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CHAPTER-I

REHABILITATION AND RESETTLEMENT PLAN

INTRODUCTION

The rehabilitation and resettlement of the families affected by the construction of Teesta stage VI by Lanco Energy Private Ltd has been considered philanthropically with proper planning and strategies in the beginning of the project.

PROCEDURE ADOPTED IN FORMULATION OF THE PLAN

The following procedure was adopted in preparation of the plan.

- i) Revenue survey of the land identified for construction of different project components.
- ii) Joint inspection of the land earmarked, by the revenue and Forest, Environment and wildlife Management Department, Government of Sikkim and other authorities of East District was carried out.
- iii) The State Land Use and Environment Board conducted public hearing at Mamring to assess and hear the psychological as well as material impact of the affected and displaced families and other organizations including senior citizens and religious leaders.
- iv) The socioeconomic profile of the state vis-à-vis project site was prepared by an expert hand giving emphasis on human settlement, education, occupation, religion, population and other relevant data.
- v) The existing status of facilities within the project affected area was prepared.
- vi) Facilities proposed to be developed by construction of the project were foreseen.
- vii) Various documents pertaining to records of social, cultural and ethnic traits of the population were consulted.
- viii) The guidance and opinions of experts were sought.
- ix) Discussions with the local people were carried out.



DETAILS OF LAND

The land required for the construction of the project has been given to the Land Revenue Department Government of Sikkim for survey and it was conducted jointly by the Forest, Environment and Wildlife Management Department Government of Sikkim and the offices of the concerned District Collectors. Accordingly this has been done by the Land revenue officers of Gangtok and Namchi in East and South Sikkim from October to November 2005. The survey of forest land by the Forest Department staff of East district and South district was done. Accordingly the maps for the actual requirement for construction of the project, approach road, infrastructure, Quarry and dumping sites were prepared.

Overall development of the project planning of main components, adequate inputs from the prevailing guidelines for project construction was placed on top priority including forests and environmental aspect. The size and status of land proposed and identified for acquisition is indicated in the map.

As per the findings total requirement of land for this purpose is 105.3358 ha, out of which 37.9058 ha is Private land, remaining is Forest land including 36 ha of submerged area. Another 42.40 ha is also involved for HRT and other underground components of the project. In this total requirement of private land only agricultural fields of 111 individuals are involved. Only part and parcel of their land has been proposed to be acquired. Since there is no house hold or its part exists, or going to be gets damaged by this proposed acquisition, necessity in preparing Rehabilitation and Resettlement has been avoided. But to avoid any damage to the near by house holds/property at the time of project construction, the following committee constituted under the chairmanship of the District Collector will inspect the area and issue directions to the Project developer to compensate the losses.

The committee shall comprise of the following:-

District Collector of the concerned distt	Chairman
Nominee of Land Revenue Department	member
DFO Territorial of the concerned distt	member
Hon'ble area MLA	member
Senior citizen	member
Representative from project authority	member
Environment officer of the project authority	member



CHAPTER-II

PUBLIC HEALTH AND SOLID WASTE MANAGEMENT

PUBLIC HEALTH

The Proposed project is mainly located under Namchi Sub- Division. In this Sub- Division Health care facilities are minimal with only one Hospital and two Primary Health centres. During the construction there will be a peak force of migrant labourers ranging from 1500 to 1600. These migrant workers may be the potential carriers of new diseases either to unknown/ unreported from the project area. Diseases like AIDS, VDS, Malaria, Gastro-enteritis, etc. are some of the potential risks to human inhabitants of this area, who could get exposed to the diseases carried by migrant workers. The skeletal health services present in the area would be insufficient to cater such an influx of outside labour in this area. Therefore, it would be mandatory for the project authorities and their contractors to have all the labourers including their family members registered and quarantined, vaccinated against common ailments like Malaria, T.B. etc. The project authorities will hold screening camps for the labourers where rapid blood tests will be conducted for diseases like AIDS, T.B. malaria, etc. Only after valid certification a labourer or his family members will be registered with a contractor. The project authorities would ensure that the contractors follow this strict quarantine procedure and this clause would be included in the award of the contract/works. Sufficient medical facilities would be provided by the project authorities.

MEDICAL FACILITIES TO BE PROVIDED

In the recent studies it has been noticed that the inhabitants of the area and also the inhabitants of the villages in the vicinities of the project site are prone to diseases like diarrhea, dysenteries. There is very little immunity to these diseases especially in the children. Therefore, it would be the responsibility of the project authorities to make provisions for at least two primary health centers. These primary health centers will not only cater to the workers and labourers engaged in the project construction work but will also provide medical services to the population of surrounding villages as there is an acute



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shortage as well as urgent need of these facilities. In addition two ambulances/mobile clinic shall also be stationed to provide emergency medical facilities in the project area. This would be extremely helpful to the authorities for the shifting of critically ill patients to the nearby hospital/clinic. Initially all the running and maintenance expenditure would be borne by the project authorities for a period of at least 5 years. Thereafter, it is assumed that the project authority will develop their own health facilities for their staff. It is also proposed to extend these facilities to the local public. It is also proposed to provide financial assistance to the near by four health centers.

Estimated cost for setting up Medical Facilities

Particulars	Amount in lakhs
A. Non recurring cost	
1. Building	16.00
2. Cost of two ambulances	12.00
3. Equipment LS	5.00
Total (A)	33.00
B. Recurring cost (For five years)	
1. Salaries and wages (two Doctors and other staff)	50.00
2. Medicines and other miscellaneous	12.00
3. Maintenance of Ambulance & POL	12.00
Total (B)	74.00
C. Lumpsum grant for strengthening of 4 existing dispensaries around the project area @ 3.00 lakhs for PHC	12.00
Total (C)	12.00
Grand Total (A+B+C)	119.00



SOLID WASTE MANAGEMENT

At the time of project construction user agency has to engage huge number of migrant labourers ranging from 1500 to 1600 per day. A large amount of solid waste will be generated by accommodating the above labourers and their families. Hence the project authorities will take sufficient precautions for developing proper system of the sewage treatment for the colonies of labourers and workers. For this septic tanks and soak pits shall be provided for individual dwellings. The project authorities will ensure proper waste disposal by adopting various disposal methods like incineration, composting, etc.,

Average per capita solid waste generated per day is reported to be 425 g (dry weight). Therefore, for about 1500 households with an average family size of 3 residing in the labour and staff colonies as estimated amount of waste 699 tonnes ($0.425 \text{ kg} \times 365 \text{ days} \times 500 \times 3 = 232687 \text{ kg}$) of solid waste will be generated per annum. No dumping of solid waste will be allowed near by water body or a stream. The solid waste will be collected in masonry vats of at least 25 cum capacity at suitable sites near the colony area will be constructed. The garbage would be transported to the landfill site located at least 0.5 km away from the colony area. The organic waste will be suitably processed to form compost, which can be used as manure. In addition to the above mentioned activities, proper sanitary facilities would also be provided at the labour colonies. Septic tanks of appropriate size will be constructed. The waste water generated from the colonies will be collected and disposed in specifically designed soak pits. Therefore, waste water and sewage generated will not be allowed to flow into the near by river/streams. Required facilities should be provided by the project authority or with their contractors. The project authorities will take sufficient precautions for developing proper system for the sewage treatment in the colonies of labourers and workers. For these septic tanks and soak pits shall be provided for each individual dwelling. The project authorities will ensure proper waste disposal by adopting various disposal methods like incineration, composting etc. Sufficient financial provisions for these activities should be provided by the project authority.

**Estimated cost for solid waste management for five years**

Particulars	Amount in lakhs
1. Community toilets @ Rs 1.00 lakh / four units for 8 sets	8.00
2. Septic tank and soak pits @ 1.00lakhs for 8 units	8.00
3. Land fill (R&M) LS @ 1.00 lakhs per year for 5 years	5.00
4. Water supply system	5.00
5. Salaries of cleaning workers and collectors 5no's for five years @ 3000/month	9.00
6. Construction of water sewerage plant at Power house LS	20.00
7. Miscellaneous expenditure including implements, transport etc. LS @ 1.00 lakhs per year	5.00
Grand total (1 to 7)	60.00



CHAPTER – III

CATCHMENT AREA TREATMENT PLAN

The river Teesta originates from the glaciers located at the far Northern part of Sikkim and travels downward from an elevation of 8500 M above MSL. Besides the numerous streams & rivers with their sources in the Himalayas & glaciers, the Teesta River meets with Talung chu at Singhik which originates from Talung glacier and is a part of Kanchenzonga range. From Singhik, the river further flows South direction to Singtam and Rangpo with a drop of about 200 M providing a fall in the order of 3600 M within 175 KM stretch, which makes it very ideal for hydro-power generation. According to the preliminary survey, the Teesta river can be harnessed in a cascade development for hydro power generation in six stages upto Singtam with a total generation capacity of 3131MW.

At present the 510 MW stage V HE Project by the NHPC is at the verge of completion and expected to be commissioned within 2007. Now the Lanco Energy Private Ltd. is entrusted with the job to develop 500MW Teesta Stage-VI H.E. Projects which is the last stage of Teesta cascade development within Sikkim State. At the origination of river Teesta, the water is very clear but as it flows downwards the colour becomes grayish white and very turbid when it ultimately reaches Singtam and Rangpo, due to the heavy soil erosion in its catchment area by way of land slides and slips of different sizes. Since the upper catchment area has been and is being treated for Stage-V, the remaining catchment area below the downstream site of Stage V needs to be taken utmost care through Catchment area treatment Plan. As a mitigation measure for checking further soil erosion in the catchment area, a comprehensive and detailed catchment area treatment Plan has been formulated with the following aims & objectives, using the land use imagery and detailed survey of the area.

AIMS AND OBJECTIVES:-

- a. To augment the life of the H.E. Project by reducing siltation.
- b. To conserve soil cover and regulate flow of water.
- c. To combat soil erosion, floods and siltation of rivers and stream.



- d. To facilitate the hydrological functioning of the catchment and to augment the quality & quantity of Teesta water & its tributaries.
- e. To prevent the land degradation by adopting multi-disciplinary integrated approach for treatment of catchment area.
- f. To optimize land use and increase production per unit area in a long term prospective.

METHODOLOGY ADOPTED

- a. Sample surveys were undertaken for determining various parameters of catchment and socio-economic characteristics of the inhabitants.
- b. Rapid reconnaissance survey was conducted for study of vegetation, erosion prone areas, land slides etc.
- c. The remote sensing maps were obtained from Remote Sensing Cell of the State Forest Department and on the basis of these maps, slides and data statistics of the catchment area, the identification and assessment of the vulnerable and problematic area was done.
- d. A brief study of soils of the area was also conducted by engaging the Sr. Soil Scientists of State Agriculture Department and ICAR, Gangtok Branch.
- e. As per the requirement of treatment for degraded zones of the catchment, various measures were outlined and estimates were framed.
- f. The choice of the species of Trees/Shrubs for plantation etc. were done as per the climatic conditions, soil types and accessibility of the areas.

