I. ENVIRONMENTAL IMPACT ASSESSMENT

1. INTRODUCTION

Dibang Multipurpose Project (3000 MW) is being conceived on River Dibang which originates from snow covered southern flank of the Himalayas close to Tibet border at an altitude of more than 5000 M. The river emerges from the hills and enters sloping plain area near Nizamghat in Arunachal Pradesh, from where the river flows a distance of 50 Km. to meet the river Lohit. The total catchment area of Dibang up to the dam site is 11276 sq km which lies entirely in India. The Project is located in Lower Dibang Valley district of Arunachal Pradesh and its site is found to be a good combination of geological and topographical features for development of hydro-potential and with no submergence of archaeological/other installations. However, the project area is extremely remote & inaccessible. The reservoir created behind Dam will provide flood moderation benefit in the down stream. The back water in the reservoir will travel up to a length of 43 km in Dibang river and its various tributaries - Airi river, Ilu river, Imu river, Ahi river, Ithun river, Emra river etc. which will facilitate promotion of navigation by connecting inaccessible upstream villages/areas. The Project after construction will be one of the biggest projects in terms of generation of power in India. The project headquarters is proposed to be at Pathar Camp on the right bank of river Dibang approximately 6 km downstream of dam site. The project has a poor connectivity from the railhead and the nearby towns (viz. Tinsukia, Dibrugarh, Pasighat, Itanagar, Tezpur etc.). The project is about 43 km from Roing which is at a distance of 110 km from Tinsukia the nearest railhead. Airport at Mohanbari (Dibrugarh) is further 45 km from Tinsukia.

Boosting up of electricity generating capacity is an urgent national need, because of the growing power demand year by year. NE region has huge hydel potential for electricity generation and also has the advantage of exporting the same to other SAARC/South Asian Countries due to its strategic location.

2. PREFERENTIAL ASPECTS OF THE PROPOSED SITE

The present dam site is found to be a good combination of geological and topographical features for development of hydro potential and with no submergence of archaeological / other installations. In addition, its other advantageous points are:

i. Exposed Gneissic rock at dam site
ii. Reasonable distance from Mishimi and Lohit Thrusts
iii. Topographic stability to accommodate all appurtenances
iv. No submergence of mineral resources
v. Easy availability of construction materials, like quartzite etc., and
vi. Having more storage capacity due to gentle river slope,

3. ENVIRONMENTAL IMPACT ASSESSMENT

EIA is a planning tool that is now generally accepted as an integral component of sound decision-making. The objective of EIA is to foresee and address potential environmental problems/concerns at an early stage of project planning and design .EIA/EMP should assist planners and government authorities in the decision making process by identifying the key impacts/issues and formulating mitigation measures. Ministry had issued sectoral guidelines some time ago.

4. OBJECTIVES OF THE STUDY

The present study covers:

- Assessment of the existing status of water, land, biological, climatic, socioeconomic, health and cultural component of environment.
- Identification of potential impacts on various environmental components due to activities envisaged during pre-construction, construction, and operational phases of the proposed Hydroelectric Project.
- Prediction of significant impacts on the major environmental components using appropriate mathematical/simulation models.
- Preparation of environmental impact statement based on the identification, prediction and evaluation of impacts.
- Delineation of environmental management plan (EMP) outlining preventive and curative strategies for minimising adverse impacts during pre-construction, construction and operational phases of the proposed project along with the cost and time-schedule for implementation of EMP.
- Formulation of environment quality monitoring programme for construction and operational phases to be pursued by the project proponent.

Table 1: Salient Features of Dibang Multipurpose Project

1	**LOCATION**	
	State	Arunachal Pradesh
	District	Lower Dibang Valley
	River	Dibang / Talon
	Dam site location	1.5 km u/s of confluence of Ashu Pani with Dibang Latitude : 28°20' 7" N Longitude : 95°46' 38" E
	Nearest BG rail head	Tinsukia (153Km)
	Nearest airport	Dibrugarh (198Km)
2	**HYDROLOGY**	
	Catchment area	11276 km^2
	Average annual rainfall	4405 mm
	Probable Maximum Flood (PMF)	26230 cumec
3	**RESERVOIR**	
	Maximum Water Level (MWL)	EL 548.0 m
	Full Reservoir Level (FRL)	EL 545.0 m
	Min. Draw Down Level (MDDL)	EL 490.0 m
	Gross storage	
	- At MWL	3850.30 Mcum
	- At FRL	3748.21 Mcum
	- At MDDL	1983.89 Mcum
	Live storage at FRL	1764.32 Mcum
	Area under submergence at FRL	40.09 sq. km
	Length of reservoir	43 km
4	**DIVERSION TUNNEL**	
	Number, diameter and shape	5 Nos. 12 m diameter horseshoe shaped
	Length	1175 m to 1325 m
	Diversion Discharge	8680 m^3/sec
5	**COFFER DAMS**	
	Height of u/s RCC coffer dam	25 m (Above RBL)
	Height of d/s coffer dam	7 m (Above RBL)

6	**DAM**	
	Type	Concrete gravity dam
	Top elevation of dam	EL 550.00 m
	Height of dam above deepest foundation level	288 m
	Length of dam at top	816.3 m
6.1	**SPILLWAY**	
	Design flood	19000 m^3/sec
	Type	Orifice type
	Crest elevation	
	Lower level	EL 455.0 m
	Upper level	EL 500.0 m
	Number & size of spillway opening	
	Lower level	7 Nos. of size 6 m x 8 m
	Upper level	4 Nos. of size 9 m x 12 m
	Energy dissipation	Ski jump
	Length of spillway	154.0 m
6.2	**CONSTRUCTION SLUICE**	
	Number and size	6 Nos. of size 4 m x 5 m
	Crest Level	EL 300.0 m
7	**INTAKE**	
	Invert level	EL 465.00 m
	Number and size of gate opening	6 Nos. of size 8.0 m x 9.0 m
8	**HEAD RACE TUNNEL**	
	Number, diameter and shape	6 Nos. 9.0 m diameter horseshoe shaped
	Length	300 m to 600 m
	Design discharge	237.80 m^3/sec
9	**PRESSURE SHAFT**	
	Number, diameter and shape	6 Nos. 7.5 m diameter Circular
	Height	184.8 m
10	**PENSTOCK**	
	Number, diameter and shape	12Nos., 5.2m diameter Circular

11	**MIV CAVERN**	
	Cavern size	17 m(W) x 26.1 m(H) x 277.8 m(L)
	MIV diameter	3.8 m
12	**POWER HOUSE**	
	Type	Underground
	Installed capacity	3,000 MW (12 x 250 MW)
	Power House cavern size	24.5 m(W) x 54.8 m(H) x 382.8 m (L)
	Type of turbine	Francis
	Speed of turbine	214.3 rpm
	Net rated head	233 m
	Overall turbine generator efficiency	92%
13	**DRAFT TUBE GATE,GIS AND TRANSFORMER CAVERN**	
	Cavern size	19 m (W) x 31.5 m (H) x 325 m (L)
	Draft tube gate no. & size	2 Nos. each of 4.5 m x 7.1 m
14	**CABLE TUNNEL**	
	Number, size &shape	1No., 4.5m(H)X30m(W), D shape
15	**TAIL RACE TUNNEL**	
	Number, diameter and shape	6 Nos. 9.0 m diameter horseshoe shaped
	Length	320 m to 470 m
	Design discharge	237.80 m^3/sec
	TRT outlet invert level	EL 283.00 m
16	**POTHEAD YARD AND GIS**	
	Size and elevation	300 m x 100 m at EL 310.0 m
17	**POWER GENERATION**	
	Installed capacity	3000 MW
	Annual energy generation in 90% dependable year	
	With Flood moderation	11330 MUs
	Without Flood moderation	12210.12 MUs

In Dibang Multipurpose project, most of the submergence area falls in the gorge area therefore, it is restricted longitudinally and no major submergence is observed laterally. In such conditions, impacts do not spill over to a large area. Thus, beyond

the designated study area, the impacts likely to accrue as a result of project construction and operation are not expected to be significant.

5. DIBANG CATCHMENT

Dibang Multipurpose Project is located on river Dibang. The river originates from the snow covered southern flank of the Himalayas / Trans Himalayas close to the Tibet border at an elevation of more than 5000 m. The river Dibang cuts through deep gorges and difficult terrains in its upper reach through the mountains of the Dibang Valley and Lower Dibang Valley districts of Arunachal Pradesh. The total length of Dibang from its source to its confluence with Lohit river at Sadia in Assam is 195 km. The major tributaries of Dibang river are Mathun, Tangon, Dri, Ithun & Emra. A number of small tributaries i.e. Ahi, Ari, Ilu, Ashu, Ephi, Deo etc also join the river. The important feature is that all the tributaries barring Ephi Pani & Deo Pani join Dibang in its hilly catchment. The three major tributaries viz Tangon, Dri and Mathun are almost equal in size because of which the shape of the Dibang catchment is comparatively wide in its upper reach. Out of the total catchment of 11276 sq km (=1127600 ha), the directly draining catchment constitutes an area of 59811.88 ha.

6. LANDUSE / LAND COVER DETAILS

About 48.76 % (29163.44 ha) of the directly draining catchment is dense forest whereas 12.41 % (7419.88 ha) is open forest. In the proposed submergence area the dense mixed forest is limited along the bank of the river. Areas under agriculture / current jhum / habitation works out to be 6.44 % (3851.64 ha) while degraded forest / abandoned jhum works out to be 17.19 % (10281.64 ha) of the directly draining catchment. Snow covered areas constitute about 0.23 % (139.52 ha) of directly draining catchment. They occur generally as isolated exposure. The area under this category is 13.13 % (7852.32 ha). Water bodies, mainly comprising river Dibang and its tributaries, constitute about 1.84 % (1103.44 ha) of the directly draining catchment.

7. CAPABILITY CLASSIFICATION

In capability classification, lands are divided into two groups, i.e. (a) suitable for cultivation, and (b) unfit for cultivation but suitable for permanent vegetation, namely pastures, orchards and forest vegetation. However, in both the groups, degree of hazards is involved. It is observed that the areas under current and abandoned jhum

is grossly mismanaged, misused or even made hazardous mainly due to shift cultivation and that's why it should be brought under permanent terrace cultivation or under silvi-pasture vegetation by persuasion as well as by applying improved technology.

