella DPF (C-II)-20 Ha

(v) **Sangella(C-III) DPF:- (Proposed area for Plantation-20 Ha)**

The aspect is Northern. The slope is gentle steep. The species naturally growing around the area are Kail, Deodar. The proposed area is situated near Deol Village. Afforestation Plan scheme is at a distance of about 3 Km from the Holi nursery. The Elevation of proposed area is 2590 m to 3475 m. Soil of the proposed area is Shallow to fairly deep, Clay loamy with exposed rock.

Sengella DPF (C-III)- 20 Ha

(vi) **Guwar DPF:- (Proposed area for Plantation-8 Ha)**

The aspect is Northern & Northern Eastern. The slope is gentle steep to moderately steep. The species naturally growing around the area are Kail, F/Sp. The proposed area is situated near Guwar Village. Afforestation Plan scheme is at a distance of about 02 Km from the Holi nursery. The Elevation of proposed area is 2225 m to 3050 m. Soil of the proposed area is Shallow to fairly deep, Clay loamy with exposed rock.

Guwar DPF- 08 Ha

vii) **Guwar DPF:- (Proposed area for Plantation-9 Ha)**

The aspect is Northern & Northern Eastern. The slope is gentle steep to moderately steep. The species naturally growing around the area are Kail, F/Sp. The proposed area is situated near Guwar Village. Afforestation Plan scheme is at a distance of about 03 Km from the Holi nursery. The Elevation of proposed area is 2225 m to 3050 m. Soil of the proposed area is Shallow to fairly deep, Clay loamy with exposed rock.

Guwar DPF- 09 Ha

viii) **Bhankhar DPF:- (Proposed area for Plantation-15 Ha)**

The aspect is Northern Eastern. The slope is moderately steep. The species naturally growing around the area are Deodar, Kail, and F/Sp. The proposed area is situated near Guwar DPF. Afforestation Plan scheme is at a distance of about 2 Km from the Holi nursery. The Elevation of proposed area is 2775 m to 3965 m. Soil of the proposed area is Shallow to fairly deep.

Bhankhar DPF- 15 Ha

ix) Andruhi DPF:- (Proposed area for Plantation-35 Ha)

The aspect is South Eastern. The slope is moderately steep. The species naturally growing around the area are Deodar, Kail. The proposed area is situated near Deosar RF. Afforestation Plan scheme is at a distance of about 4 Km from the Holi nursery. The Elevation of proposed area is 1980m to 3182 m. Soil of the proposed area is Clay loamy and Shallow to fairly deep.

Andruhi DPF- 35 Ha

PROPOSED AREAS FOR AFFORESTATION

IN BARABANCHHO AND HOLI BLOCK

(UNDER CAT PLAN OF BAJOLI- HOLI HEP) IN TREHTA RANGE

Sr. No.	Name of Block	Name of Beat	Legal Status	Area proposed for Afforestation (Ha)
1.	Barabanchho	Nayagram	TundaMunda(C-I) DPF	25
2.			Tunda Munda(C-II)DPF	26
3.			Agrali RF (C-II)	20
4.			Luwain DPF	15
5.			Agrali DPF	25
6.			Agrali RF (C-II)	25
7.			Tunda Munda (C-II)	20
8.			Kut (C-I) DPF	18
		Total Proposed Afforestation in Nayagram Beat		**174**
1.		Bajol	Bajol DPF	31
2.			Sindi DPF	25
3.			Dhardi DPF	25
4.			Khanar DPF	20
5.			Garonda DPF	15
6.			Gowar DPF	35
7.			Bajoli DPF	20
		Total Proposed Afforestation in Bajol Beat		**171**

PROPOSED AREAS FOR AFFORESTATION
IN BARABANCHHO AND HOLIBLOCK
(UNDER CAT PLAN OF BAJOLI- HOLI HEP) IN TREHTA RANGE

Sr. No.	Name of Block	Name of Beat	Legal Status	Area proposed for Afforestation (Ha)
1.	Barabanchho	Surehi	Chaloon DPF	25
2.			Urna DPF	25
3.			Chulan DPF	30
4.			Surehi DPF	21
5.			Thana DPF	20
		Total Proposed Afforestation in Surehi Beat		**121**
1.		Yada	Yada DPF	35
2.			Batbaih DPF	21
		Total Proposed Afforestation in Yada Beat		**56**
1.	Holi	Deol	Kiur DPF	35
2.			Deol RF	10
3.			Sengella (C-I) DPF	20
4.			Sengella (C-II) DPF	20
5.			Sengella (C-III) DPF	20
6.			Guwar DPF	17
7.			Bhankhar DPF	15
8.			Andurahi DPF	35
		Total Proposed Afforestation Deol Beat		**172**
***TOTAL PROPOSED AREA FOR AFFORESTATION**				**694**

***Out of 694 Ha identified for plantation, 104 Ha is proposed for medicinal plantation.**

ENRICHMENT PLANTATION

Enrichment plantation will be carried out in degraded forest area in the Catchment, so as to increase stocking in already existing open forest. This has to be a selective process and should result in better diversity / abundance of key species. A norm of 800 plants per ha (notional) would be adopted and tall plants of the desired species would be planted under this component. Since such planting would be scattered in the nature, the traditional barbered wire fencing is not to be done; instead of individual protection to the tall plants using thorny bushes, will be resorted to. Provision for such individual protection has been included in the cost norms.

A total of 270 Ha has been indentified for planting including thorny brush protection guard under this scheme for a total outlay of **Rs. 88.75 lacs**. The preliminary forest identified for this purpose are as under;

BARABANCHHO BLOCK

(A) BAJOL BEAT

1. Bajol DPF (25 Ha)

Total area available is about 25 Ha. It has southern aspect. The slope is moderate to steep. Tree species like Kail, F/Sp, etc.found in the area Deodar, Horse Chest Nut (Goon) etc. species can be tried in the area. Nearest nursery is Bajol (Proposed) at a distance of about 1.5 Km The Elevation of proposed area is 2440 m to 3355 m. Soil of the proposed area is Clay Loamy, moderate to fairly deep.

2. **Dhardi DPF : 20 Ha**
3. **Guwar DPF : 10 Ha**
4. **Garonda DPF : 15 Ha**
5. **Sindi DPF : 10 Ha**

(B) NAYAGRAM BEAT

1. Tunda Munda DPF (C-I) (15 Ha)

Total area available is about 15 Ha. It has eastern aspect, The slope is moderate steep. Tree species like Kail, F/Sp found in the area &Ban, Deodar, Horse Chest Nut (Goon) etc. species can be tried in the area. Nearest nursery is Nayagram (Proposed) at a distance of about 03 Km. The Elevation of proposed area is 1920 m to 2805 m. Soil of the proposed area is shallow to fairly deep.

2. Tunda Munda (C- II) DPF: - 15 Ha

3. Suwen RF (20 Ha)

Total area available is about 20 Ha. It has northern and northern eastern aspect, the slope is gentle steep. Tree species like Kail, F/Sp, Deodar etc. found in the area Ban species can be tried in the area. Nearest nursery is Nayagram (Proposed) at a distance of about 1.5 Km. The Elevation of proposed area is 1900 m to 2800 m. Soil of the proposed area is Clay Loamy, shallow to superficial.

Suwen RF – 20 Ha

4. Agrali DPF (20 Ha)

Total area available is about 20 Ha. It has northern eastern aspect, the slope is moderate steep. Tree species like Kail, F/Sp, and Deodar found in the area Ban species can be tried in the area. Nearest nursery is Nayagram (Proposed) at a distance of about 1.0 Km. The Elevation of proposed area is 1980 m to 2285 m. Soil of the proposed area is Clay Loamy, shallow to fairly deep.

5. Nawai RF : 10 Ha

6. Pani Nalli (C-II) RF :- 10 Ha

7. Thaneter DPF :- 20 Ha

(C) YADA BEAT:-

1. **Pandvan DPF (15 Ha)**

Total area available is about 15 Ha. It has eastern aspect, the slope is moderate steep. Tree species like Kail, F/Sp, and Deodar found in the area Ban species can be tried in the area. Nearest nursery is Surehi (Proposed) at a distance of about 4 Km. The Elevation of proposed area is 2240 m to 3240 m. Soil of the proposed area is Clay Loamy, shallow to fairly deep & Rocky.

D) Surehi Beat :-

1. Surehi DPF : - 10 Ha

2. Urna DPF : - 25 Ha

3. Deoti DPF : - 30 Ha

Plantations over these **270 hectares** are proposed to be completed in 5 years. Sequence of forests for planting in table is merely suggestive and not binding. Due to any administrative exigencies, Divisional Forest Officer, Bharmour may make any adjustment in the yearly sequence.

PROPOSED AREAS FOR ENRICHMENT PLANTATION IN

BARABANCHHO BLOCK

(UNDER CAT PLAN OF BAJOLI- HOLI HEP) IN TREHTA RANGE

Sr. No	Name of Block	Name of Beat	Legal Status	Area proposed for Enrichment Plantation (Ha)
1.	Barabanchho	Bajol	Bajol DPF	25
2.			Dhardi DPF	20
3.			Guwar DPF	10
4.			Garonda DPF	15
5.			Sindi DPF	10
		Total Proposed Enrichment Plantation Area in Bajol Beat		**80**
1.		Nayagram	Tunda Munda (C-I,II) DPF	30
2.			Suwen RF	20
3.			Agrali DPF	20
			Nawai RF	10
			Pani Nalli (C-II)RF	10
			Thaneter DPF	20
		Total Proposed Enrichment Plantation Area in Nayagram Beat		**110**
1.		Yada	Pandvan DPF	15
1		Surehi	Surehi DPF	10
2.			Urna DPF	25
3.			Deoti DPF	30
		Total Proposed Enrichment Plantation Area in Surehi Beat		**65**
TOTAL PROPOSED AREA FOR ENRICHMENT PLANTATION				**270**

ENERGY PLANTATION

Energy plantation would be carried out to fulfill the wood and fodder requirements of the local people. The locally available fuel wood and fodder plant species in various agro-climatic conditions will be planted. The energy plantation would be carried out over 240 Ha land in the vicinity of the habitations. Owing to the increased biotic pressure in these areas, greater emphasis would be placed on effective closure and hence 5 strand barbed wire fencing 3 strands & 2 cross wise; with creosoted wooden fence posts would be adopted. 5000 tall plants per ha of Fuel & Fodder value will be planted. Maintenance intervention shall be taken by direct funding of user group. The provisions for outlay of **Rs. 270.3 lacs** including fencing has been considered under this scheme. ***Annex.-G.***

NURSERY DEVELOPMENT

There is one old forest nursery in the project vicinity which are considered for production of quality seedlings / rhizomes. The nurseries will also be managed to accelerate timely production of seedling required for plantation and soil conservation works in the catchment. Bulk planting of Bio-engineering species suitable for the catchment would be raised in these nurseries in addition to regular forestry species. In addition to this vermi-compost units and poly house will be installed in each nursery. The following nurseries in the project vicinity will be taken up for development under the CAT plan of Bajoli-Holi HEP (180 MW).

Nurseries in Project Area

Name of the Forest Range	Location	Proposed Area	Proposed Amount (Nursery development & Raising of Plants (In Lacs)
Trehta	Khannar	0.40 Ha	15.0
Trehta	Garonda	0.40 Ha	15.0
Trehta	Bajol	0.50 Ha	16.0
Trehta	Kharudu	0.40 Ha	15.0
Trehta	Surehi	0.50 Ha	16.0
Trehta	Nayagram	0.30 Ha	12.3
Total Amount for Proposed Nurseries including Nurseries development & Raising of Plants			**89.3**

The work on raising / development of nurseries will start from first year and the plants will be maintained subsequently. Provision for vermi composting unit has also been proposed under this scheme for these nurseries. The provision for outlay of **Rs. 89.3 lacs** has been kept.

Local Bio- Engineering Species identify for propagation in the Nurseries & subsequent planting.

The following Bio-engineering Species of Local origin have been identify for their propagation in the above mentioned Nurseries and subsequent planning in Forest area. These plants species will be planting along the various Nallas, Slip and Ghars to reduce Soil erosion, and bank stabilization.

Sr.No.	Local Name	Botanical Name
1	Aakhe	Rubus Spp.
2	Bhekal	Prinsepia utils
3	Benus	Salix spp.
4	Piyak	Alnus nitida
5	Khat-Mits	Rumex hastatus
6	Jangli- Gulab	Rosa Spp.
7	Yuca	Yuca americana
8	Robinia	Robinia psudocasea
9	Siaru	Debregeasia hypoleuca
10	Karaneh	Spiraia lindeleyana

NURSERY LAYOUT FOR RAISING HEALTHY STOCK

A. POLY HOUSE/GERMINATION CHAMBERS.
B. IRRIGATION SYSTEM-SPRINKLERS, FOGGRES, WATER PUMP ETC.
C. PERFORATED TRAYS.
D. VERMI COPOST UNITS.
E. COMPOST HOUSE.
F. CHAFF CUTTER/CHOPPER.
G. REGISTERS.

POLY HOUSE/GERMINATION CHAMBERS:

Poly house should have the following articles:-

i. Size : 4-6 x 2x1.5 m.
ii. Foggers/splinklers, irrigation system.
iii. Max.-Min. thermometers.
iv. Hygrometer for recording humidity.
v. Perforated trays.
vi. Register.
vii. Plantation-Micro Planning, Grading of plants, Size of pits, closure cases.

Date of sowing	Date of Germination	No. of Days for acclimatization	Date of Pricking	Date of shifting	Study of growth pattern

Vermi Compost:

- Vermi Compost Unit 4 to 6 in Nos.
- Collection of twigs/weeds/leaves.
- Chopping into small pieces.
- Mixing with cow dung.
- Mixing inTubs/buckets.
- Adding in vermin compost unit.
- Verms 2 to 3 Kg. per pit.

Sr. No.	Nallah	Block	Beat	Micro-watershed	Providing Crate Wire Work		Vegetative Check Dam		Gully Plugging		Stream Bank Protection		Water Harvesting		TOTAL IN RS
					Qty.(m3)	Amount(Rs) @1400 Rs/m3	Qty.(No)	Amount(Rs) @650 Rs/No.	Qty.(m3)	Amount(Rs) @1200 Rs/m3	Qty.(m3)	Amount(Rs) @1400 Rs/m3	Qty.(No)	Amount(Rs) @2,50,000Rs/ no.	
1	Dhardi	Barabanchho	Bajol	Tm2d	260.00	364,000.00	300.00	195,000.00	600.00	720,000.00	235.00	329,000.00	0.00	0.00	1,608,000.00
2	Garonda			Tm2d	300.00	420,000.00	400.00	260,000.00	300.00	360,000.00	240.00	336,000.00	0.00	0.00	1,376,000.00
3	Sindi			Tm2d	300.00	420,000.00	350.00	227,500.00	250.00	300,000.00	265.00	371,000.00	0.00	0.00	1,318,500.00
4	Gurwar			Tm2g	400.00	560,000.00	450.00	292,500.00	350.00	420,000.00	295.00	413,000.00	0.00	0.00	1,685,500.00
5	Chadnu			Tm2g	350.00	490,000.00	400.00	260,000.00	200.00	240,000.00	225.00	315,000.00	0.00	0.00	1,305,000.00
6	Khabhar			Tm2g	250.00	350,000.00	400.00	260,000.00	500.00	600,000.00	225.00	315,000.00	0.00	0.00	1,525,000.00
7	Gaur			Tn2d	200.00	280,000.00	450.00	292,500.00	350.00	420,000.00	325.00	455,000.00	0.00	0.00	1,447,500.00
8	Tilla			Tm2g	250.00	350,000.00	350.00	227,500.00	500.00	600,000.00	225.00	315,000.00	0.00	0.00	1,492,500.00
9	Bhanora		Yada	Tk3m	300.00	420,000.00	450.00	292,500.00	400.00	480,000.00	225.00	315,000.00	0.00	0.00	1,507,500.00
10	Rihli			Tk3k	200.00	280,000.00	250.00	162,500.00	200.00	240,000.00	175.00	245,000.00	0.00	0.00	927,500.00
11	Tapu			Tk3m	250.00	350,000.00	150.00	97,500.00	450.00	540,000.00	375.00	525,000.00	0.00	0.00	1,512,500.00
12	Barbahi			Tk3m	250.00	350,000.00	300.00	195,000.00	250.00	300,000.00	275.00	385,000.00	0.00	0.00	1,230,000.00
13	Magru			Tk3m	200.00	280,000.00	350.00	227,500.00	300.00	360,000.00	325.00	455,000.00	0.00	0.00	1,322,500.00
14	Biyadi			Tk3k	150.00	210,000.00	250.00	162,500.00	200.00	240,000.00	150.00	210,000.00	0.00	0.00	822,500.00
15	Pandpan			Tk3m	250.00	350,000.00	450.00	292,500.00	500.00	600,000.00	225.00	315,000.00	0.00	0.00	1,557,500.00
16	Khurlma			Tk3m	200.00	280,000.00	200.00	130,000.00	450.00	540,000.00	240.00	336,000.00	0.00	0.00	1,286,000.00
17	Channer			Tk3m	200.00	280,000.00	300.00	195,000.00	500.00	600,000.00	255.00	357,000.00	0.00	0.00	1,432,000.00
18	Chedi			Tk3k	100.00	140,000.00	200.00	130,000.00	350.00	420,000.00	100.00	140,000.00	0.00	0.00	830,000.00
19	Jahu			Tk3m	200.00	280,000.00	350.00	227,500.00	600.00	720,000.00	100.00	140,000.00	0.00	0.00	1,367,500.00
20	Mohan			Tk3m	200.00	280,000.00	150.00	97,500.00	530.00	636,000.00	250.00	350,000.00	0.00	0.00	1,363,500.00
21	Jui			Tk3k	120.00	168,000.00	270.00	175,500.00	150.00	180,000.00	100.00	140,000.00	0.00	0.00	663,500.00

198

Compost House: -

- Register.

Date of Chopping	Date of mixing with Urea.	Date of adding in compost house.	Date of taking out.

Date	Time 3 Pm.	Min. Temp.	Max. Temp.	Humidity

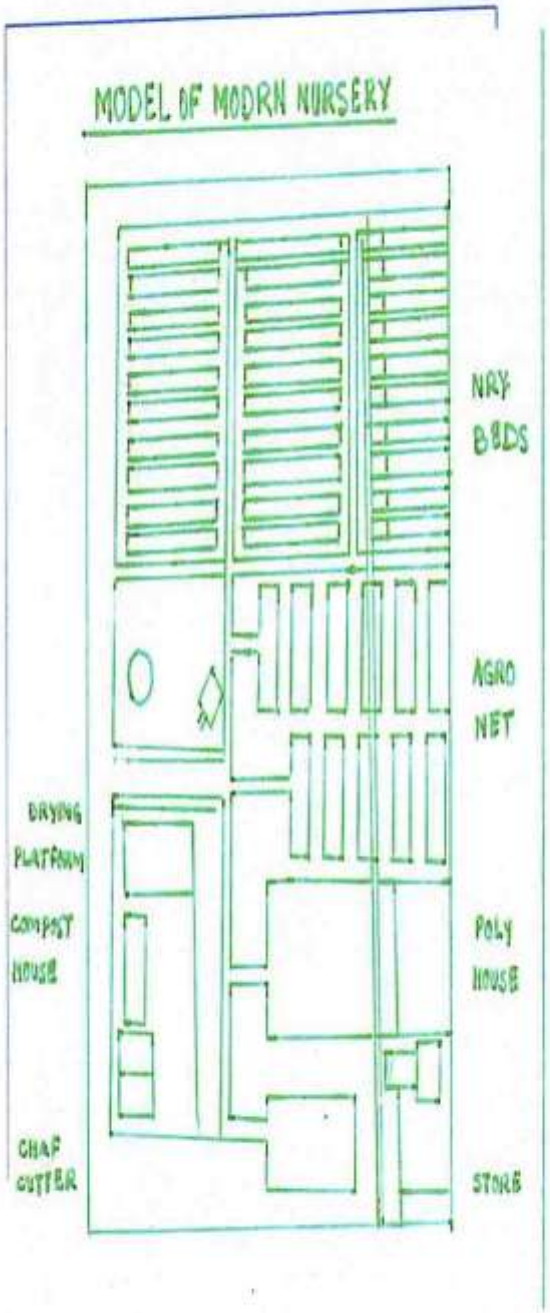
Sowing of Seeds: -

- Trays should be field 1:1 sand & Vermi compost.
- 2nd fortnight of Jan./Ist fortnight of Feb. depending upon location/weather.
- Germination timing is different for different species.