GENERAL DESCRIPTION

Location & extent of the area:

The total catchment area of Teesta above the proposed barrage of stage VI which is 2 Km upstream of Rongni-chu & Teesta confluence is 4510 sq. km. But the catchment area of stage VI HE Project from barrage site of stage VI and dam site of stage V HE Project is 277.5 sq. Km. and lies in both South & East District of Sikkim, geologically extending from 27°-12'



to 27⁰-26' North latitude and 80⁰-21' to 88⁰-32' East longitude. The villages falling within the catchment area are as follows:

A. South District.

- | | |
|---------------|------------------|
| 1. Lingkiong | 2. Rumdum |
| 3. Mendongla | 4. Lum |
| 5. Soukpe | 6. Lingi |
| 7. Khap | 8. Payong |
| 9. Lingmo | 10. Mangjing |
| 11. Nihyan | 12. Brum |
| 13. Yangyang | 14. Kalyang |
| 15. Ribong | 16. Dezong |
| 17. Pathing | 18. Aitabare |
| 19. Khesar | 20. Sangmo |
| 21. Samphiok | 22. Nimang |
| 23. Gyagong | 24. Namprik |
| 25. Rangang | 26. Ben |
| 27. Phyak | 28. Dintam Tarku |
| 29. Simkharka | 30. Amlai |
| 31. Simkharka | 32. TanakTemi |
| 33. Deo | 34. Daring |
| 35. Papong | 36. Tokol |
| 37. Raigaon | |

B. East District

- | | |
|-------------|--------------|
| 1. Kambu | 2. Tinek |
| 3. Samdong | 4. Tumin |
| 5. Patuk | 6. Makha |
| 7. Lingze | 8. Dhanbari |
| 9. Singjel. | 10. Lingdong |
| 11. Simik | 12. Badang |
| 13. Ralep | 14. Khamdong |



15. Brang

16. Namgeythang

17. Sirwani

The upper area of the catchment above 4572 m. is 2287 Sq.Km. and under permanent snowline, which is studded with 22 nos. of small and big glaciers. The area under glaciers and ice caps is 426 sq. Km. and the peculiar occurrence in the glaciers is the existence of 6 nos. of glacial lakes.

REGIONAL GEOLOGY

The geological and structural control of topography is a dominant feature of this area. It includes mainly of Darjeeling gneiss in the southern portion and Chungthang Calcsilicates and quartzite in the northern portion. The area exhibits sharp and rugged hills with steep inaccessible rock scarps. The hill ranges on the southern half follow the regional trend of the rocks along NW-SW and also the major joints transverse in NE-SW directions. The main drainages like Talung Chu, Ong Chu, Richu, Dickchu etc. follow the regional strike of foliation and the other streams like Rahi Chu, Raman Chu etc flow across these streams along the joints. All these are tributaries of main Teesta. The northern half of the catchment area has ridges trending along ENE-WSW to NE- SW which are the regional strike of the formation north of Tong (27* 2' ; 88*39 ; 78 A/10). The ridges form the southern end of the nearly E-W trending hill ranges between the Trans-Himalayan Zone and the Lesser Himalayas.

The valleys are usually flat bottomed 'U' shaped, characteristic of 'glacial origin'. The evidences of glaciations are well marked by the presence of numerous lakes of various sizes which were scooped by the glaciers or might have resulted by the natural damming of the glacial melts by the terminal moraines in the valleys through which the glaciers once flowed.



GLACIER INVENTORY PARAMETERS OF TEESTA VALLEY

(Table – CAT – 1)

Sl. No.	Glacier name	Orientation	Glacier Area (Km ²)	Glacier Length (km)	Glacier Lake Area (km ²)
1	Zemu	East	25.5	133	-
2	Changsang	“	13.1	27.4	
3	Lonak Tista	“	7.7	30.1	1.9
4	Khangse	North	9.0	9.1	3.2
5	Talung	South East	10.8	51.2	-
6	Number 1	South West	5.3	8.7	-
7	“ 2	South	8.3	23.7	-
8	“ 3	South West	10.5	23.3	-
9	“ 4	South	6.0	7.7	-
10	“ 5	“	5.9	10.4	-
11	“ 6	“	2.0	2.8	-
12	“ 7	South East	3.5	3.3	-
13	“ 8	East	3.0	1.5	0.7
14	“ 9	South West	6.9	8.4	0.8
15	“ 10	South	2.7	3.7	0.7
16	“ 11	North East	3.2	3.3	0.3
17	“ 12	South East	7.1	11.2	-
18	“ 13	“	8.4	19.2	-
19	“ 14	“	3.8	6.9	-
20	“ 15	East	3.9	3.5	-
21	“ 16	South	6.8	17.0	-
22	“ 17	“	5.0	20.7	-

**CLIMATE:**

Due to the difference in the altitude, the temperature also varies from one place to another. The upper reaches are very cold and foggy while it is comparatively hot and humid in the lower reaches. But the climate is generally pleasant throughout the year. The mean temperature in the lower reaches varies from 3°C to 32°C whereas it is 1°C to 9°C in the upper reaches. Winter season is experienced from Nov. to Feb. with 7 to 8 hours of sunshine and summer starts with the rainfall from May to August with 9 to 10 hours of sunshine. It has been experienced that Dec and Jan are the coolest months whereas May-June are the hottest.

RAINFALL

Rainfall is heavy and well distributed which starts from June and continues till late October. Light showers prevail in the later part of March, usually accompanied by hails. Occasional showers do occur in Dec to Feb assisting snow fall in the higher altitudes. Heavy rainfall has been experienced during July and August. On the basis of the rainfall data the catchment has been divided into three parts viz. upper, middle and lower.

The monthly break-up of the annual rainfall of the basin is given in the Table CAT - 2

AVERAGE MONTHLY AND ANNUAL RAINFALL OF TEESTA BASIN**Table CAT – 2**

Month	Upper mm	Catchment	Middle mm
Jan	21	-	23
Feb	41	-	32
Mar	73	-	66
Apr	72	-	147
May	142	-	274
Jun	245	-	463
Jul	236	-	621
Aug	222	-	512
Sep	171	-	338
Oct	77	-	112
Nov	15	-	19
Dec	13	-	12



Thus it can be seen that July is the wettest month followed by August and June. The upper and middle catchment receives 71.6 % and 78.1 % of annual rainfall respectively.

RUN OFF SERIES AT DIKCHU & SIRWANI SITES (Million cum)

Table CAT - 3

YEAR	Dikchu	Sirwani
1984-85	10080	11957
1985-86	10061	11787
1986-87	8274	10292
1987-88	8998	12020
1988-89	9283	12044
1989-90	9426	12794
1990-91	9111	12733
1991-92	11328	13130
1992-93	-	10461
1993-94	-	11284
1994-95	-	10081
1995-96	-	13673
1996-97	-	11524
1997-98	-	10943

NOTE : Source from CWC Report

**SEDIMENT RUN OF IN HA. M**

Duration	Coarse (0.2 mm dia & above)	Medium (between 0.2mm & 0.075 mm dia)	Fine (below 0.075 mm dia)	Total
1	2	3	4	5
JAN - DEC 1986	300.186	37.32	131.261	468.767
% TO ANNUAL	64.037	7.961	28.001	100
JAN - DEC 1987	667.037	132.13	361.129	1160.175
% TO ANNUAL	57.494	11.389	31.127	100
JAN - DEC 1988	612.021	103.468	258.692	974.182
% TO ANNUAL	62.824	10.621	26.555	100
JAN - DEC 1989	355.426	66.929	190.446	612.801
% TO ANNUAL	58	10.922	31.078	100
JAN - DEC 1990	365.018	49.964	185.136	600.118
% TO ANNUAL	60.824	8.326	30.85	100
JAN - DEC 1991	278.64	124.224	320.035	722.899
% TO ANNUAL	38.545	17.184	44.271	100
JAN - DEC 1992	150.071	83.333	123.863	357.267
% TO ANNUAL	42.005	23.325	34.67	100
JAN - DEC 1993	162.058	96.589	123.863	382.476
% TO ANNUAL	42.453	25.254	32.376	100
JAN - DEC 1994	44.38	83.114	140.526	268.02
% TO ANNUAL	16.558	31.01	52.431	100
JAN - DEC 1995	139.677	186.368	291.87	617.914
% TO ANNUAL	22.605	30.161	47.235	100
JAN - DEC 1996	393.003	233.679	308.396	935.078
% TO ANNUAL	42.029	24.99	32.981	100
JAN - DEC 1997	329.959	204.255	320.797	855.011
% TO ANNUAL	38.591	23.889	37.52	100



SOILS OF SUBMERGENCE AND CATCHMENT AREA

Soil is one of the most important natural factors that generally, determine the structure of the surface layer of the landmass. It is derived from rocks under the influence of the climate, living organisms, relief, time and parent material (Mieckenhausen, 1936). Soil body consists of soil particles of variable sizes ranging from molecules to large boulders. The soil possesses certain physical and chemical characteristics due to the action and interaction of the above said factors which have a profound influence on vegetation and other structures. Therefore general information of soil is necessary for any kind of developmental activities.

COLOUR

Soil of the right bank of the submergence area is grey or grayish-white coloured but on the left bank is reddish along with black on the top because of the organic matter deposition. However, at the higher reaches red colour is predominant. Soils of catchment area are generally reddish clay loam with grey or grayish-white in some spots at lower Lingmoo, middle Lingi, lower Samdong, etc. The grey or grayish-white coloured soils are prone to easy erosion and can be clearly seen in the land slide areas.

PHYSIOGRAPHY

Surface of the submergence area (both flanks) are moderately (15-30%) to steep slope (30-50%) whereas the catchment areas consist of terraces, moderate to steep slope, valleys, ridges (< 30%), dissected , escarpments (< 50%) and rocky cliffs and precipitous slope at higher reaches. Light snow fall occurs in Ben top, Mainam and its vicinities and Samdong top during winter season. Majority of the areas are under steep (30-50%) to very steep slope (< 50%). These are very susceptible to different types of soil erosion during heavy or high rainfall so they require immediate treatments.



COMPACT LAYER

Submergence area is less compacted i.e., generally rock surface is not exposed which indicates the area is subjected to some treatments. In catchment area, spots or places like Mangzing, lower part of Samdong, lower Tokal Bermek the surface layers are less compacted. However, there are some places which do not expose their rock surfaces but possess compacted soil layer. Places like upper and middle Khamdong, Dhanbari, upper Tumin, Yangang, Temi-Tarku, etc are more or less compacted. The grey or grayish-white soils are less compactly formed as compared with the reddish coloured soils.

SOIL DEPTH

Soil depth determines the type of vegetation. Generally, soil depth depends on the pattern of land surfaces. It is seen that the soil depth increases where slope percentage decreases. In submergence area, where land surface is moderately (15-30%) to steep slope (30-50%), the soil depth varies from moderately deep to moderately shallow but at higher reaches it is shallow. In the catchment area the depth of soil ranges from very shallow in the very steep slope to deep in moderately slope surfaces. Soils in major area (like middle Khamdong, Dhanbari, upper Ben forest, lower Niya, middle and upper Lingmoo, Yangang, Namphok, upper Sangmoo, Temi-Tarku) show moderate shallow to moderate deep where top soils are either black or reddish clay. Deposition or accumulation of soils and organic matters brought down from higher reaches by the action of rainwater and other agents in these areas soils are best suited for immediate selection and effective management purposes. But, on the other hand, where soils are shallow to very shallow (places like Lingi-Paiyong, Mangzing, upper Tumin, Samdong, etc.) with large rock formation these have serious problems in perfect management and require special treatment.