8. PHYSIOGRAPHICAL, TOPOGRAPHICAL AND RELIEF FEATURES OF THE CATCHMENT

The Dibang Basin lies between Lat 28°11'50" N to 29°25'59" N and Long 95°14'47" E to 96°36'49" E and has a very severe and rigorous topographic feature. Its elevation ranges from 300 m in the outer Siwalik type hills rising from plains of Assam to as high as 5500 to 6000 m in the Greater Himalayas, bordering China.

The Basin has a catchment area of 11,242sq km. The upper reach of the river is known as R. Mathun, R. Dri and then R. Tangon. As per Agro-climatic Zone, the area falls within (i) Alpine Zone, and (ii) Mild Tropical Plain Zone. Within the Dibang basin, the hills and mountains occupy nearly 66.7% of the total land area and the relief difference vary from 540 m to 5400 m.

9. DIBANG CATCHMENT DRAINAGE SYSTEM AND DRAINAGE PATTERN

The Dibang River is snow as well as rainfed. At its upper reach, it is known as R. Mathun, R. Dri and R. Tangon in chronological descending order. It is known as R. Dibang from the confluence point with R. Ahi. It originates at an altitude of 5355 m to 5375 m in the glacial ranges of Great Himalayas and flows in a general southward direction.

10. METEOROLOGY

The Dibang basin falls partly in climatic zone I and partly in zone III. Zone I comprises of North and North Eastern part of India including Myanmar, Nepal, Bhutan, Bangladesh and part of Pakistan. Zone No. III comprises China, Tibet and portion of North and North Eastern part of Arunachal Pradesh. Two distinct climatic conditions prevail over the entire Dibang Catchment. The upper reach starts from the Indo-Tibet border up to Mayudiya Hill Range and the lower reach starts from Mayudiya Hill range to the confluence of Lohit. The rainfall in the basin is mainly influenced by the mountain system and occurs due to the Southwest monsoon, which sets in by the

second week of May and continues up to the middle of October. On the basis of the available data, average rainfall in the basin up to the dam site has been estimated to be 4405 mm

11. GEOLOGY OF THE RESERVOIR AREA

Regionally, the reservoir area lies at the junction of Eastern Himalayan mobile belt which terminate against N-W tending Parametamorpites and Diorite-Granodiorite Complex of *Mishmi block* in the Dibang Valley. The Eastern Himalayan mobile belt embodies a succession of northern dipping thrust sheets that occupy almost the whole of Arunachal Pradesh. It consist of high grade biotite gneiss and garnetiferous mica schist termed as ***Ithun Formation*** and low grade chlorite schist with intercalations of phyllites and carbonate rocks termed as ***Hunli Formation***.

In Dibang river valley, structural elements related to five phases of deformation are present. Each phase has produced folds with distinct characteristic geometry. Broad wraps along sub-horizontal axial plane having joint set as their axial planar structure represent fifth phase of folding (F5) that are of local importance.

Planar structures observed in the area are bedding, schistosity/gneissosity, cleavage, joint, shear and fault. Of these bedding is the only primary planar structure and the rest are secondary. Bedding is well developed in quartz-chlorite schist; carbonate rock and green quartzite of Hunli formation and quartzite of Ithun formation. Schistosity is well developed in chlorite schist and phyllite of Hunli Formation and gneissosity in gneissic rock of Ithun Formation

Following major thrust/faults are present in reservoir area: Lohit Thrust, Tidding Suture. The rock exposure along the river banks, nala section, foot tracks were studied for reservoir mapping and it is noted that a variety of rocks belonging to different formations/groups are present. The litho units of the area are briefed hereunder.

In the reservoir area upstream of dam axis along the course of Dibang river and its tributaries viz *Ilu Pani* and *Ar Pani*, rocks of Ithun formation comprising of quartzo-

feldspathic biotite gneiss, biotite amphibolite gneiss with bands of amphibolite chlorite schist are exposed.

The major rock type belonging to Hunli formation exposed in Ahi river section are quartzite gneiss with amphibolites and mica, graphite mica schist with occasional carbonaceous bands, crystalline limestone and quartz chlorite schist.

12. LANDSLIDES

During the course of reservoir mapping of Dibang Multipurpose Project several active and potential landslide along with other zones of mass movement were identified. Following categories of unstable zones were identified within the reservoir area:

(i) Ancient/passive slide debris cone covered with vegetation.

(ii) Active landslide in overburden material.

(iii) Active landslide in bedrock.

(iv) Potential area of mass-movement and soil creep.

In the entire reservoir area overall 60 number of active landslide zones forming unstable slopes has been identified.

Most of larger landslides are developed in bedrock. However smaller and medium size landslides are observed in both rock and overburden cover along the proposed reservoir rim. The other large landslide zones are located in the upstream reaches of the reservoir; many of them are at higher elevations in various tributaries of Dibang and may not pose much threat.

13. SEISMOLOGY

The North Eastern Region of India and its environment are both tectonically as well as seismically very dynamic and active. This region has been a source of two of the greatest earthquakes in the world with magnitude greater than 8.5, besides which, several earthquakes of magnitude 7.0 and more occurred in the region.

14. TECTONO-STRATIGRAPHIC SET UP

Regional tectonics and seismic history of the North Eastern Region is highly significant. It constitutes active, unparallel relief, complex geological set up and anomalous crustal structure, which are attributed to the direct collision between Indian

plate (Himalaya) and China / Tibet plate in the north and Indo- Burma subduction plate tectonics in the south east.

15. TECTONIC SETTING

The East West structural trend of the Himalaya has- taken a sharp bend towards North East - North in the Siang Valley, Arunachal Pradesh The available geological information do not indicate physical continuity of the Himalayan rock units across the Siang fracture (Nandy, 1980) into the Mishimi block, rather the north east trending elements of Arunachal Himalaya with its thrust sheets abut against the north-west trending structural grain of the Mishimi block.

The most prominent and significant tectonic feature around the project site is apparently parallel NW trending Mishimi thrust and Lohit Thrust. The Great Assam Eartquake of 1950 (M=8.7), originating from this domain, illustrates similar right lateral sense of displacement (Ben-Menahem etal, 1974).

16. SEISMICITY OF THE REGION

In a very generalized way epicenter clustering can be visualized around (1) Western part of Shillong Plateau, (2) Central Assam & Western Arunachal Pradesh, (3) Indo Burma Border, and (4) North Eastern part of Arunachal Pradesh.

From the study of seismicity and tectonics of the region, the following active seismo-tectonic domains that have bearing on the construction of projects in the region, have been visualized.

a) Mishimi tectonic domain,
b) Kopili Bomdila tectonic domain (Himalayan),
c) Sylhet tectonic domain,
d) Indo Burma plate tectonic domain, and
e) Shillong plateau domain.

The proposed Dibang Multipurpose project falls within **Zone V** of the Earthquake Zoning Map of India.

17. WATER QUALITY

The Dibang river basin has low population density, with low irrigation intensity. In addition, there are no major sources of organic pollution also in the catchment area

intercepted till the dam site. The absence of industries implies that there is no pollution loading from this source as well. From the water sample analysis of the Dibang River it is clear that that the quality of water of river Dibang is good. The hardness levels indicate the soft quality of water. Most of the residents in the area were using water of adjacent rivers and streams without any disinfection. Low BOD levels indicate the absence of organic pollution source.

18. SOIL QUALITY

Soil is sandy loam type with presence of free acids & likely occurrence of exchangeable Aluminium. From dispersion ratio it is assumed that Hydraulic conductivity is very low. Electrical Conductivity is normal & porosity is good for drainage. This soil is good for agriculture and horticulture crops & pH shows strongly acidic nature and also the organic carbon content is also good. Nitrogen level is normal & good (122.1 to 130.4 ppm).

Crops that can be grown are Rice, Wheat, Maize, Auto, Mustard, Sugarcane, fruit crops like Citrus, Lemon, Banana, Pineapple, Litchi etc.

19. AMBIENT AIR QUALITY

Ambient air quality is a complex interwoven network involving interaction of emissions, chemical changes and transport of pollutants in the atmosphere. A well-designed monitoring programme was designed to assess the status of ambient air quality in the project area. The ambient air quality monitoring established by the Consultants are Munli Camp and Pather Camp. The prime objective of the ambient air quality monitoring was to assess the existing level of air pollutants. The parameters monitored were SPM, SO_2 and NO_x. The SPM, SO_2, NO_x levels in the study area are much below the desirable limits.

20. TERRESTRIAL ECOLOGY

The catchment area which has an altitudinal range from 300 m to 5400 m has a very interesting floristic composition representing changes in forest types, typical of the Eastern Himalayas with the change in altitude. The favourable rainfall, temperature and high humidity have caused the vegetation to acquire the general characteristics of the Northern Tropical Semi- Evergreen & North Indian Moist Deciduous Forests.

Assam Valley & Eastern Sub-montane Semi-evergreen Forests (2B/C1a and 2B/C1b) cover the foothills and extend up to 1000 m altitude. The climatic conditions and high humidity make the area highly suitable for luxuriant growth of vegetation and many trees attain magnificent growth in height and diameter. The forests are of mixed broad–leaved type.

Top storey of the forest comprises *Aglaia spectabilis*, *Ailanthus integrifolia* subsp. *calycina*, *Altingia excelsa*, *Artocarpus chaplasa*, *Canarium strictum*, *Castanopsis indica*, *Chukrasia tabularis*, *Duabanga grandiflora*, *Syzygium cumini*, *Gmelina arborea*, *Magnolia* spp., *Mesua ferrea*, *Morus laevigata*, *Phoebe cooperiana, Pterospermum acerifolium*, *Sterculia villosa*, *Stereospermum chelonoides*, *Terminalia myriocarpa*, *T. bellerica*, *Tetrameles nudiflora*, *Toona ciliata* etc.

Middle storey comprises *Dillenia indica*, *Dysoxylum binectariferum*, *Gynocardia odorata*, *Macaranga denticulata*, *Michelia* spp. etc. Several species of canes viz. *Calamus erectus*, *C. flagellum*, *C. floribundus* etc. occur in these forests. *Caryota* spp. also occurs in these forests. *Cyathea* sp. (tree fern) is quite common everywhere. *Musa balbisiana* (wild banana) occurs in gregarious patches on hill slopes.

However, interspersed with this thick vegetation, there are occasional patches of open forests presumably created as a result of past jhuming. Such types of forests are generally covered with bamboos and shrubs dotted with scattered trees giving the appearance of 'scrub forest'. Grasses like *Imperata cylindrica*, *Saccharum spontaneum*, *Phragmites karka* with trees like *Bischofia javanica* and *Kydia glabrescens* predominate in this formation. There are also stretches of bamboo forests consisting mainly of *Bambusa pallida*, *Dendrocalamus hamiltonii* and occasionally *Schizostacyum polymorphum*.