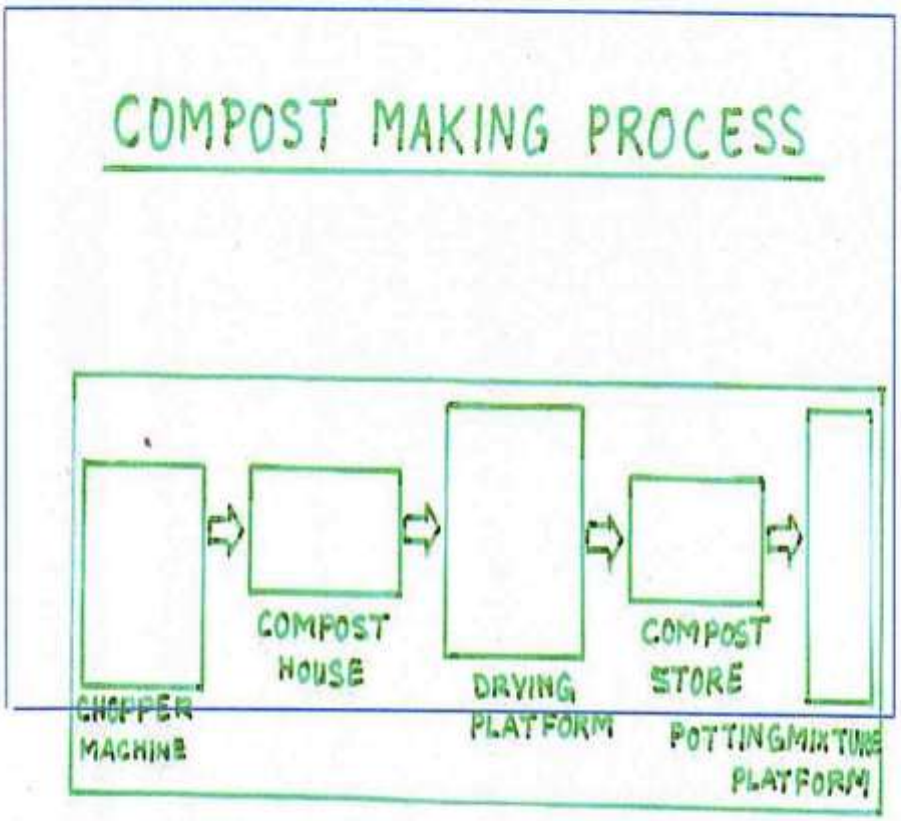
MODERN NURSERY

IT HAS FOLLOWING COMPONENTS:-

- COMPOST HOUSE WITH ACCESSORIES.
- VERMI –COMPOST UNIT
- CHAFF CUTTER WITH PLATEFORM
- POLYHOUSE/ GERMINATION / MIST CHAMBER WITH MODERN EQUIPMENTS
- AGRO-NET SHED
- ROOT TRAINERS WITH STAND
- NURSERY BEDS
- STORE AND CHOWKIDAR HUT



COMPOST MAKING PROCESS

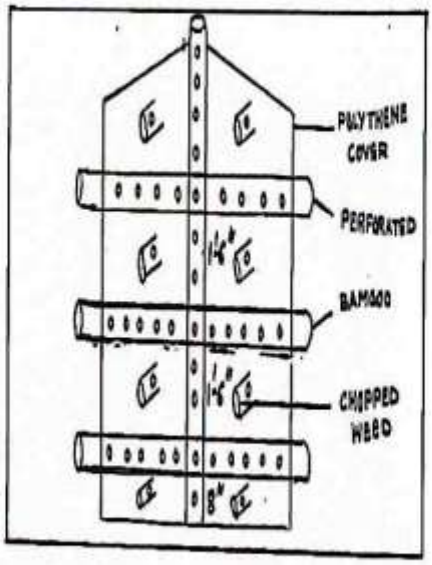


IN THE INITIAL STAGE OF PLANT LIFE, PARTICULARLY IN NURSERY STAGE, PROPER MEDIA AND NUTRITION ARE VERY IMPROTANT FACTORS WHICH DETERMINE THE FUTURE GROWTH OF PLANTS. THE COMPOST IS LIGHT, FRIABLE AND RICH IN NUTRIENTS TO SUPPORT THE YOUNG SEEDLINGS WHICH CAN BE PREPARED FROM CHOPPED WEEDS OR STRAW OR GRASS BY AEROBIC DECOMPOSITION.

ESTABLISHMENT OF MODREN NURSERIES WIT

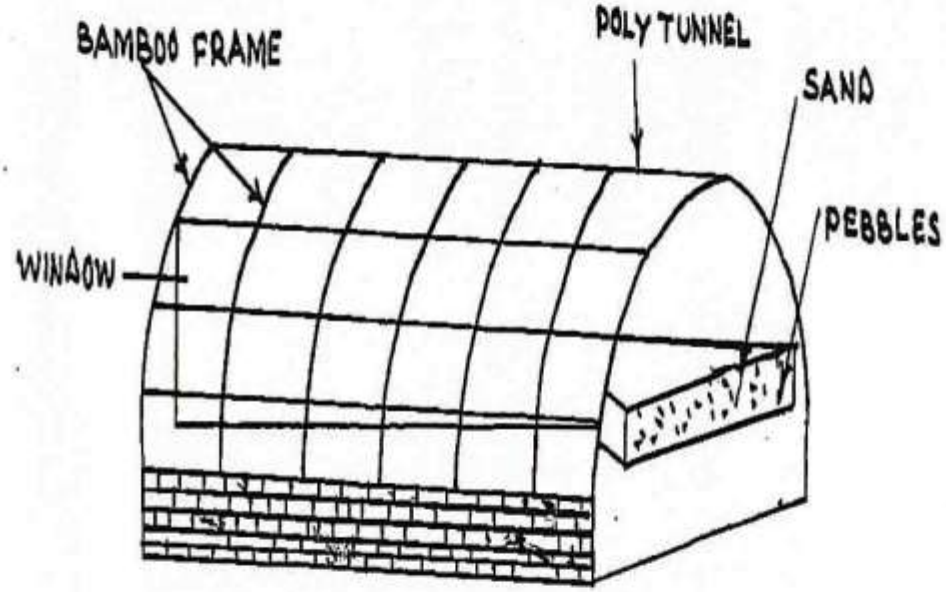
<u>The compost unit</u> is a masonry chamber shed of fitting by 15' length 5' in width & 4 ' in height depending upon the amount of compost to be produced.

- Shed is divided into 3 chambers
- Roof of the shed and top portion is covered with transparent polythene sheets of proper thickness.
- The foundation and plinth is in masonry cement & floor is of cement concrete.
- Sheds are provided with 4 " PVC or cemented pipes with holes inbuilt for proper aeration.
- 1st pipe is kept about 8" above the ground and the second & subsequent are at 1.5' above it as shown in the diagram.
- The pipe shown criss –cross for proper circulation of air.
- Doors of the shed are made of wood.
- Material used (weeds, twigs or grasses) for making compost is mixed with approximately 1 Kg. of Urea in about 1 m^3 of chopped material and duly moisturized to give a good compost (preferably 4-5 days material is mixed for facilitating proper decomposition).
- Aerobic degradation starts in optimum temperature of 25^0 C-30^0 C. and once decomposition starts the heat is generated upto 55^0 to 60^0 C.
- During the process various chemical reactions takes place.
- Register is maintained for recording the daily temperature and amount of compost produced.
- High temperature is the indication of process of composting whereas falling temperature to the atmospheric temperature is indication of Completion of process.
- Compost will be ready in about 25 to 30 days if, suitable moisture and temperature is maintained for aerobic decomposition.
- Record for minimum & maximum temperature is maintained in a register.



AEROBIC DECOMPOSITION FOR MAKING COMPOST FROM WEEDS

136



GERMINATION CHAMBER

Platform for drying

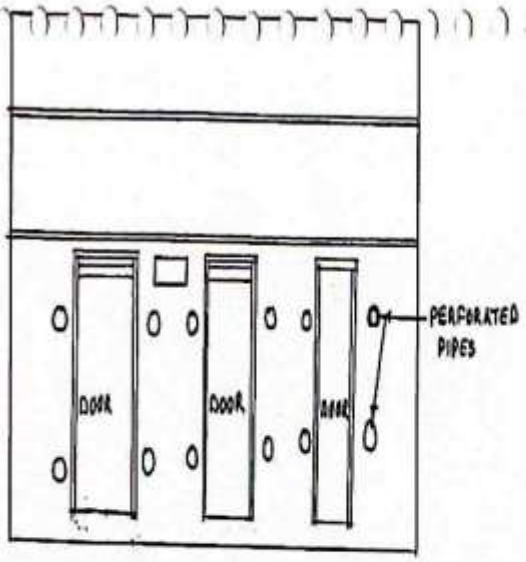
Cemented platform of 10 feet to 8 feet provided in front of composting shed.

Compost extracted from the shed is removed and put on the platform for drying.

Dry it and sieve it and will be ready for use in the route trainers.

Compost so prepared will be light, friable and riche in nutrients to support the young seedlings.

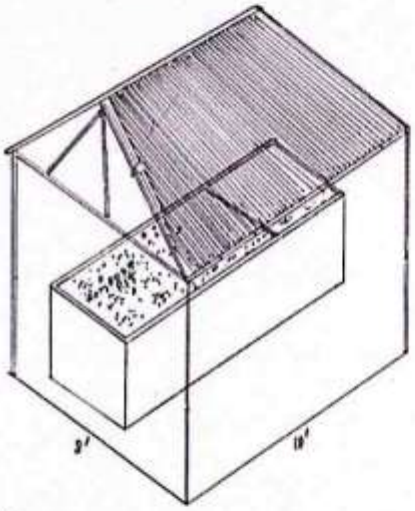
Compost so prepared is mixed with sand 1 part and compost 2 parts in route trainers, preferably the sand should be sterilized by heating before it is mixed with compost.



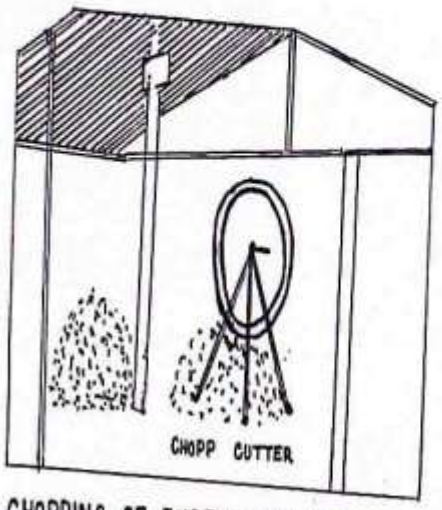
COMPOST HOUSE

Vermi –Compost Unit

- Above ground pit is constructed upto 1' & 2'.
- The twigs, grasses chopped and mixed with FYM to make slurry in big tub.
- Doom like packing are filled in the pit.
- Verms are put in the pit @ of 2 - 3 Kg. per pit developing upon the vermi compost is prepared.
- These pits is covered with grasses in order to give proper environment.
- Vermi compost is seived & colleted after 30-35 days and packed in gunny bags.
- The verms increased in number of geometric regression and number of pits be increased accordingly.

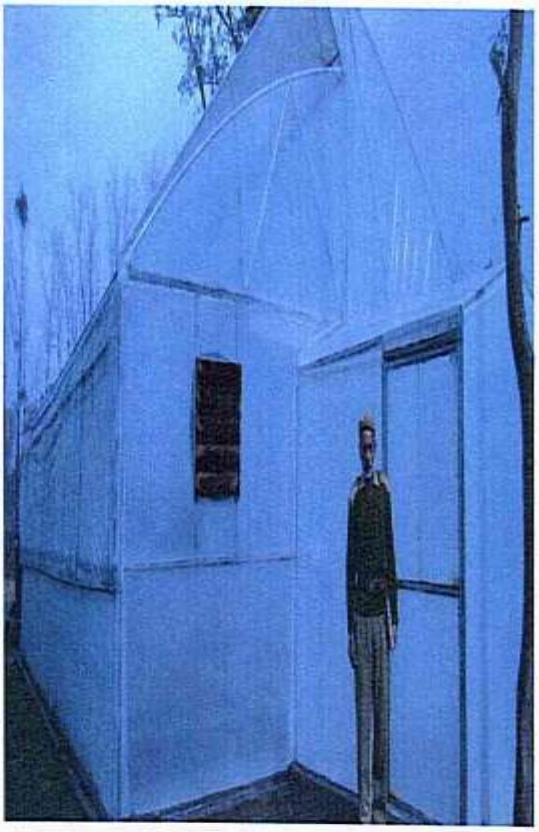


VERMI-COMPOST



CHOPPING OF EUPETORIUM BEFORE FEEDING IN COMPOST HOUSE

Poly house/Mist chamber/Germination Chamber



•Shed is fabricated and supported by G.I. pipe frame.

•Being technical, help of trained personnel is procured.

•It is covered with ultra-violet stabilized plastic sheet of 200-micron thickness.

• Misting/Fogging, sprinkler irrigation, temperature, and humidity recording instruments are provided in the chamber.

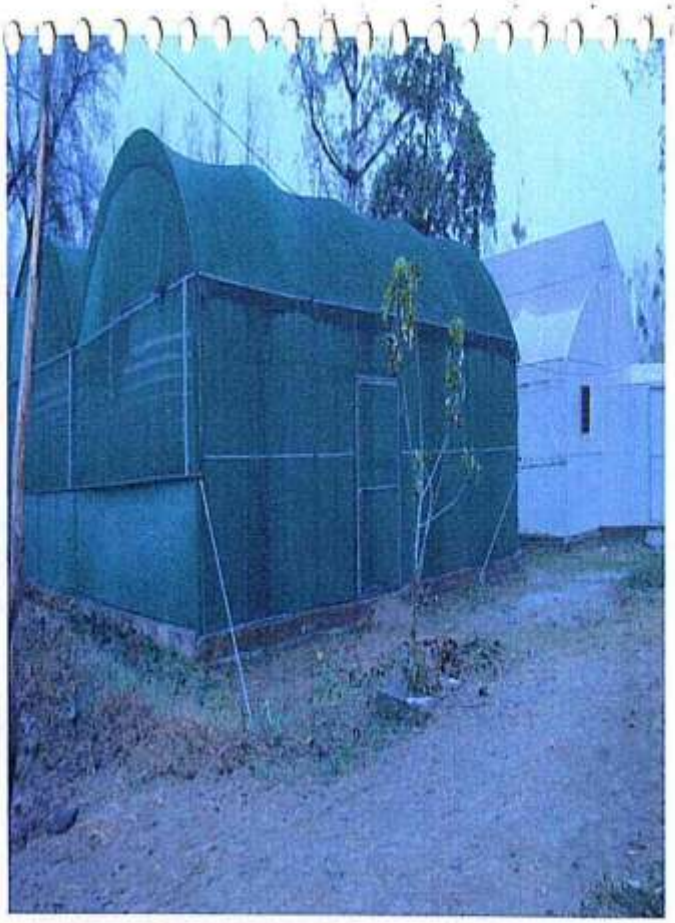
• If necessary exhaust fans also provided.

• Record be maintained on the register for showing date of germination, date of pricking, height of seedling & height of the plants are transplanting in the field.

• Used for germination of hard coated seeds & for growing valuable species.

• Germination, seedling or plants are put in route trainers on stand.

Agro-Net shed



This shed stands on the angle iron at a height 7 feet to 8 feet.

Shed is covered with agronets with 50 % shade.

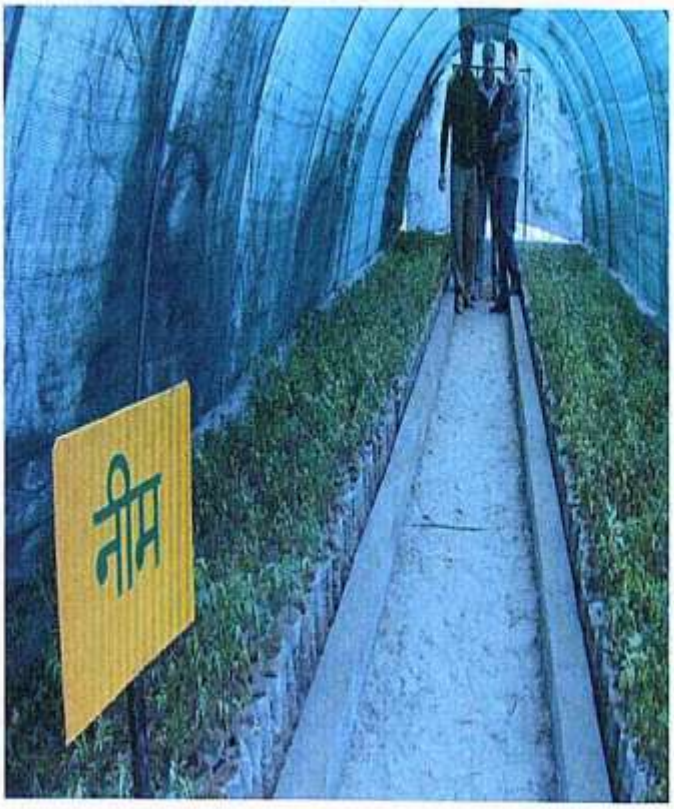
Arrangement for sprinkler irrigation are made.

Route trainers on stand are put inside the shed.

The route trainers used to give a good height and good route system before planting in the rainy season.

Nursery beds are also prepared for consuming the extra seedlings so produced and for comparison of results in and outside.

Proper register is kept for recording the data.



144

SUBSIDIARY SILVI CULTURE

Following activities will be carried out under Subsidiary silviculture operation:

a) Cutting of bushes.

b) Trimming of branches.

c) Gully plugging.

d) Climber cutting.

A total of 350 Ha has been indentified for Subsidiary silviculture under this scheme for a total outlay of **Rs.52.5 lacs.**

PROPOSED AREAS FOR SUBSIDIARY SILVI CULTURE IN

BARABANCHHO BLOCK

(UNDER CAT PLAN OF BAJOLI- HOLI HEP) IN TREHTA RANGE

Sr. No	Name of Block	Name of Beat	Legal Status	Area proposed for Subsidiary Silviculture (Ha)
1.	Baraba-nchho	Bajol	Sindi DPF	45
2.			Bajol DPF	25
		Total Proposed Subsidiary silviculture Area in Bajol Beat		**70**
1.		Nayagram	Agrali DPF(C-I,II,III)	60
2.			Luwain	10
3.			Nawai RF	35
4.			Pani Nalli RF (C-I,II)	25
		Total Proposed Subsidiary silviculture Area in Nayagram Beat		**130**
1.		Yada	Pandvan RF	30
2.			Gandhir RF	35
		Total Proposed Sub sidiary silviculture Area in Yada Beat		**65**
1		Surehi	Chulan RF(C-I,II)	60
2.			Surehi DPF	25
3.				
		Total Proposed Sub sidiary silviculture Area inSurehi Beat		**85**
TOTAL PROPOSED AREA FOR SUBSIDIARY SILVI CULTURE				**350**

PASTURE MANAGEMENT

A total of 380 Ha has been indentified for Pasture management under this scheme for a total outlay of **Rs.97.00 lacs** Under this activity only the lower area of the catchment adjacent to the habitation will be taken up for Pasture reclamation/managrment. In these areas, fodder plant species like Oak Species, Celtis australis etc. @ 400 plants per hact. shall be planted along with the introduction of local grasses and clovers (white and red clovers) etc. Further fencing of the said areas will be carried out. In addition to this activity, rotational grazing on the basis of agreement with local stake holders will also be encouraged at the time of implementation of this activity by the field staff. Suitable incentives will also be provided to stake holders. Wherever possible the deweeding of unwanted weeds will be done as most of the sheep and goats migrate from lower areas to higher reaches during summer season and vice- versa.

Barabanchho Block:

1. Bajol Beat :-

i) **Ballan Phtar Dhar :-**
Proposed area for Pasture management is 30 Ha.

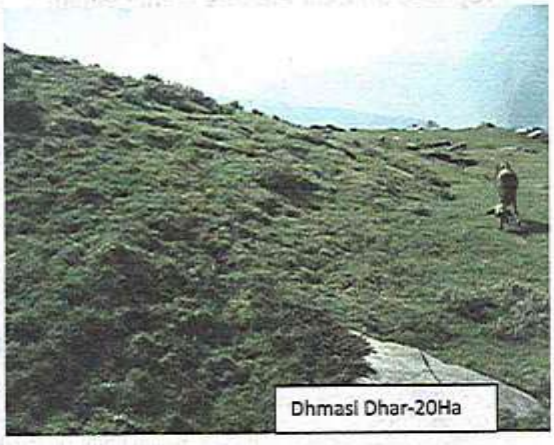
Ballan Phtar Dhar-30Ha

ii) **Urna Dhar:- Proposed area for Pasture management is 25 Ha.**

Urna Dhar – 25Ha

2. Naya gram Beat:

i) **Dhmasi Dhar (20 Ha):-**
Proposed area for Pasture management is 20 Ha.



Dhmasi Dhar-20Ha

ii) **Riyali Dhar (30 Ha):**
Proposed area for Pasture management is 30 Ha.

Riyali Dhar-30 Ha

iii) **Papnu Dhar :**
Proposed area for Pasture management is 25Ha.

Papnu Dhar- 25 Ha

3. Yada Beat:

i) **Langha Kanar Dhar:**
Proposed area for Pasture management is 40 Ha.

Lanfha Kanar Dhar-40 Ha

ii) **Yada Dhar (30 Ha):**
Proposed area for Pasture management is 30 Ha.

Yada Dhar-30 Ha

4. **Surehi Beat:**

i) **Deoti Dhar (40 Ha):**
Proposed area for Pasture management is 40 Ha.


Deoti Dhar-40 Ha

ii) **Sarang Dhar: 35 Ha**
Proposed area for Pasture management is 35 Ha.