SOIL TEMPERATURE REGIME

Soils of both submergence and catchment areas fall under the typical Thermic soil temperature regime. Soils of this regime are ranged from deep to moderately shallow and developed on moderate to steep slope hill sides. Their particle sizes range from coarse gravel to fine clay with moderate erosion but in the spot like Mangzing, soils are associated with severe erosion. Broadly the classes of these soils are Typic Haplumbrepts, Typic Dystrochrepts, Typic Udorthents, etc. However, soils of high altitudes that experience mostly cold temperature and remains moist throughout the year (place like Mainam) falls under the Mesic temperature regime. Dominant soils in this regime are Typic Haplumbrepts and Fluventic Hapludolls.



Soil Sampling by Field Staff

SOIL TEXTURE

Soils in the submergence area are coarse loam, sandy and fine loamy. In the catchment area soils broadly ranges from fine clay to coarse gravel (0.001mm to above 5.000mm) with surface stoniness in some area. Siltation occurs in the Teesta River during monsoon is partly contributed from these areas. Mostly light textured coarse gravel soils are predominant in the majority of the catchment area that has low water holding capacity, low bulk density and less cohesiveness. These soils are fragile in nature and get easy



fragmentation and erosion during rainy season. Such fragile sites can be seen in Mangzing, lower Lingmoo, Samdong, lower Khamdong, lower Ben, near Tokal-Bermek, etc (refer table CAT-5).

SOIL TAXONOMY

As found in other parts of the state soils of both submergence and the catchment area fall under three different order namely- Inceptisols, Entisols and Mollisols. Soils of these types are comparatively new in the process of soil formation. Majority of the area is under Inceptisol in groups Dystrochrepts and Haplumbrepts Sand are as follows:-

Table CAT - 5

Sl. No.	Location	Soil Texture	Soil Depth	Soil Family	Group	Soil Order
1	Submergence site- I	Coarse to Fine Loam/Stoniness	Moderately Shallow	Typic Haplumbrepts	Haplumbrepts	Inceptisols
2	Submergence site- II	Fine Loam	Moderate to Deep	Typic Udorthents	Udorthents	Entisols
3	L. Khamdong	Coarse to Fine Loam	Moderately Shallow	Typic Dystrochrepts	Dystrochrepts	Inceptisols
4	U. Khamdong	Fine loam	Moderate to Deep	Umbric Dystrochrepts	Dystrochrepts	Inceptisols
5	Dhanbari	Fine Loam	Moderate to Deep	Umbric Dystrochrepts	Dystrochrepts	Inceptisols
6	U. Samdong	Coarse Loam Stoniness	Moderately Shallow	Typic Dystrochrepts	Dystrochrepts	Inceptisols
7	Makha	Coarse to Fine Loam	Moderately Deep	Typic Haplumbrepts	Haplumbrepts	Inceptisols
8	M. Lingi	Coarse Loam Stoniness	Moderately Shallow	Typic Haplumbrepts	Haplumbrepts	Inceptisols
9	U. Lingmoo	Coarse to Fine Loam	Moderately Deep	Typic Haplumbrepts	Haplumbrepts	Inceptisols
10	M. Yangang	Fine Loam	Moderately Deep	Typic Haplumbrepts	Haplumbrepts	Inceptisols
11	Near Rabongla	Coarse to Fine Loam	Moderately Shallow	Typic Haplumbrepts	Haplumbrepts	Inceptisols
12	U. Sangmoo	Coarse to Fine Loam	Moderately Shallow	Umbric Dystrochrepts	Dystrochrepts	Inceptisols
13	Tarku	Fine Loam	Moderate to Deep	Typic Argiudolls	Argiudolls	Mollisols

Note: U = Upper, M = Middle and L = Lower.



Chemical properties of soil

The chemical property of soil is of utmost importance in the proper understanding of soil-plant relationship. Its composition is largely dependent on the original mineral composition of the parent rock materials, the weathering processes and the nature and amount of organic matter added to it by the vegetation growing therein. To analyze the chemical property samples were taken from both submergence and catchment area (refer table CAT-6).

SOIL pH :

It is a measure of acidity or alkalinity of soil. Factors affecting soil pH are type of soil, vegetation, agricultural practices, temperature and rainfall. Generally soil acidity is associated with leached soils and alkalinity occurs in drier region. The pH measurement actually measures the H^+ in the soil solution.

Soils are extremely to slightly acidic ranging from 4.2 to 6.7. The mean pH value ranges from 4.9 to 5.8 which is strongly acidic soil. High acid soil is found at Dhanbari and near Rabongla (pH 4.9) which indicates it is a humid forest soils and the lowest acid soil is at Submergence site II (pH 5.8). The optimum soil pH for most crops lies in between 6.5 to 7.0 and soil reclamation can be achieved with liming.



Chemical composition of soil

Table CAT - 6

Sl No	Location	pH Range	Mean	OM in %-age	Nitrogen (ppm)	Phosphate (ppm)	Potash (ppm)	Fertility Status
1	Submergence site- I	4.2-6.5	5.7	2.01	142	18.42	75	3
2	Submergence site- II	4.2-6.4	5.8	4.25	201	21.83	101	2
3	L. Khamdong	4.4-5.6	5.2	3.10	195	20.10	82	2
4	U. Khamdong	4.5-5.8	5.3	3.85	110	25.46	108	2
5	Dhanbari	4.2-5.6	4.9	5.92	135	18.90	97	2
6	U. Samdong	4.8-6.7	5.3	3.54	70	13.20	70	3
7	Makha	4.2-6.6	5.1	3.96	165	24.55	140	2
8	M. Lingi	4.5-5.7	5.5	2.95	69	18.62	69	3
9	U. Lingmoo	4.5-5.7	5.6	3.15	92	25.80	92	2
10	M. Yangang	4.5-5.6	5.5	4.68	176	26.35	176	1
11	Near Rabongla	4.2-6.5	4.9	6.45	88	17.49	105	2
12	U. Sangmoo	5.0-6.6	5.2	3.74	83	16.97	83	2
13	Tarku	4.2-6.5	5.4	5.65	205	25.74	180	1

Note: 1 = Best soil, 2 = Fertile and 3 = Less fertile; OM = Organic Matter.

Organic Matter content:

From the soil developmental point of view, information of soil organic matter is paramount. Nature and amount of organic matter greatly influence site quality, soil texture and structures, water-holding capacity, availability and abundance of nutrients and biological populations and their activities. It plays a key role both in forest and agricultural productivity.



Generally soil organic matter depends on the type of vegetation, cropping pattern, decomposition rate of litters soil type and physiography. Places like Submergence site I, other places Dhanbari, near Rabongla, Tarku and Yangang have high organic matter.

Nitrogen:

Amount of nitrogen availability in soil depends mainly on type of vegetation, agricultural practices, availability of micro-organisms in soils, organic matters, etc. It plays a vital role in plant developmental activities. Nitrogen availability in majority of the areas is at medium ranges, the lowest nitrogen is found at Lingi and the highest is at Tarku.

Phosphate:

Generally high acid soils have low phosphate. Phosphate availability is medium in all cases. It ranges from 13.20 (Samdong) to 26.35 (Yangang).

Potash:

Availability of potash in soil determines the soil fertility. It ranges from low to medium potash availability (69-180 ppm).

Soil Fertility:

Majority of the area falls under fertile soil (Status 2). The data indicates the best suited fertile soil is found at Tarku and Yangang (Status 1) with less fertile soil at Lingi, Samdong and Submergence site-I. Application of medium level fertilizer (Cow-dung @ 1000kg/acre) is essential in places like Lingi, Samdong, Lingmoo, Mangzing and other areas for good agricultural productivity.

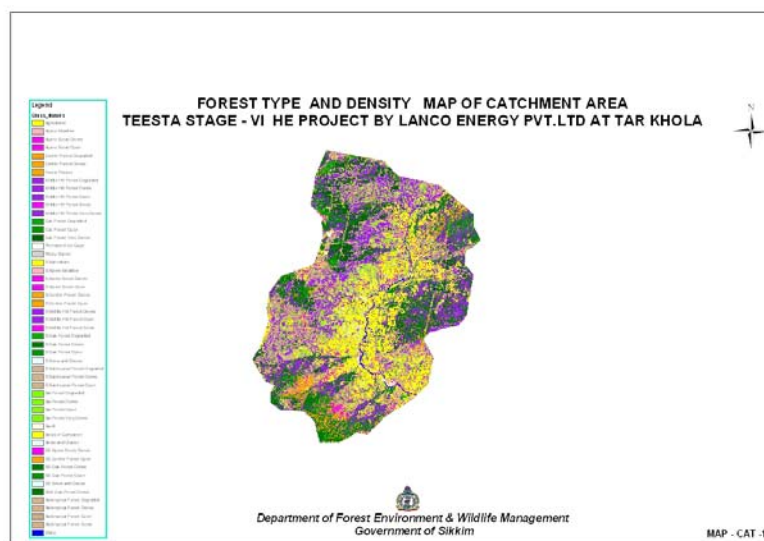
VEGETATION TYPE:

The forest & vegetation type of the free draining catchment area is distributed which comprises of different species of trees, bamboos, ferns and its allied species like Orchids, herbs and many other plants. The catchment is rich in floral & faunal species, mammals, reptiles, butterflies & moths and so on. Dickhu area itself is known for abundance of butterflies. The Meenam Wildlife Sanctuary and Fambong Lho Wildlife Sanctuary are the



part of the catchment area and are situated in upper reaches of left & right flank of the catchment. Many important medicinal plants are also found in the lower & higher altitude areas. The variation in climate, topography, soil characteristics, elevation & aspects has markedly influenced the distribution of vegetation within the catchment.

The vegetation of the catchment area varies with altitude and topography. The elevation within the study area ranges from 350 M to 3200 M and various types of vegetation are observed.



The vegetation in the study area is classified into the following categories (refer Map No. CAT-1)

1) LOW HILL FORESTS (350 – 750m)

The vegetation and flora of this zone ranging up to 900M consists mainly of tropical moist deciduous to semi-evergreen species. The important species of trees, shrubs, herbs, climbers and pteridophyte in this area are:-

TREES: Terminalia myriocarps, Bischofia javanica, shorea robusta, Bombax ceiba, Alstonia neriifolia, Alstonia scholaris, Chukrasia tabularis, Duabanga sonneraiodies, Albizia species, Bassia buyracea, Berchemia floribunda, Engelhardtia spicata, Litsea Polyantha, Macaranga



denticulate, Mallotus Phillipinensis, Oroxylum indicum, Ostodes paniculatus, Tectona grandis, Terminalia belerica, T.Chebula, Schima wallichii, Ficus religiosa, Dendrocolamus homiltonii, Bambusa tulda, Ficus clastica, Ailanthus grandis, Ficus cunia, Alnus nepalensis.