Subtropical Moist Semievergreen Forests occurs generally in a limited area of the middle hills between El 1000 m and 1500 m or slightly higher. The vegetation is very typical of this altitude and consists of a few selected species like *Schima wallichii*, *Callicarpa arborea*, *Macaranga* spp., *Castanopsis indica*, *Engelhardtia spicata*, *Actinodaphne ovata*, *Ostodes paniculata*, *Ficus gasperiniana* and *Bauhinia variegata* at higher elevations. *Musa balbisiana* is very common in the lower zone. The vegetation is very dense and the undergrowth is profuse. Several species of bamboos like *Cephalostachyum latifolium*, *Phyllostachys bambusoides* and *Chimonobambusa*

callosa are common in this type with grasses such as *Arundinella bengalensis*, *Saccharum arundinaceum*, *Setaria palmifolia* and *Thysanolaena maxima*.

East Himalayan Wet Temperate Forests (8B/C1) are characterised by prevalence of *Quercus* and *Castanopsis* spp. These forests are not as dense as the previous ones but when well protected, will provide good ground cover. The important tree species representing this type are *Quercus griffithii*, *Castanopsis* sp., *Alnus nepalensis*, *Engelhardtia spicata*, *Cornus controversa*, *Acer* sp., *Michelia baillonii*, *Betula alnoides*, *Magnolia* spp., *Prunus* spp., *Macaranga spp.*, *Nyssa javanica*, *Eriobotrya* and *Rhododendron* spp. Rhododendrons give bright hue to these forests in the advent of spring. In the undergrowth *Berberis wallichiana*, *Osbeckia* spp. and *Lycopodium* spp. and various other flowering herbs predominate.
Several conifers like *Abies spectabilis*, *Cupressus torulosa*, *Taxus wallichiana* and *Tsuga dumosa* occur sporadically, but pines are absent from this area.

Subalpine or Temperate Montane Forests go through a transitory stage and this catchment has a fairly large area between EL 3000 m and 5500 m representing the sub-alpine and alpine vegetation. Conifers like *Abies* sp (Silver Fir), *Tsuga dumosa* (Hemlock), *Pinus wallichiana* (Blue Pine) and *Taxus wallichiana* occur in the forests.
The understorey consists of a dense bushy zone of *Rhododendron* spp., *Berberis* spp., *Salix* spp., *Cotoneaster* spp. and some other herbaceous species, particularly of the families Rosaceae and Ranunculaceae, with some Polygonaceae and Gentianaceae here and there. The alpine vegetation is limited to altitudes 4500 m to 5500 m. The vegetation becomes scarce, and the general look is that of coarse meadow. The vegetation consists of stunted gnarled shrubs with deep roots and stunted shoots. Species of *Abies*, and *Berberis* are common. Above the tree line, the vegetation consists of herbaceous Primulas, *Rhus*, *Saxifraga*, *Sedum*, *Saussurea*, *Gentiana* with few *Bromus*, *Stipa* and *Festuca*. The alpine and sub-alpine areas are presumably included within the Dibang Wildlife Sanctuary and are expected to receive almost total protection.

The entire catchment area of Dibang River is also very rich in Epiphytic orchids. The dense vegetation, well distributed rainfall and humid conditions encourage the growth of these wonderful plants known for its magnificent and scented flowers the world

over. Some of the species are terrestrial in nature. Even a single tree in the dense forest of this region is a natural orchidarium in itself with many taxa growing on it.

The rich and diverse flora is exposed to a variety of external factors that push them to the verge of threat. To mention a few of these forces acting on are habitat destruction, over exploitation, biotic pressures, endemicity etc. needless to mention some of them are already listed in the Red data book of Indian plants. Considering the local conditions and extent of distribution a few locally threatened plants have also been considered worthy of conservation, though they do not appear in the red data book. The endemic plants deserve special attention for conservation for their survival. A few of these plants are the following:

Albizia arunachalensis	Endemic
Angiopteris evecta	Habitat loss & destruction
Coptis teeta	Endemic & over exploited (Vulnerable – as per BSI's Red Data Book of Indian Plants)
Cyathia spinulosa	Habitat loss & destruction
Entada pursaetha	Habitat destruction, narrow distribution
Gynocardia odorata	Rare and habitat destruction
Podophyllum hexandrum	Rare
Rhododendron edgeworthi	Rare
Taxus wallichiana	Over exploited

21. Fauna

The area around the proposed Dibang Multipurpose Project has fairly rich forest cover. The animal habitat is concentrated on lower slopes and terraces edging to major river system .The animals also adapted according to the riverine environment. Many arthropods such as Coleopterans, arachnids and insects were observed.

The catchment of the proposed Dibang Multipurpose Project is the major habitat of scheduled species and IUCN red data book recorded species. But due to the wide range of free habitat and less human pressure area they can move freely. All the listed mammals were not sighted during the field survey. However, they have been enlisted

in the report based on secondary data available. Mishimi takin, Serrow, Snow leopard and Himalayan black beer are high altitude animals whereas different cat sp., different macaques, Langurs, Civets, Wild boar, Squirrels, Mongooses etc. were directly sighted in the catchment area of the project.

The project catchment area and its surroundings are quite rich in avifauna. In Arunachal Pradesh a large no of avifauna were recorded by Power and Birans (2001) in lower altitude as well as middle ranges of Dibang valley. Out of 83 no of avifauna, only two species i.e. Rufous-necked Hornbill and Chestnut-breasted Partridge are recorded in IUCN red data book as vulnerable Most of the birds are migratory in nature and generally migrate to the nearby sanctuaries or different altitudinal areas depending upon the food availability and breeding habitat. Water birds are not very common in the area probably due to the swift running water. With the damming of the river the reservoir banks will have wet environment throughout the year, which can lead to proliferation of vegetation e.g grass and aquatic insects along the reservoir banks. It is expected that the whole catchment area will become birds' paradise if authority takes proper measure to check hunting, poaching etc.

There are 14 no of snakes recorded in the area whereas only 3 no of species of snaked are found in the submergence area i.e Banded krait (*Bangarus fasciatus*), Asiatic Rock Python (*Python molurus*) and Chequered Keelback (*Xenochrophis piscator*). Most of the snakes are found in the higher altitudinal area. Among the 7 species of lizards Bronze Mabuya (*Mabuya macularia*), Common Indian monitor (*Varanus bengalensis*) and Oriental Garden Lizard (*Calotes versicolor*) were mostly found in the submergence area. Others species were detected only in the dense forests of high altitude area.

22. Fishes & Fisheries

There are three categories of fish species based on their occurrence viz.-

A. Upper reaches: Cold temperature zone 1200 -1400 m.
B. Middle reaches: Subtropical zone 800 -1200 m.
C. Lower reaches: warm tropical zone bellow 800 m.

The catchment area of Dibang river of Dibang Multipurpose Project covers the middle reaches and lower reaches. The observed species in the dam site are *Schizothorax richardsonii, Tor putitora, Tor tor* and *Chagunus chagunio*. Other mentioned common species are found mostly in lower stream that is up to Kundil and these are not migratory in nature. In the upstream of the catchment area except *Chagunus chagunio* and *Garra* spp. no other species was found, probably due to the seasonal behavior.

Four species viz. *Schizothorax richardsonii*, *Tor tor, Tor putitora* and *Chagunius chagunio* are migatory in nature for breeding purpose. Four species viz. *Crossocheilus latius latius*, *Garra annandalei*, *Garra gotyla gotyla* and *Psilorhynchus balitora* are local migratory for feeding purpose.

Tor putitora species starts spawning from the onset of south-west monsoon in mid July which continues till the middle of October in flooded river. The other important migratory species *Tor tor* has a prolonged breeding period commencing from July-August continuing sometimes till November. Their rate of growth is slow, average sizes vary from 35 to 125 mm.

Dibang Valley is a paradise of Butterflies also; so protective measure should be taken with the project. During the monsoon season the butterfly population increases as compared to other seasons. Most of the population is found in nearby water sources. Indian fritillary and Common Earls were found enormously in the riverside. In the catchment area, only three scheduled species were found.

23. SOCIO-ECONOMIC STUDIES

Total land required for various project components of the project viz. dam structure, power house structure, submergence, colony development etc. is 5827.80 ha. It includes Unclassed State Forest (USF) of 5056.50 ha out of which, 4009 ha falls under submergence and 1047.50 ha is required for various project components. Therefore, adequate compensation is required to be provided for the same. Table 2 provides details of land requirement for the project and Table 3 provides the break-up of land requirement.

Table 2: Land requirement for the project

S. No.	Land Classification	Land (ha)
1.	Unclassed State Forest (USF) including river bed and water body	5056.50
2.	Community land without forest cover	701.30
3.	Land under Wet Rice Cultivation	70.00
	Total	**5827.8**

Table 3: Break-up of land requirement

S. No.	Name of Project Component	Area (ha)
A.	Submergence area	4009
B.	Project area	250
C.	Project Components & Construction Facilities	
(i)	Area for Dam, DT, HRT, Pressure Shaft, Power House, TRT, cable crane on right bank & left bank	100.06
(ii)	Area for muck disposal, batch plant, switch yard & aggregate processing plant	20
(iii)	Area for NHPC, contractor camp & office	79.25
(iv)	Area for permanent Magazine opposite to Pathar Camp on left bank	2.5
(v)	Rest area for project	165.92
D.	Epali clay quarry	4.52
E.	Colony area	100
F.	Land for Rehabilitation purposes	137.02
G.	Road land -New Road & Widening of existing road	177
H.	Area for Towers for 66 KV Line from Chimari to Project site and substation at Chimari	0.2275
I.	Area for Right of Way for 66 KV Line from Chimari to project site area	81
J.	Project Components & Construction Facilities	
(i)	Area for DT outlet & TRT outlet are on right bank	13.3
(ii)	Area for muck disposal, fabrication yard & aggregate processing plant	40
K.	Eme river/Diri river deposit (As per Construction Survey Material Report)	167
L.	Nizamghat- Sirki (As per Construction Survey Material Report)	108

S. No.	Name of Project Component	Area (ha)
M.	Aya river/ Aka river fan Deposit	373
	Total	**5827.8**

As a part of the field studies, survey of the affected households was conducted. The survey covered 43 villages comprising 859 PAFs / households. The total population of these households is 1877. Out of 859 PAFs only 115 PAFs / households of 5 villages will be affected due to submergence. Remaining 744 PAFs / households belonging to 39 villages are residing above submergence level but having jhum / agriculture land / properties below submergence level as well as having claims over USF land, which will be diverted for the construction of the project.