Sarang Dhar- 35 Ha

iii) **Sirog Dhar :- 30 Ha**

PROPOSED AREAS FOR PASTURE MANAGEMENT IN

BARABANCHHO BLOCK

UNDER CAT PLAN OF BAJOLI- HOLI HEP) IN TREHTA RANGE

Sr. No	Name of Block	Name of Beat	Legal Status	ProposedPasture management Area in
1.	Barabanchho	Bajol	Ballan Phtar Dhar	30
2.			Urna Dhar	25
		Total Proposed Pasture management Area in Bajol Beat		**55**
1.		Nayagram	Dhmasi Dhar	20
2.			Riyali Dhar	30
3.			Papnu Dhar	25
		Total Proposed Pasture management Area in Nayagram Beat		**75**
1.		Yada	Langha Kanor Dhar	40
2.			Yada Dhar	30
3.			Jalsu Dhar	35
4.			Khadyala Dhar	40
		Total Proposed Pasture management Area in Yada Beat		**145**
1		Surehi	Deoti Dhar	40
2.			Sarang Dhar	35
3.			Sirog Dhar	30
		Total Proposed Pasture management Area in Surehi Beat		**105**
TOTAL PROPOSED AREA FOR PASTURE MANAGEMENT				**380**

SOIL & WATER CONSERVATION

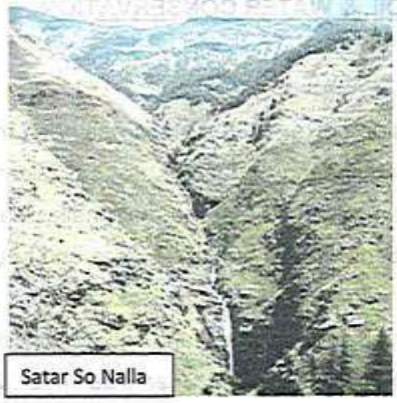
A total budget provision of **Rs. 1065.22 lacs** has been made towards the Soil Stabilization and engineering measures to be taken up in Bajoli- Holi catchment.It has been observed that the main nallas have loose strata, solid stable banks, rocky beds with lot of loose stones and boulders. The nallas are perennial, seasonal with heavy, medium & Low water flow. The details of various areas observed for treatment and recommended for soil & moisture conservation works in different nalla & Ghar is as under, where a ever possible jute mash/matting can also be used to hold the loose soil till plants and bio engineering species are established. It has been demonstrated in **Annexure-D & H.**

Barabanchho Block

1. **Bajol Beat**

a) Satar So (Bajol DPF)

Approximate length of the nalla is about 4.5 km. The nalla is totally stabilized with rocky base, good vegetation, having sparse bushes. Nalla is perennial with medium flow of water. Trees along the nalla on the upper portion are F/Sp,Ban etc. Bushes- Berberis spp, Princepia utilis, Ariesma, Rosa moschata, Daphne etc. Some portion of the nalla about 1000 m in length having **latitude N 32^0-18'32", longitude E 076^0-39'40" and height 2385 mtr** is affected by soil erosion along the bank and needs side stabilization by Bioengineering measures for the protection of the nalla.



Satar So Nalla

Some slides in small patches have been found in different portions of the nala which can be treated with mechanical measures with vegetative support. Middle & Lower portion of nalla is rocky and narrow.

(b) Sindi Ghar (Sindi DPF)

The approx. area of the Ghar is 1.0 Ha. Slides have been found in all portions of the Sindi Ghar which can be treated with Check walls, Retaining walls & Crate walls with vegetative species like Berberis spp Willow, Spiraea lindleyana, Zanthoxylum acatum, Daphne cannabina,Debregeasia hypoleuca etc.

Sindi Ghar

(c) Gohar Nalli (Bajol DPF) :-

Approximate length of the nalli is about 1.5 km. The nalli is having totally loose strata and surrounding of nalli is having good vegetation and sparse bushes like Berberis spp, Princepia utilis, , Daphne etc.are found in. Nalli is seasonal with medium flow of water. Some portion of the nalla which is about 1000 m length having **latitude N 32^0-16'35", longitude E 076^0-39'30" and height 2370 mtr** is affected by soil erosion along the bank and needs side stabilization by Bioengineering measures for the protection of the nalli.

Gohar Nalli

2. <u>Nayagram Beat</u>

i) Agrali Ghar (Agrali DPF)

The approx. area of the Ghar is 1.5 Km. Slides have been found in maximum portions of the Agrali Ghar and soil erosion can be seen along the ghar which can be treated with Check walls,

Retaining walls & Crate walls etc. according to the slope of ghar and run-off of water with Bio-engg. species .

Agrali Ghar

ii) **Thaneter Ghar (Thaneter DPF)**

The approx. area of the Ghar is 1.5 Km.During field verification soil erosion and slides were noticed in the maximum portions of the Thaneter Ghar. To control soil erosion activity engineering measures along with the bio-engineering measures will be followed.

Thaneter Ghar

iii) **Nayagram Nalla (Nayagram DPF)**

Approximate length of the nalla is about 2.5 km. All the portion of the Nalla is having loose strata. Nalla is perennial with medium flow of water. Indigenous bio-engg.spp. along the nalla on the upper portion - Berberis spp, Princepia utilis, Spiraea lindleyana, etc.can be seen. Some portion of the nalla about 1000 m length having latitude **N 32^0-16'40", longitude E 076^0-38'20" and height 1965 mtr** is affected by soil erosion along the bank and needs bank stabilization by Bioengineering measures.

Some slides in small patches have been found in lower portions of the nalla which can be treated with engineering measures with vegetative support.

Nayagram Nalla

iv) **Lingti Ghar (Tunda Munda DPF)**

The approx. area of the Ghar is 1.5km. Slides have been found randomly in the Lingti Ghar which can be treated with check walls, Retaining walls & Crate walls with vegetative species like Berberis-spp,Spiraea-lindleyana,Zanthoxacatum,cannabina,Debregeasia etc. Nature of strata of Lingti Ghar was observed very loose when field visit was done by user-agency along with the field staff of forest division.

Lingti Ghar

v) **Chuned Ghar (Chuned DPF)**

The approx. area of the Ghar is 1km. Slides have been found in maximum portions of the Chuned Ghar which can be treated with check walls, Retaining walls & Crate walls with vegetative species like Berberis spp ,Spiraea lindleyana,Willow,Zanthoxylum acatum, Debregeasia hypoleuca Daphne cannabina, etc.

Chuned Ghar

vi) **Gharoh Nalla (Nawai RF)**

Approximate length of the nalla is about 6.0 km. The lower portion of nalla is totally stabilized with rocky base, good vegetation, having sparse bushes. Nalla is perennial with medium flow of water. Trees along the nalla on the upper portion are Kail,Ban etc. Some portion of the nalla about 3000 m length having **latitude N 32^0-16'50", longitude E 076^0-36'40" and height 2870 mtr** is affected by soil erosion along the bank and needs side stabilization by Bioengineering measures for the protection of the nalla.

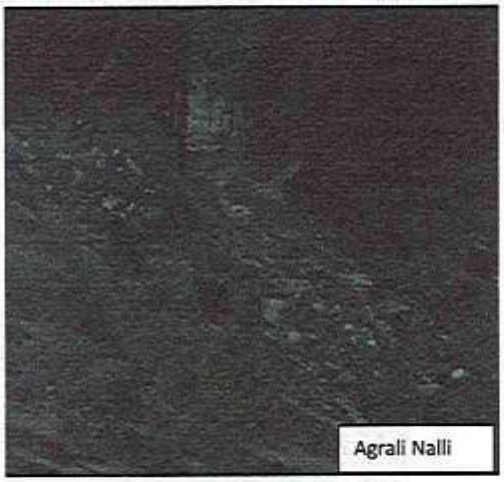
Gharoh Nalla

vii) **Agrali nalli (Agrali DPF)**

Approximate length of the nalli is about 1.0 km. The lower portion of nalli is totally stabilized with rocky base, good vegetation, having sparse bushes. Nalli is seasonable with low flow of water. Trees along the nalla on the upper portion are Kail,Deodar,Ban,F/sp etc.and bushes like Berberis spp, Princepia utilis, Rosa moschata, etc can be seen. Some portion of the nalli about 500 m length **having latitude N 32^0-16'55" and longitude E 076^0-39'15" and height 2420 mtr** is affected by

soil erosion along the bank and needs side stabilization by Bioengineering measures for the protection of the nalla.

Some slides in small patches have been found in both sides of the nalli which can be treated with mechanical engineering measures with vegetative support.



Agrali Nalli

viii) **Agrali Ghar (Agrali DPF):-**

The approx. area of the Ghar is 1.5 Ha. Slides have been found in randomly portions of the Agrali Ghar which can be treated with Engineering & bio – engineering measures.

Agrali Ghar

ix) **Chuned Nalla (Agrali RF)**

Approximate length of the nalla is about 3.0 km. The lower portion of nalla is totally stabilized with rocky base, good vegetation, having sparse bushes. Nalla is seasonable with medium flow of water. Trees along the nalla on the upper portion are Kail, Deodar, Ban, F/sp etc., and bio-engg.spp.like- Berberis spp, Princepia utilis, Rosa moschata, Daphne etc. are found along the nalla.Some portion of the nalla about 2000 m length having **latitude N 32^0-16'20" , longitude E 076^0-39'50" and height 2480 mtr** is affected by soil erosion along the bank and needs side stabilization by Bioengineering measures for the protection of the nalla.


Chuned Nalla

3) **Surehi Beat**

i) **Urna Nalla (Urna DPF):-**

Approximate length of the nalla is about 2.0 km. The lower portion of nalla is totally stabilized with rocky base, good vegetation, having sparse bushes. Nalla is perennial with high flow of water. Trees along the nalla on the upper portion are Kail,Deodar,Ban,F/sp etc. Bushes- Berberis spp, Princepia utilis, Ariesma, Rosa moschata, Daphne etc. Some portion of

the nalla about 1500m length having **latitude N 32^0-16'55", longitude E 076^0-42'10" and height 3350 mtr** is affected by soil erosion along the bank and needs side stabilization by Bioengineering measures for the protection of the nalla.

Urna Nalla

ii) **Pharnate Nalla (Bella DPF):-**

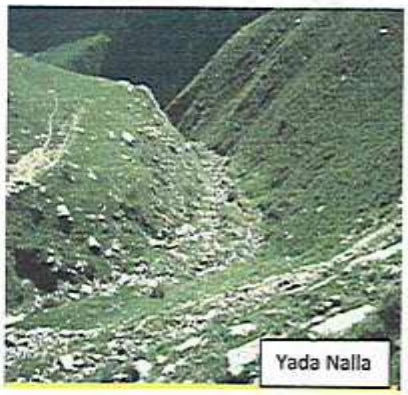
Approximate length of the nalla is about 1.0 km. The lower portion of nalla is totally stabilized with rocky base. Nalla is seasonal with medium flow of water. Trees along the nalla on the upper portion are Kail, F/sp etc. Bushes- Berberis spp, Princepia utilis, Ariesma, Rosa moschata, Daphne etc. Some portion of the nalla about 1000 m length **having latitude N 32^0-19'45" , longitude E 076^0-43'22" and height 3080 mtr** is affected by soil erosion along the bank and needs side stabilization by Bioengineering measures for the protection of the Pharnate nalla.

Slides have been found in both sides of the nalla which can be treated with check walls, check dams & crate check dams with vegetative support.

4) **YADA BEAT**

i) **Yada Nalla (Yada DPF):-**

Approximate length of the nalla is about 1.5 km length. The lower portion of nalla is totally stabilized with rocky base, good vegetation, having sparse bushes. Nalla is seasonal with low flow of water. Trees along the nalla on the upper portion are Kail,Deodar,Ban,F/sp etc. Bushes- Berberis spp, Princepia utilis, Ariesma, Rosa moschata, Daphne etc . Some portion of the nalla about 1000 m length having **latitude N 32^0-15'20",longitude E 076^0- 41'35" and height 3000 mtr** is affected by soil erosion along the bank and needs side stabilization by Bioengineering measures.


Yada Nalla


Yada Nalla

ii) **Jalsu Nalla (Jalsu DPF):-**

Approximate length of the nalla is about 1.0 km length. The lower portion of nalla is totally loose strata, good vegetation, having sparse bushes. Nalla is seasonable with low flow of water. Trees along the nalla on the upper portion are Kail,Deodar,Ban,F/sp etc. Bushes- Berberis spp, Princepia utilis, Ariesma, Rosa moschata, Daphne etc. Some portion of the nalla about 1000 m length having **latitude N 32^0- 13'45",longitude E 076^0- 40'55" and height 3000**

mtr is affected by soil erosion along the bank and needs side stabilization by Bioengineering measures for the protection of the nalla.

Jalsu Nalla

iii) **Churi Ghar**

The approx. area of the Ghar is 4 Ha.

Churi Ghar

iv) **Yada Ghar (Yada DPF) :-**

The approx. area of the Ghar is 2 Ha. Slides were found during the visit for field verification in maximum portions of the Yada Ghar which can be treated as per slope vis-a-via engineering measures with vegetative species.

Yada Ghar

v) **Pandvan Ghar (Pandvan DPF):-**

The approx. area of the Ghar is 2 Ha in Pandvan DPF.Treatments of the nature of engineering & bio-engg.are strictly prescribed for the stabilization of the Pandvan Ghar.

Pandvan Ghar

Different treatment measures shall be taken up from top to bottom in a scientific way and the following measures will be implemented under this head.

a. **Bio-Engineering Measures**

The bio-engineering methods are being developed for controlling the soil erosion in a cost effective manner & provide lasting solution to problem of soil erosion. These are very effective when used in combination with civil structures and reinforced those structures. These are being successfully used where the availability of stones, steels, cement, sand etc at the site is poor. Various biological materials like grass tufts, pine needles and various agricultural waste is being used to stabilize the loose soil on slopes or in gullies. The bio engineering species will be raised and planted every year up to 8 years of plan. Wherever feasible, stress would be on undertaking bio-Engineering measures and detailed site specific plan will be worked out at the time of implementation of the plan.

b. **Soil Conservation Works**

These works will be taken up as erosion control measures in gullies and eroding stream and river training works. This component concentrates on protection works where lasting benefits will be assured in the lower catchment areas. The type of structure will be decided as per site specific physical requirement accompanied by tree planting to stabilize banks and planting for short vegetative cover in the land slide prone areas through brushwood and perennial grasses. The following measures are suggested to be undertake; depending upon site specific requirements:

- Vegetative structures like fascines, brush-wood check dams, bamboo crib etc.
- Live hedge vegetative spurs along the nalla shall be put up.
- Local species, which are known as good soil binders like Salix, Alnus nitida, Ailanthus, bamboo species etc will be planted.

INFRASTRUCTURE BUILD-UP & FOREST PROTECTION

A total provision of **Rs. 645 lacs** is being made under various heads for Forest Protection measures. The details are as follows:

1. Repair of boundary pillars

Though the boundary pillar registers have been maintained but all of these are required to be updated. The boundary pillars of most of the DPF's have been erected randomly. At places whole rows of boundary pillars can be seen, but at other places the boundary pillars are too distantly placed. Therefore, it is necessary that a plan be prepared for construction of large and intermediate BP's in all forests. All the BP's along the cultivations shall be taken due care of and should be constructed of used Railway graders with GPS reading. A sum of **Rs.64.00 lacs** is kept under this component as shown in **Annexure-I.**

2. Fire Protection

Where necessary fire preventive & control will be entrusted to village level user groups/SHG's etc. & they would be incentivized by making suitable provision of monetary award for this work. A provision of **Rs 74.34** has been made for the first five years of the project for this activity / purpose as shown in **Annexure-I..**

3. Infrastructure Development

a). Buildings

Various types of buildings have been constructed in the recent past; however, there is still necessity of some more inspection huts and living quarters for field staff. Most of the field staff huts have miserably damaged and needs to be replaced. These are required to be reconstructed. The existing forest rest houses are very poorly furnished. An amount of Rs. **179.50 lacs** has been kept for new buildings and maintenance/furnishing of existing buildings. APO shall be prepared and got approved before taking up activity under this head. Project level committee shall prioritize and make final selection. List is enclosed as **Annexure-J**

b). Roads, Paths and Bridges

No jeepable road would be constructed in the catchment area; otherwise this would lead to increased siltation. Only bridle paths, inspection paths and footbridges shall be constructed/maintained for which an amount of Rs. **91.15 lacs** has been kept. No major roads will be constructed in the scheme. The details of paths and bridges to be constructed / maintained under each watershed is as per **Annexure- J.**

Fuel Wood for Project Labour and Administrative Staff- Project Authority's responsibility.

Administrative staff with a proposed strength of about 150 will be adequately paid and will be expected to purchase kerosene and cooking gas which is readily available from existing outlets at Bharmour.

During the construction of the project, it is estimated that a peak labour force of 1450 will be employed but it will be gradually increased and after attaining the peak force, it will be gradually decreased towards the completion of the project. During the 60 months of planned period of construction, the labour force will be increased / decreased as under:

Period	Labour Force
1 Year	1300
II Year	1450
III Year	1450
IV Year	1000
V Year	950

It would be the responsibility of the project authorities to provide for the requirements of their labour force & administrative staff.

OPERATIONAL SUPPORT

For an efficient management of forest resources, it is essential that operational support to the Forest Department is adequately developed. Similarly, in remote localities of the division there are no places for shelter for the staff, people and trekkers. Therefore, following provisions have been made under the CAT Plan. A budget provision of **Rs. 117 lacs** has been kept. Component of proposals are given as below:

Sr. No.	Description	Amount (Rs. in Lacs)
1.	Field Vehicle / Inspection vehicles.	41
2.	Computers with Printer and Fax machine, Photocopy Machine, Scanner etc.	18
3.	GPS, Differential GPS	06
4.	Misc. Office Furniture Almirahs, File Racks etc.	05
5.	Fire Equipments	02
6.	Binoculars, Digital Camera, Forest Book	05
7.	R&M of vehicles and machinery for 5 years @ Rs. 8.00 lacs per year.	40
	TOTAL	**117.0**

ENERGY SAVING DEVICES

In order to address the monitoring problem of energy scarcity and its immediate adverse fall out on the forests, the local people have to be provided energy-efficient alternatives. Under the CAT Plan, provision is being made for distribution of energy-saving devices to the BPL families & weaker section **on a cost-sharing pattern.** Under this component, LPG connections, Pressure Cookers, Fuel-efficient Tandoors etc. would be made available to the catchment dwellers, to reduce the pressure on the adjoining forests & to inculcate a culture of energy efficiency & environmental friendly approaches.

The total provision of **Rs. 50 lacs** is being made for the purpose.

SILT OBSERVATION POST

Two nos. silt observation locations for regular monitoring of silt load coming in tributaries of sub-watersheds falling under high and very high categories have been suggested. This would ensure monitoring efficacy of implementation various treatments measures suggested as in CAT plan. Monitoring would be undertaken for a period of 05 years including cost towards this should be kept in project estimates and could be taken as below:

Cost of Two laboratories – Rs10,00,000/- for silt analysis per laboratory = Rs. 20.0 lacs

One hut at each site (@ Rs5,00,000/-) = Rs. 10.0 lacs

Cost for hiring services of persons (@ one person at each site) (Average salary- Rs 10,000/- for next 05 years) = Rs. 12.0 lacs

Cost for hiring services of supervisor (one person for all the sites) (Average salary Rs. 15,000/- for next 05 years) = Rs. 9.0 lacs

Consumables for the measurement Rs. 2.00 lacs per year for next 05 years = 10.0 lacs

Training and up gradation of Data Collection, Software & Maintenance of Automatic Silt Observatory is Rs. 8.0 lacs. Lump-sum for 5 years is kept as corpus fund.

Total cost = Rs. 69.0 lacs

GENERAL AWARENESS / PUBLICITY

Mass awareness and education programme in the project area villages is a must to reduce anthropogenic pressure. Education and awareness generation programmes for garnering public support for biodiversity conservation is the need of the day. Community education and involvement is a crucial component of a biodiversity conservation strategy because the condition of the environment is reflected by the manner in which the communities treat and manage the natural resources.

Under this programme, various activities viz. trainings, publishing of research documents, pamphlets, brochures, hoardings, etc. shall be carried out during the implementation period of CAT plan. Awareness should be imparted to the school teachers in the area for introduction of environment education among the school children and exchange of knowledge on environment and ecology between the monastic and village school. The basic purpose of this is to create awareness among young generation and also among the local villagers so as to protect the wildlife for future generation.

Biodiversity education and community awareness will therefore be strengthened in a variety of ways to reach people of all sections. Activities like opening of biodiversity register in every village and promotion of traditional farming, advertisement of hazardous effect of fire through press, sign boards and public meetings will form the important activities under this component. A provision of **Rs. 66 lacs** has been kept for the purpose for the total period of Implementation of the CAT plan. A lump-sum provision of Rs. 6 lacs per years against Biodiversity education, Community awareness, Sign boards & Public meeting is kept under the provision of General Awareness & Publicity.

TRAINING OF FOREST OFFICERS / OFFICIALS AND COMMUNITY

The specialized training and study tours for forest officials / officers, who are executing the plan, will be provided. The objective of this training component would be to provide the officers and the staff to augment their skills, professional knowledge, capacity building to be effective and efficient. The basic components of capacity building includes:

- Developing human resources through training and education.
- Generate new information for better knowledge and understanding.
- Providing an adequate institutional framework and material support to enable acquired skills to be fully utilized.

Training for staff will be organized at the Forest Training Institutes of HP Forest Department, where services of resource persons from specialized institutions / organizations in the field of Soil & Water Conservation, Information Technology, Environment, Socio-economic issues etc. would be utilized for imparting practical training to the forest field staff & also communities.

The provision for outlay of **Rs. 89 lacs** has been allocated under the scheme.

PARTICIPATORY ACTION RESEARCH FOR MINIMIZING NEGATIVE IMPACT OF TRANSHUMANCE

Chamba district is characterized by presence of transhumant groups viz-Gaddis & Gujjars, due to the presence of high altitude pastures. These groups follow a routine of moving from place to place with the change of season, in a customary usage pattern, with their flocks. Regulations on grazing lands, size of flocks permitted to graze in defined pastures, grazing rights, etc are some of the problem frequently encountered in the area, relating to migratory grazers. For in-depth understating of the real issues involved, Participatory Action Research is an effective tool and could provide workable solutions to the problem. Under the CAT Plan, provision of **Rs. 60 lacs** is being made for undertaking Participatory Action Research (PAR) for minimizing the negative impact of Transhumance in the catchment and then implementing the good practices emerging out of this PAR.