SHRUBS: Balispermus axillare, pandanus nepalensis, Musa species, Pieris pvalifolia, Boehmeria platyphylla, Capparis Clacifolia, Girardinia palmate, Henslowia granulate, Holmskioidia sanguinea, Laportea cranulata, Rubus ellipticus, smilax ovalifolia, lantana camara, Anthocephalus chinensis, clerodendrum japonicum.

CLIMBERS: Rhabdophora decursiva, Banhinia vahlii, piper hamil tonii, Entada scandens, Ichnocarpus frutescens, cissus adnata, C.repanda, Dioxorea species.

HERBS: Eupatorium adenophorum, Alpinia nigra, Amomum aromaticum, Thysanolaena maxima, Burmannia coelestis, Phoenix rupiola, curcuma aromatica, curcumorpha congiflora, Arisaema species, Eulalia fastigiata, Poa species, Cyperus species, Calanthe alismaefolia, Dendrobium species calamus acantho spathus, Imperata cylindrical.

PTERIDOPHYTA: Vittaria elongate, Dryopteris filix-mas, Pteris species, Nephrolepia cordifloia.

2. MIDDLE HILL FOREST (750 M to 1500 M):

These are formed largely of evergreen species which are dominant. These forests are confined at elevation from 750 M to 1500 M especially along the Teesta Rivers and their tributaries. It comprises the following species of trees, herbs, shrubs, climbers, and pteridophyte.

TREES: Adina cordifolia, castanopsis indica, schima wallichii, viscum articulatum, Garcinia cowa, Evodia fraxinifolia, Bischofia javanica, callicarpa arborea, Gynocardia odorata, Macaranga denticulate, Engelhardtia spicata, Exbucklandia Populriea, Artocarpus lakoocha, Brassaiopsis utis, Citrus reticulate, cryptomeria japonica, Rhus semialata, Ficus benjamina, F.clavata, F.cunia, F.roxburghii, Alnus nepalensis, Nyssa javanica, Prunus Cerasoides,



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P.persica, P.communis, Alangium alpinum, Andromedia villosa, Antiderma diandrum, Betula cylindrostachys, connamonum candatum, Bambusa tulda, Dendrocalomus sikkimensis.

SHRUBS: Buddleja asiatica, vitex negundo, clerodendurm species, Mussaenda roxburghii, Melastona malabaricum, premna barbata, cestrum species, Daphne cannabina, Edgeworthia gardeneri, Smilax ovalifolia.

CLIMBERS: Piper congum, Entada scandeus, climati's buchananiana, stephania hernandifolia, Ampelocissus barbata, calamus acantho spathus, cuscuta reflexa, Dioscorea species, cyelanthera peduta, cissus elongate, Rubia cordifolia.

HERBS: Amomum subulatum, cannabis sativa, cynodon dactylon, Thysanolaena maxima, Imperata cylindrical, Arisaema species, Drymaria cordata, Zingiber officinale, centella asiatica, Artemisia vulgaris, Nasturtium Fontana, Tupistra nutans, Ageratum conyzoides, Acorus Calamus Aloe barbadensis, Anagallis arvensis, Arundina graminifolia, Biermannia bimaculata, ulbophyllum affine, cymbidium dayanum, C.ensifolium, Dendrobium ramosum, D.stuposum, D. terminale, D.nobile, D.densiflorum, Eria pubescens, curcuma aromatica, C.Conga, Hedychium spicatum, urticadioca, Erigerom species, Aeschynanthus sikkimens, poa species, Bulbostylis barbata, cyperus compressus, C.halpan, Pogonatherum crinitum.

PETRIDOPHYTA: Cyathea species, Lycopodium clavatum, selaginella species, Equisetum aruense, Osmunda regalis, Dicranopteria dichotoma, Petridum aquilinum.

III. UPPER HILL FORST (1500 M – 2700 M) :

This forest area is evergreen with medium sized trees. There are numbers of deciduous tree species but they form only a small proportion. The forest is extremely thick and the requisite amount of moisture available for epiphytic vegetation and prolific growth of small herbs, shrubs and fern.

It comprises the following species of trees, herbs, shrubs, climbers, and pteridophyte.



TREES: Ailanthus grandis, Alnus nepalensis, castanopsis hystrix, Juglans regia, Quercus fenestrata, Michelia cathcartii, M.excelso, Acer campbelli, Betula alnoides, Litsea sericea, cinnamomum obtusifolium, Andromeda elliptica, Ficus roxburghi, Cryptomeria japonica, Grewia asiatica, Virburnum cordifolium.

SHRUBS: Daphne cannabina, Edgeworthia gardrieni, Rhododendron species, Arundinaria racemosa, Yushania-maling, Sinarundinaria hookeri, Berberis angulosa, Berchemia floribunda, Boehmeria macrophylla, Ficus fereolata, Girardinia palmate, Hymenopogon parasiticum, Hypericum patulum.

CLIMBERS: Calamus acanthospathus, C.floribundus, Cissus javana, C.elongata, cryptolepis, bucuannani, Dioscorea species.

HERBS: Amomum subulatum, Bergenia species, Glycine max, Arisaema species, Cardamine, Scutata, Impatiens urticifolia, Aeschynanthes sikkimensis, Houttuynia cordata, Rumes nepalensis, Astilbe rivularis, swertia – chirata, Juncus species, Carex capillacea, Microstegium vimineum, Poa species, Bromus himalaicus, calanthe species, Cymbidium devonianum, Dendrobium ramosum, Goodyera procera.

IV) RHODODENDRON – CONIFER – ZONE (Cold temperate, 2700 M – 3200 M):

The forests of this zone are also evergreen, mainly composed of broad leaved tree species, Rhododendrons and conifers and Oak forests which are the characteristic feature of this zone.

I. The following species are found:

TREE : Quercus lineate, Q.lanata, Q.glauca, Q.pachyphylla, Exbucklandia populnea, Betula utilis, juglans regia, Lithocarpus pachyphylla, Engelhardtia spicata, Acer species, Magnolia cambelli, Rhododendron barbatum, R.grande.



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SHRUBS: Gaultheria fragrantissima, Berberis umbellate, B.Wallichiana, Piptanthus nepalensis, Arundinaria racemosa, Yushania maling, Rhododendron species, Rubus ellipticus.

HERBS: Panax pseudoginseng, primula denticulate, Galium molluga, Aster tricephalus, Swertia chirayita, Chrysplenium nepalensis, Acnitum ferox, A.heterophyllum, Astilbe rivularis, nardostachys jatamonsi.

CLIMBERS: Holbollia latifolia, Aristolochia griffithii, Celastrus stylosa.

Coniferous Forests: The predominant in coniferous forests are Abies densa, Larix griffithiana, Psuga dumosa and Juniperus species.



Vegetation Study carried out by Field Staffs

Land Use Pattern

1) According to the information obtained from the remote sensing map and field survey the whole catchment can be grouped into three different land use pattern. The whole of the upper hills of the catchment and few patches along the lower hills and along river side is covered



with either Reserve Forest or other Forest land. Most of the area in the middle hills & lower hills are all agricultural land. The major land use details of the catchment are as follows (refer table No. CAT-7):

1. Forest land	-	21,271.47	---	76.74 %
2. Agricultural land	-	4,789.04	---	17.25 %
3. Other Govt. land	-	<u>1,694.90</u>	---	06.01 %
		27,755.41		

Note: other Govt. land includes, sand, water, rocky barren, thicket forest, snow & ice laden, alpine meadow & scrubs.

Landuse, Forest Type and Forest Density Statistics of Catchment Area

TABLE No: CAT 7

Forest Type	Forest density	Area ha	Pixels	Code	% Image
Snow & Ice		8.78	166	1	0.03
Alpine Meadow		19.31	365	2	0.07
Alpine Scrub	Dense	86.54	1636	3	0.31
	Open	292.64	5532	4	1.05
Conifer Forest	Dense	507.79	9599	5	183
	Open	20.15	3423	6	0.07
	Degraded	160.92	38005	7	0.58
Oak Forest	Dense	4607.33	87095	8	16.60
	Open	768.00	36134	9	2.77
	Degraded	1143.49	19553	10	4.12
Middle Hill Forest	Dense	3059.10	57828	11	11.02
	Open	2168.11	58287	12	7.81
	Degraded	915.28	39914	13	3.30
Sub-Tropical	Scrub	531.01	10038	14	1.91
	Dense	1492.73	28218	15	5.38
	Open	1940.32	83918	16	6.99
	Degraded	2498.94	24386	17	9.00
Sal Forest	Scrub	140.56	2657	18	0.51
	Dense	327.45	6190	19	1.18
	Open	114.69	18720	20	0.41
	Degraded	875.60	16718	21	3.15



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Forest Thicket		467.58	8839	22	1.68
Sand		143.04	2704	23	0.52
Water		236.94	4479	24	0.85
Rocky Barren		440.08	8319	25	1.59
Agriculture		4789.04	90530	26	17.25
Total		27755.41	663253		100

Density	Canopy Cover
Dense	> 40%
Open	20-40%
Degraded	< 20%

LANDUSE AND FOREST TYPE STATISTICS OF CATCHMENT AREA

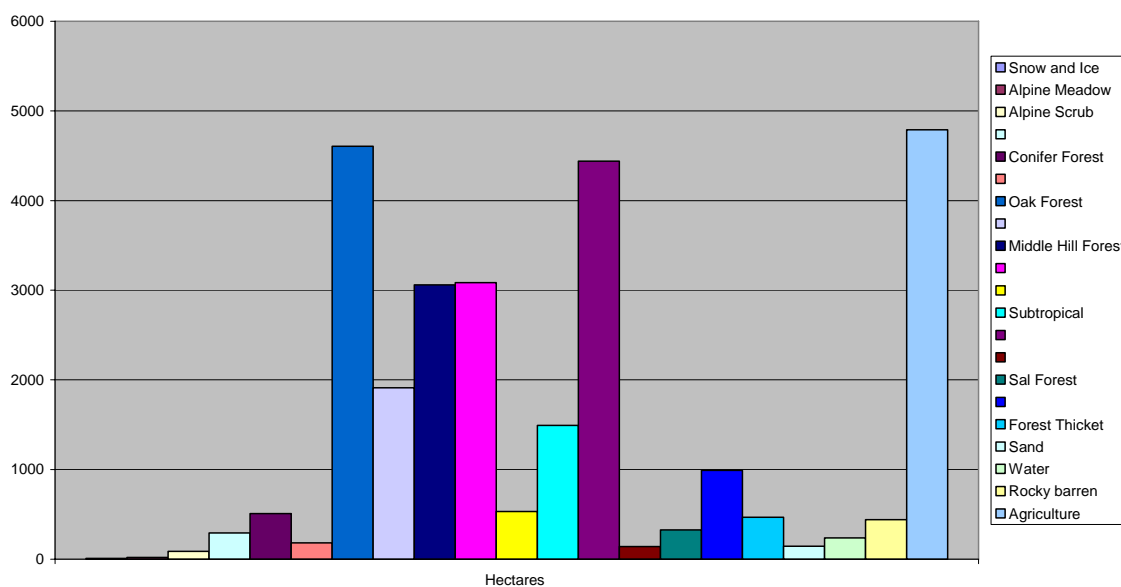


TABLE - CAT - 7

PRIORITY GRADING OF SUB-WATERSHEDS OF CATCHMENT AREA:

As per the All India Soil & Land Use Survey Report No 440, the catchment area for Teesta Stage VI upto the Dam site of stage V can be divided into eight numbers of sub-watersheds namely Ta1d, Ta1g, Ta1h, Ta1j, Ta1k, Ta2a, Ta2b, and Ta2c. The last three sub-watersheds are in the left flank of the catchment falling under East District and rests are in the right flank falling under South District. The Ta2b sub-watershed falls under medium priority whereas all other remaining seven sub-watersheds falling under very high priority.