Five villages coming under the submergence area, are fully affected. The total families residing in these villages are 115 having a total population of 328.

Table 4: Villages likely to be submerged

S. No.	Name of Village	District	Status
1.	Awali (Suklanagar)	Dibang Valley	Fully Affected
2.	Eprali/ Alili	Dibang Valley	Fully Affected
3.	New Anaya	Dibang Valley	Fully Affected
4.	Kano	Dibang Valley	Fully Affected
5.	Pinli/Kebabolin	Lower Dibang Valley	Fully Affected

Details of socio-economic survey conducted in the above fully affected villages are given in Table 5:

Table 5: Details of Fully Affected Villages

S. No.	Name of Villages	District	Number of Households	Number of Population
1.	Awali (Suklanagar)	Dibang Valley	26	88
2.	Eprali / Alili	Dibang Valley	15	55
3.	New Anaya	Dibang Valley	53	126
4.	Kano	Dibang Valley	6	19

S. No.	Name of Villages	District	Number of Households	Number of Population
5.	Pinli / Kebabolin	Lower Dibang Valley	15	40
		Total	**115**	**328**

Thirty nine villages located above the submergence level but having jhum / agriculture land / properties below submergence level as well as having claims over USF land, which will be diverted for the construction of the project, will be partially affected. 744 PAFs / households having a total population of 1549 residing in these villages will be affected due to diversion of community land / USF for the construction of the project. Summary of partially affected families, which have been obtained from the socio-economic survey conducted in these partially affected villages located above submergence level have been presented below in Table 6:

Table 6: Details of Partially Affected Villages

S. No.	Name of Villages	District	Number of Households	Number of Population
1.	Akaya	Dibang Valley	7	28
2.	Amili	Dibang Valley	25	63
3.	Amrali	Dibang Valley	9	24
4.	Amuli	Dibang Valley	2	4
5.	Anelih	Dibang Valley	23	26
6.	Angolin	Dibang Valley	11	24
7.	Apako	Dibang Valley	8	23
8.	Aprunli	Dibang Valley	9	24
9.	Arzoo	Dibang Valley	32	120
10.	Atali	Dibang Valley	10	14
11.	Ataya	Dibang Valley	6	13
12.	Eprali/Alili	Dibang Valley	5	22
13.	Grinli	Dibang Valley	14	19
14.	Grunli	Dibang Valley	7	17
15.	Kronli	Dibang Valley	91	224
16.	New Endolin	Dibang Valley	37	123
17.	Ranli	Dibang Valley	7	22

S. No.	Name of Villages	District	Number of Households	Number of Population
18.	Shisho	Dibang Valley	18	32
19.	Wanli	Dibang Valley	18	24
		Subtotal (A)	**339**	**846**
1.	Alilido	Lower Dibang Valley	15	15
2.	Amali	Lower Dibang Valley	1	4
3.	Apali	Lower Dibang Valley	4	6
4.	Ato	Lower Dibang Valley	1	1
5.	Atoba	Lower Dibang Valley	9	15
6.	Brinli	Lower Dibang Valley	21	64
7.	Cheto	Lower Dibang Valley	22	25
8.	Chidu	Lower Dibang Valley	59	59
9.	Chimri	Lower Dibang Valley	4	4
10.	Ehali	Lower Dibang Valley	2	2
11.	Elopa	Lower Dibang Valley	84	84
12.	Elope	Lower Dibang Valley	22	50
13.	Erondo	Lower Dibang Valley	10	21
14.	Iluli	Lower Dibang Valley	20	42
15.	Ipili	Lower Dibang Valley	3	6
16.	Ithungo	Lower Dibang Valley	23	60
17.	Meyapa	Lower Dibang Valley	2	4
18.	Mrambo	Lower Dibang Valley	73	208
19.	New Chidu	Lower Dibang Valley	25	25
20.	Sindili / Ahokali	Lower Dibang Valley	5	8
		Subtotal (B)	**405**	**703**
		Total	**744**	**1549**

The estimation of land details of partially as well as fully affected families is based on field survey only as such there is no land area record available with the PAFs/land management wing of District Authorities.

The details of the families and villages getting affected is also under discussion with the District Level Rehabilitation and Resettlement Committees constituted by the respective Deputy Commissioners of Dibang Valley and Lower Dibang Valley Districts.

24. ASSESSMENT OF IMPACTS

Based on the project details and the baseline environmental status, potential impacts, as a result of the construction and operation of the proposed Dibang Multipurpose Project have been identified which are as under:.

IMPACTS ON LAND ENVIRONMENT

Majority of the impacts on land environment are temporary in nature, lasting mainly during the construction phase and often little beyond the construction period. The major anticipated impacts during the construction phase are as follows:

- Impacts due to Quarrying operations
- Impacts due to Operation of Construction Equipments
- Impacts due to Soil Erosion
- Impacts due to Muck Disposal
- Impacts due to Construction of Roads

Impacts due to quarrying operations

During DPR stage investigation of Dibang Multipurpose Project, availability of construction material was studied keeping in view the requirement of the construction material. About 0.74 lakh cum of shell material, 193 lakh cum of coarse aggregate, 96.50 lakh cum of fine aggregate and 0.26 lakh cum of impervious material will be required for construction of the project. The requirement of the construction material is to be met from river shoal/fan deposits only.

Impacts due to Operation of Construction Equipments

During construction phase, various types of equipment will be brought to the site. These include crushers, batching plants, drillers, earth movers, rock bolters, etc. The siting of these construction equipment would require significant amount of space. Similarly, space will be required for storing of various other construction equipments. In addition, land will also be temporarily acquired, i.e. for the duration of project construction for storing the quarried material before crushing, crushed material,

cement, rubble etc. Efforts must be made for proper siting of these facilities. During construction phase, there will be increased vehicular movement for transportation of various construction materials to the project site. Large quantity of dust is likely to be entrained due to the movement of trucks and other heavy vehicles. However, such ground level emissions do not travel for long distances. In addition, there are no major habitations in the project area. Thus no significant impacts are anticipated on this account.

Impacts due to Soil Erosion

The runoff from the construction sites will have a natural tendency to flow towards river Dibang or its tributaries. For some distance downstream of major construction sites, such as dam, power house, etc. there is a possibility of increased sediment levels which will lead to reduction in light penetration, which in turn could reduce the photosynthetic activity to some extent as it depends directly on sunlight. This change is likely to have an adverse impact on the primary biological productivity of the affected stretch of river Dibang and its tributaries. The impact is likely to be greater for the smaller rivers/rivulets, where large flow is not available for dilution, or are seasonal in nature.

Impacts due to Muck Disposal

The total excavation quantity likely to be generated at the project will be around 177 lakh cum, out of which 59 lakh cum will be common excavation. Effectively, total rock excavation will be 117.8 lakh cum. Out of 117.8 lakh cum of total rock excavation, approximately 35 lakh cum will be used for production of aggregate and remaining 82.84 lakh cum will have to be disposed of. Adding 25% to 60% bulkage factor for common excavation and rock excavation, the quantity to be disposed of would be 198 lakh cum.

The above said quantity of muck generated needs proper disposal, so that the disposed muck would not cause any ecological damage in the dumping area. In addition, necessary care should be taken to avoid any flushing down of the excavated material in the river during monsoon, as it may significantly bring down changes in the aquatic ecosystem of the river. Proper phytoremediation plan for muck disposal areas needs to be formulated and be applied during construction phase.

Impacts due to construction of roads

The topography of the project area has steep slopes, which descends rapidly into narrow valleys. The conditions can give rise to erosion hazards due to net downhill movement of soil aggregates. The project construction would entail significant vehicular movement for transportation of large construction material and heavy construction equipments. Some of the roads (19.5 km length) in the project area would require widening and many new roads (a total of 64 km length) would have to be constructed. The construction of roads can lead to removal of trees on slopes and reworking of the slopes in the immediate vicinity of roads which increases the vulnerability of the area to landslides, erosion gullies, etc.

TOTAL LAND REQUIREMENT

The total land required for the project is 5827.80 ha. The details are given in table 3.

IMPACTS ON WATER QUALITY

The major sources of water pollution during project construction phase are as follows:

- Sewage from labour camps/colonies
- Effluent from crushers

Sewage from labour camps

The project construction is likely to last for a period of 8 years. About 5000 workers and 800 NHPC employees (including family) are likely to congregate during project construction phase. The domestic water requirement of the labour / employee population is expected to be of the order of 0.40 mld @ 70 lpcd. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, the total quantum of sewage generated is expected to be of the order of 0.30 mld. The BOD load contributed by domestic sources will be about 237 kg/day. Even if the sewage is discharged without treatment in river Dibang, the flow required for dilution will be of the order of 9 cumecs. The minimum flows in river Dibang much higher than this flow, hence no major adverse impacts are anticipated. However, the sewage generated from labour colonies should be treated before disposal. Normally, during project construction, the labour population will be concentrated at 2 or 3 locations. Thus, the sewage/BOD loading would outfall into river Dibang at 2 or 3 locations.

Effluent from crushers

During construction phase, at least two crushers, one near the dam site and another near the powerhouse site will be commissioned. The total capacity of the crusher is likely to be of the order of 120-150 tph. Water is required to wash the boulders and to lower the temperature of the crushing edge. About 0.1 m3 of water is required per tonne of material crushed. The effluent from the crusher would contain high suspended solids. The quantum of effluent generated is of the order of 12-15 m3/hr. The discharge from the crushers is required to be treated before its disposal on land and/or water.

The various aspects covered as a part of impact on water quality during project operation phase are:

- effluent from project colony
- impacts on reservoir quality
- eutrophication risks.

Effluent from project colony

During the operation phase, due to absence of any large-scale construction activity, the cause and source of water pollution will be much different. Since, only a small number of O & M staff will reside in the area in a well-designed colony with sewage treatment plant and other infrastructural facilities, the problem of water pollution due to disposal of sewage is not anticipated. In the operation phase, about 500 families (total population of 2500) are likely to be residing in the project area. About 50 kiloliter/day of sewage will be generated @ 20 liter/person. Proper disposal measures for sewage are required to be implemented at the project.