PAYMENT FOR ENVIORM`ENTAL SERVICES INCLUDING ECO-TOURISM

DEVELOPMENT OF BARABANCHHO VALLEY AS ECO-TOURISM

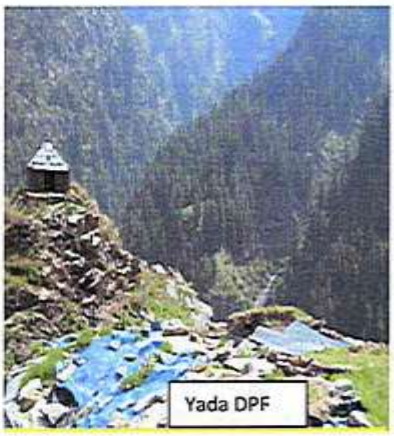
Introduction

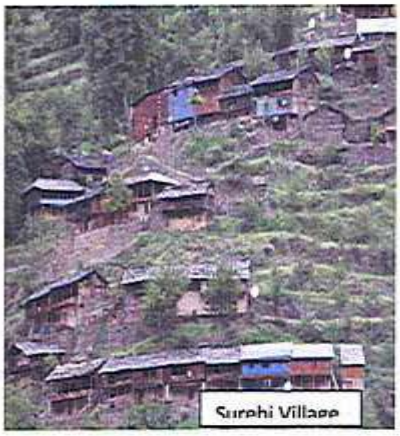
Ecotourism has come to be regarded as a type of responsible tourism where tourists, as individuals or in small groups, venture into lesser known destinations to enjoy the nature in its pristine form along with gaining understanding of local cultures and customs in such a way as to cause minimum impact on the nature and the local culture. Since ecotourism entails understanding of local culture, it involves local communities living in their usual lifestyles and provides them a livelihood option. Subscription to ecotourism does not envisage large scale investments on the part of local communities and it remains a low cost low impact operation. As ecotourism is essentially based on Nature and managed by the local communities, it provides an incentive to the local communities to protect and sustainably manage the landscape.

Himachal Pradesh, a paradise of scenic beauty with very hospitable local communities, forms an ideal ecotourism destination. As the word is spreading, more and more eco-tourists are thronging the State to enjoy Himalayan landscape and the variety of local cuisine and folk dances. The Government of Himachal Pradesh, realizing the potential of ecotourism in the State, has already enunciated a Policy on Development of Eco-tourism in Himachal Pradesh (2005), wherein blueprint for development of ecotourism in the State has been provided.

Ecotourism Potential in Barabanchho Valley

Barabanchho valley, lying in the lap of Pir Panjal mountain range, has an excellent potential from ecotourism point of view. The seemingly narrow valley at the point of entry suddenly opens up beyond the confluence of Ravi River and Channi,Jalsu Nalla to offer a panoramic view of the vast tracts of lush green Oak and Conifer forests and snow clad alpine slopes. One also stands a good chance of sightings of rare temperate Himalayan wild animals in this valley.


Yada DPF


Surehi Village


Dhardi village

For the trekkers, the area offers challenging treks over high altitude passes to mystic Barabanchho Valley. Yada jot & Jalsu jot,on the way to District Kangra has many eco-spots & other pilgrims areas along with the majestic beauty of nature,can be developed as best eco-tourist site to enhance the eco-tourisum potentialty of the catchment area for e.g Surehi village, Channi Nalla, Yada village, Jalsu,Garonda,Dhardi village,Khannar,Phled Nalla,Thaneter village etc.

The valley located in the interior Chamba district, still has many a remote villages that are not connected with road or other means of communication. As such the people have only limited livelihood options. The major vocation being farming and livestock rearing.

The general lifestyle of the local people still remains traditional, that suits the needs of ecotourism. The houses are still constructed in the typical pahari style. The cuisine

remains traditional and the people enjoy their folk dances. Promotion of ecotourism in this area would provide the local communities with an additional livelihood option as hosts, guides, porters, cooks, etc., besides strengthening their bond with Nature.

Strategy for Developing Ecotourism in Barabanchho Valley

In the first two years of the project a study would be conducted to access the Eco tourism potential & requirements of the area & to suggest a modus operandi for operational zing Eco-tourism.

The study on Eco-tourism would form part of the study being proposed under the PES component, though the implementation of the Action Plan on Eco-Tourism, emerging out of the PES study.

Provision for Specific Study on Catchment Area:-

The provision for Conducting Specific study on Catchments to identify proposals and activities to be taken comes under PES in the early years and then keeping provision for implementation of these identify activities in the later years of the annual phasing of activities after approval by the HPFD.

PAYMENT FOR ENVIRONMENTAL SERVICES

Payments for Environmental Services (PES) is a tool to incentivize the local communities for sustainable and environmentally friendly use of the Catchment. The PES mechanisms suitable for the Bajoli-Holi HEP 180MW Catchment area would be identified by conducting a study on the issue, to identify the most appropriate routes and activities under PES. This study should be carried out in the first two years of the Project and shall be approved by the Forest Department, before implementation. Hence, a small part of the PES funds are being allocated in the early years of the implementation of the CAT Plan for getting this study conducted.

The actual implementation of the PES mechanisms, so identified by the approved study, shall begin from the 5th year of implementation of the CAT Plan. The interventions under the Eco-tourism head would also be defined through the PES study; though provisions for its implementation have been made separately under Eco-tourism head.

A total provision of **Rs. 425.8 lacs** has been earmarked of PES & Eco-Tourisum.

No.
Himachal Pradesh Forest Department
Wildlife Wing
Dated, Shimla 28th Feb., 2012 -171001

From: Principal CCF (WL)-cum-
Chief Wildlife Warden, HP Shimla-1

To: Add.PCCF(CAT&ES)
O/o PCCF (T), HP, Shimla-1

Subject: Vetting of Wildlife Chapter of CAT Plan for GMR Bajoli HEP (180MW)

Memo,

This has reference to GMR Bajoli Holi Hydro Power Pvt. Ltd. letter no. GMR/Hydro/01/11/37 dated 29- 11-2011 on the subject cited above.

As requested by GMR Bajoli Holi Hydro Power Pvt. Ltd in their letter under reference, the Wildlife Chapter is vetted/approved and copy thereof is enclosed for including in the final CAT Plan document of this HEP.

Enclosed: As Above.

Principal CCF (WL)-cum-
Chief Wildlife Warden, HP Shimla-1

Endst. No. 6919 **Dated:** 29-02-2012

Copy alongwith enclosures is forwarded to the Manager, GMR Bajoli Holi Hydro Power Pvt. Ltd for information and necessary action please. This is with reference to his letter dated 29th November, 2012.

Enclosed: As Above.

Principal CCF (WL)-cum-
Chief Wildlife Warden, HP Shimla-1

Vetted/Approved by CWLW

Improvements and Development of Wildlife & Wildlife habitat

Background

Himachal Pradesh is a north-western Himalayan state which provides spectacular and magnificent diversity of wildlife and it is an integral part of Himachal's culture and landscape. Bio-geographically Himachal Pradesh can be divided into three distinct regions, the trans- Himalayas, the greater Himalayas (high and middle mountains) and the semi-arid zone. These three zones include varying altitudinal forests, which harbour several rare and threatened faunal species. Prominent species found in Himachal are Snow Leopard, Brown Bear, Himalayan Black Bear, Himalayan Ibex, Himalayan Tahr, Serow, Musk deer, Western Tragopan, Monal, Cheer pheasant etc. Numerous terrestrial and wetland habitat birds, Insects and butterflies, reptiles and fishes etc are found in this state.

In Himachal Pradesh, there are 35 existing Protected Areas (2 National Parks and 33 Wildlife Sanctuaries) and these areas are the keystone for biodiversity conservation.

The Bajoli area does not form part of the Protected Area Network in the State as no Wildlife Sanctuary, National Park or Conservation Reserve is located within or adjoining to this area.

Introduction

The Barabanchho valley, located in the Pir Panjal range forming boundary between Holi sub-division and Barabanchho Block with altitude varying from 1716m above msl near power house to ± 2800m above msl. The wide altitudinal range in the valley supports vegetation varying from sub-tropical to alpine type and is believed to form good habitat for a number of typically temperate animal species so characteristic to this biotic province.

No systematic survey in respect of the fauna of the area has ever been carried out and as such no check-list of the fauna of the area is available. During the process of preparing this CAT Plan, a rapid survey of the project area was, therefore, carried out to record the presence of wild animal species. Some of the mammal species recorded during the survey based on direct sightings are: *Hylopetospetaurista* (Flying Fox), *Mustelasibirica* (Himalayan Weasel), *Rhesus macaque* (Monkey), *Vulpes vulpes* (Indian Red Fox), *Semnopithecus entellus* (Langur), Bats, *Moshomourus* (Hill Mouse), Himalayan yellow throated Marten and Jackals. However, indirect evidences and secondary information gathered during the survey suggest the presence of Common Leopard, Himalayan Black Bear, Indian Wild Boar, Common Langur, Leopard Cat, Porcupine, Barking Deer and Goral amongst other common mammals; and possibility of the presence of Musk Deer and Himalayan Brown Bear amongst mammal species of conservation concern towards higher reaches.

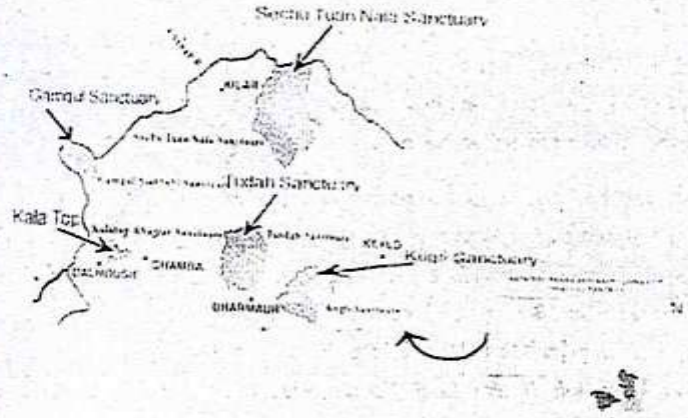
As far as birds are concerned, a total of about 50 species of birds were recorded during the survey from the project area. Some of the common bird species recorded during the survey are: House Crow, Common Myna, Rock Pigeon, Spotted Dove, Slaty Headed Parakeet, Blue Throated Barbet, Brown Fronted Woodpecker, Black Drongo, Yellow billed Blue Magpie, Scarlet Minivet, Himalayan Bulbul, Black Bulbul, Streaked Laughing Thrush, Leaf Warbler, Pied Bush Chat, Green Bee-eater, Great Tit and Eurasian Tree sparrows. In addition, occasional sighting of the Grey Wagtail, Blue Rock Thrush and Alpine Swift were also made. The Plumbeous Water Redstart, Blue Whistling Thrush, and the Brown Dipper formed the group of birds having strong association with riparian areas. Amongst the birds of prey, species like Himalayan Griffon Vulture, Eurasian Hobby and Common Kestrel were frequently encountered. Secondary information gathered from the local people also suggests the presence of the Western Tragopan and the Himalayan Monal pheasant species of conservation concern, towards higher reaches in the valley.

In addition few species of reptiles, amphibians and about 50 species of butterflies were also recorded from the area during the survey. The Barabanchho Valley, in its entirety, is therefore quite rich in its faunal wealth. However, the area of

influence due to the project is limited up to an altitude of 2018m above msl and supports fauna that usually come across at the Himalayan foothills. No endemic species of conservation concern is reportedly found in the area of influence of the project.

The Barrabanchho valley also does not form part of the Protected Area Network in the State as no Wildlife Sanctuary, National Park or Conservation Reserve is located within or adjoining this valley. There is, however, a network of Protected Areas covering similar type of habitats outside the Barrabanchho valley.

The figure below depicts the location of such Protected Areas in Chamba district.



General Concerns about Wildlife Conservation

The Barabanchho valley, especially the area taken up under this CAT Plan, has never been a subject of focused wildlife management being falling outside Protected Area Network. As such specific problems associated with wildlife of the area have also not been documented. This CAT Plan, therefore, provides a unique

opportunity to document the wildlife of the area and initiate programs for management of wildlife habitats with the active participation and involvement of local communities.

The Himalayan region is witnessing a very high and increasing biotic pressure causing degradation and fragmentation of its fragile habitats and putting the survival of many a plant and animal species under threat. Whereas much of this biotic pressure is on account of increased incidence of grazing, both local and migratory, fuel and fodder removals, and extraction of herbs; developmental projects like construction of roads, hydroelectric projects and transmission lines are also significantly contributing to habitat degradation.

Whereas the lower Barabanchho valley has sizeable population of domestic cattle grazing on the lower slopes all the year round, the upper Barabanchho valley supports vast alpine meadows that attract thousands of migratory livestock every year during summers. This domestic livestock provides stiff competition to the wild animals, especially in the already overgrazed alpine meadows. The presence of livestock in the meadows also drives away the shy wild animals from their natural habitats.

The developmental projects also bring in an influx of outside labour that is generally not concerned about the local environmental customs and traditions, causing damage to the local ecology through various acts of omission and commission including removal of biomass from forests and poaching. The wild animals become especially susceptible to poaching during winters when water sources tend to freeze at upper reaches and they descend to lower slopes in search of water and food.

The areas hitherto inaccessible used to provide safe havens to a variety of temperate Himalayan fauna. However, as more and more remote areas are getting connected with road network, even the remote habitats are coming under increased activity, causing threat to the populations of usually shy temperate Himalayan fauna.

A provision of Rs 215.00 lacs has been made for implementation of the Wildlife related activity as per the draft guidelines of Himachal Pradesh Forest Department and detailed expenditure is placed on abstract of expenses towards wildlife.

Strategies

The following strategies are suggested under wildlife activities for the Bajoli-Holi HEP catchment. **Rs 215.00 lacs** provided for Wildlife activities shall be spent as per the following broad norms tabulated below spread evenly over a period of 10 years.

Table.1

Wildlife Conservation		
S.No.	1. Planning	Percentage
1.1	**Planning Perspective, Approach and Objectives**	2% In first two years
	Landscape/an Eco regional Perspective	
	The Key Issues	
	Planning Approach	
	Objectives	
	Working with the local communities to reduce/mitigate their dependencies on the natural resources.	
1.2	**Assess the strengths and assets of the natural resource dependent community members (with an emphasis on the women of poor households) to establish explicit links between the CAT plan activities and livelihood priorities of these people.**	3% In first two years
1.3	**Facilitate organizing of sustainable community based organizations, user groups of rural poor and women, preferably with strong linkages to the local village councils known as Panchayats. Establish the biodiversity conservation efforts at Panchayat level through the consultative process of micro planning.**	5% In first two years
	Formation of Self Help Groups	
	Preparation of Micro Plan	

	2. Implementation	
2.1	Implementation of developmental or income generation programmes so that they better address the livelihood priorities of the local people and facilitate conservation of the CAT Plan area biodiversity.	50%
	Income generation activities based on micro-planning	
	Street Theatre for WL awareness	
	Energy saving devices	
	Non conventional energy such as solar	
2.2	Help resolve man-animal conflict with emphasis on social and environmental justice especially for farmers	10%
	Compensation for animal damage	
	Chemical Restraint; Traps, Cages	
2.3	WL Habitat Management: Maintain and protect the natural vegetation communities, populations of large ungulates (with emphasis on Himalayan species), carnivores and pheasants; Protection of unique WL habitats such as gorges, burrowing sites of WL, etc.	25%
	3. Training	
3.1	Develop competence based training programmes including Monkeys & Wildlife Trapping for the Forest staff and the local community, gun licence holder, and NGOs,	2%
	4. Research & Monitoring	
4.1	Provide facilities and opportunities in natural areas for purposes of formal and informal education, research and the study and the Long Term Ecological Monitoring (LTEM).	2%
	5. Contingency	
5.1	Contingency, other interventions	1%

Yearwise Budgetory Provision in respect of Wildlife activities to be carried out under GMR Bajoli- Holi CAT Plan (180MW) (Rs. In Lacs)											
S.No.	Activities	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year
1	**Planning**										
1.1	Planning Perspective,Approach and Objectivea. Landscape/an Eco regional Perspective The key issues Planning approach Objectives Working with the local communities to reduce/mitigate their dependencies on the natural resources	2.15	2.15	0	0	0	0	0	0	0	0
1.2	Assess the strengths and assets of the natural resource dependent community member (with an emphasis on the women of poor households) to establish explicit links between the CAT plan activities and livelihood priorities of these people	3.2	3.3	0	0	0	0	0	0	0	0
1.3	Faacilitate organizining of sustainable community based organization ,user group of rural poor and women,preferably with groups of rural and women preferably with strong linkages to the local village councils known as Panchayats. Establish the biodiversity conservation efforts at Panchayat level through the consultative process of micro planning. Formation of Self Help Groups Preparation of Micro Plan	6.25	6.5	0	0	0	0	0	0	0	0
2	**Implementation**										
2.1	Implementation of developmental or income generation programmes so that they better address the livelihood priorities of the local people and facilitate conservation of the CAT Plan area biodiversity Income generation activities based on micro-planning Street Theatre for WL awareness Energy saving devices Non- conventional energy such as solar	10.75	10.75	10.75	10.75	10.75	10.75	10.75	10.75	10.75	10.75
2.2	Help resolve man-animal conflict with emphasis on social and environmental justice especially for farmers Compensation for animal damage chemical Restraint,Traps,Cages	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15
2.3	WL habitat Management: maintain and protect the natural vegetation communities,populations of large ungulates(with emphasis on Himalayan species), carnivores and pheasants;Protection of unique WL habitats such as gorges, burrowing site of WL, etc.	6.37	6.38	6.37	6.38	6.37	6.38	6.37	6.38	6.37	6.38
3	**Training**										
3.1	Develop competence based training programmes including Monkeys & Wildlife Trapping for the Forest staff and the local community,gun licence holder,and NGO	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
4	**Research & Monitoring**										
4.1	Provide facilities and opportunities in natural areas for purposes of formal and informal education, research and the study and the Long term Ecological Monitoring(LTEM)	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
5	Contingency										
5.1	Contingency, other interventions	0.21	0.22	0.21	0.22	0.21	0.22	0.21	0.22	0.21	0.22
	TOTAL	29.94	30.31	19.34	19.36	19.34	19.36	19.34	19.36	19.34	19.36

MONITORING AND EVALUATION

Monitoring and evaluation will be developed as in-built part of the project management. Thus, a process of self-evaluation at specified intervals of time will ensure the field worthiness and efficacy of the CAT Plan. The emphasis would be on Monitoring and impact studies of the works done under the plan. This should ideally be done in the 6th year of the implementation of the CAT Plan, in order to apply the findings / lessons learnt, in the revision / recasting of the CAT Action Plan in the remaining years. It is therefore, proposed that no new works be carried out in the 6th years of the CAT Plan schedule.

A sum of **Rs. 297 lacs** has been provided for monitoring and evaluation. Under this component, independent consultants or third party evaluation will be done to make Base Line Survey, Mid-term Survey and end of project survey/evaluation to find out effectiveness of CAT Plan activities in the catchment area.

Miscellaneous activities

Support for preparing Site specific work plan

The amount of **Rs. 128 lacs** lump- sum has been kept against this activities for span of **11 years.**

5% of Catchment area treatment plan i.e **Rs 215 lacs** has been kept for **Contingencies.**

The Proposed and existing infrastructure of Bajoli-Holi HydroPower Project is annexured at page no.-301 in Annexure-K.

ANNEXURE – A

No.J-12011/86/2007-IA.I
Government of India
Ministry of Environment and Forests

Paryavaran Bhawan,
CGO Complex,
Lodhi Road
New Delhi -110 003

Date; 24th January, 2011

President (Hydro)
GMR Bajoli Holi Hydropower Private Limited,
Old udaan Bhawan
2nd Floor, Terminal 1
I G I airport, palam
New delhi-110037

Subject –Bajoli Holi Hydroelectric Project (180 MW) in Himachal Pradesh – Environment clearance reg.

Sir,

This has reference to your letter No. GMR / Hydro / 501/1248 /10 dated 22-11-2010 and subsequent letters dated 21.12.2010, 05.01.2011, and 12.1.11 on the above mentioned subject.

2. The project envisages construction of a concrete gravity dam of 66.0 m height from foundation level across Ravi river near village Bajoli and surface power house near village Holi in Chamba district for generation of 180 MW electricity. This is run off the river scheme. The length of the HRT is 15.56 km. The length of reservoir is 2.42 km. FRL is 2018.25 m and MDDL is 2012.00 m. Live storage is 0.92 MCM. The total land requirement for the project is 85.70 ha. Out of which 75.23 ha is forest land, 0.90 ha horticultural land and 9.57 ha is private land. In all there are 288 project affected families (PAFs) whose land is likely to be acquired permanently and 2 PAFs who will lose land as well as house. The rehabilitation & resettlement of project affected persons will be implemented as per NRRP, 2007.

3. The above referred proposal was considered by the Expert Appraisal Committee for River Valley & Hydroelectric Projects at its meeting held on 20th & 21st December 2010.