The priority grading of the above sub-watersheds with its sediment yield index as derived by the AISLUS is as follows:

<u>Sl.No.</u>	<u>Sub W/S Code</u>	<u>Sediment Yield Index</u>	<u>Priority Grading</u>
1.	Tald	1641	V.H.
2.	Talg	1504	V.H.
3.	Talh	1504	V.H.
4.	Talj	1468	V.H.
5.	Talk	1472	V.H.
6.	Taza	1578	V.H.
7.	Ta2b	1288	M
8.	Ta2c	1565	V.H.

NOTE: Sediment yield index

Above – 1450

1350 – 1499

1250 – 1349

1000 – 1249

Priority categories

Very High

High

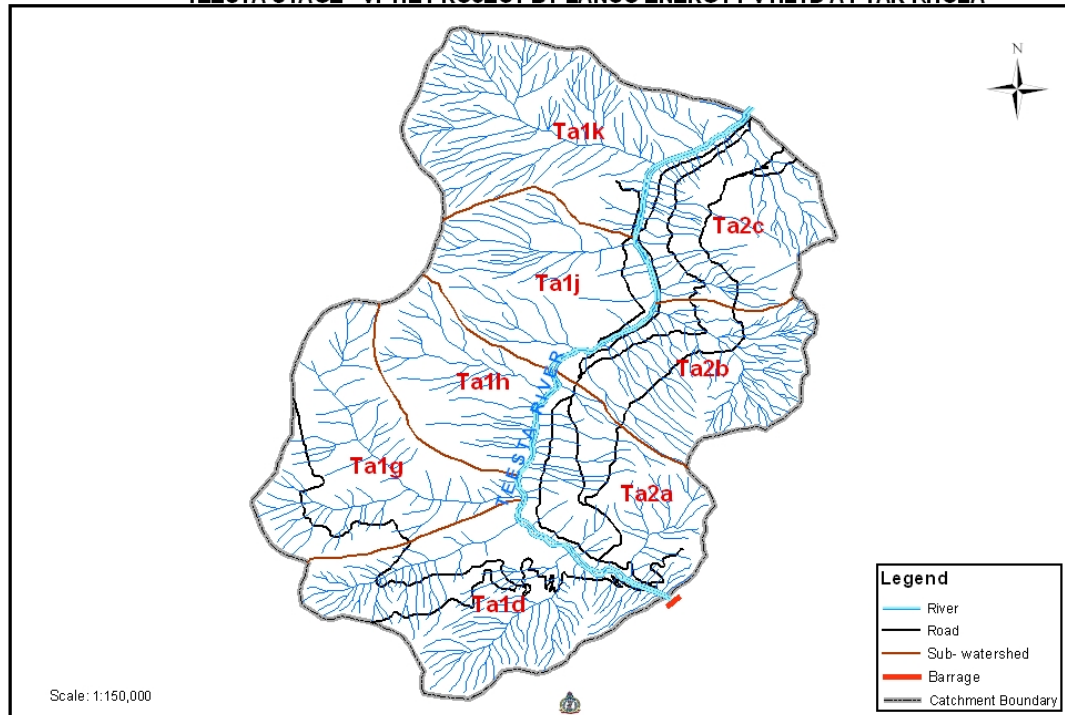
Medium

Low

Source: AISLUS- AGRI REPORT No. 440.



**SUB- WATERSHED MAP OF CATCHMENT AREA
TEESTA STAGE - VI HE PROJECT BY LANCO ENERGY PVT.LTD AT TAR KHOLA**



Source: - AISLUS Report

Department of Forest Environment & Wildlife Management
Government of Sikkim

MAP - CAT - 5

Land slide problem of the Catchment area.

1. LANDSLIDES

The catchment area is affected by land slides of various sizes and shapes. The steep topography, disturbance in angle of repose due to road construction, unstable geological condition, toe cutting by rivers & streams and distribution of forest are the main contributing factors for the landslide occurrence. The land slides are found in both Agriculture & Forest land.



Landslide of Lower Lingmoo



Landslide of Mangzing



TREATMENT MEASURES SUGGESTED

1. All these slides require engineering and biological measures to check further gravity movement of slips. Engineering measures such as sausage retaining walls are required to be constructed along the contour to check further sliding of over-burdened loose soil mass. These over-burdened soil mass is found to be most active during rainy season. In such cases the catch water drains can be constructed, so that the water is collected and safely disposed off into the natural nalas/streams. Wherever the land slides have occurred due to the toe cutting effects appropriate Jhora training works can be executed along the unstable areas of the Jhora line providing series of drops for reducing the velocity of flowing water. The slide-prone areas where the slope is comparatively milder, bally benching works can be carried out. The species which can easily be grown by vegetative cuttings should only be selected for making bellies such as Erythrina. Ficus spp. etc. Biological measures such as plantation of fast growing & soil binding species including tall trees, shrubs and grass like Thsoleana, agave, small bamboos can be planted in the land slide areas. These measures need to be executed in both Agricultural and Forest land wherever the land slides are prevalent.

a) ENGINEERING MEASURES

- i) Sausage retaining wall/ CCM wall
- ii) Cement Concrete Catch water drains
- iii) Jhora Training with sausage walls & drops
- iv) Bally benching
- v) Contour stagged trenching

b) Biological measures:

- i) Mixed plantation of fast growing species
- ii) Mixed plantation of soil binding species
- iii) Sowing & broadcasting of seeds etc.
- iv) Plantation of small bamboos.



The above suggested measures will help in stabilization of land slides and aesthetically merge with the surrounding green cover of the area.

EXISTING STATUS OF FOREST LAND AND ITS PROBLEMS

Out of the total catchment area, 76.74% of the areas are under Forest land. As per the satellite imageries the present status of Forest land comprises of 24.30 % as open forest, 27.15 % as degraded Forest and only 48.55 % as dense forest land. (Refer table No. CAT-7)

The main reason for the degradation of forest is due to the heavy biotic interference. The axe has taken heavily in these forests to meet the demand for firewood and timber. Unrestricted grazing of cattle, illicit felling of trees, lopping of branches for fodder is also responsible for the degradation of forests. Forest fire is not a serious problem but certainly the forest land encroachment at the fringe area is rampant due to the absence of proper boundary demarcation.

The crown density in the dense forest category ranges from 0.4 to 0.5 only. This may be due to the selection system of felling followed in the past where the deceased, dying, topless trees were felled to meet up the public demand. Few blank and open patches were also noticed in this category of forest where the natural regeneration is either nil or very poor. The natural regeneration is moderate in the middle & lower hills while in the upper hills the regeneration is satisfactory.

The forests adjacent to the human habitation areas are severely degraded due to the continuous biotic interference such as encroachment of forest land, illicit felling for firewood & timber and collection of fodder by lopping of trees. The requirement of a huge quantity of firewood for the purpose of drying cardamom is also met from the forest. The accumulation of all the above mentioned problems has resulted to the cause of heavy soil erosion and land slides.

**EXISTING STATUS OF FOREST LAND****A. Dense Forest (> 40 %)**

1. Dense Conifer Forests	--	507.79	hects	02.46	%
2. Dense Oak Forests	--	4607.33	hects.	22.39	%
3. Dense Middle hill Forests	--	3059.10	hects	14.88	%
4. Dense Sub Tropical Forests	--	1492.73	hects	7.24	%
5. Dense Sal Forests	--	327.45	hects	1.58	%
		9994.40	hects	48.55	%

B. Open Forest (20-40 %)

1. Open Conifer Forests	--	20.15	hects	0.09	%
2. Open Oak Forests	--	768.00	hects.	3.72	%
3. Open Middle hill Forests	--	2168.11	hects	10.52	%
4. Open Sub Tropical Forests	--	1940.32	hects	9.42	%
5. Open Sal Forests	--	114.69	hects	0.55	%
		5011.27	hects	24.30	%

C. Degraded Forests (< 20 %)

1. Degraded Conifer Forests	--	160.92	hects	0.78	%
2. Degraded Oak Forests	--	1143.49	hects.	5.55	%
3. Degraded Middle hill Forests	--	915.28	hects	4.44	%
4. Degraded Sub Tropical Forests	--	2498.94	hects	12.13	%
5. Degraded Sal Forests	--	875.60	hects	4.25	%
		5594.23	hects	27.15	%

Grand Total 20,599.90 Hects 100 %

Field surveys of the few selected areas of all categories of forests were also carried out for ground truthing of open, degraded & dense forests. It was noticed that many of the areas under open & degraded categories has been covered with new plantation programme



under different schemes and the plantations were coming up nicely. Plantations of mixed species such as *Juglans regia*, *michelia* spp., *Chikrasia*, *Albezia*, *Grevilla*, *Termenalia*, etc were found to be planted mostly in Oak forests, Middle hill forests and Sub-tropical Forests. But still many more areas are left unattended and needs to be covered by planting suitable species. Natural regeneration in the conifer, oak & Sal forest is coming up fairly good in the open and degraded categories of forests but few area needs aided natural regeneration programme.

Therefore, duly considering the existing status of forest land according to the satellite imagery data and ground realities after ground truthing, the treatment area of the Forest land for open and degraded categories are taken as follows.

Treatable area to be taken for open & degraded categories of forest land.

Table CAT - 8

Sl. No.	Land cover category	Total Area in hecets.	Total treatable Area in hecets
1	Open conifer Forest	20.15	-
2	Degraded conifer Forest	160.92	80
3	Open oak forest	768.00	190
4	Degraded oak forest	1,143.49	450
5	Open middle hill forest	2,168.11	300
6	Degraded middle hill forest	915.28	450
7	Open sub tropical forest	1,940.32	400
8	Degraded sub-tropical forest	2,498.94	800
9	Open sal forest	114.69	100
10	Degraded sal forest	875.60	430
	Total	10,605.50	3200

The above treatable area shall be taken for the execution of various biological and engineering measures as suggested in the plan.



Treatment measures suggested for forest land

BIOLOGICAL MEASURES

The Afforestation has to be carried out in all the open blank and degraded forest land with suitable species. Preferably the poly potted, two to three years old nursery raised superior quality seedlings are to be introduced in the plantation site. The choice of species & planting season should also be strictly followed for the success of plantation. The clearing of sites & digging of pits at 2m x 2m spacing should be completed in the dry season and left for atleast two months for weathering of the soil & pits. The plantation can be started in the first week of June onwards.