Impacts on reservoir water quality

The flooding of previously forested and agricultural land in the submergence area will increase the availability of nutrients from decomposition of vegetative matter. Phytoplankton productivity can supersaturate the euphotic zone with oxygen before contributing to the accommodation of organic matter in the sediments. Enrichment of impounded water with organic and inorganic nutrients will be the main water quality

problem immediately on commencement of the operation. However, this phenomenon is likely to last for a short duration of few years from the filling up of the reservoir.

Eutrophication risks

Another significant impact which is generally observed in the reservoir is the problem of eutrophication and which occurs mainly due to the disposal of nutrient rich effluents from the agricultural fields. The fertilizer use in the project area is negligible, hence runoff at present does not contain significant amount of nutrients. Even in the post project phase, the use of fertilizers in the project catchment is not expected to rise significantly. Thus, in the post-project phase, problems of eutrophication, which is primarily caused by enrichment of nutrients in water, are not anticipated.

IMPACTS ON TERRESTRIAL FLORA

Increased human interferences

The direct impact of construction activity for any water resource project in a mountainous terrain, similar to that of the proposed project, is generally limited in the vicinity of the construction sites. A population of about 5800 people including technical staff and workers are likely to congregate in the area during the project construction phase. It can be assumed that the technical staff will not use wood as fuel. However, workers and other population groups residing in the area may use fuel wood (if no alternate fuel is provided) for whom firewood / coal depot could be provided. There will be an increase in population by about 5,800 of which about 4500 are likely to use fuel wood. On an average, the fuel wood requirements will be 10^{-3} m^3 per person per day. Therefore, the fuel wood requirement of 4500 labourers per year will be of the order of (10^{-3} x 365 x 4500) = 1643 m^3. The wood generated by cutting one tree is about 3 m^3. Thus, every year, fuel wood equivalent to about 548 trees will be cut for meeting fuel wood requirement, if no alternate sources of fuel are provided. Hence, to minimize felling of trees by the labourers, alternate fuel supply facilities have to be provided.

Acquisition of forest land

The total land requirement for the project is 5827.80 ha, of which 5056.50 ha is under forest cover. For this land, compensatory afforestation will be undertaken by the State Forest Department.

IMPACTS ON TERRESTRIAL FAUNA

Disturbance to wildlife

FRL of the proposed reservoir is at El 545 m and length of the reservoir is about 43 km which is confined to the river gorge. Animals like Mishmi Takin, Serrow, Snow Leopard and Himalayan Black Beer are found at high altitude in the catchment and as such no major impact is anticipated on these animals. Normally the animals easily change their niche to other forested areas.

During construction phase, a large number of machinery and construction labour will have to be mobilized. This activity may cause some disturbance to the wildlife population. The operation of various construction equipments is likely to generate significant noise, especially during blasting. The noise may scare the fauna in the region and force them to migrate to other areas.

Impacts on migratory routes

The faunal species observed in the project area are not migratory in nature. The construction of the proposed Dibang Multipurpose Project will form a reservoir, and is not expected to have any impact on the migratory route. The river in the pre-project scenario, runs through the gorge portion, and acts as a barrier to the movement of fauna; as a result no major migratory route has developed. Thus, no adverse impact on migratory routes is anticipated as a result of the proposed project.

Impacts on Mehao and Dibang Wildlife Sanctuaries

Mehao Wildlife Sanctuary is located in south-east direction at a distance of about 11 km from reservoir periphery. Likewise, Dibang Wildlife Sanctuary is located in north-east direction at a distance of about 35 km from tail end of the reservoir. Since, wildlife sanctuaries are quite away and no portion of these wildlife sanctuaries is getting affected, as a result of the proposed project, hence no impact on fauna is anticipated as a result of the construction and operation of the proposed project.

IMPACTS ON AVI-FAUNA

The project area and its surroundings are quite rich in avi-fauna. With the damming of the river, a reservoir of an area of about 4009 ha will be created, with

quiescent/tranquil conditions. The reservoir banks will have wet environment throughout the year which can lead to proliferation of vegetation e.g. grass, shrubs etc. along the reservoir banks. Such conditions are generally ideal for various kinds of birds, especially, water birds. This is expected to increase the avi-faunal population of the area.

IMPACTS ON AQUATIC ECOLOGY

During construction phase of the proposed Dibang Multipurpose Project, large quantity of building material like stones, pebbles, gravel and sand would be needed for construction of various project appurtenances. The cumulative impact of this activity may result in increase in turbidity level. Good dredging practice can however minimize turbidity.

The second important impact is on the spawning areas of cold-water fisheries. Almost all the cold-water fish breed in the flowing waters. The spawning areas of these fish species are found amongst pebbles, gravel, sand etc. The eggs are sticky in nature and remain embedded in the gravel and subsequently hatch. Any disturbance of stream bottom will result in adverse impacts on fish eggs. Thus, if adequate precautions during dredging operations are not undertaken, than significant adverse impacts on aquatic ecology are anticipated.

The damming of River Dibang will result in creation of 4009 ha of submergence area. The dam will change the fast flowing river to a quiescent / lacustrine environment. The positive impact of the project will be the formulation of a water body which can be used of fish stocks on commercial basis to meet the protein requirement of region. Since construction of the dam affects the flow of water in the river, the river bed below the dam site gets invariably affected and many a time a long stretch of river bed down stream of a dam gets affected due to reduction in the quantum of water. However, in case Dibang Multipurpose project, the Power House is proposed to be constructed very close to the dam and as such there are very low chances of the down stream of the dam getting dried up. However, the minimum flow of water required for the maintenance of aquatic flora and fauna, especially fish, be maintained in the downstream of the dam at least up to tail water discharge point. Proper measures for fish conservation and management may be proposed in the EMP report.

The construction of dam also will not affect the water requirement of the population residing in the downstream areas. This population generally depends upon the local streams and springs for drinking purpose and for other domestic uses. There is also no competitive use of water downstream of dam for industrial purposes. Therefore, the impact of damming on the downstream areas is not anticipated.

IMPACTS ON MIGRATORY FISH SPECIES

The obstruction created by the dam would hinder the migration of certain commercial species especially the Mahseers (from downstream to upper reaches) and *Schizothorax* (from upper reaches to the lower reaches). These fishes undertake annual migration for feeding and breeding. Finding their migratory path obstructed due to high dam, they are expected to congregate below the dam wall and will be indiscriminately caught by the poachers. Proper mitigatory measures, therefore, have been proposed in the EMP report.

IMPACTS ON NOISE ENVIRONMENT

In a water resource project, the impacts on ambient noise levels are expected only during the project construction phase, due to operation of various construction equipments. Likewise, noise due to quarrying, blasting, vehicular movement will have some adverse impact on the ambient noise levels in the area. The noise is also generated due to blasting during tunneling operations. Since there are no major habitations in the nearby areas of project site, it is not likely to have any effect on habitations.

AIR POLLUTION

In a water resources project, air pollution occurs mainly during project construction phase. The major sources of air pollution during construction phase are pollution due to fuel combustion in various equipments, emission from various crushers and fugitive emissions from various sources. The short-term increase in SO2, even assuming that all the equipments are operating at a common point, is quite low. Hence, no major impact is anticipated on this account on ambient air quality. However, plan for air quality management is required to be formulated especially for the construction stage of the project in which there will be large movement of vehicles and operation of various equipment, generators etc. which may impair the air quality of the project area

IMPACTS ON SOCIO-ECONOMIC ENVIRONMENT

The construction phase will last for about 8 years. The peak strength of labour force and NHPC staff is estimated at about 5800 (including family members). During construction phase, the basic problem will be related to management of large population which migrate to the construction area in search of jobs. Those who would migrate to this area are likely to come from various parts of the country having different cultural, ethnic and social backgrounds. Such a mixture of population has its own advantages and disadvantages. The advantages include exchange of ideas and cultures between various groups of people which would not have been possible otherwise. Due to longer residence of this population in one place, a new culture, having a distinct socio-economic similarity would develop which will have its own entity. Work opportunities will drastically improve in this area.

II. ENVIRONMENTAL MANAGEMENT PLAN

Environmental Protection and Sustainable Development have been the cornerstones of the policies and procedures governing the industrial and other developmental activities in India. The Ministry of Environment and Forests has taken several policy initiatives and enacted legislations to prevent indiscriminate exploitation of natural resources. One such initiative is Environmental Impact Assessment (EIA) Notification of developmental projects issued on 14.09.2006 under the provisions of Environment (Protection) Act, 1986 making EIA mandatory for 39 categories of developmental projects.

Any water resource management project that requires the construction of dam and/or a reservoir can provide significant economic and environmental benefits in its capacity as a renewable energy source. However, the adverse environmental effects of such a project can also be substantial. In order to make the Dibang Multipurpose Project fully eco-friendly and ameliorate all possible negative impacts on the economy and ecology of the area, the Environmental Management Plans for the proposed project, including Resettlement and Rehabilitation Program for the project affected human population, have been prepared based on the findings of the EIA study. Following management measures are suggested so as to ameliorate the negative impacts as well as to enhance the positive impacts:

1. CATCHMENT AREA TREATMENT

In order to minimise the damage to the project as well as the immediate environment, the watershed management programmes involving extensive soil conservation measures in the catchment have assumed tremendous importance.

The total catchment area of the Dibang River up to the proposed Dam site 11276 sq km. The directly draining catchment is 59811.88 ha, which constitutes the study area for CAT. The directly draining catchment comprises nine sub-watersheds around the proposed reservoir area from the confluence of river Tangon with river Dibang up to the Dam site. The hierarchical delineation system developed by AISLUS (AISLUS Technical Bulletin - 9) was followed for the demarcation of sub-watersheds within the study area. The codification system as given in Watershed Atlas of India (AISLUS)

was followed for Dibang catchment on 1:50,000 Survey of India topographical sheets. Directly draining catchment of river Dibang divides into nine sub watersheds.

Land use and land cover mapping of the study area was carried out by standard methods of analysis of data through remote sensing technique coupled with GIS, followed by ground truthing. Geo-coded LISS-III data on CD ROMs and hard copies on the scale 1: 50,000 (available for the year 2003) were procured for digital image processing and preparation of thematic maps. The landuse landcover map is prepared using GIS mapping where inputs of toposheets of the catchments area and satellite imageries are used to come out with the land use / land cover pattern. The prioritization of the hydrologic units within the vast catchments is based on the Sediment Yield Indices (SYI) of the smaller units. The subwatersheds are subsequently rated into various categories corresponding to their respective values.