4. The Ministry of Environment and Forests hereby accords environmental clearance as per the provisions of Environmental Impact Assessment Notification, 2006 subject to strict compliance of the terms and conditions as follows:

Part A: Specific Conditions

(i) Catchment Area Treatment Plan as has been proposed should be completed in 5 years. The plan is given below:

Year wise target (physical) for Catchment Area Treatment Plan

Measures	Year I	Year II	Year III	Year IV	Year V	Total
	Physical	Physical	Physical	Physical	Physical	Physical
Biological measures						
Enrichment Plantations	200 ha	200 ha	200 ha	200 ha	67 ha	867 ha
Afforestation	200 ha	200 ha	200 ha	200 ha	49 ha	849 ha
Maintenance of afforestation	400 ha	400 ha	400 ha	400 ha	116 ha	1715 ha
Pasture Development	300 ha	300 ha	300 ha	300 ha	249 ha	1449 ha
Nursery development	10 no.	10 no.	-	-	-	20 no.
Maintenance of Nursery	-	-	-			
Vegetative fencing	5 km	5 km	5 km	5 km	5 km	25.0 km
Watch and ward	-	-	-	-	-	-
Engineering Measures						
Contour Bunding	140 ha	125 ha	125 ha	125 ha	125	640.0 ha
Check Dams	20 no.	20 no.	20 no.	20 no.	20 no.	100 no.

(ii) Prior approval under Forest (Conservation) Act, 1980 for diversion of forest land should be taken. No physical work will be initiated without forest clearance for this project.

(iii) In all there are 288 project affected families (PAFs) whose land is likely to be acquired permanently and 2 PAFs who will lose land as well as house. The rehabilitation & resettlement of project affected persons should be completed before commissioning of the project.

(iv) The following commitments made during the public hearing should be fulfilled:-

a) Appointment of two numbers of MD doctors and one of them shall be lady doctor. Both these doctors are to be on the pay rolls of the company.

b) Training to the 120 Nos of the local youths for the ITI course.
c) Strengthing of the existing Holi-Nayaram road, once the same is handed over to GMR after necessary clearance.

(v) Environmental flow should be 20% of the average lean season flow of 90% dependable year for four consecutive leanest months.

(vi) Biodiversity conservation & management plan as proposed in the EMP should be implemented in totality. From the study area 272 flowering plant species were recorded qwhich include 28 trees, 48 shrubs, 10 climbers and 186 herbs. However listing of bryophytes / teridophytes has not been done. This may be done and submitted within three months.

(vii) Fishery conservation & Management plan as proposed in the EMP should be undertaken in consultation with the Fisheries department, Government of Himachal Pradesh. The up gradation of existing facilities of fish firm at Holi in Chamba district should also be done to meet the demand of fish seeds.

(viii) All the equipments which are likely to generate high noise levels are to be fully mollified (noise reduction measures).

(ix) Consolidation and compilation of the muck should be carried-out in the muck dumping sites and the dumping sites should be above high flood level. The proposed plan envisages generation of total volume of Muck as 21.64 lakh cum(including 40 % swell factor). Out of which about 9.32 lacs cum of muck will be ytilised as construction material for various project components and 12.32 lacs cum of muck will be disposed off at pre designated seven number of disposal sites.

(x) Green belt development is proposed around project areas, reservoir periphery (12.00 ha) road side (13.8 nkm) and other components. The average width of the green belt around reservoir rim will be around 40 m varying from about 15 m at places to 120 m or as physiographic and land features allow. The allocated amount of R.s. 9.28 lakhs for green belt development should strictly be used for the purpose.

(xi) The environment clearance does not necessarily imply that forestry clearance shall be granted to the project and that the proposals for the forestry clearances shall be considered by respective authorities on their merit. The investment made in the project, if any, based on environmental clearance so granted, shall be entirely at the cost and risk of the project proponent

Part-B: General Conditions

(i) Adequate free fuel arrangement should be made for the labour force engaged in the construction work at project cost so that indiscriminate felling of trees is prevented.

(ii) Fuel depot may be opened at the site to provide the fuel (kerosene/wood/LPG). Medical facilities as well as recreational facilities should also be provided to the labourers.

(iii) All the labourers to be engaged for construction works should be thoroughly examined by health personnel and adequately treated before issuing them work permit.

(iv) Restoration of construction area including dumping site of excavated materials should be ensured by leveling, filling up of burrow pits, landscaping etc. The area should be properly treated with suitable plantation.

(v) Financial provision should be made in the total budget of the project for implementation of the above suggested safeguard measures.

(vi) Six monthly monitoring reports should be submitted to the Ministry and its Regional Office, Chandigarh for review.

(vii) Officials from Regional Office MOEF, Chandigarh who would be monitoring the implementation of environmental safeguards should be given full cooperation, facilities and documents / data by the project proponents during their inspection.

5. The responsibility of implementation of environmental safeguards rests fully with the M/s GMR Bajoli Holi Hydro Power Pvt. Ltd. & Government of Himachal Pradesh.

6. The total amount of Rs. 15603.28 Lakhs kept in the budgetary provisions for implementation of environmental management plan should be strictly adhered and not to be diverted for any other purpose.

7. In case of change in the scope of the project, project would require a fresh appraisal.

8. The Ministry reserves the right to add additional safeguard measures subsequently, if found necessary and to take action including revoking of the clearance under the provisions of the Environment (Protection) Act, 1986, to ensure effective implementation of the suggested safeguard measures in a time-bound and satisfactory manner.

9. This clearance letter is valid for a period of 10 years from the date of issue of this letter for commencement of construction work.

11. A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zilla Parishad/ Municipal Corporation, Urban local body and the local NGO, if any, from whom suggestions/ representations, if any, were received while processing the proposal. The clearance letter shall also be put on the website of the Company by the proponent.

12. The proponent should advertise at least in two local newspapers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality concerned informing that the project has been accorded environmental clearance and copies of clearance letter are available with the State Pollution Control Board/Committee and may also be seen at Website of the Ministry of Environment and Forests at http://www.envfor.nic.in.

13. The project proponent shall also submit six monthly reports on the status of compliance of the stipulated EC conditions including results of monitored data (both in hard copies as well as by e-mail) to the respective Regional office of MoEF, the respective Office of CPCB and the SPCB.

Yours faithfully,

(Dr. S. Bhowmik)
Additional Director &
Member Secretary,EAC

Copy to:-

1. Secretary, Ministry of Power, Shram Shakti, Bhawan, Rafi Marg, New Delhi-1.
2. The Adviser (Power), Planning Commission, Yojna Bhawan, New Delhi-1.
3. Principal Secretary (MPP & Power), Government of Himachal Pradesh, Shimla
4. The Secretary, Department of Environment, Government of Himachal Pradesh, Shimla.
5. The Chief Engineer, Project Appraisal Directorate, Central Electricity Authority, Sewa Bhawan, R.K. Puram, New Delhi-110066.
6. The Regional Office, Ministry of Environment & Forests, Chandigarh
7. Member Secretary, Himachal Pradesh State Pollution Control Board, Phase-III, Him Parivesh, New Shimla – 171 009
8. DG (FC), MoEF, New Delhi
9. ADG (WL),MoEF, New Delhi
10. EI- Division, Ministry of Environment & Forests, New Delhi-110003.
11. Guard file.

(Dr. S. Bhowmik)
Additional Director &
Member Secretary of EAC

ANNEXURE - B

भारत सरकार /Government of India
केंद्रीय विद्युत प्राधिकरण/ Central Electricity Authority
कार्यालय सचिव/Office of Secretary
पी एसी निदेशालय/ PAC Directorate
सेवा भवन/Sewa Bhavan
आर.के.पुरम/ R.K. Puram
नई दिल्ली/ New Delhi - 110066

[आई.एस.ओ. : 9001-2008]

No.2/HP/34/CEA/09-PAC/ 690-720 Dated the 30th December, 2011

OFFICE MEMORANDUM

Subject: **Bajoli Holi Hydro Electric Project (3x60=180 MW) in Himachal Pradesh by M/s. GMR Bajoli Holi Hydropower Pvt. Ltd. (GMRBHHPL) at an estimated completed cost of US $ 3.214 Million+ Rs. 1681.82 Crores including IDC of Rs. 412.87 Crores & FC of Rs.7.18 Crores at FE Rate Rs.47.00/US $ - Issue of Concurrence.**

M/s GMR Bajoli Holi Hydropower Pvt. Ltd. (GMRBHHPL)submitted 4 sets of the Detailed Project Report (DPR) of the generation scheme of Bajoli Holi Hydro Electric Project (3x60=180 MW) in Himachal Pradesh on 19.11.2009 and 18 sets on 30.12.2009. Presentation meeting to assess adequacy / completeness of the DPR was held on 22.1.2010 and DPR was taken under examination in CEA / CWC / GSI.

Since a number of projects are at different stages of development in the basin and with a view that levels of this project may not interfere with levels of other projects, M/s GMRBHHPL was requested to obtain confirmation of levels for the project from Govt. of Himachal Pradesh. Govt. of Himachal Pradesh vide letter dated 9.4.2009 had recommended that FRL and TWL of Bajoli Holi HEP be fixed at 2018.25m and 1706.75 m respectively. Govt. of Himachal Pradesh also indicated levels of up stream Bara Bangahal and down stream Kutehr Project.

DPR was returned on 28.6.2010 and the developer was advised to submit revised Power Potential Studies, revised design, drawing, etc. by keeping TWL at 1706.75 m which is same as FRL of down stream Kutehr HEP or above and FRL at 2018.25m as indicated by Govt. of Himachal Pradesh. The Power Potential Studies was submitted on 12.7.2010 and subsequently resubmitted on 11.2.2011 taking into account aquatic release equal to 20% discharge of consecutive 4 lean months of 90% dependable year, as indicated in MoEF environment clearance letter dated 24.1.2011.

214

DPR was submitted vide letters dated 18.11.2009 &-29.12.2009 for concurrence with proposed water conductor system and power house works on left bank of river Ravi, as per consent given by Govt. of Himachal Pradesh vide letter dated 9.4.2009. However, the above consent was withdrawn by Govt. of Himachal Pradesh vide letter dated 9.9.2010 till such time the developer demonstrated that local opposition based on environmental and land consideration have been amicably resolved. Govt. of Himachal Pradesh was requested to convey their decision with regard to placement of the water conductor system and power house works on right or left bank of river. The decision for placing water conductor system and Power House works on left bank was received vide Govt. of Himachal Pradesh letter dated 7.3.2011.

The proposal for establishment of Bajoli Holi Hydro Electric Project (3x60=180 MW) in Chamba District of the State of Himachal Pradesh proposed by M/s. GMRBHHPL was considered in the 312th Meeting of CEA held on 9.9.2011 at Sewa Bhawan, R.K. Puram, New Delhi-110606 based on the Agenda note circulated vide CEA letter No.3/106/312th /2006-PAC/6341-69 dated 8.9.2011 & No. 3/106/312th /2006-PAC/6397-6425 dated 9.9.2011. M/s. GMRBHHPL after tying-up/compliance of various pending issues of CEA/CWC/GSI submitted the Final / Updated DPR on 16.12.2011.

In exercise of the powers vested with the Authority under Section 8 of the Electricity Act, 2003, the Central Electricity Authority accords Concurrence to the aforesaid scheme at an estimated cost of US $ 3.214 Million+ Rs. 1681.82 Crores including IDC of Rs: 412.87 Crores & FC of Rs.7.18 Crores at FE Rate Rs.47.00/US $ with the following stipulations:-

1. The cost of the scheme shall not exceed the above cost except on account of:-
   - (a) Change in rates of Indian taxes and duties such as custom duty, excise duty, sales tax, works tax & service tax and additional taxes and duties levied, if any, subsequent to issue of this O.M.
   - (b) Change in Indian Law resulting in change in cost.
   - (c) Variation in actual interest rate.

2. Interest During Construction (IDC) & financing charges (FC) shall be as per actuals but not exceeding the amount as indicated at *Annex-I* except for variation in actual interest rate(s) and the pro-rata variation in hard cost, as stated in clause 1. (a), (b) & (c) of this O.M.

3. The abstract of Project Cost approved by CEA, is furnished at *Annex-I, IA and IB*. The summary of tentative Financial Package, as submitted by M/s. GMRBHHPL and considered by CEA and the salient features of the scheme are given in *Annex- II & III* respectively.

4. **This Concurrence is subject to fulfilment of the following conditions:-**

i) The following conditions/circumstances shall not be a re-opener of the Project Cost/ Concurrence:-
   - (a) Non-acquisition of land.
   - (b) Non-finalisation of power purchase agreement.

ii) M/s GMRBHHPL shall incorporate the suggestions/observations of Central Water Commission (CWC) on Hydrology, Design Flood, Diversion Flood,

Sedimentation, Dam Design aspect, Hydel Civil Design aspect, Foundation Engineering & Seismic Design aspect, Inter-State aspect, Central Soil and Material Research Station (CSMRS), and Plant Planning aspects during the detailed design stage as given in *Annex–IV*.

iii) M/s. GMRBHHPL to collect site specific observed short interval runoff data and corresponding short interval rainfall for at least 4 to 5 flood events for updating design flood before construction. The spillway capacity, energy dissipation arrangement, free board and other related parameters shall be checked before taking up construction.

iv) M/s GMRBHHPL shall complete balance explorations/investigations works before detailed design stage as given in *Annex – V – A & V - B* by May 2012 as per the schedule given in the *Annex-V-B* and the results of the explorations/investigations shall be communicated from time to time for appraisal. M/s. GMRBHHPL shall submit the monthly progress report of balance explorations/investigations to CEA/ CWC/ GSI regularly. Further, suggestions of GSI furnished as comments from time to time shall be followed. Cost for changes required subsequent to investigations shall be absorbed by the company.

v) The site specific seismic parameters to be adopted for design should be got approved from the National Committee on Seismic Design Parameters.

vi) Govt. of H.P. have confirmed FRL and TWL of Bajoli Holi HEP as 2018.25 m and 1706.75 m respectively vide their letter No. MPP-F(2)-14/2007 dated 9.4.2009 *(Annex-VI)*. As such, responsibility of correctness of levels of Bajoli Holi HEP lies with the Govt. of H.P. and M/s GMRBHHPL.

vii) M/s GMRBHHPL shall carry out physical / numerical model studies during detailed design stage as agreed by Project Authority vide letter dated 11.10.2011.

viii) M/s GMRBHHPL shall carry out Dynamic analysis for normal operating condition with Maximum Credible Earthquake (MCE) before taking up construction.

ix) Central Soil & Material Research Station (CSMRS) has cleared DPR from Soil & Material aspect vide their letter dated 10.1.2011 subject to compliance of certain conditions. M/s GMRBHHPL shall finalize material to be exploited from the potential quarry based on the physical/mechanical property of test results.

x) In case, changes are made in design parameters during construction due to site conditions or otherwise, the same shall be intimated and got concurred from the Authority before M/s GMRBHHPL implements such changes.

xi) M/s. GMRBHHPL shall ensure that current rating of 220 KV busbar and switchyard equipments at Bajoli HEP is adequate for carrying the combined generation of Bajoli Holi and Bara Bangahal HEP.

xii) M/s. GMRBHHPL shall ensure space for accommodating 2 no. 220 KV line bays in GIS Switchyard for terminating lines from Bara Bangahal HEP.

xiii) A provision of Rs 73.08 Crores has been made in the cost estimates of civil works, under the sub-head 'Environment and Ecology' (at July, 2010 PL).

xiv) Under the cost of civil works, total provision under the head "B-Land" has been made as Rs. 72.88 Crores (at July, 2010 PL).

xv) MOEF has accorded environment clearance to project, however, M/s GMRBHHPL shall comply with the terms and conditions stipulated in Environmental clearance issued by MOEF vide their letter No. J-12011/86/2007-IA.I dated 24.1.2011. M/s GMRBHHPL shall obtain Forest clearance and comply with the terms and conditions to be stipulated by MOEF while according forest clearance.

xvi) M/s GMRBHHPL has proposed to avail the potential benefit of the Green House Gas (GHG) abatement by selling carbon credits under the Clean Development Mechanism (CDM). Benefits due to above shall be regulated by the appropriate Regulatory Commission.

xvii) If any impact on wild life is observed, M/s GMRBHHPL shall obtain clearance from National Board of Wild Life.

xviii) As the Schedule Tribe population is getting affected, clearance from Ministry of Social Justice and Empowerment/ Tribal Affairs shall be obtained by M/s GMRBHHPL.

xix) M/s GMRBHHPL shall obtain clearance of the project from security angle from the Ministry of Defence.

xx) M/s GMRBHHPL shall comply with the guidelines for participation of foreign Companies in tendering for work packages of Hydro Electric Projects in sensitive areas, issued by Ministry of Power vide No. 7/1/2002-DO(NHPC) [Vol. II], dated 03.09.2009 appended at ***Annex- VII***.

xxi) M/s GMRBHHPL shall take appropriate action in regard to inter-state aspects as desired by CWC as given in ***Annex-IV***. M/s GMRBHHPL has informed that copies of DPR have been sent by them to Govt. of Punjab and BBMB.

xxii) M/s GMRBHHPL shall take appropriate precautions to avert flooding of power house by appropriately adopting measures listed at ***Annex-VIII***.

xxiii) Fly ash and fly ash based products shall be used in the construction of various works to the extent possible in accordance with MOE&F notification dated 14.09.1999 and its amendment dated 27.08.2003 and 03.11.2009 and further revision/amendment, if any. The construction material surveys shall include the required investigations for use of fly ash and fly ash based products in various works, infrastructure facilities etc. and their feasibility shall be ascertained by M/s GMRBHHPL.

xxiv) The availability and suitability of construction material shall be ensured by the Project Authority during pre-construction stage including carrying out necessary tests and precautions during construction. No increase in cost of civil work on this account shall be allowed.

xxv) M/s GMRBHHPL shall ensure that during detailed design and construction stage erection bay, control room block, generator transformers or any other important project structures shall not rest on backfill soil. No increase in civil cost on this account shall be allowed.

xxvi) M/s GMRBHHPL shall deploy modern tools/software for construction monitoring of the project by establishing IT based monitoring system& linking the same to CEA network.

xxvii) M/s GMRBHHPL shall submit the updated DPR to the State Govt., Appropriate Electricity Regulatory Commission and Central Transmission Utility, BBMB and Govt. of Punjab.

xxviii) Information in respect of tying up essential inputs/statutory clearances, results of investigations/ studies shall be submitted to CEA/CWC/GSI on receipt of same from time to time.

xxix) Concurrence is subject to compliance by M/s GMRBHHPL of various policies/guidelines etc. issued by Govt. of India from time to time

5. Broad technical aspects of the project proposal in the project report have been examined in CEA in consultation with CWC, GSI and other concerned agencies. The scrutiny is based on the data, assessment and certificates presented in the report and information/clarifications received as compliances to the observations on the assumption that the data and information furnished are accurate and have been collected reliably by the project authorities from dependable sources and /or after carrying out detailed surveys and investigations as presented in the report .

6. The cost of the project cleared by the Authority is indicative. The tariff of the project shall be regulated by the Central Electricity Regulatory Commission.

7. Commissioning schedule of generating units (from zero date -1st January, 2012 including 6months for pre construction activity) shall be as follows:

Unit –1: 58 months
Unit –2: 59 months
Unit –3: 60 months

8. Monthly Status Report of compliance of the conditions stipulated under para 4 of this Concurrence letter shall be submitted to Secretary, CEA.

9. Monthly Progress Report of the project shall be submitted to Hydro-Project Monitoring (HPM) Division of CEA. Three (3) copies of the half-yearly reports on both physical progress of the scheme and expenditure actually incurred, duly certified by statutory auditors shall be submitted to the Authority till the Commercial Operation Date of the plant. The project authorities shall give free accessibility to CEA officers and staff to have on the spot assessment of various aspects of the project.

10. Monthly Status of the project from date of Concurrence to Financial Closure shall be furnished to Secretary, CEA as per proforma enclosed at *Annex-IX*.

222

11. In case the time gap between the Concurrence to the scheme by CEA and the actual start of work by M/s. GMRBHHPL is three years or more, a fresh Concurrence of CEA is required to be obtained by M/s. GMRBHHPL before the start of actual work.

12. The Authority reserves the right to revoke this concurrence, if the conditions stipulated in this Office Memorandum are not complied with to the satisfaction of the Authority.

Encls: *Annexes I, IA, IB, II, III, IV, V-A,V-B, VI, VII, VIII, &IX.*

(AMARJEET SINGH)
SECRETARY, CEA

1. Managing Director, GMR Bajoli Holi Hydropower Pvt, Ltd., Old Udaan Bhawan, 2nd Floor, Terminal-1, IGI Domestic Airport, Palam, New Delhi 110037.
2. Secretary, Ministry of Power, Govt. of India, Shram Shakti Bhawan, Rafi Marg, New Delhi –110119.
3. Secretary, Ministry of Environment & Forests, Government of India, Paryavaran Bhawan, CGO Complex, Lodhi Road, New Delhi – 110003.
4. Chairman, Central Electricity Regulatory Commission, 3rd & 4th Floor, Chanderlok Building, 36, Janpath, New Delhi-110001.
5. Chairman, Central Water Commission, Sewa Bhawan, R.K. Puram, New Delhi – 110606.
6. Chairperson, Central Electricity Authority, Sewa Bhawan, R.K. Puram, New Delhi.
7. Chairman, HP Electricity Regulatory Commission, Keonthal Commercial Complex, KHALINI, Shimla.- 171 002.
8. Chairman-cum-Managing Director, Power Grid Corporation of India Limited, Saudamini, Plot No.2, Sector 29, Gurgaon - 122001 (Haryana).
9. Secretary (Department of Power), Government of Himachal Pradesh, Secretariat, Shimla, Himachal Pradesh -171 002.
10. Adviser (Energy), Planning Commission, Yojana Bhawan, New Delhi – 110001
11. Member (D&R), Central Water Commission, Sewa Bhawan, R. K. Puram, New Delhi - 110606.
12. Member (WP&P), Central Water Commission, Sewa Bhawan, R.K. Puram, New Delhi – 110606.