Compaction of soil and staking should be provided to enable the plants to easily establish their roots. Proper after-care and maintenance of the plantation is most essential. Therefore, two weeding in 1st and 2nd year and one weeding in 3rd & 4th year must be provided for the success of plantation.

Casualty fillings must be done whenever required. The plantation is also required to be protected from grazing by providing B/Wire fencing in the vulnerable areas. In the lower hills upto 1500 mts, vegetative fencing should be provided preferably with the plantation of *Jatropha carcus* at close spacing in two to three rows. This species is not browsed by the cattle and a damage of such vegetative fencing is minimum. Later on the villagers can be allowed to collect the seeds and sell it for the preparation of bio-diesel and helps in their economic upliftment.

Forest chowkidars need to be engaged to keep vigil for any kind of biotic and forest fire hazards. It is suggested that plantation works should be started only after 2nd or 3rd year of the Plan period, so that proper size of planting materials are ready in the nursery created in the 1st year of the plan period. Besides the creation of nurseries, the engineering works can be started in the 1st year and effort should be made to complete all the engineering works within 4th year.

The required numbers of nurseries should be maintained till the last year of the Plan to meet up the seedling requirements for casualty filling. The catchment area harbors a large variety of medicinal plants, some of these medicinal plants are at the verge of extinction due



to large scale unscientific collection. The depletion of such important plants has been a major concern from ethno-herbal treatment as well as bio-diversity point of view. Therefore, in situ and ex-situ conservation of various medicinal plants should also find a place in the CAT Plan. The creation of nurseries would be the first step for catering the needs of the Afforestation programme. The nurseries are required to be created very near to the plantation site to minimize the transplantation cost. The nurseries should also raise some medicinal plants besides the species raised for the main Afforestation scheme. Barbed wire fencing should be provided for the protection from grazing of nursery. Species like *Shorea robusta*, *Terminalia*, *Chekrasia*, *Ailanthus*, *Toona ciliata*, *Bombax ceiba* etc. can be grown in the lower hills and *Juglans regia*, *Michelus* species, *Buklandia populnea*, *Lapsi*, *Malagiri*, *Bakaina* etc can be grown in the Middle hill whereas *Acer* species. *Abies densas*, *Betula*, *salix*, *Rhododendron* etc in the upper hills. Apart from this some medicinal plants & herbs of high medicinal value such as *Aconite*, *Jatamasi*, *Asparagus*, *Panchawley*, *Chirata*, *Bikhma*, *Pakhanbed* etc. can be grown in small patches & blocks. In the landslide areas sowing & broadcasting of seeds of *Alnus*, *Agave*, small bamboos i.e. *Pareng* and *Thysoleana* is recommended. In small patches & blocks natural regeneration can be encouraged by providing soil working technique to enable the seeds to have access to the mineral soils.

Engineering Measures:

1. Jhora Training with sausage wall and drops.
2. Dry stone protective wall
3. Catch water drain
4. Balley Benching Works

FOREST LAND



Biological Measures						
Sl.No.	Items of work	Altitude	Rate	Unit	Physical	Financial
1	Aided natural regeneration Maintenance:- Two weedings in 1st and 2nd year and one weeding in 3rd & 4th year	High	12,500	Hect.	80	10,00,000
2	Aided natural regeneration Maintenance:- Two weedings in 1st and 2nd year and one weeding in 3rd & 4th year	Low	8,300	Hect.	1,200	99,60,000
3	Medicinal Plants Plantation Maintenance:- Two weedings in 1st and 2nd year and one weeding in 3rd & 4th year	High	42,200	Hects	100	42,20,000
4	Medicinal Plants Plantation Maintenance:- Two weedings in 1st and 2nd year and one weeding in 3rd & 4th year	Low	28,400	Hects	100	28,40,000
5	Sowing/Dibbling & Broadcasting in landslide areas	Low	10,400	Hects	20	2,08,000
6	Artificial Regeneration Maintenance:- Two weedings in 1st and 2nd year and one weeding in 3rd & 4th year	Low	12,340	Hects.	1,500	1,85,10,000
7	Silvi-pasture Development	Low	14,300	Hects.	100	14,30,000
8	Bamboo (Pareng) Plantaion	Low	14,500	Hects.	100	14,50,000
9	Watch & Ward	High	128	mandays	3,000	3,84,000
		Low	85	mandays	10,000	8,50,000
10	Barbed wire fencing with wooden posts at vernerable areas only	Low	151,000	Km	10	15,10,000
11	Framers/ Kishan nurseries	High/low	-	-	-	70,00,000
12	Vegetative Fencing with Jatropha Plantation in rows	Low	31,400	Km	25	7,85,000
	Sub Total				3200 ha + 25km	5,81,47,000



EMP Report

Engineering Works						
Sl.No.	Items of work	Altitude	Rate	Unit	Physical	Financial in lakhs
1	Jhora Training with sausage wall with drops	Low	1548/cumt	Cum	2,000	30.96
2	Dry stone wall	Low	768/cumt	Cum	2,000	15.36
3	Catch water drains	Low	1188/mts	mts.	2,000	23.76
4	Bally benching	Low	18,100/ha	Hects	50	9.05
Sub Total						79.13

AGRICULTURAL LAND AND ITS PROBLEMS

The catchment area of Teesta H.E.P. stage VI is a part of South and East district of Sikkim. The economy of the people residing in the catchment is mainly agriculture. Mostly they grow cereals, pulses and oil seed. Large cardamom & orange is the main cash crop for them. The people of the south district have mostly cardamom plantation and due to this agro-forestry system, soil of these areas are well protected. In the east district side it is noticed that few farmers has still maintained a good orange orchards in their land holding.

The main problems of the area are:

1. Loss of top soil due to heavy precipitation and steep slope.
2. Landslides & slips of various sizes are common in the area.
3. Faulty agricultural practice with heavy tillage operation, resulting to heavy soil erosion.
4. Soil fertility is very poor due to the loss of top soil.



PROTECTIVE MEASURES SUGGESTED

1. Providing RCC & Sausage retaining walls in the landslide and slip area
2. Jhora Training works to prevent the toe-cutting effect by stream water and to provide drops at appropriate intervals to check the velocity of water.
3. Catch water drains in the slips areas to divert water in the natural jhoras for safe disposal.
4. To provide contour bunds with vegetative support of desired species for soil & water conservation.
5. To discourage faulty agricultural practice in sloppy land and to encourage for horticulture crops by providing various incentives like planting materials of cardamom, orange, guava, peach, plum, pears, passion fruit etc. with technical support and marketing facilities for their socio-economic upliftment.
6. To encourage for medicinal plants cultivation for better income generation.
7. Plantation of fodder trees & grasses in the steeper land instead of agricultural crops to control soil erosion.
8. To encourage people on floriculture and village Eco-Tourism for their economic development by providing planting materials, awareness and training programmes.
9. Sloppy and uncultivable areas should be brought under *Jatropha cascus* plantation for soil & moisture conservation as well as economic upliftment of the people.

Following Biological & Engineering measures with Physical & Financial targets are proposed for the treatment of Agricultural land:

**AGRICULTURAL LAND****BIOLOGICAL MEASURES**

Sl.No.	Items of work	Altitude	Rate	Unit	Physical	Financial
1	Fodder development (Broom grass plantation)		3,000	Hect.	1,000	30,00,000
2	Agro-Forestry (200 nos of plants/hects, preferably ficus spp. & Morrus alba)		2,600	Hect.	1,000	26,00,000
3	Jatropha Plantation (in uncultivable lower areas)	Low	31,000	Hects	100	31,00,000
					Total Rs	87,00,000

ENGINEERING WORKS

Sl.No.	Items of work	Altitude	Rate in Rs	Unit	Physical	Financial in lakhs
1	Jhora Training with sausage wall with drops, chutes	Low	1548/cum	cum	2,000	30.96
2	Dry stone wall	Low	768/cumt	cum	2,000	15.36
3	Catch water drains	Low	1188/mt	mts.	2,000	23.76
4	Bally benching	Low	18,100/ha	Hects	50	9.05
					Total Rs	79.13

**WELFARE AND INCOME GENERATION PROGRAMME**

Sl.No.	Items of work	Altitude	Rate	Unit	Physical	Financial
1	Horticulture development (Incentives to farmers in the form of planting materials, technical support & training.)	L.S. Rs	10	each	1,50,000	15,00,000
2	Medicinal Plants cultivation (Incentives to farmers in the form of planting materials, technical support & training.)	L.S. Rs	8	each	1,50,000	12,00,000
3	Floriculture development (Incentives to farmers in the form of planting materials, technical support & training.)	L.S. Rs	10	each	1,00,000	10,00,000
4	Alternative fuel programme (Distribution of LPG to below poverty line people of the catchment area)	Rs	2,500	each	200	5,00,000
					Total Rs	42,00,000

INFRASTRUCTURES

For better execution of the catchment area treatment works, the implementing agency will be in need of at least one vehicle. Few field staff quarters are also required to be constructed at suitable locations for the effective execution of field works.

Therefore, the following Physical & Financial outlay has been proposed:

**TRANSPORTATION AND ACCOMMODATION**

Sl No.	Items	Physical	Financial
1	Bolero vehicle	2 nos	12 lacs
2	Three roomed staff quarter with furnishings	1, Rabongla 2, Temi 3. Khamdong	21 lacs
		Total Rs	33 Lacs

ESTABLISHMENT COST

Sl. No.	Items	Financial Target
1	Pay & allowances for M/Roll office staffs, drivers, peons, typists etc	21.00 Lacs
2	Contingencies including office expenses, furniture, computer, photocopying machine, field equipments, POL, Electricity & Telephone bills, vehicle maintenance etc.	14.00 Lacs
3	Construction and shifting of temporary huts, camps, stores, procurement of implements, accessories etc.	10.00 Lacs
4	Monitoring by remote sensing, Project & State level committees	10.00 Lacs
5	Awareness campaign & training of farmers, officers & field staffs	10.00 Lacs
6	Publicity & Printing works etc.	05.00 Lacs
7	Entry Point activities	10.00 Lacs
	Total:	80.00 lakhs



RESERVOIR RIM TREATMENT

An area of about 36 hect. shall be submerged under the water due to the construction of a barrage where a reservoir shall be created in the upstream side of the barrage. The water level in the upstream side of the barrage will increase upto a maximum height of 23.5 mts. from the original river bed and gets contact with the loose land mass. The toe cutting effect of the loose land mass will trigger off further landslides all along the reservoir rim area. This will result to slope instability of the whole surrounding area of the reservoir and a large scale damages of the various properties are anticipated.