For the catchment area treatment areas falling under very severe and severe erosion intensity categories i.e., 10539.56 ha will be required for treatment. Various engineering and bioengineering measures like brushwood check dams, contour bunding, gabion structures, loose boulder check dams and silt retention dams are suggested for the very severe and severe erosion intensity areas. In addition, biological measures like plantation of shrubs and trees are also suggested for these areas.

In the upper catchment of the subwatersheds brushwood check dams are proposed to control the erosion in the first order basin. The whole length of the streams are segmented into 50 m interval and depending upon the gradient a total of 1276 brushwood check dams are proposed. In first order basin in the lower reaches, where discharge is higher and valley length is less, at 30 m intervals loose boulder check dams are proposed. Therefore, a total of 768 loose boulder check dams are proposed. In those areas where discharge is much higher, 259 gabion structures are proposed. In those areas where erosion intensity is severe and very severe contour bunding is proposed. Therefore, a total of 82 contour bunding will be constructed. In third order and more than third order basin 124 silt retention dams are proposed. It is seen that about 12 % and 18 % of the area are composed of open forest and degraded forest /

abandoned jhum, respectively. Therefore, about 12 % of the total area of subwatershed shall be treated by means of plantation.

The plan needs to be implemented in a phased manner so as to attain the goals set successfully. Keeping in view the local topography and climate, it is proposed to complete the CAT programme in five years. A micro-level planning shall be done by State Forest Department at the time of implementation of CAT plan.

In order to help reduce the erosion of soil and its transport to the reservoir it is suggested to undertake plantation of shrubs as well as trees, wherever the soil characteristics permit, in the various subwatersheds. A total of 770 ha of land are proposed to be planted by different plant species.

2. BIODIVERSITY CONSERVATION AND MANAGEMENT PLAN

Extensive floral and faunal survey carried out in the project area, has enabled to identify the rare and endangered species likely to be affected by the project. In the following paragraphs the mitigation measures are suggested for translocation and relocation of the species. General measures are also suggested for conservation plan of flora and fauna.

Following plants are mentioned under the category of endangered species which require measures for conservation:

Albizia arunachalensis	Endemic
Angiopteris evecta	Habitat loss & destruction
Coptis teeta	Endemic & over exploited (Vulnerable – as per BSI's Red Data Book of Indian Plants)
Cyathia spinulosa	Habitat loss & destruction
Entada pursaatha	Habitat destruction, narrow distribution
Gynocardia odorata	Rare and habitat destruction
Podophyllum hexandrum	Rare
Rhododendron edgeworthi	Rare
Taxus wallichiana	Over exploited

The peculiar topography, the area and the location of the dam on a comparatively narrow gorge, perhaps makes the creation of a comparatively long reservoir submerging more than usual, large forest area obligatory in this case. However, it is suggested that while clearing the forest area to be submerged, the Forest Department should take adequate care to translocate the rare species of plants particularly orchids, tree ferns and medicinal herbs and shrubs to other adjoining forest areas as far as feasible and the Project Authority should fully co-operate in this job. These should also ensure that their men and machineries create the least disturbance in the neighbouring forest areas.

Ex situ conservation is one of the conservation methods, which involves the conservation of components of biological diversity outside their natural habitats (CBD, 1992). Creation of botanic garden is proposed for *ex-situ* conservation of endangered plants found in Dibang catchment area. It is proposed to afforest rare and endangered species over an area of 50 ha (as a part of compensatory afforestation) as a measure for *ex-situ* conservation and propagation. The rehabilitation plots are to be at least the size of 35 ha for trees and 10 ha for shrubs and 5 ha for herbaceous plants.

There are many important trees and superior germplasm in the area particularly of timber species and bamboos. Germplasm banks may be created with the materials obtained from it. Though the same species could be found elsewhere, the germplasm may not be available. The propagation and cultivation of these species may be done in co-ordination with the State Forest Research Institute (SFRI), Itanagar or Regional Forest Research Institute, Jorhat. Similarly NERIST and RRL could take up some aspects of the study and action. The Forest School at Roing Range offices located at Roing and Santipur are key players in rescue and rehabilitation.

In addition, an orchidarium and a fern house are proposed to be developed in the project area, in which important species of orchids and ferns collected from the catchment area will be conserved.

A large number of animals like Goral, Takin, Snow-leopard, Hoolock gibon. Assam Macaque, Mithun, Himalayan Black Bear, Wild Dog, Leopard, Clouded leopard,

Leopard cat, Jungle cat, Pangolin etc. are reported to be residents of this catchment. Even tigers may be sighted within the lower reaches. There are a large number of other species of deer, monkeys, antelopes, wild boar and smaller animals like mongoose, civets and squirrels that live in these forests. It is mentioned that, no part of Mehao and Dibang Wild Life Sanctuaries will be affected either due to construction activities or due to submergence. It is expected that as the clearing of forest progresses, the wild animal population, including birds, will by natural instinct migrate to neighbouring safer places. However it is important that the adverse impact of the proposed Dibang Multipurpose Project on the faunal resources is kept at the minimum level. The Project Authority must take certain precaution that the labour force engaged in the construction work or the floating populations of outsiders, who visit the site for business, do not come in conflict with the wildlife population in the working area as well as its neighborhood forests. If possible, carrying firearms in the project area and its vicinity should be banned. Use of explosives and blasting material should be rigidly controlled and kept to the minimum.

It is proposed that provision for revival of the Zoo at Roing and development of a Butterfly Park in the project area may be kept.

3. FISH MANAGEMENT

High river discharge, fast water currents and want of suitable spawning ground in the lower reaches of the river are the reasons which force the fish to swim upstream in search of suitable eco-system to spawn.

Creation of a barrier in the form of a dam across the migratory path of some fishes may considerably undermine the survival and breeding of fishes. Hence hatchery in the nearby areas is the most suitable proposition for the fish population.

For the development of cold-water fishery in the area, construction of a Hatchery is the most important. The location of the hatchery can be identified somewhere near Etalin in consultation with the State Fisheries Department and State Fishery Colleges. The fish hatchery can be managed by the State Fisheries Department, which may be equipped with the technical know-how for running trout and carp culture fisheries. The

total hatchery of 1.5 ha area would require about 15-20 kg seeds for the stocking in the first year.

4. GREEN BELT DEVELOPMENT

Although the forest loss due to the reservoir submergence and construction of other project appurtenances have been compensated as a part of compensatory afforestation. However, in addition to above, it is proposed to develop greenbelt around the perimeter of various project appurtenances, selected stretches along reservoir periphery, etc.

5. GEO-ENVIRONMENTAL MANAGEMENT PLAN

Geo-Environmental Management Plan is formulated to protect and/or improve the reservoir zone and to provide stability to the reservoir. There are 60 landslides in the reservoir area that are classified into small (10 landslides), medium (38 landslides) and large (12 landslides) categories based on their dimension and area. Following are the Mitigation Measures suggested for controlling the Landslide in the Project area

a. Rock anchoring, carving out of slopes, shot creting etc. should be planned.
b. The impact of landslide on the project could be managed by arresting the potential landslides zones through suitable engineering treatments like retaining walls, afforestation etc.
c. Landslide Control with Coir-Geotextile.

6. MUCK DISPOSAL PLAN

The Dibang Dam of 288 m height is proposed at 1.5 km upstream from Ashu Pani river near Munli in Lower Dibang Valley district of Arunachal Pradesh. The proposed project would involve a number of civil engineering activities leading to production of large quantities of muck. This muck would be excavated from the HRTs & TRTs during the tunnelling, construction of desilting arrangement, underground power house complex, approach roads etc. Even though some of the muck will be utilized for back filling, yet a large quantity of the excavated material will need to be relocated and dumped in such a manner that it does not impose any negative impact on terrestrial and aquatic environment.

The total excavation quantity likely to be generated at the project will be around 177 lakh cum, out of which 59 lakh cum will be common excavation. Effectively, total rock excavation will be 117.8 lakh cum. Out of 117.8 lakh cum of total rock excavation, approximately 35 lakh cum will be used for production of aggregate and remaining 82.84 lakh cum will have to be disposed of. Adding 25% to 60% bulk factor for common excavation and rock excavation respectively, the quantity of muck to be disposed of would be 198 lakh cu.m. Three muck disposal areas have been identified for accommodating 198 lakh cum of muck generated. However, the capacity of the three dumping sites is 220 lakh cum. The unused material (198 lakh cum of muck) would be piled at an angle of repose at the proposed dumping sites. For the stabilization of dumped materials various engineering and phyto-remedial measures are being proposed in the management plan. The work plan formulated for re-vegetation of the muck disposal areas through "Integrated Biological and Biotechnological Approach". The afforestation with suitable plant species of high ecological and economic value, which can adapt to local habitat, will be undertaken.

Areas of approximately 120 ha, would require phytoremediation measures. The Cost for remediation includes the cost of turfing of slopes, preparation of ground, spreading of manure, providing 5 cm of soil cover, provision of retaining wall and transportation and carriage etc. It also includes the cost of fencing, watch and ward, irrigation, etc.

7. RESTORATION PLAN FOR QUARRY AREAS

Three rock quarries namely DBR-1, DBR-2 and DBR-4 located within 5 km upstream of dam axis have been explored. The possibility of utilising excavated muck likely to be generated during excavation from dam abutments, powerhouse and tunnels (DBR-3, DBR-5 & DBR-6) was also explored to minimize quarrying from rock quarries.

Three shoals / fan deposits namely DBG-1, DBG-2 &DBG-3, located within 13.5 km downstream of dam axis have been identified and explored extensively to establish the suitability of the same for use as coarse and fine aggregate for concrete.

Only two quarry sites i.e. Epali Impervious soil deposit site DBC -2 (located 13.5 km downstream of Dam between Aya Korang fan deposit and Eme river), and Yagang Impervious soil deposit DBC-3 (30km downstream of Dam) will only require

restoration. It is suggested that for stabilization, grass, herbs & shrubs should be grown over these slopes. An area of 82 ha will be required to be restored through engineering and biological measures. The plantation could be proposed over 60% of the quarry area to be restored. Remaining area i.e. 33 ha will be taken up for turfing.

8. LANDSCAPING AND RESTORATION OF CONSTRUCTION AREAS

As a part of various project related activities it is also proposed to develop nature parks, Children parks, gardens, and other recreation facilities near the project area once the construction activities of the project are over. During the construction of main features like Dam, Tunnels, Power House and other building structures of the project including residential and project roads, various slopes may be disturbed which shall be stabilized using bio-engineering measures like benching and terracing and plantation of grasses, herbs, shrubs and trees.