13. Member (Hydro / Planning / Thermal / Grid Operation & Distribution / Economic & Commercial / Power System), CEA, Sewa Bhawan, R.K. Puram , New Delhi – 110606.

14. Joint Secretary (Hydro), Ministry of Power, Shram Shakti Bhawan, Rafi Marg, New Delhi-110119.

15. Chief Engineer (HPA/ SP&PA/ F&CA/ TCD/ Legal/ HPM / IRP/ HP&I / HE&TD/ LD&T), CEA, Sewa Bhawan, R.K. Puram, New Delhi – 110606.

16. Chief Engineer (PAO), CWC, Sewa Bhawan (S), R.K. Puram. New Delhi – 110606.

17. Director (LHIM&EPE Division), Geological Survey of India, A-II, Pushpa Bhawan, Madangir Road, New Delhi – 110062.

Annex-I

Bajoli Holi Hydro Electric Project (3x60=180 MW) in Himachal Pradesh by M/s. GMR Bajoli Holi Hydropower Pvt. Ltd. (GMRBHHPL)
(Abstract of Estimated Completed Cost)

1 US $ = Rs.47.00

S.No.	Description	Foreign component		Domestic Component (Rs. Crs.)	Total (Rs. Crs.)
		Million US $	Equv. INR (Rs. Crs.)		
1.	Civil works	-	-	1005.41	1005.41
2.	E&M Works	3.214	15.11	256.36	271.47
3.	Total Hard Cost	3.214	15.11	1261.77	1276.88
4.	IDC	-	-	412.87	412.87
5.	FC	-	-	7.18	7.18
	Total Project Cost	3.214	15.11	1681.82	1696.93

Bajoli Holi H. E. PROJECT (180 MW)			
ABSTRACT OF COST ESTIMATE - CIVIL & H M WORKS			
Sl.No.	DESCRIPTION	P.L. July,2010 (Rs. lakhs)	Completion cost (Rs. CRORES)
DIRECT CHARGES			
I	WORKS		
	A. Preliminary	2332.54	25.86
	B. Land	7288.87	80.44
	C. Works	23874.39	293.77
	J. Power Plant Civil works	32682.12	401.89
	K. Buildings	1448.44	16.25
	M. Plantation	12.75	0.18
	O. Miscellaneous	876.41	9.75
	P. Maintenance during construction	591.23	7.40
	Q. Special T&P	70.75	0.80
	R. Communication	917.55	9.62
	X. Environment,Ecology & Afforestation	7308.35	84.38
	Y. Losses on stock	147.81	1.92
	Total of I - Works	77751.20	932.30
II	ESTABLISHMENT	5637.00	67.20
III	TOOLS & PLANTS	100.00	1.10
IV	RECEIPTS & RECOVERIES	(-)66.69	-0.92
	TOTAL DIRECT CHARGES	83421.50	999.68
INDIRECT CHARGES			
a	Capitalisation of abatement of land revenue.	75.05	0.93
b	Audit & Account Charges	388.75	4.80
	Total Indirect Charges	463.81	5.73
	TOTAL COST OF CIVIL & H M WORKS	83885.31	1005.41
	Say Rs. (in Crore)	838.85	1005.41

230

ANNEX.-E

Percentage Allocation of Total CAT Plan of Bajoli- Holi HEP

(180 MW) is stipulated as under

Sr. No.	Items	Out Lay(In Lacs)
1.	Afforestation measures (25%)	1094.01
2.	Soil & Water Conservation measures (25%)	1065.22
3.	Payment for Environmental services including Eco-Tourism (10%)	425.80
4.	Research, Training & Capacity Build-up (5%)	215.00
5.	Infrastructure build-up & Forest Protection (15%)	645.00
6.	Improvements & Development wildlife & wildlife habitate (5%)	215.00
7.	Monitoring & Evalution (7%)	297.00
8.	Support for Preparing Site Specific plan (3%)	128.00
9.	Contingency (5%)	215.00
TOTAL OUTLAY(In Lacs)		**4300.03**
Rupees Forty Three hundred lacs & Three thousand only.		

Remarks: - With Increase in Project Cost, outlay of CAT Plan will be revised proportionately and review will be done after every Two years.

ANNEX.-F

BAJOLI-HOLI HYDRO ELECTRIC PROJECT (180 MW)

CAT PLAN WORKS-AFFORESTATION SCHEME

Sr. No.	Description	Remarks
1.	Area in Hectare	**694 Ha**
2.	Executing Agency	Forest Department
3.	Legal Status	The afforestation shall be carried out in DPF itself.
4.	Name of Division	Bharmour Forest Division
5.	Name of Range	Trehta Range
6.	Block	Barabanchho,Holi
7.	Beat	Nayagram,Bajol,Yada,Surehi,Deol Beat
8.	Type of works to be carried out in catchments	1.TundaMunda(C-I,II)-71ha, 2.AgraliRF-45Ha 3.Luwain DPF- 15 Ha 4.Agrali DPF:25Ha 5.Kut(C-I)DPF-18Ha 6.Bajol DPF-31Ha 7.Sindi DPF- 25 Ha 8.Dhardi DPF: 25Ha 9.Khanar DPF:20Ha 10. Garonda DPF:15 Ha 11.Gowar DPF: 35Ha 12. Bajoli DPF-20Ha 13.Chaloon DPF: 25Ha 14.Urna DPF: 25Ha 15.Chulan DPF: 30Ha 16.SurehiDPF:21Ha17.Thana DPF:20Ha 18. Yada DPF: 35 Ha 19.Batbaih DPF:21 Ha 1.Kiur DPF:35Ha 2. Deol RF: 10Ha 3.Sengella (C-I,II,III)-60Ha 4.Guwar DPF:17 Ha 5.Bhankhar DPF:15 Ha 6.Andurahi DPF: 35 Ha **Total: 694 Ha.**
9.	Average Elevation	1900 - 2200 m above msl.
10.	Species to be planted	Kail,Deodar,Ban/Broad Leave& Medicinal Plants
11.	Estimated Cost of Afforestation including maintenance.	**Rs. 496.16Lacs**
12.	Number of years for maintenance of afforestation	Five Year

Main Species to be planted are

1. Albizzia procera benth
2. Melia azedarach
3. Goon (Aesculus indica)
4. Piak (Alnus nitida)
5. Ritha (Sapindus mukrossi)
6. Robinia pseudacacia
7. Akhrot (Juglans regia)
8. Grewia oppositifolia (Bihul, Dhaman)
9. Deodar (Cedrus deodara)
10. Banoak (Quercus leucotricophora)/ Green Oak

ALBIZZI PROCERA BENTH

Artificial Propagation

Ripe pods are collected before they dehisce on the tree. These are dried in the sun, beaten and winnowed to get the clean seed which is dried for a few days before storage.

For raising nursery stock, the sowing is done in April-May under irrigated conditions; the seed is put in cooling boiled water and allowed to soak for 24 hours to soften the seed coat. Sowing is done in lines about 8 cm. Apart and the seedlings are spaced about 5 cm. in the lines. About 30 gm seed is sown per square metre of nursery area. The germination of the treated seed commences in about 3-4 days and takes about 2-3 weeks to complete. Weeding and watering of nursery beds are regularly done.

The seedlings raised from April-May sowing attain a height of about 5 cm by July-August when these are planted out in 30 cm pits dug during summer months. Monsoon planting is better than either summer or winter planting. The seedlings taken out from the nursery are planted out either with balls of earth or with naked roots. In the latter case, the lateral roots of the seedlings are pruned and some lower leaves are plucked at the time of planting.

MELIA AZEDARCH

Artificial Propagation

Melia azedarach can be raised either by direct sowing or by planting out nursery raised seedlings or stumps.

Seed Collection and Storage

Fruits are collected during January-February from the trees. They are rubbed and washed to remove the outer pulp. The stones are dried and stored.

Nursery Technique

Sowing is done in nursery beds during February-March in drills 15 cm apart. Keeping the seed in liquid farm yard manure for about a week is reported to improve germination. The seeds are sown about 2 cm deep and about 5 cm apart in the drills. About 1000 gm seed is needed to sow each square metre of the nursery area. The nursery beds are irrigated after sowing and at regular

intervals thereafter till germination are completed. Germination starts in about three week's time and may take about two months to complete. Each fruits may give rise to as many as four seedlings and at places the seedlings will appear in clumps and will have to be subsequently thinned. Regular weeding of the nursery beds is also necessary as the seedling are susceptible to weed competition on completion of germination, the seedlings should be thinned to a spacing of about 10 cm so as to have a spacing of 15 x 10 cms. The seedlings are transplanted in the nursery beds in July when these are about 2-3 months old. They are retained in the nursery for one more year when they are uprooted for planting out.

Planting Technique

The seedlings are planted out either in July or during winter months when these are leafless. For planting out entire plants in July, the seedlings are uprooted from the nursery with balls of earth. Planting is done in 30 cm3 pits dug in advance.

Stumps are prepared from 15 months old seedlings are planted in 30 cm3 pits in the same manner as entire plants.

GOON (Aesclus Indica)

Goon can be raised by direct sowing. Ripe fruit is collected during October-November and sown in patches during December. About 4-6 seeds are sown in a patch. Germination starts in March-April. At the end of one season, only one best frown plant be retained in patch and remaining ones be safely cut. Regular weeding of patches can be done during first year.

PIAK (Alnus Nitida)

Piak can be raised either by direct sowing or by nursery raised seedlings.

Seeds are collected during October-November rubbed and washed to get the seed which is dried in shade. Seed can also be separated by winnowing lightly.

For direct swing, the seed is mixed in fresh cow dung and then the cow dung mixed with seed and diluted with some water is broadcast over the area in thin layers during winter (December-January). This method is useful particularly in case of land slips. The seeds germinate during March-April and plants soon take possession of the ground. For nursery raised plants, the seed is mixed with some soil and sown in nursery beds in lines 22 cm apart. There is no need to further cover the seed by soil since seed is very small. Sowing is done during December. The nursery should be located in planting zone. Germination starts in March-April. Regular watering is done in dried months. Weeding too is necessary when plants become 10-15 cm high, these are spaced out about 10-15 cms. The weaklings are uprooted from lines with care and well grown seedlings are retained at a spacing of 15-20 cms. Plants become plantable when about 8-9 months old. Planting be done preferably in 45 cm pits, naked root.

RITHA (Sapindus Mukrossi)

Ritha can be grown by nursery raised transplants. It is natural to the tract. It can be grown at elevations from 800-1500 m on hot aspects.

Fruits are depulped and seed which is loose inside is taken out. Seed is sown either during August-September or March-April in sunken nursery beds. Nursery should be located in planting zone. Seed is sown at a spacing of 10 x 22 cm and a depth of 2-2.5 cm. regular watering to beds is done but flooding is to be avoided. Germination starts in about two weeks and takes 5 weeks to complete.

Plants sown in August-September are pricked out in December in nursery beds at spacing 15 x 22 cm. Lines being kept 22 cm apart and plant to plant spacing is kept 15 cm. Plants of March-April sowing are pricked out in July-August. Regular watering / weeding to nursery beds is done. Pricking is done in holes made with debblers. The hole should be of sufficient depth to accommodate roots of plants. Plants become fit for planting when about 15 months old. August-September sowing is planted in next winter while March-April is planted in next monsoons. Naked root planting is done. Plant lesser than 30 cm height should be culled out in nursery and should not be planted.

Ritha can also be raised by P. Bags raised plants. For it, the nursery should be located near planting site. The P. Bag method be used for low elevation, planting (800-1200) because the plants are kept in P. Bags for a short duration (3-4 months) and may not attain plantable size (about 20 cm) at higher elevation. For monsoon planting, sowing in P. Bags is done during March-April. Sown P. Bags plants are planted during monsoon rains and planting be completed by end of July. Similarly for winter planting seed is sown in P. Bags during August/Early September sown and plants are planted during winter rains.

ROBINIA PSEUDOACACA

Artificial Propagation

Black locust can be propagated by planting out either nursery raised seedlings or root suckers.

Seed Collection and Storage

The pods are collected from October to December. These are dried in the sun, thrashed and winnowed to obtain clean seed.

Nursery Technique

The seed requires pre-sowing treatment which may consists of immersion in sulphuric acid or dipping in hot water or soaking in cold water. Hot water treatment, which is normally adopted, consists in soaking the seed in cooling boiled water for 2 to 5 minutes and allowed to soak at room temperature for 8 to 10 hours.

Sowing is done in the nursery beds in lines about 20 cm. apart. The spacing between the seeds in the lines is about 5 cm. and depth of sowing is about 1.5 cm. Sowing is normally done in March in irrigated nurseries.

Germination starts in about 7 days and takes about 10 days to complete.

Planting Technique

The plants from March sowings become fit of planting in the following December-January months when they attain height of about 1-2 m.

Planting is done in pits of 30 cm^3 in advance. Spacing adopted is generally 2.5x2.5 m for compact block planting. Space of 2x2 m is adopted for comparatively poorer sites. Bush cutting is done at the time of planting. Naked root plants are planted out. Sometimes root suckers are also used for planting. The tap root is cut and the lateral roots are pruned so as to accommodate the root system of the plants in 30 cm^3 pits. The plants are bundled and the roots wrapped in gunny bags during transport.

AKHROT (Juglans Regia)

Seeds are collected during October-November and sown in nursery beds either during December before snow fall or during March just after snow melting. Spacing is kept 10 cm. between seed to seed and 22 cm. from line to line. Seeds germinate after snow melting and germination completes within a month. Regular watering is done to beds. Weeding too is necessary but care be taken not to disturb the plant. Plants are planted naked root in field during next winter when these are about twenty one months old. In case plants develop long taproot, then the taproot portion is cut to size so as to accommodate it in 45 cm. size pit. Planting should not be done during monsoon rains.

GREWIA OPPOSITIFOLIA (Bihul Dhaman)

Artificial propagation is done by planting out either nursery raised seedlings of stumps.

Seed Collection and Storage

The fruits ripen from October to December depending upon the locality. The flesh of fruits is sweet and as such these are devoured by birds. A substantial quantity of the fruit crop may be eaten away by birds if seed collection is delayed. The fruits are not borne on current year shoots. Trees lopped completely do not, therefore, bear fruits. The trees reserved for seed production should either not be lopped at all or should be lopped only partially.

The fruits are rubbed and washed in water to remove the flesh. Each fruit contains 2-4 seeds. The seeds have hard testa and store well for at least a year without any appreciable drop in vitality.

Nursery Technique

Sowing in the nursery is done in March. Pre-sowing seed treatment is necessary to hasten and improve germination as the seed testa is hard. The seed is sown in 2 cm. deep in lines 15 cm. apart. About 250 g. Seed is required to sow each square metre of nursery area. The nursery beds are irrigated after sowing and regularly thereafter till germination is over. Germination starts in about 10 days and takes about a month to complete. Regular weeding is also necessary. At the time of weeding, the seedlings are spaced about 10cm. apart in lines. The seedlings grow fairly fast and attain plant able size by July. For stump planting, seedlings of 15 months age are normally used.

Planting Technique

Planting is done in July. Late planting usually results in poor survival. The seedlings are uprooted from the nursery with balls of earth and wrapped in moist gunny bags. Planting is done in pits of 30 cm^3 dug during summers or with the beginning of rainy season.

DEODAR (Cedrus Deodara)

Preparation of Nursery

The nursery should be located in low elevation in deodar zone. Natural blanks, frost holes, badly drained pockets and exposed ridges should be avoided. Soil should be deep fertile and well drained. Loamy soil be preferred. Regular water supply is very essential particularly in drier months. It is estimated that for 1000, plants about 40m^2 nursery area is required.

Seed Collection and Storage
Seed be collected from healthy, middle aged, self pruned trees of good form and quality. It is desirable to select good quantity forests stand to manage them as seed stands. Cones are collected and during October-November and dried in sun. After these have opened, the seed is separated by winnowing. Sufficient quantity of seed be stored in sealed tins in cool/dry place.

Sowing in Nursery
Sowing is done in raised nursery beds before first snowfall in November-December. Seedlings should be sown in line 10 cm. apart. Germination will take place in March-April when snow melts. Beds may be watered in May-June, if dry weather prevails. Weeding in nursery but care be taken not to disturb the roots of seedlings.

Transplanting
During July when seedlings are about 4 months old, these are transplanted in nursery at a spacing of 15x22 cms. In raised beds. Lines being 22 cm. apart and plants in lines 15 cm. apart. For transplanting, holes be made with dibblers. Regular weeding is necessary. Light watering is done in drier months. The plants are to remain in nursery till 2 years after transplanting.

Planting
Pits should be dug in March-April after slash clearance in the area is over so as to allow sufficient time for weathering of the soil and to complete the planting work in time when the rains set in. Pits should be 30 cms deep and 30 cms in diameter at the escapement of 2.5m x 2.5m approximately. Planting shall be done with the onset of rains and should be completed by the first week of August at the latest. Plants should be culled from the nursery beds with great care and this work should not be left to the labourers. In case the plants are to be carried for long distances they should be wrapped in moist gunny bags. While carrying out these operations, it is absolutely necessary to ensure that the root system does not get damaged even in the least. Grading of nursery stock is absolutely essential and all unhealthy or weakly growing stock is required to be discarded. While planting out special care is required to avoid the curling of the top of the seedlings root.

BANOAK (Quercus Incana)
Propagation and Protection
The ban is best propagated by direct sowing in situ in March under cover. The growth of young seedlings is exceedingly slow under natural conditions. Working of the soil, weeding and watering assist their establishment and accelerate their growth. Coppice shoots can be depended upon from trees only up to three feet in girth. As the Ban is of low economic importance, the nursery technique is seldom resorted to. Dry, hot, southern slopes should be avoided for raising Ban plantations.
The Ban suffers most at the hands of graziers; its leaves are avidity sought out for leaf fodder. Continuous lopping of oak forests around human habitations in

the tract has led to their deterioration and therefore its growing stock is on decline. The technique adopted for artificial reproduction is as under:-

Seed Collection

Fruit, acorns are collected in November-December while still on trees. Collection is done either by plucking individual acorns which is very costly or by light lopping of the trees bearing good fruit because the fallen seed is immediately attacked by some worm/insects creating holes in the seed which renders it unfit for germination.

Seed Storage

The acorns should be dried in the shade and kept in cool place. Storage of oak acorns is difficult and efforts should be made to sow them immediately after collection.

Afforestation cost/Ha of plantation including maintenance

A) Plantation including Fencing:

S.No	Description	Unit	Rate	Cost(Rs)
1.	Survey & demarcation of plantation & area I/C marking of seditions, path preparation of maps	1Ha	80.80	80.80
2.	Cutting & preparation of wooden fence posts2 mtr & 8 to 10Cm diameter I/C debarking & fashioning the top 15Cms in conical shape	60 No	1036.02 per%	621.61
3.	Carriage of fence posts upto 2mtr long & 8 to 10cm diameter over a distance of 2Kms	60 No	272.20 /%/Km	326.64
4.	Charring & coal tarring of the ends of the fence posts	60No	223.60/%	134.16
5.	Preparation & digging of holes 20-30 cm dia. & 45cm deep	60 No	725.41/%	435.25
6	Fixing of wooden posts I/C strutting	60 No	572.80	343.68
7.	Carriage of B.wire bundles uphill over an average distance of 2Km	0.7Qtl.	65.40./Qtl/Km	91.56
8.	Stretching & fixing of barbed wire with U- stapple in 3 strand	540 Rmt.	3.80	2052.00
9.	Interlacing of thorny bushes with barbed wire obtained from planting site.	180 Rmt.	3.30	594.00
10	Preparation of Live hedge Fencing (Two Rows)	180 Rmt (Each).	10.60/Rmt	3816.00
10.	Preparation of inspection path60cm wide	250 Rmt.	8.70	2175.00
11.	Preparation of water retention mounds/trenches	L/S	L/S	2200.00
12.	Digging of pits(30x30x30) cm	660No	381.86/%	2520.30
13	Digging of pits(45x45x45) cm	440 No	763.53/%	3359.55
14	Filling of pits(30x30x30) cm	660No	152.66/%	1007.58
15	Filling of pits(45x45x45) cm	440 No	218.77/%	962.59
16	Carriage of plants in P.Bags from nursery site over an average distance of 2Km uphill	1100 No	174.46/%/Km	3838.12
17	Planting of plants raised in P. Bags	1100	174.58/%	1920.40
18	Planting of grass tufts/preparation of strips I/C sowing in strips 100x30x5cms for grass sowing	500 strips	735.99/%	3679.98
19	Cost of B. Wire/U- nail	0.70Qtl	7000	4900.00
21	G.Total			35059.22
22	Or Say			35100.00
B) Nursery Cost of Plants		**1100**	**3.80/plant**	**4180.00**

Total (A+B) **39280.00**

Increase in Tribal area with 25% **49100.00**

C) Maintenance:

1st Year Maintenance	6500.00
2nd Year Maintenance	5300.00
3rd Year Maintenance	3920.00
4th Year Maintenance	3530.00
5th Year Maintenance	3180.00
G.Total Maintenance	**22430.00**

ANNEX.-G

BAJOLI-HOLI HYDRO ELECTRIC PROJECT (180 MW)