The Sirwani bridge is just above 300 mts. upstream of the proposed barrage and nearly half of its foundation of both side of the river bank will come under submergence and the foundation of bridge at both the side of the river bank are susceptible to seepage and erosion for which protective measures are required to be carried out. Few private houses and some Government structures and roads are found to occur at the left bank of the river whereas at the right bank one road and only one govt. structure exists just above Sirwani bridge. All these are susceptible to subsidence due to toe-cutting effect of the raised water level. Therefore the reservoir rim treatment is very necessary to prevent the damages of the public property as well as to check sedimentation in the reservoir caused by the loose debris and landslides. Therefore the reservoir rim treatment is necessary to fulfill the following objectives.

- a) To prevent public and govt. structures/properties from subsidence and provide stability.
- b) To prevent sedimentation in reservoir and to augment the life of the project.
- c) To stabilize the surrounding land mass and check soil erosion and landslides.
- d) To beautify the reservoir area and promote tourism.



Barrage Site of Stage VI



View of Submergence Area of Stage VI



TREATMENT MEASURES SUGGESTED

The following reservoir rim treatment measures are necessary to be adopted to achieve the above mentioned objectives.

a) *Engineering measures*

Reinforced Cement concrete wall, crate walls, stream banking, Bunds with boulders crates, rock bolting, Jhora treatment, fencing etc. Where ever necessary L.S. Rs.1.80 crore

b) *Biological measures*

Mixed plantation of soil binding species, ornamental creepers & plants, larval food plants for butterflies, turfing, bamboo, agave plantation etc.

Besides the above, the reservoir area can be developed as a tourist and picnic spot for which the following facilities can be provided.

- 1) Creation of garden's/footpath around the reservoir L.S. @ Rs. 10.00Lakh
- 2) Resting shed including C.C.benches 4 nos @ Rs. 5.00 Lakh each = Rs.20.00 Lakh
- 3) Coffee & snacks bar including furniture – 1 no @ Rs. 10.00 lakh
- 4) Boating facilities L.S. @ Rs. 10.Lakh
- 5) Toilets – 4 units 2 nos @ Rs.1.00lakh each = Rs. 2 lakh
- 6) Children Park etc. – 2 nos. @ Rs. 5 Lakh each = Rs. 10 Lakh
- 7) Ticket counter cum security hut- 2 nos @ Rs. 4 Lakh each = Rs. 8.00 lakh

Total = 70.00 Lakh

**FINANCIAL PROVISION**

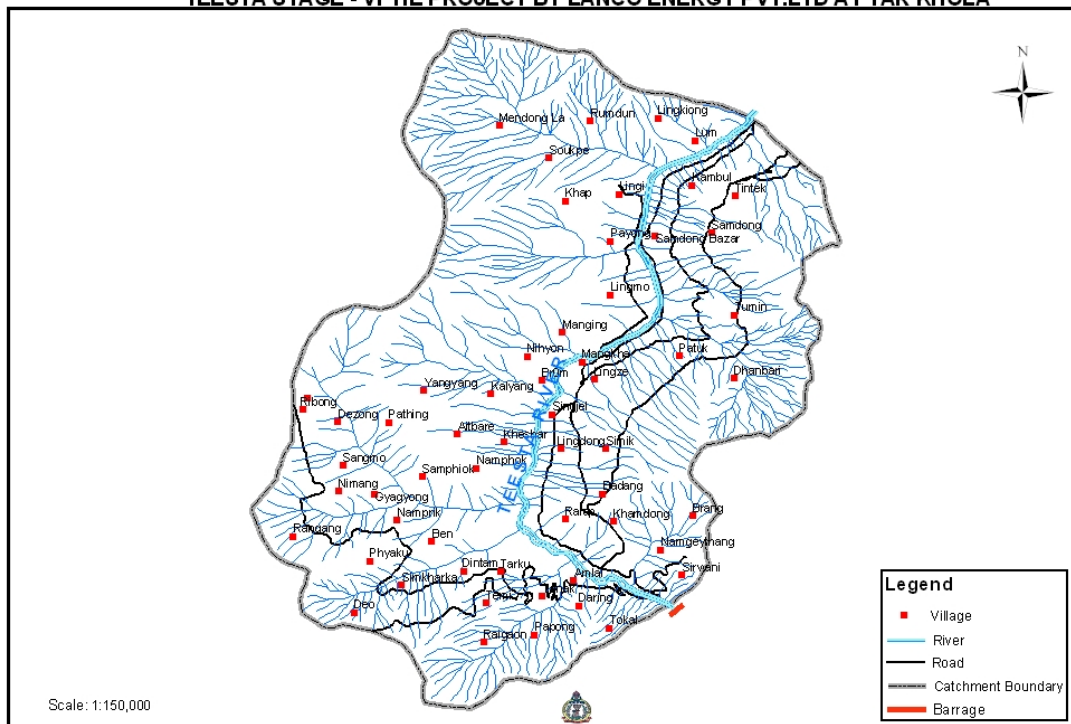
A provision of **Rs 2.5 crores** is proposed for the above work.

Summary of allocation of fund for different activities.

Sl. No.	Items	Outlay (Rs in Lakhs)	Total (Rs in Lakhs)
1	Agriculture land i) Biological ii) Engineering iii) Income generation	87.00 79.13 42.00	208.13
2	Forest land i) Biological ii) Engineering	581.47 79.13	660.60
3	Reservoir rim treatment	250.00	250.00
4	Infrastructure & establishment cost	80.00	80.00
5	Transportation & Accommodation	33.00	33.00
		Grand Total:	1231.73



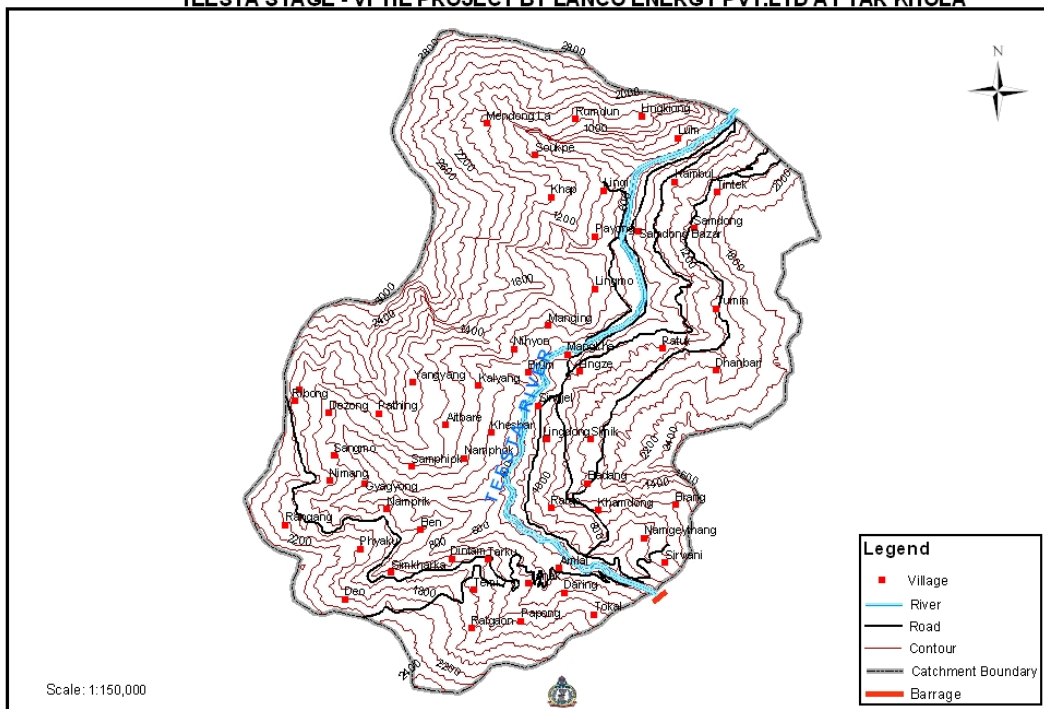
**DRAINAGE MAP OF CATCHMENT AREA
TEESTA STAGE - VI HE PROJECT BY LANCO ENERGY PVT.LTD AT TAR KHOLA**



Department of Forest Environment & Wildlife Management
Government of Sikkim

MAP - CAT - 4

**CONTOUR MAP OF CATCHMENT AREA
TEESTA STAGE - VI HE PROJECT BY LANCO ENERGY PVT.LTD AT TAR KHOLA**



Department of Forest Environment & Wildlife Management
Government of Sikkim

MAP - CAT - 3



LIST OF SUITABLE SPECIES FOR CAT PLANTATION

Mixed Plantation

i) Plantation upto 2000 M

Terminalia
 Grevilla robusta
 Michelia spps.
 Toona ciliate
 Cryptomeria japonica
 Cupressus spps.
 Juglans regia
 Spondius axillaries
 Shorea robusta
 Chekrasia tabularis
 Bochmaria rugulosar (Dhar)
 Gemelina arborea

ii) Upto 2000 M- 3500

Terminalia spps.
 Castonopsis spps.
 Betula spps.
 Acer spps.
 Salix Machilus edulis
 Mechilus spps.
 Rhododendron spps.
 Abies densa spps.
 Juniper spps.

B) Fodder/Fuelwood spps.

Ficus cunia
 Ficus hookeri
 Ficus nemorabis
 Sourauia griffithi
 Trevesia palmata
 Litasae polyantha
 Thysonalia spps.
 Morus alba
 Bahunia spp.
 Alnus nepalensis
 Duabanga indica
 Eucalyptus spps.
 Betula spps.
 Albizzia procera
 Beilschimdeia roxbergi



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Cedrela toona
Morus alba

C. Roadside Ornamental Plant spp.

Grevilla spp.
Prunus spp.
Delonix regia
Cassia fistula
Acaria auriculiformis
Bougan-vellia
Hebiscus spp.
Erythrina indica
Bottle brush spp.
Polythia spp.

D. Sowing & Boadcasting

Shorea robusta
Bamboo spp.
Alnus spp.
Terminalia spp.
Thysolania spp.
Agave spp.
Schima wallichii

E. Medicinal Plants Plantation

Picorizha kurrowa
Nardotachys jatamasi
Spondus mukrosi
Emblica officinalis
Terminalia Chebula
Terminalia bolorica
Acoutum Falcarum
A Jcrox
Acorum calanus
Spondus mukrosi

F. Bamboo Species

Arundaria maling
Bambusa nutans
Bambusa tulda
Cephalostachyum fuchcapitatum var dacomposita
Cephalotachyum hookeriana
Dendrocalamus hamiltoni
Dendrocalalmus sikkimensis



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Semiarundinaria plentlingil

G. Horticulture

Peach
 Orange
 Plum
 Pear
 Guava
 Cardamom
 Naspatti
 Banana
 Lemon
 Papaya

H. Silvi-pasture Development (Trees Species)

Buklandia populnia
 Ficus hookeri
 Ficus nemoralis
 Ficus enjamina
 Gmelina aorborea
 Litsea nepalensis
 Sauria nepalensis
 Morrus alba

(Shrubs)

Nepeir grass
 Thysolania grass
 Coetemala grass
 Cencrus spp.

I. Natural Regeneration

Shorea robusta
 Castonopsis spp.
 Quercus spp.
 Acer spp.
 Betula spp.
 Abies spp.
 Juniper spp.