9. PUBLIC HEALTH DELIVERY SYSTEM

During the construction period of the project, a population of about 5000 migrant labourers (including family members) needs to get vaccinated against infectious diseases. The identified possible health threat due to dam construction and other peripheral activities as identified in the EIA study were analysed and suitable measures are suggested for mitigating the threats. Recommendations for regular health check-up and programme for checking endemic disease is also suggested. Suggestion for health facilities and infrastructure is made and cost estimation for the same also is given.

10. SOLID WASTE MANAGEMENT AND SANITATION FACILITIES

The residential colonies of the Dibang project will be located on the right and left bank of the Dibang River. The colonies will be of two types, one for the NHPC employees and their families, with an approximate population of 800, and, the other for labourers, with an approximate population of 5000 (peak labour requirement). In addition to this, during construction stage it is expected that about 100-200 people from nearby villages will visit project site everyday for commercial purposes and constitute the regular floating population. This floating population may also generate Solid Waste Management System.

The quantity of waste generated in Indian cities reported to be in the range of 0.2-0.6 kg/capita /day as per the "Manual on Solid Waste Management" prepared by Central Public Health & Environment Engineering Organisation (CPHEEO), Ministry of Urban Development, Govt. of India. As the major share of the population is labour force in Dibang, the waste generation factor of 0.3 kg/capita/day has been taken into consideration.

The recommended Solid Waste Management system for the project is presented below:

- Segregation of Solid Waste at source
- Storage & primary collection of waste from project colonies, offices, guest houses, labour colonies/sheds, minor commercial establishments, market, community centre, Hospitals, workshops, canteen/mess, school, garden, parks etc.
- Waste Transportation mechanism
- Waste Storage Depots/enclosures
- Waste Processing & Disposal

Administratively, a Solid Waste Management Committee (SWMC) comprising of the project representatives will look after the management of solid waste. The SWMC will be supported by sanitary workers, sweepers etc., the number of which may be decided by the SWMC after assessing the work requirement.

For biodegradable part of SW, it is recommended to plan a Composting Plant of about 1 ton per day capacity. The land requirement etc. could be based on 1 ton per day capacity, but initially, the composting process may be started with requirement of present day only (0.8 ton/day capacity). The compost plant may follow Windrow Composting Technology which has been recommended as a suitable technology for Indian conditions.

In order to handle the present load of biodegradable waste (around 1 ton/day), around 267 m^2 of area would be required for windrow-platform. As per the requirements of the Municipal Solid Waste (Solid Waste Management & Handling) Rules 2000, land filling would be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing.

11. ENERGY CONSERVATION MANAGEMENT PLAN

It is estimated that during the construction of the project, which would last for about 8 years, around 5000 labourers (including family members) will be working during the peak construction period. To provide an alternate for the energy requirement of the workers, contractor/s will be made responsible to provide subsidized kerosene/LPG to their workers which will in turn discourage them from illegal tree felling and removal of fuel wood and timber from the adjoining forests. Further, community kitchen facilities would also be provided to the labourers by the contractors. Conventional Kerosene oil Stoves is a good substitute for fuel wood and will be distributed amongst the workers and the locals in the nearby villages. The distribution of the pressure cookers may also be taken as one of the attractive option for energy saving. Provisions may also be made for availability of smokeless chullhas to the workers and villagers. These chulhas are scientifically designed for optimal regulation of heat flow and better fuel utilization. These improved chullhas not only economies fuel wood consumption but also help in keeping the house clean, i.e. free from smoke and also help in preventing eye ailment due to smoke.

12. REHABILITATION AND RESETTLEMENT PLAN

The objectives of the Resettlement and Rehabilitation Plan envisaged for Dibang Multipurpose project are to provide assistance and other support to the PAFs so that they regain their previous standard of living; even improve if possible, within a reasonable transition period and pay compensation for the loss of land, houses and all other immovable properties to the PAFs as per the State Rehabilitation and Resettlement Policy, 2008 of Arunachal Pradesh and Land Acquisition Act (LAA) 1894. Project will provide adequate compensation to the project affected tribal community for extension of tradition right and privilege of USF land use and collection of forest produce.

The Rehabilitation component primarily means to assist the affected population so that every individual could regain or improve lifestyle and socio-economic condition. This is done primarily by imparting skills and/or vocational training to the PAPs. Resettlement on the other hand, primarily involves the physical relocation of the affected population to new residential sites. The Rehabilitation package is conceptualized around a development strategy to bring about a positive socio-economic transformation of the

PAFs, so as to improve the quality of their life and also to facilitate harmonious relationship between the project proponent and project affected people.

12.1. Resettlement and Rehabilitation Grants

12.1.1. Compensation for land alongwith rights and privileges: The process of land acquisition will be dealt by NHPC alongwith PAFs and Government of Arunachal Pradesh. Land for various components involves Unclassed State Forest (USF), community land without forest cover and land under wet rice cultivation (WRC). PAFs shall be compensated as per the norms of State Government for the community land. The community shall be compensated @ **Rs 1.56 lakhs/ ha** for loss of customary rights and privileges of tribal people to collect and use forest produce (traditional land use) from USF. In addition to this, the community will be paid a sum equivalent to **25 %** of Net Present Value (Rs. 42980.25 lakhs @ Rs 8.5 lakhs/ha for 5056.5 ha) of the USF. Community land without forest cover and land under WRC will be paid @ Rs 1.75 lakhs/ha. Compensation for crops will be paid @ Rs 1.25 lakhs/ha for land under jhum cultivation and Rs 1.5 lakhs/ha for land under WRC.

12.1.2. R & R Benefits: The budgetary provision of R & R benefits is presented in the following Table 7:

Table 7: R & R Benefits with budget

S. No.	Benefits	Criteria	Amount (Rs. in lakhs)
1.	Homestead land	Max. 0.025 ha @ Rs 1.75 lakhs /ha for 115 PAFs	5.00
2.	House construction grant	2 lakhs/PAF for 115 PAFs	230.00
3.	Compensation for land	Rs 1.75 lakhs/ha for 2 ha for 115 PAFs	402.50
4.	Ex-gratia payment for landless	Rs 50,000/PAF for 115PAFs	57.50
5.	Ex gratia payment for those who are left with less than 1 ha of land	Rs 40000/PAF for 744 PAFs	297.60
6.	Land development assistance	Rs 25,000/PAF for 115 PAFs	28.75
7.	Livelihood grant for landless	1000 days MAW @ Rs 100/day for 115 PAFs	115.00

S. No.	Benefits	Criteria	Amount (Rs. in lakhs)
8.	Livelihood grant for those who are left with less than 1 ha of land	750 days MAW @ Rs 100/day for 744 PAFs	558.00
9.	Financial assistance for self employed persons	Lump sum	20.00
10.	Transportation grant	Rs 20000/PAF for 115 PAFs	23.00
11.	Assistance for construction of cattleshed	Rs 15000/PAF for 115 PAFs	17.25
12.	Subsistence allowance	25 days MAW @ Rs. 100 per day for 12 months for 115 PAFs	34.50
13.	Scheduled Tribe Family Grant	Rs 50,000/PAF for 859 PAFs	429.50
14.	Provision of annuity policies for pension for life to vulnerable affected persons @ Rs. 500/ month	Lump sum	30.00
15.	Free electricity @ 100 units per PAF per month	Lump sum	50.00
	Total		**2298.60**

**Exact number of PAFs left with less than 1 ha of land would be identified by District Administration during implementation of R&R Plan.*

12.2. Application for Grant and Grant Distribution

The Commissioner / District Magistrate or his/her representative not below the rank of ADM / SDM from Dibang and Lower Dibang Valley District will be the sanctioning authority for the rehabilitation grant, which shall be provided by the project authorities. Affected family / person will apply on a general prescribed form, which will furnish the information of the village, details of his/her land acquired, family status, etc. The form will be submitted to the project office and evaluated by Land Acquisition Officer and General Manager of NHPC Ltd. After receiving the list of PAFs by District Magistrate, the options will be invited from head of affected family on stamp paper and this will be routed through SDM concerned. District Magistrate shall be the final authority to sort out the disputes between affected families and the project authorities. All stamp duty and fees of registration shall be borne by the project developers. After submitting all the necessary documents, R&R cell would disburse the compensatory amount to the

affected person. If there is any dispute between affected person and the project, Commissioner / DM can interfere to sort out the disputes. Alternatively, if GoAP directs NHPC for distribution of grant then the R&R cell of NHPC would distribute the grants by involving a reputed NGO or civil society group as agreed upon by the Administrator (R&R).

12.3. Infrastructure Facility at Resettlement Site / Colony

Project Affected Families will be resettled to a new location. New Resettlement sites shall be finalized by the Administrator (R&R) in consultation with PAFs and it will be developed with all the basic infrastructural facilities well before the filling of reservoir. Fully affected families shall be resettled in a group to maintain their socio-cultural compatibility. The basic amenities to be provided in the resettlement colonies are given as Table 8

Table 8: Financial Outlay for providing infrastructural facilities

S. No.	Parameter	Criteria	Total Cost (Rs. lakhs.)
1	Water supply	Lump sum	60.00
2	Community toilets	Lump sum	30.00
3	Development of sewage treatment system including drainage system	Lump sum	60.00
4	Electrification and Street lights	Lump sum	100.00
6	Construction of shopping complex	Lump sum	30.00
7	Construction of community centre	Lump sum	100.00
8	Construction of vocational activity centre	Lump sum	60.00
9	Children's park	Lump sum	40.00
10	Avenue plantation & block plantation	Lumpsum	20.00
11	Internal roads in the resettlement colony	Lump sum	250.00

S. No.	Parameter	Criteria	Total Cost (Rs. lakhs.)
12	Link roads to the resettlement colony	Lump sum	4000.00
13	Irrigation facilities to PAFs	Lump sum	175.00
14	Construction of Hospital Building	Lump sum	150.00
15	School Complex including play ground	Lump sum	150.00
18	Miscellaneous	Lump sum	100.00
		Total	**5325.00**

The above-mentioned facilities will also be available to the host population and the neighboring community in the Resettlement colonies/sites. The responsibility of project authority shall be limited to incurring one-time capital cost for creation of these facilities. Efforts will be made to involve PAFs in creation of these infrastructure facilities by giving contracts to their co-operative societies or otherwise for construction works to the extent possible. This will also help in developing a sense of ownership among the PAPs regarding these facilities.