CAT PLAN WORKS-ENERGY PLANTATION SCHEME

Sr. No.	Description	Remarks
1.	Area in Hectare	240 Ha
2.	Executing Agency	Forest Department
3.	Legal Status	The energy plantation shall be carried out in around habitations in small patches.
4.	Name of Division	Bharmour Forest Division
5.	Name of Range	Trehta Range
6.	Block	Barabanchho
7.	Beat	Bajol,Nayagram,Yada,Surchi Beat
8.	Type of works to be carried out in catchments	1. Guwar DPF-15Ha 2. Bajol DPF-10Ha 3.Dhardi DPF- 12 Ha 4.Garonda DPF- 14 Ha 5. Sindi DPF-10 Ha 6.Surehi Thana DPF-12Ha 7. Urna DPF-14 Ha 8. Chaloon DPF- 15 Ha 9.Deoti DPF- 12 Ha 10. Surchi DPF-11Ha 11.Kut DPF-15 Ha 12.Nawai RF-07 Ha 13. Tunda Munda DPF-07 Ha 14.Pani Nalli DPF-12 Ha 15.Thaneter DPF-08 Ha 16.Agrali DPF-13 ha 17. Yada DPF- 14 ha 18.Baitbaih DPF-12 Ha 19.Jalsu DPF- 12 Ha 20. Pandvan DPF-15Ha **Total: 240 Ha.**
9.	Average Elevation	1900- 3200 m above msl.
10.	Species to be planted	Broad Leaved Plants (Fuel & Fodders Spices)
11.	Estimated Cost of Energy Plantation including maintenance.	**Rs. 270.3 Lacs**

Energy Plantation cost/Ha of plantation (No Maintenance)

A) Plantation including Fencing:

S.No	Description	Unit	Rate	Cost(Rs)
1.	Survey & demarcation of plantation & area I/C marking of seditions, path preparation of maps	1Ha	80.80	80.80
2.	Layout of pits/patches per Ha	1Ha	81.78	81.78
3.	Cutting & preparation of wooden fence posts2 mtr & 8 to 10Cm diameter I/C debarking & fashioning the top 15Cms in conical shape	60 No	1036.02 per%	621.61
4.	Carriage of fence posts upto 2mtr long & 8 to 10cm diameter over a distance of 2Kms	60 No	272.20 /%/Km	326.64
5.	Charring & coal tarring of the ends of the fence posts	60No	223.60/%	134.16
6.	Preparation & digging of holes 20-30 cm dia. & 45cm deep	60 No	725.41/%	435.25
7	Fixing of wooden posts I/C strutting	60 No	572.80	343.68
8	Carriage of B.wire bundles uphill over an average distance of 2Km	1.17.Qtl.	65.40/Qtl/Km	153.04
9.	Stretching & fixing of barbed wire with U- stapple in 5 strand	900 Rmt.	3.80	3420.00.
10.	Interlacing of thorny bushes with barbed wire obtained from planting site.	180 Rmt.	3.30	594.00
11	Preparation of Live hedge Fencing(Two Rows)	180 Rmt (Each).	10.60/Rmt	3816.00
12.	Digging of pits(30x30x30) cm	5000No	381.86/%	19093.00
13	Carriage of plants in P.Bags from nursery site over an average distance of 2Km uphill	5000 No	174.46/%/Km	17446.00
14	Planting of plants raised in P. Bags	5000 No	174.58/%	8729.00
15	Filling of pits(30x30x30) cm	5000No	152.66/%	7633.00
15	Cost of B. Wire/U- nail	1.17.Qtl	7000	8190.00
17	G.Total			71097.96
18	Or Say			71100.00

B) Nursery Cost of Plants	**5000**	**3.80/plant**	**19000.00**
Total (A+B)			**90100.00**
Add 25% escalation for Tribal area			**112625.00**

Per Hactare Cost of Enrichment planting

A) Plantation with Thorny brushwood guard protection around individual plant:

S.No	Description	Unit	Rate	Cost(Rs)
1.	Digging of pits(45x45x45) cm	800 No	763.53/%	4581.18
2.	Filling of pits(45x45x45) cm	800 No	218.77/%	1312.62
3.	Carriage of plants in P.Bags from nursery site over an average distance of 3Km uphill	800 No	174.46/%/Km	3140.28
4.	Planting of plants raised in P. Bags(Tall plants)	800	174.58/%	1047.48
5.	Thorny brushwood guard protection around individual plant	800	7.00	4200.00
21	Total			14281.56
22	Or Say			14300.00

B) Nursery Cost of Plants	**800**	**3.80/plant**	**3040.00**
Total (A+B)			**17340.00**
Add 25% escalation for Tribal area			**21675.00**

C) Maintenance:

1st Year Maintenance	4400.00
2nd Year Maintenance	2700.00
3rd Year Maintenance	1500.00
4th Year Maintenance	1350.00
5th Year Maintenance	1250.00
G.Total Maintenance	**11200.00**

ANNEX.-H

BAJOLI-HOLI HYDRO ELECTRIC PROJECT (180 MW)

CAT PLAN WORKS-SOIL & WATER CONSERVATION

Sr. No.	Description	Remarks
1.	Executing Agency	Forest Department
2.	Legal Status	The SWC works shall be carried out in DPF itself.
3.	Name of Division	Bharmour Forest Division
4.	Name of Range	Trehta Range
5.	Block	Barabanchho,Holi
6.	Beat	Bajol,Nayagram,Yada,Surehi,Deol Beat
7.	Type of works to be carried out in catchments	1. Providing Wire Crate Work, 2. Stream Bank Protection, 3. Stone Masonary Check Dam, 4. Gully Plugging, 5. Vegetative Dams are being proposed for following nallahs & Ghar in the Catchments: 1.Gohar Nalli 2.Agrali Ghar 3.Khudma Ghar 4. Thaneter Ghar 5.Nayagram Nalla 6.Lingti Ghar 7. Chuned Ghar 8.Gharoh Nalla 9.Agralli Nalli 10.Chuned Nalla 11.Urna Nalla 12.Pharnate Nalla 13.Sundrali Nalla 14.Khor Nalla 15.Yada Nalla 16.Jalsu Nalla 17. Churi Nalla 18.Yada Ghar 19. Pandvan Ghar 20.Sindi Ghar 21.Dhardi nalla 22.Garonda nalla 23. Sindi Nalla 24. Urna ghar 25.Surehi ghar 26.Channi ghar 27.Kalangmadi ghar 28.bhanora nalla 29.Raddi nalla. 30.Deoti nalla.
8.	Average Elevation	1900-3200 m above msl.
9.	Estimated cost of SWC Works.	**1065.22 Lacs**

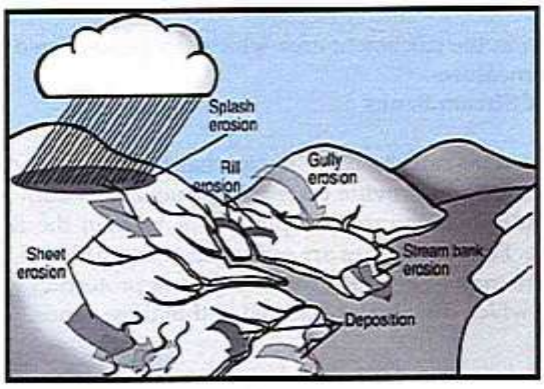
SOIL EROSION

Definitions

The loss of soil by wind and water or gravitational creep is known as erosion. Two categories are commonly recognized. **Normal erosion** - which proceeds at a pace much slower, than the process of soil formation? It is beneficial, as it checks soil senility. **Accelerated erosion** is excess of the normal and is chiefly due to changes in the nature and density of native vegetation by human activities. The process is invariably harmful as it leads to the removal of fertile top soil at the rate greatly exceeding that of soil formation. The discussion that follows is, therefore, mainly concerned with accelerated erosion.

Type of Erosion

The natural agencies chiefly responsible for accelerated erosion are wind and water. Since wind is not responsible for any serious erosion in this part of the land. We are mainly concerned with the latter. Erosion by water involves hydraulic action, abrasion, solution and transportation of soil. The velocity of flow has an important bearing on its erosion power. The following categories are recognized: -



Sheet Erosion

This applied to the removal of a more or less uniform layer of surface soil. The general contour of the land surface remains unaltered and so the insidious effects so unnoticed until most of the top soil have been lost. Sheet erosion is most active on cultivated lands but is unimportant in forests where unincorporated organic matter covers up the soil.

Rill Erosion (fingering or incipient gullying)

This implies the formation of small channels in the land surface. It represents an intermediate stage between sheet and gully erosion. In forest areas, this type of erosion is generally seen along the extraction paths and in fire brunt areas.

Gully Erosion

This refers to the formation of large channels or gullies. This develops in situation where concentrated run off attains sufficient volume and velocity to cut deep into the soil body. Gullies have their origin in rills, side roads, trials, cattle treads of natural depressions. Gullying commonly proceeds by waterfall erosion at its head. If the material is easily eroded, the gullies tend to be deep and narrow but if the substratum is hard, the gullies are shallow with sides gently sloping. As a rule, gullies carry water only during or immediately after the rains.

Stabilization of Land Slips

Relatively weak geological structure of the terrain and its disturbance through road and other on-land construction programme disturb the strata and many a time results in landslips. Left unattended some of these get naturally stabilized whereas others aggravate to such an extent that special efforts are needed to stabilize these.

Landslides seen in the catchment area which can be stabilized with engineering and vegetative measures.

Stabilization of Stream Banks

The stretch of streams causing bank erosion has been identified. In the identified stretch it is necessary to provide crate wire structure on both banks to save the banks and simultaneously provide spurs so as to train the flow of water in a specified course. Forty structures are estimated to be needed along the banks and also spurs. There may be need for some odd bank protection structure or a spur here and there, which can also be adjusted within these funds.

Gullied Area

In totally degraded land, gullies can make up for a large part of the area. The objective of reclaiming these gullies is to prevent further erosion and utilize the land again for protective and productive use. Effective closures and afforestation will promote vegetational growth and retard further growth of gullies. However, to increase sedimentation to fill up the gulley gradually, check dams may have to been constructed where even seasonal water flow is still expected. Typical measures for reclamation of small gullies include brushwood plugs and loose stones. Their function is to reduce the velocity of the flood and 'comb out' the sediments so that gulley is gradually silted up.

Brushwood plugs

At first trenches which should follow the contour is dug 40 to 60 cm deep across the gulley bed and the banks. Seen from above the layer will be more or less V-shaped. The brushwood which must be of sprouting species is placed upright and tightly together on the downstream side of the trench. Afterwards the trench is refilled and tamped.

Loose stone plugs

Smaller gullies of less than one meter in depth can often be stabilized by plugging them with loose stones, which may be simply heaped in the gully. It can be in combination with bushy brushwood which may not even be sprouting species.

Nallas

Large gullies and nallas have to be treated to prevent further deepening and widening. This is done mainly by various types of check dams.

The purpose of check dam is to reduce the gradient and break the velocity of the flow. Through check dams the water is conducted safely from a higher to a lower point without causing erosion at the gulley/nalla bed and banks. The water pools behind the dams promote the percolation of water into the soil. Check dams still serve their purpose even when they are completely silted up by reducing the gradient inside the gulley/nalla. Longer life-span should be aimed in case of check dams to be constructed in nallas. They should be constructed in places where the bed is narrow and the banks are firm. Curves or sites within or just below gulley/nalla junctions must be avoided.

In an ideal case, check dams should be spaced in such a way that the bottom of the upper check dam is in level with the top of the next lower one. In steep area as in the Himalayan region, this is difficult to achieve because too many check dams will be required. If the section between two successive check dams cannot be made level, the gradient should at least not exceed 5 percent for greater success.

The height of the dams influences their spacing. There is the alternative of constructing a few high or many low dams on a certain gradient. High check dams have to resist a greater pressure than the low ones and, therefore, are more liable to damages. While concrete or masonry dams can be built to any height, dry stone or brushwood dams should be low.

Check dams must be well anchored in the ground and particularly in the banks to prevent under-scouring and scouring between the dame and the banks. The flow is directed through a water spill or notch in the center of the dam. Below the dam where the water hits the bed, a protective apron must be constructed. For additional strength the check dam is filled up to the notch with soil on the upstream side.

Types of check dams are distinguished according to the material used.

Dry Masonry Check Dam

These are generally constructed in upper reaches of eroding nalas to reduce the bed slope, stabilize the grade and check the bed scouring and retain silt, sand and pebbles.

Depending upon the size of the dam depth of foundations may vary from 30cm to 60cm. Foundation should be dug across the nalla width extending well into the banks. The soil is piled up-stream to be used later for the refill. The largest stones are placed in the bottom layers. Larger check dams with steps in front are stronger, safer and more useful. In every layer of stones a step of 15 to 20 cm is left on the downstream side, so that width is reduced from base to top. The advantage is that the flow is gradually conducted down to the apron. Two wing walls with appropriate foundation are often constructed at the upper side to force the flow into the water spill or notch and prevent it from damaging the banks. The wing walls should form an angle of about 30° with the banks.

In the center of the "crown" a notch of concave shape is to be provided which must be wide enough to cope with the peak run-off. Generally a length of half the span of the dam and depth of 20 to 30 cm are considered appropriate.

Below the dam an apron has to be constructed with stones. On the up-stream side the dam has to get an earth fill for greater strength. Finally, the structure is supplemented by planting seedlings and cuttings of suitable species along the banks on the upstream side. Alnus & willows, form good species for this purpose. Such check dams are provided in areas closed for afforestation.

In bouldery nallas, with or without some water flow, check dams may be constructed of gabions, masonry with mortar or concrete. Each situation will have to be looked into for the type of dam that needs to be constructed.

Sr. No.	Nallah	Block	Beat	Micro-watershed	Field Crop Wise Work		Vegetative Check Dam		Gully Plugging		Stream Bank Protection		Water Harvesting		TOTAL IN RS
					Qty.(m3)	Amount(Rs) @1400 Rs/m3	Qty.(No)	Amount(Rs) @650 Rs/No.	Qty.(m3)	Amount(Rs) @1200 Rs/m3	Qty.(m3)	Amount(Rs) @1400 Rs/m3	Qty.(No)	Amount(Rs) @2,50,000Rs/ no.	
22	Khol		Surchi	Tm2	285.00	399,000.00	120.00	78,000.00	500.00	600,000.00	225.00	315,000.00	0.00	0.00	1,392,000.00
23	Kud & Sundrali			Tm2j	230.00	322,000.00	160.00	104,000.00	360.00	432,000.00	250.00	350,000.00	0.00	0.00	1,208,000.00
24	Barla Phat			Tm2j	220.00	308,000.00	120.00	78,000.00	440.00	528,000.00	275.00	385,000.00	0.00	0.00	1,299,000.00
25	Surchi			Tk3p	125.00	175,000.00	90.00	58,500.00	80.00	96,000.00	185.00	259,000.00	0.00	0.00	588,500.00
26	Balla			Tm2	350.00	490,000.00	200.00	130,000.00	250.00	300,000.00	225.00	315,000.00	0.00	0.00	1,235,000.00
27	Khidki			Tm2	220.00	308,000.00	200.00	130,000.00	310.00	372,000.00	165.00	231,000.00	0.00	0.00	1,041,000.00
28	Uma			Tm2	300.00	420,000.00	120.00	78,000.00	200.00	240,000.00	125.00	175,000.00	1.00	250,000.00	1,163,000.00
29	Jarulu			Tk3p	120.00	168,000.00	120.00	78,000.00	290.00	348,000.00	200.00	280,000.00	0.00	0.00	874,000.00
30	Deyoti			Tk3n	250.00	350,000.00	120.00	78,000.00	150.00	180,000.00	100.00	140,000.00	0.00	0.00	748,000.00
31	Chulan			Tm2j	320.00	448,000.00	220.00	143,000.00	400.00	480,000.00	185.00	259,000.00	0.00	0.00	1,330,000.00
32	Pani		Nayagram	Tk3	100.00	140,000.00	150.00	97,500.00	70.00	84,000.00	105.00	147,000.00	0.00	0.00	468,500.00
33	Kurehed			Tk3	125.00	175,000.00	150.00	97,500.00	200.00	240,000.00	120.00	168,000.00	0.00	0.00	680,500.00
34	Baggi			Tk3k	200.00	280,000.00	120.00	78,000.00	350.00	420,000.00	100.00	140,000.00	0.00	0.00	918,000.00
35	Nayagram			Tk3k	150.00	210,000.00	120.00	78,000.00	230.00	276,000.00	110.00	154,000.00	0.00	0.00	718,000.00
36	Gadoh			Tk3	100.00	140,000.00	160.00	104,000.00	200.00	240,000.00	100.00	140,000.00	0.00	0.00	624,000.00
37	Agruli & nawai			Tk3	150.00	210,000.00	100.00	65,000.00	330.00	396,000.00	100.00	140,000.00	0.00	0.00	811,000.00
			TOTAL		8175		9040		12290		7400		1		42,679,000.00

Micro-watershed	SYI	Priority
Tm2	1237	High
Tm2d	1204	High
Tm2g	1254	High
Tm2j	1248	High
Tk3m	1225	High
Tk3	1181	Medium
Tk3k	1127	Medium
Tk3p	1198	Medium
Tk3n	1165	Medium

SOIL AND WATER CONSERVATION WORKS PROPOSED UNDER Bajoli-Holi (HEP 180 MW) CAT PLAN

Sr. No.	Nallah	Block	Micro-watershed	Beat	Stone Masonary Check Dam	
					Qty(m3)	Amount(Rs) @1200 Rs/m3
1	Dhardi	Barabanchho	Tm2d	Bajol	600.00	720,000.00
2	Garonda		Tm2d		440.00	528,000.00
3	Sindi		Tm2d		490.00	588,000.00
4	Guwar		Tm2g		440.00	528,000.00
5	Chadnu		Tm2g		390.00	468,000.00
6	Khabbar		Tm2g		400.00	480,000.00
7	Gour		Tn2d		490.00	588,000.00
8	Tilla		Tm2g		540.00	648,000.00
9	Bhanora		Tk3m	Yada	540.00	648,000.00
10	Rddi		Tk3k		240.00	288,000.00
11	Tapa		Tk3m		600.00	720,000.00
12	Batbahi		Tk3m		540.00	648,000.00
13	Magru		Tk3m		490.00	588,000.00
14	Biyadi		Tk3k		350.00	420,000.00
15	Pandpan		Tk3m		740.00	888,000.00
16	Khudma		Tk3m		690.00	828,000.00
17	Chanser		Tk3m		680.00	816,000.00
18	Chodi		Tk3k		400.00	480,000.00
19	Jalsu		Tk3m		700.00	840,000.00
20	Mohan		Tk3m		780.00	936,000.00
21	Jot		Tk3k		440.00	528,000.00

22	Khol		Tm2	Surehi	500.00	600,000.00
23	Kud & Sundrali		Tm2j		650.00	780,000.00
24	Barla Phat		Tm2j		440.00	528,000.00
25	Surehi		Tk3p		190.00	228,000.00
26	Balla		Tm2		590.00	708,000.00
27	Khidki		Tm2		550.00	660,000.00
28	Urna		Tm2		440.00	528,000.00
29	Jaralu		Tk3p		340.00	408,000.00
30	Deyoti		Tk3n		340.00	408,000.00
31	Chulan		Tm2j		540.00	648,000.00
32	Pani		Tk3	Nayagram	340.00	408,000.00
33	Kurehed		Tk3		400.00	480,000.00
34	Baggi		Tk3k		440.00	528,000.00
35	Nayagram		Tk3k		250.00	300,000.00
36	Gadoh		Tk3		325.00	390,000.00
37	Agrali & nawai		Tk3		310.00	372,000.00
				TOTAL	**17625**	**21,150,000.00**

BIOENGINEERING MEASURES

CONCEPT, APPROACH AND PRACTICABLE TECHNIQUES OF BIOENGINEERING

1 Concept of Bioengineering

Wood and living plants were the only materials for hill and slope stabilization works for hundreds of years. These days some of the old techniques have been modified and applied, which mainly use live material such as willow branches, willow cuttings, and rooted deciduous trees. The duration for implementing vegetation for slope stabilization works depend on the technique of soil bioengineering measure and the type of the plant that has been used. The techniques used in soil bioengineering are traditional and have been used since very long time ago.

Bioengineering is a sustainable approach where the combination of live and dead plants and plant parts are used as building materials for erosion reduction and upland slope prevention. This is based on engineering concept. The combination of vegetative engineering systems and civil engineering systems normally offers the most complete natural and cost effective solution to the variety of instability problems affecting a site

The overall objective is to provide better living conditions to the population by the provision of environment sound and improved sustainable mountain system so as to make a rapid economic growth in tune with economic growth of the country. Specifically bioengineering is adapted with a view to

i) examine soil bioengineering needs of project,
ii) monitor existing slope stabilization works.
iii) study plant species compositions and plant species which can be used for future soil bioengineering purpose.
iv) survey a plan of soil bioengineering activities.
v) test plant species in combination with different soil-bioengineering techniques for its suitability in winter plantations.
vi) stabilize the unstable slopes through a suitable application of vegetation in different soil-bioengineering methods, either alone or in combination with civil engineering structures.
vii) use indigenous materials, low capital costs compared to civil engineering structures.

Slope bioengineering is totally labour based approach providing benefits to the local people. It focuses on minimizing the damage to the natural environment as well as reducing the future maintenance costs. Major portion of the cost of the hill stabilization goes toward the payment of wages to the local labour. Hydro Project construction approach incorporates social, environmental and technical issues. The people's participation is most essential for the success of slope conservation works. The use of local materials motivates local people's participation. Soil bioengineering is an important and an integral part of construction, which is environment sound

and cost effective. The use of plants for land stabilization is applied either alone, or in conjunction with civil engineering structures and non-living plant materials to reduce shallow-seated instability and erosion on slopes.

2 Bioengineering Approach

Experiences have proven that without adequate planning hills are not sustainable. Evidences have also shown that in the past some hill slopes of the Himalayan region needed rehabilitation because of no maintenance or very poor maintenance. The conventional method of hydro power project construction are generally being followed and are increasingly being questioned due to the use of large scale engineering structures with high investments.

3 Practicable Ways for Technique Adoption and Construction of Nurseries

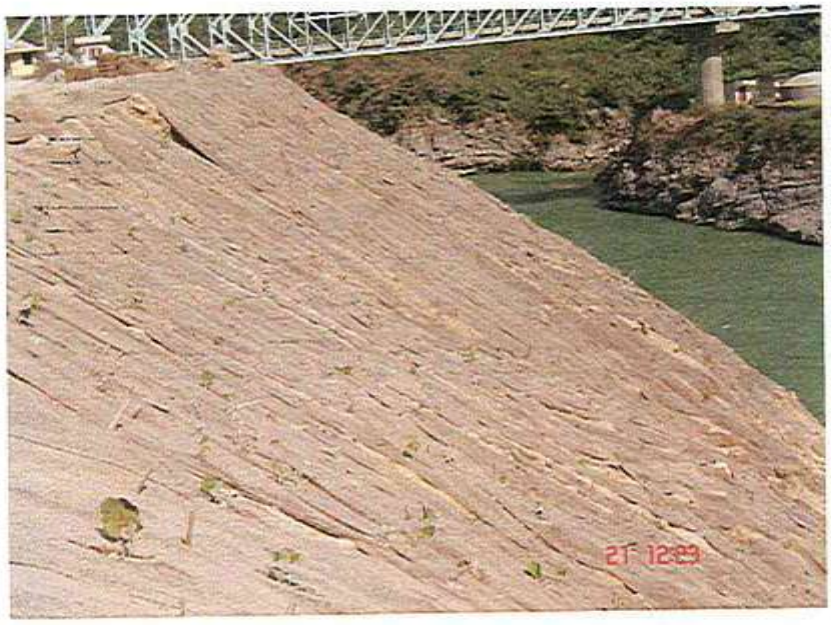
Bioengineering methods can be used to protect almost all type of slopes against erosion and reduces the instance of shallow failures. However, the establishment process may take some time. Vegetation is more dynamic than inert and takes some time to reach their maximum strength. They tend to become stronger over time. The application of soil bioengineering in combination with civil engineering structures would be most appropriate.

Dry stone walls or gabion retaining structures are built in the valley side of the road to protect the fill volume to reduce mass wasting and erosion process. Erosion control plantings are carried out on bare fill surface. Every attempt is made to maintain mass balance of hill slopes (cut and fill). The incorporation of soil bioengineering is a vital and integral part of road construction.

Cuttings and rooted plants are used during the dormant season. Various methods are available for hill side slope stabilization.

Jute and Wire Matting

The methods for seeding are dry-seeding and hydroseeding. The seed will be protected with straw in combination with bitumin or meshes of jute and wire on exposed areas. The stabilisation can be increased through transplanting stump sprout deciduous trees after revegetation with seeding. Jute matting is a tested method in many areas where soil is loose and difficult to hold as such. A few photographs has been depicted to the authenticity in Kol Dam area. This matting will be spread in between the check walls and Bioengineering works will be carried out by planting suitable local spp such as Agave, Yucca, Vitex etc. The matting will be affixed with wooden pegs and after some time this will biodegrade with the time



Loose rock slopes can be stabilized with different types of brush layering. The applications with rooted plants are known as hedge layer. The unrooted plant installations are brush layer. A combination of both is a hedge brush layer.

Dewatering and stabilization of wet slopes can be done through the use of drain and slope fascines. The fascines consist of live branches of willows that are tied together with wire.

There are numerous different hill side slope stabilization methods, which utilize plants in combination with construction of wood, stone and wire such as planted pole walls, live slope grids, live bamboo crib walls, vegetated stone walls and vegetated gabions. Choosing the right method depends on various factors such as the position of slope, ground and available material. The sections given below presents the techniques adopted in brush layer, drainage fascines, pallisade, single tree planting and grass planting. The advantages and disadvantages of each of these techniques are also given under the respective techniques.

3.1 Brush Layer Techniques

Brush Layer consists of placing live branch cuttings laid in small benches excavated into slopes. The benches can range from 2 to 3 ft wide. Live materials should be 1/2 to 2 inches in diameter. It is long enough to reach the back of the bench. The side branches should remain intact for installation.

Brush layer construction placing live branch cuttings in slopes

The cuttings are placed into slopes and oriented perpendicular to slopes. This is a more effective for earth reinforcement and mass stability of slope. It is also recommended on slopes up to 2:1 in steepness. It serves as tensile inclusions or reinforcing units. It assists in retarding runoff and reducing surface erosion.

The construction breaks up the slope length into series of shorter slopes separated by rows of brush layer. It also reinforces the soil with un rooted branch stems and reinforces the soil as roots develop, adding significant resistance to sliding or shear resistance.

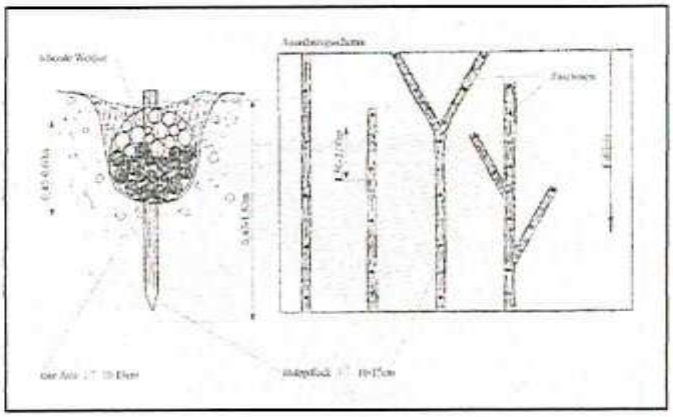
Whereas on dryer sites it helps infiltration on dry sites and drying excessively wet sites. It also adjusts the sites micro-climate, thus aiding seed germination and natural regeneration. The technique also acts as horizontal drains by redirecting and mitigating adverse slope seepage.

The construction is started at the toe of slope. Benches are excavated horizontally, on the contour, or slightly down the slope, if needed to aid the drainage. The surface of the bench slope should be constructed in such a manner that the outside edge is higher than the inside part. The live branch cuttings placed on the bench.

Branch growing tips (shoot bud) should be aligned towards the outside of the bench. The backfill is placed on top of the branches and compacted to eliminate air spaces. The brush tips should extend slightly beyond the fill to filter sediment. Each lower bench is backfilled with soil obtained from excavating the bench above.

3.2 Drainage fascines

Fascines are used for a variety of slope stabilization purposes. Fascines slow runoff, catch debris and reinforce the slope due to rooting. Drainage fascines in particular stabilize and drain slopes and are built into rills or small gullies. Immediately after establishment they have a draining effect because the water is channelled through the straight branches. With shoot and root development they form a strong line of vegetation. Additionally they achieve water-removal due to transpiration of plants.



Drainage fascines

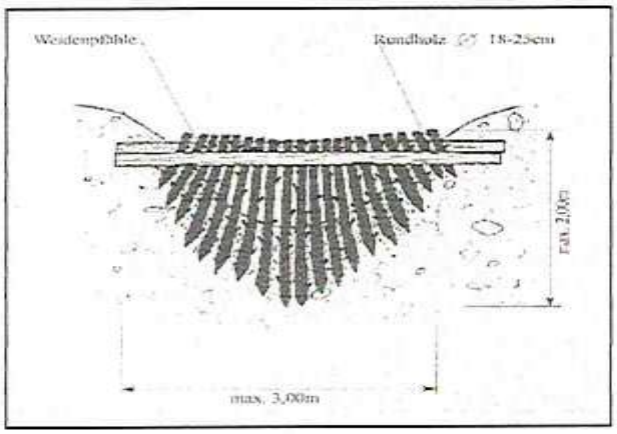
Draining fascines are long bundles of live branches or stems approximately 20 to 40 cm in diameter. The branches are placed with the butt ends pointing at the same direction into existing rills or dug trenches following the contour or desired angle precisely.

The bundles are tied together with 1.5 to 2.0 mm wire every 1 m and fixed into the ground every meter by wooden pegs or live stacks with a minimum length of about 80-100 cm. For the lower third of the fascine green branches of non-sprouting plants or gravel can be used. After placement the fascines are covered with a thin soil layer of about 3 to 4 cm. All branches should be in contact with soil to enable rooting and shoot development.

3.3 Palisades

Vegetated palisade constructions are ancient techniques, which were already used by the first people in Central Europe. At the beginning of the 20th century vegetated palisade constructions were still common in Bohemia, Moravia and Slovakia.

Palisades are used for protection of small but deeper, narrow gullies and shallow V-shaped rills. Immediately after construction they provide mechanical protection by catching debris, armouring and reinforcing gully floors. These effects are increasing after shoot development of cuttings. As a result of plant transpiration, they achieve water-removal from soil.



Palisades

Huge live poles are driven or dug half of their length, vertically into the ground. 5 to 20 live poles per running meter with at least 5 cm in diameter should be used. On their top they are fixed by wire on one or two cross beams, which have been anchored into the sides of the gully. The distance between the palisades depends on the steepness of the gully slope and profile of the gully floor. On slopes with less than 30° inclination 2 m are convenient, on slopes with an inclination between 30° and 60° a distance of 1 m is recommended.

3.4 **Single tree planting**

Growing shrubs and trees form a dense network of roots in the soil. Reinforcing and in the longer term anchoring, are the main engineering functions. Shrub and tree planting can be applied on almost every slope. It is often used in combination with other soil-bioengineering measures.

Rooted plants from the nursery (usually raised as polypot seedlings) are planted in off-set rows or in other specific pattern on the slope. One plant per m^2 should be enough. Main considerations are the costs of establishment and the period in which a dense plantation is required. The plants are put into a pit large enough for the rooting system. After filling soil carefully around the cylinder of roots and soil from the polypot, the soil is firmed gently around the plant. Stump-sprouting species should be preferred. Mulching, with for instance compost or chopped grass helps the young plants to grow faster by regulating the moisture and suppressing competing vegetation.

3.5 Grass planting

For grass planting, grass slips, cuttings, or clumps grown from seed are planted in lines or at random on the slope. Grass plantations protect the slope, due to rooting and by providing a surface cover. They reduce the speed of runoff, catch debris and armour the slope.

By using a planting bar holes just big enough for the roots are made. The grass slips or cuttings are placed into it, the soil filled around it and firmed gently. Grass planting is started from the top of the slope working downwards.

Different patterns of grass lines can be used as given below:

- Contour/horizontal lines: They reduce speed of runoff and catch debris thereby armouring the slope.
- Down-slope/vertical lines: Armour, reinforce and drain the slope. Used for damp sites and poorly drained materials where an intensified infiltration can lead to liquefaction of the soil.
- Diagonal lines: Main functions are armouring and reinforcing. Secondary they catch debris and drain the slope. Best compromise of horizontal and vertical planting.
- Random planting: it is often used in combination with jute netting on very steep harsh slopes where complete surface protection is needed.

The locally available grass species can be used for erosion control purpose and are useful for thatch, fodder, pasture and medicines.

SOIL AND WATER CONSERVATION WORKS PROPOSED UNDER BAJOLI-HOLI (HEP 180MW) CAT PLAN

Sr. No.	Name of Block	Name of Beat	Legal Status	Name of Ghar	Total Area of Ghar in (Ha)	Activity				Total Amount (Rs) (A+B)
						Protection work of Land		Bio-engg works		
						Qty (m3)	Amount (Rs)@ 1200 per m3 (A)	Area (Ha)	Amount (Rs) @ 78000/- per Ha (B)	
1	Bara-Banchho	Bajol	Bajoli DPF	Kalang madi	15	1115	1338000	8	624000	1962000
2			Gowar DPF	Gowar	10	1155	1386000	7	546000	1932000
3			Sindi DPF	Sindi	15	1210	1452000	6	468000	1920000
4			Sindi DPF	Kharudu	15	1080	1296000	5	390000	1686000
5			Garonda DPF	Garonda	20	1215	1458000	6	468000	1926000
1		Surehi	Urna DPF	Urna	10	1160	1392000	7	546000	1938000
2			Surehi DPF	Surehi	10	1050	1260000	8	624000	1884000
1		Yada	Chullan DPF	Channi	12	1080	1296000	4	312000	1608000
2			Pandvan DPF	Khudma	8	1075	1290000	5	390000	1680000
1		Nayagram	Chuned DPF	Chuned	12	1140	1368000	6	468000	1836000
2			Agrali DPF	Agrali	8	1100	1320000	8	624000	1944000
3			Nayagram DPF	Nayagram	10	1105	1326000	7	546000	1872000
4			Gharo DPF	Gharo	12	1125	1350000	10	780000	2130000
1	Holi	Deol	Phat DPF	Thanether	8	575	690000	8	624000	1314000
2			Nehra DPF	Kuleth	10	1080	1296000	9	702000	1998000
3			Nehra DPF	Surehi	12	1065	1278000	5	390000	1668000
4			Deol DPF	Deol	8	1025	1230000	8	624000	1854000
5			Phat DPF	Khart	11	1005	1206000	10	780000	1986000
6			Jable DPF	Jabal	6	520	624000	9	702000	1326000
GRAND TOTAL					212	19880	23856000	136	10608000	34464000

NOTE:- Rs. 2.50 per plant for Bio-Engg plants and 25% over the above Cost for tribal area development is proposed

279

ANNEX.-I

BAJOLI-HOLI HYDRO ELECTRIC PROJECT (180 MW)

CAT PLAN WORKS-FOREST PROTECTION

Sr. No.	Description	Remarks
1.	Executing Agency	Forest Department
2.	Legal Status	The forest protection Repair of Boundary Pillars & Fire protection shall be carried out in DPF itself.
3.	Name of Division	Bharmour Forest Division
4.	Name of Rang	Trehta Rang
5.	Block	Barabanchho
6.	Beat	Bajol,Nayagram,Surehi,Yada Beat
7.	Type of works to be carried out in catchments	Boundry Pillars in RF = 150 No. Boundry Pillars in DPF = 1311 No. Boundry Check Pillars in DPF=724 No.
8.	Average Elevation	1900 to 3200 m above msl.
9.	Works to be done.	Forest protection including construction / repair of boundary pillars & Fire protection.
10.	Estimated Cost of Forest Protection	**Rs. 138.34 Lacs**

DETAIL OF FOREST FIRE LINES IN BARABANCHHO BLOCK			
Sr.NO	Name of Forest	Area (Ha)	Length of Fire Line
1	Agrali RF(C-I,II,III)	256.98	4 km
2	Tunda Munda DPF (C-I,II)	670.97	5 Km
3	Suwen RF	122.72	2 km
4	Sindi DPF	349.84	3 km
5	Guwad DPF	226.64	2 Km
6	Bajol DPF	114.53	2 Km
7	Bajoli DPF	57.87	1 Km
8	Urna DPF	81.34	1.5 Km
9	Chulan RF (C-I,II)	106.84	3 Km
10	Surehi DPF	24.72	1 km
11	Deoti DPF	912.15	6.5 Km
12	Pandvan DPF	142.8	2.5 Im
13	Gandhir DPF	385.67	3.5 Km
14	Gandhir RF	180.49	2 km
TOTAL		3633.56	39 Km

Total Fire Line is 39 km @ 1.5 lacs per km = 58.5 lacs

DETAIL OF FULLY REPAIRS OF BOUNDRY PILLARS IN BARABANCHHO BLOCK

Sr. No.	Name of Forest (RF/ DPF)	Boundary Pillars	Check Pillers
1	Chulaan RF	15	0
2	Pandvan RF	4	0
3	Gandhir RF	4	0
4	Agrali RF	75	0
5	Swan RF	23	0
6	Pani Nalli RF	29	0
(A)TOTAL BOUNDAR PILLARS IN RF		**150**	**0**
1	Daruni Dhar DPF	13	0
2	Nirpath	26	0
3	Bagh DPF	3	0
4	Nahera DPF	26	44
5	Yada DPF	17	46
6	Dheri da Phat DPF	14	0
7	Luwen DPF	37	0
8	Kholi da Khil DPF	25	0
9	Sindi DPF	22	140
10	Nahera (C-I) DPF	22	0
11	Deoti DPF	19	34
12	Pandvan DPF	7	4
13	Urna DPF	73	15
14	Gandhir DPF	8	0
15	Pani Nalli DPF	35	26
16	Kut C-I DPF	4	0
17	Kut C-II DPF	32	13
18	Guwari DPF	104	42
19	Garonda DPF	14	87
20	Godhan DPF	120	34
21	Chaloon DPF	22	0
22	Tunda Munda DPF	19	0
23	Chuned DPF	82	16
24	Bajol DPF	24	0
25	Habbu- da- Pad	34	36
26	Surchi DPF	96	33
27	Thaneter DPF	33	0
28	Agrali DPF	19	0
29	Nayagram DPF	29	32
30	Phat DPF	24	6
31	Bajoli DPF	96	23
32	Dhardi DPF	84	76
33	Khabber- Juwar DPF	16	0
34	Khudma DPF	15	0
35	Dhangi DPF	12	4
36	Thaneter Dhar DPF	16	0
37	Riyali Dhar DPF	16	0
38	Sirog Dhar DPF	7	0

285

39	Thana DPF	8	13
40	Bhanghal Dhar DPF	5	0
41	Jalsu Dhar DPF	15	0
42	Khudma Dhar DPF	18	0
(B) TOTAL BOUNDRY PILLARS & CHECK PILLARS IN DPF		1311	724
GRAND TOTAL (A+B)		1461	724

Legal Status	No. Of Pillars	Rates	Cost (Rs)
RF(Boundry Pillars)	150	3300	495000
DPF (Boundry Pillrs)	1461	2800	4090800
DPF(Check Pillars)	724	2500	1810000
GRAND TOTAL			6395800

ANNEX.-J

BAJOLI-HOLI HYDRO ELECTRIC PROJECT (180 MW)

CAT PLAN WORKS-INFRASTRUCTURE DEVELOPMENT

Sr. No.	Description	Remarks
1.	Executing Agency	Forest Department
2.	Name of Division	Bharmour Forest Division
3.	Name of Range	Trehta Rang
4.	Block	Barabanchho,Holi
5.	Beat	Bajol,Nayagram,Yada,Surchi,Deol Beat
6.	Type of works to be carried out in catchments	**Repair of Forest Inspection Hut:** 1. Surchi **Repair of Forest Guards Huts:** 1. Yada 2. Surchi 3. Nayagram **Repair of BO Qtr.** 1. Gharoh (Barabanchho Block) **Repair of Range Office cum Residence:** 1. Holi **Construction Of I/ Hut:** 1. Yada 2. Dhardi 3. Kharuddu **Construction Of Forest Rest House:-** 1. Holi (Alternation & Addition). **Construction Of Seed Store:-** 1. Holi 2. Nayagram **Repair of B/Path:** 1. Dhardi to Khanar (8 Km) 2. Nayagramto Thanethcr biaChuned (8 km) 3. Thaneter to Jalsu via Muchdu (8 km) **Construction of I/Path:** 1. Guad DPF to Sindi DPF via Bajol,Bajoli DPF (6 Km) 2. Surchi to Pandvan RF via Gandhir RF (7Km). 3. Bajol to Sindi DPF (4 Km). 4. Khanar to Phaled pass (5.5 Km) **Construction of wooden Bridges:** 1. Khardu nalla Bridge at Khardu. 2. Jalsu nalla Bridge at Jalsu. 3. Graggu nalla Bridge at Sindi village. **Construction of Tracking Hut:** 1. Jalsu pass
7.	Average Elevation	1500 to 2400 m above msl.
8.	Estimated Cost of Energy Plantation including maintenance.	**Rs. 270.65 Lac**

REPAIR OF B/PATH in Barabanchho block		
Sr.No.	Name of B/Path	Length
1	Dhardi to Khanar	6 Km
2	Nayagram to Thaneter bia Chuned	8 Km
3	Thaneter to Jalsu via Muchdu	10 Km

Total Length of B/Path is 24 km @ 85000/- per km = 20.4 lacs

CONSTRUCTION OF I/PATH

Sr.No.	Name of B/Path	Length
1	Guwar DPF to Sindi DPF	6 km
2	Surehi DPF to Pandvan DPF	7 Km
3	Bajol DPF to Sindi DPF	4 Km
4	Khanar DPF to Phaled Pass	5.5 km

Total Length of B/Path is 22.5 km @ 1.5 lacs per km = 33.75 lacs

CONSTRUCTION OF BUILDINGS			
Sr.No.	Name of Buildings	Name of Station	Amount (In Lacs)
1	Inspection Hut	Yada	8.5
2	Inspection Hut	Dhardi	8
3	Inspection Hut	Kharudu	9.5
4	Seed Building	Holi	8.4
5	Seed Building	Nayagram	9.5
6	Rest House Building	Holi	68
7	Tracking Hut	Jalsu	50
Total Cost for Construction of Buildings			161.90

REPAIRS OF BUILDINGS			
Sr.No.	Name of Buildings	Name of Station	Amount (In Lacs)
1	Inspection Hut	Surehi	2.6
2	Forest Guard Hut	Yada	2.7
3	Forest Guard Hut	Surehi	2.5
4	Forest Guard Hut	Nayagram	2.2
5	BO Quarter (Barabanchho Block)	Ghadoh	3.1
6	Range Office cum Range Recidence	Holi	4.5
Total Cost for Repair of Buildings			17.6

CONSTRUCTION OF WOODEN BRIDGES			
Sr.No.	Name of Wooden Bridges	Name of Station	Amount (In Lacs)
1	Khardu nalla Bridge	Khardu.	13
2	Jalsu nalla Bridge	Jalsu.	12
3	Graggu nalla Bridge	Sindi village	12
	Total Cost for Construction of Wooden Bridges		37