Table 9: Summary of Budget for Resettlement & Rehabilitation Plan

S. No.	Parameters	Total Cost (Rs. lakhs.)
1.	R&R Benefits	2298.60
2.	Compensation of land and rights and privileges	21369.58
3.	Basic amenities in the resettlement colony	5325.00
4.	Community and social development	4500.00
5.	Monitoring and Evaluation	50.00
	Total	**33543.18**

**Cost of Govt/Community properties is not included and is still under assessment at DCs level.*

12.4. Lump Sum Cash Assistance

All the affected families shall be given an option to take a lumpsum cash amount in lieu of one or more the benefits specified in the R&R package, depending upon their entitlement.

13. COMMUNITY AND SOCIAL DEVELOPMENT PLAN

Community and Social Development Plan (CSDP) will be taken up by the project for social and community development activities in and around project affected areas including vocational training for self employment, infrastructure development in affected area including approach roads, community buildings, health and hygiene facilities, water supply, programmes to encourage students/entrepreneurship etc. CSDP has been framed based on the inputs received from PAFs, senior citizens, Panchayat leaders and *Gram Budha* of the local area. The aims of Community and Social Development Plan are given below**:**

- CSDP will aim principally to support and facilitate training programmes to create self-employment amongst the communities in the affected zone viz. in computer application, poultry farming, animal husbandry, dairy, handicrafts, knitting, tailoring, etc.
- Vocational trainings would be imparted based on literacy, basic aptitude and skill level of the affected PAPs, local products available and scope for developing a sustainable market. The selection of candidates for various training and the associated procedures will be decided by the CSDP execution committee which will include representatives of district administration, elected members, project authority, panchayat members etc.

In addition of the above, NHPC Ltd. has decided to undertake the initiative for the preservation cultural identity of the local tribal. All efforts would be made by NHPC in consultation with the State Govt. and local public representatives to maintain the cultural identity of the people. The requirement of labourers will be in a phased manner. All efforts would be made to keep the labour population to the minimum. Maximum deployment would be only during peak construction period. All statutory guidelines will be followed during influx of labour population. All precautionary

measures shall be taken by the project with the help of District Administration, NGO and elected representatives to avoid any adverse impact on demographic status of the local area.

14. DISATER MANAGEMENT PLAN

The study of catastrophic flooding that may occur in the event of a dam failure is of great concern and importance because of the risk of life and property in the potentially inundated reaches downstream of the structure. In fact the evaluation or determination of the submersion wave of dam break due to extreme flood events is an initiative needed for defining the risk of submergence of areas located downstream of the existing dams and consequently to prepare protective measures, both active (reservoirs, dikes) and passive (emergency and evaluation plans) in the areas affected.

The topographic characteristic varies significantly within the computation domain. The river passes through deep gorges, terrains with pebbles and boulders and then through alluvial plains. Most of the portion on downstream of the dam lies in the plains.

The expected flood due to the failure of the proposed dam has been analyzed. The channel sections for the entire width have been approximated as parabolic channel for the purpose of computing dam break flow passing over the terrain. The difference in flow depth computed by the (i) concept of rectangular channel of limited width and (ii) concept of parabolic channel of entire cross section. From the comparison it is clear that the flow depth computed by considering the parabolic channel is realistic as the depth drops with the expansion of the channel, which is logical. However, for making disaster management plan we suggest to increase the depth by 10% than that computed by the parabolic section, as the channel section has been approximated.

In the event of any breach, it is to be ascertained that losses to lives and properties could be kept at minimum by administering the feasible measures. To achieve this, non-structural measures are found to be substantially effective. The important measures are:

i. To provide flood forecasting services and quick dissemination of forecasts to

important and heavily populated towns, villages, including other potential areas.

ii. To formulate flood proof communication system, and

iii. To form a disaster mitigation network/system, including relief fund.

It is suggested that the project authorities should prepare some thing like a mission plan which can be called as master plan setting out the over all frame work within well laid policies.

Plans at lower levels like districts, sub division should be worked out in consultation with local administration and communities. At this level it should be tailor made to more specific confidences.

The project area being under seismic Zone-V disaster management gains much importance both due to earthquake, change of river courses and floods. Financial provisions for a corpus fund and annual budgetary provisions for ten years are included in the EMP. However the project authorities in collaboration with the district administration, concerned Flood Control Boards and disaster management cells established under Govt. of India should collaborately plan out a strategy for making full preparedness to reduce the damage to life and property and misery of the people.

Emergency Action Plan includes evacuation plans and procedures for implementation based on local needs. These are:

- demarcation/prioritization of areas to be evacuated,
- notification procedures and evacuation instructions, .
- safe routes, transport and traffic control.
- Shelter areas, and
- functions and responsibilities of members of evacuation team.

The flood prone zone in the event of dam break of Dibang shall be marked properly at the village locations with adequate, factor of safety. As the flood wave takes sufficient time in reaching these villages, its population shall be informed well in time through wireless and sirens etc. so that people may take shelter at some elevated place beyond the flood zone which has been already marked as safe.

The copies of the Emergency Action Plan should also include the inundation map, which would be displayed at prominent locations and in the rooms and locations of the personnel named in the notification chart. Inundation maps will be displayed in the Village Panchayats nearby the project area and also of the villages falling under flood prone zone. For speedy and unhindered communication, a wireless system will be a preferable mode of communication. Telephones would be kept as backup, whenever required.

The Dam break analysis of Dibang dam has been carried out using three different FD schemes. Out of all these schemes the most convenient one, namely the FD Diffusive scheme has been tested for its validity with laboratory data generated elsewhere and then adopted for computing various information, required for preparation of disaster management plan to mitigate flood hazard in the event of failure of the dam. Computed result has shown that several villages located at the downstream side of the dam is expected to be flooded in the event of instantaneous failure. The inundation area shown in the fig will be more by 10% in terms of depth of submergence. This has to be taken into consideration as a safety margin, while preparing the actual disaster management plan for any eventuality of breaking of the DAM.

15. MAINTENANCE OF AIR, WATER AND NOISE QUALITY

At present no developmental activities such as industries etc. are going on in the upstream of the catchments as well as proposed reservoir, therefore, any probabilities of water quality degradation are minimal. From the water testing results as shown in EIA report it can be well inferred that the quality of water of the Dibang river is reasonably of good quality. Also, that there are hardly any human habitations draining their refuse into the river which could charge the nutrient status of the river waters and bring about degradation of the Dibang aquatic eco-system. However, the project authority should take effective and proactive measures to ensure that such activities would not be carried out in the upstream catchment, which may bring about water quality degradation in the future as well. Necessary financial outlay for establishing water quality testing has been kept in the Plan for Environmental Monitoring.

In case of Hydropower Projects the Air and Noise pollution basically occur during the construction period when different project related activities like stone crushing, use of

diesel generators, muck disposal, etc are undertaken. It is therefore recommended that necessary preventive measures be taken during all those activities that can lead to air and Noise pollution. The various crushers need to be provided with wet scrubbers to control the dust generated while crushing the stone aggregates. It should be made mandatory for the Contractor involved to install cyclone separators/ scrubbers in crushing plants. During the execution of the project, due care has to be exercised to minimise the exposure of workers to excessive noise. As far as possible even consideration is to be given to locate the Site office, Stores, etc. in the minimal noise locations. Appropriate safety measures for workers (e.g., protective equipment for workers like ear protectors, ear muffs, ear plugs / defenders) to protect from high noise levels need to be adopted.

16. ENVIRONMENTAL MONITORING PROGRAMME

An Environmental Monitoring Cell (EMC) will be formed in order to assess and review the progress of the various mitigation measures suggested in the Environmental Management Plan. The committee will sit at predetermined intervals for verifying progress and reporting the same. The project authority shall depute a Senior Officer to coordinate with the monitoring committee.

The project authority will engage neutral agency or organization for supervision and monitoring of the environmental management components as discussed below. The project authority will also depute a full time Sr. Officer to look and co-ordinate the progress of the environmental management activities. The independent supervising agency will work closely with the project environmental cell and will carry out necessary laboratory analysis, collection of data's and information regarding the progress and will prepare the progress report in every two months and will present to the Monitoring Committee through the environmental cell. For any major comments or obstacles the independent agency may call a meeting where representatives from independent agency, project authority and environmental committee will be present and any issue may be discussed in the meeting. The major progress report will be with respect to:

- Progress of Catchment Area Treatment works, fish management etc.

- Status of protection measures, sausage / gabion walls etc. at the dumping and quarry sites.
- Whether dumping is done so as to avoid spillage of muck into the river, especially during rains.
- Leveling and slope stabilization works at dumping sites.
- Status of afforestation / turfing works on the dumping/quarry sites.

In addition to above following parameters will also be monitored by the EMC:

- Status of protection measures, sausage/gabion walls etc. at the dumping and quarry sites.
- Levelling and slope stabilization works at dumping sites.
- Status of afforestation / turfing on the dumping/quarry sites.

17. COST ESTIMATE

Total cost of Environment Management Plans is Rs. 37689.02 lakhs (at 2010 price level) and, the break-up of which is given in Table 10.

Table 10: Cost of Environmental Management Plans

S. No.	EMP Component	Amount (Rs. in Lakhs) At 2006 Price Level	Revised Amount (Rs. in Lakhs) At 2010 Price Level
1.	Catchment Area Treatment	813.00	1039.34
2.	Bio-diversity Conservation & Management Plan	248.00	317.04
3.	Fish Management	112.00	143.18
4.	Green Belt Development	80.00	102.27
5.	Geo-Environmental Management Plan	755.00	965.19
6.	Muck Disposal Plan	213.00	272.30
7.	Restoration Plan for quarry areas	91.00	116.33
8.	Landscaping And Restoration of Construction Area	135.00	172.58
9.	Public Health Delivery System	214.00	273.58
10.	Solid Waste Management and Sanitation Facilities	185.00	236.50

11.	Energy Conservation Management Plan	40.00	51.14
12.	Resettlement and Rehabilitation Plan	12173.60*	12173.60
12a.	Compensation of land and rights and privileges (including 25% of NPV)	21369.58*	21369.58
13.	Disaster Management Plan	255.00	325.99
14.	Maintenance of Air, Water And Noise Quality	24.00	30.68
15.	Environmental Monitoring Programme	78.00	99.72
TOTAL		**36786.18**	**37689.02**