CHAPTER-IV

BIO-DIVERSITY CONSERVATION

INTRODUCTION:

The need of Bio-diversity conservation arises due to the anticipated threats to the ecosystem by taking up the proposed project. Due to this project, threats may arise as a result of destruction in the vegetation, Noise and Air pollutions. As per the survey report 147.7358 ha of land is involved. Out of which 37.9058 ha is non-Forest land along with 67.43 Ha of Forest land(including 36.00 ha of submergence) and 42.40 ha of underground. According to the enumeration conducted by the Forest field staff there are 2244 no's of trees (1792 trees and 452 poles) and 100 no, s of bamboo clumps in the Forest land i.e 67.43 ha. Each Clump consists an average of 40 to 50 culms. There are 512 no's of tree species in the Private holding i.e. 37.9058 ha. The likely disruptive activities include cutting, filling, dumping of excavated materials and population pressure at the time of work execution/construction will occur in and around the proposed project area.

PROBLEMS AND NEEDS.

The major part of lower and middle catchment area is spread over agriculture land and the upper portion of the land comprises Reserved Forests and patches of small land makes the Gaucharan and Khasmal in between the private holdings. There are intensive biotic interferences in the middle zone of the catchment and ecotone between the village and Reserved Forests as collection of minor forests produce in the form of small timber, fuel wood, fodder, bamboo and other day to day needs of the villagers. As a result of disturbances soil stability and erosion vis-à-vis landslides are noticeably quite frequent. There had been selection felling of trees before the H/Supreme courts ban on green felling in 1996 from the adjoining forests which has indicated opening of the canopy at several places which are now invaded with bamboo and scrub forests in the area. The parts of the forest areas have shown greater degree of degradation due to over use and interferences. The gaps have been created in the forest.



EXISTING STATUS OF FOREST

The forest in the catchment area plays vital resources of the local villagers which provide fuel wood requirement, minor timber, fodder supply, in-situ water conservation and other intangible benefits. The portions of the forest in the area are in the process of climax stage as the canopy density is very close and the process of regeneration is not favorable. There is trend of indicators of slow degradation of the forests especially in the upper regions of the catchment area. This may be due to lack of proper management intervention and scientific planning.

The growth of Uttis (*Alnus nepalensis*) in the cardamom fields and other private forest area has reached the succession of climatic climax in case of this species in this part of the region and even if there is initial recruitment, the survival would be extremely poor beneath the dense shade of tree and undergrowth. Further, the judicious utilization of the species is very necessary to benefit the economy from the forest which in turn the farmers may be encouraged to take interest in growing trees in the farm lands. Bamboos also provide excellent resources from the forest to meet the daily requirement of the villagers. Bamboos are means of protecting soil and landslide with their deep rooting system. However, propagation of the species in the area not taken up so far and this item should be included in the catchment area treatment.

TIMBER REQUIREMENT

The general trend of timber and other wood produce requirement is very high in the state due to various constructions of private houses, business centers and other development activities. The same is applicable in the project area too. But, the Forests, Environment and Wildlife Management Department have allowed importing timber from the neighboring state and from Bhutan which has reduced the pressure on the forest. The pressure on the forests is growing rapidly and at a faster rate than ever, it is imperative that some acceptable alternatives for fuel wood are formidable. The main reason for rapid pressure on the forest is due to the colossal population growth in a small state like Sikkim. The demand for fodder, fuel wood, timber and land has rendered unstable area in the state. The landslides and soil erosions are occurring here and there and if proper steps are not taken it is like that the



construction of the proposed project may add more problems. The demand and supply of fodder, fuel wood, timber and other natural resources in the project area should be addressed with creation of other alternative avenues and improvement of the quality of the land. The lands which are very vulnerable should be given proper attention and necessary arrangement should be made to avoid further problem.

GRAZING

The grazing has been banned in the state since the year 1996 however; there are quite a few numbers of livestock in the R.F which are in the process of eviction. But the cattle population in the villages remains the same, in fact it has been increased due to the imposition of ban in the forest. The fodder biomass requirement has been increased due to introduction of stall feeding conditions after the ban. The Gaucharan and Khasmal forests are in very poor condition and the extent of area available is shrinking side by side and year after year due to encroachment of land. The average number of cattle population per household is estimated to 8 to 10 animal heads. The dominant cattle population is the cow, followed by goat though the number is very large but it has low status in the family. The Yak and few sheep population is also distributed in the alpine regions especially in West, East and North districts. The decentralization of plantation programme in the village level by the joint forest management committee should be given wide publicity and awareness campaign through out the villages and proper quality nursery raising inputs and plantation techniques should be imparted at the community level plantation. The choice of plantation species of fodder and other requirements have been discussed at the village level so that proper planning can be drawn with specific objectives.

FOREST FIRES

Project area is prone to forest fires especially in winter seasons because of continuous dry spell from December to April. If we see the present instances of fires from the month of December 2005 to April 2006 there are total 83 numbers of instances in all the four districts and an area of 1,110 ha of forest land has been burnt. Out of which 120 ha has been affected in 21 instances in South Sikkim and 113.7 ha in 24 instances in East district. All the JFMC's,



EDC's along with the local public and Panchayats are effectively involving in fire fighting incase of forest fire occurrences.

SUGGESTIONS FOR REGENERATION.

As stated in the foregoing paragraphs the major parts of high forests has indicated climax series and intervention in the form of improvement. This can be developed through regeneration and management practices by application of suitable techniques. The application of natural regeneration techniques depend on the site condition and type of forests. Some of the relevant inputs are light requirement and canopy manipulation, regular cutting back, control burning, uprooting, use of pesticides, control of grass, control of bamboo, weeding, cleaning, thinning, cultural operation and tending regime. The most important part of the improvement of forests is preparation of workable working plan for all types of forest management including private forests. This would meet the directives of the Hon'ble Supreme Court also.

CONSERVATION AND PRESERVATION AREAS

There are no such type of areas in the form of any Wild life sanctuaries, National parks and Biosphere reserves etc in the vicinity of the project, hence the proposed Stage-VI project doesnot pose any threat to any ecosystem and microclimate having the species of conservational significance. In the project development as much as possible private land has been proposed to be acquired, hence the pressure on pristine natural eco system will come down. To reduce destruction on the existing forest cover underground power house has been proposed. Most of the species found in the proposed submergence area are common and widely distributed. The natural terrestrial ecosystem in the project catchment area is mostly represented by broadleaved mixed and Mixed coniferous forests.



FLORA DIVERSITY

The tropical semi evergreen and sub tropical mixed broad leaved forest zones in the project catchment are characterized by the moist deciduous and ever green species, in low altitude. Proposed areas are rich in Medicinal plants and other NTFP species. Proper measures like plantation and its protection has been proposed. Care has been taken to descries monoculture and plantation of teak in the slope areas.

Sl.No	Perticulars	Physical	Unit cost in Rs	Financial in lakhs
1	Planttion of Medicinal plants	40 ha	28400	11.36
2	Plantation of local species	40 ha	12350	4.94
	Total	80 ha		16.30

FAUNAL DIVERSITY

The faunal diversity of Teesta stage VI Hydro electric project catchment area is comprised of 21 mammalian species belonging to five orders namely primates, carnivores, artiodactyla, perissodactyla and rhodentia. The single primate species is represented by Presbytis entellus in the lower reaches i.e. 1400 mt . To provide better habitation to the wild animals it has been proposed to take up 25 ha of plantation with fruit bearing plants, tubers and grasses, studies on wild life diversity and its conservation, to construct checkpoints with transportation facilities have been proposed. The area proposed for the project is famous for Butterflies hence it is proposed to create a butterfly park in the surrounding area.



EMP Report

Estimated Expenditure for Wildlife Management Plan

1. Habitat Improvement - by planting fruit bearing, Succulent, tubers, grasses etc. @ Rs. 14950/Ha. – 25 Ha.	Rs. 3.80 lakhs
2. Surveillance Check Post : 2 Nos. @ Rs. 6.00 lakhs each	Rs. 12.00 lakhs
3. Vehicle – 1 No. @ Rs. 7.00 lakhs	Rs. 7.00 lakhs
4. Studied on Wildlife Diversity & Conservation	Rs. 7.00 lakhs
5. Salvation and rehabilitation of Schedule I Wild animals from submerged areas	Rs. 20.00 lakhs
6. Protection- cum- Conservation of habitat vulnerable species	Rs. 3.00 lakhs
7. Census and estimation of wildlife in effected areas and surroundings	Rs. 3.00 lakhs
8. Creation of Butterfly park	Rs. 25.00 lakhs
9. Wildlife equipments	<u>Rs. 3.00 lakhs</u>
	Rs. 86.80 lakhs
10. Contingencies 10% of the above	Rs. <u>8.68 lakhs</u>
Total	Rs 95.48 lakhs

(Rupees ninety five lakhs forty eight thousand only)



FISHERIES

The Mahaseer fish species is likely to be affected mostly by the stage VI Hydro Electric Project. As such as a short term measure a Mahaseer farm needs to be constructed in order to save Mahaseer Fishery. The construction of Mahaseer Farm may require some major efforts. Therefore, collection of Mahaseer fish seeds and if possible brood fish from other streams is necessary in order to raise the brood stock in other near by existing Fisheries Farms and for stocking the seeds directly in the affected site once the project starts. The long term strategy includes establishment of research station near dam site and manning the research station and recurring expense for the research project with the above mentioned objective till the project completion. The required guidance will be obtained in consultation with the ICAR, Central Inland Riverine Fisheries Institute Barrakpore West Bengal under Indian Council of Agricultural Research, New Delhi. It may be worth mentioning here that Tata Electric Company (TEC) under its Hydro Electric Power supply Project at Lonavala in Maharashtra is managing a Mahaseer Farm for Mahaseer Seed Production to rehabilitate the Deccan Mahaseer in rivers and reservoir. The concept of establishing a Mahaseer Farm under stage VI H.E. Electric project in the State can be examined in the line of what TEC is doing. The financial provision of Rs 50.00 lakhs has been kept to meet the required expenditure, the component of which includes basic infrastructure like Mahaseer farm, equipments etc, operational expenses and to provide alternative source to the fisherman depending in the disturbed stretch by this project.

Sl.No	Particulars	Numbers	Financial in lakhs
1	Hatchery building	1	5.00
2	Hatching trough each with 4trays	10	5.00
3	Nursery ponds(cement lined)	10	5.00
4	Rearing tanks(cement lined)	10	7.50
5	Stock raceways(cement lined)	3	10.00
6	Storage cum silting tank	1	5.00
7	Alternative livelihood for the affected fishermen		14.50
	Total		50.00

Total outlay is Rs.Fifty lakhs only



OR otherwise provision of Fish ladder at barrage can be made with this Rs 50.00 lakhs provision as decided by the Director Fisheries.

MANAGEMENT PLAN

As per the findings, there are no rear or endangered plants or animals species likely to be affected by the proposed project activities. The existing natural ecosystem in the upstream catchment needs protection and further strengthening of conservation and preservation. To ensure proper implementation of the present environmental policies, additional financial support to the Forest, Environment and Wildlife Magt.deptt. has to be provided to aid protection and conservation efforts. For proper maintenance of terrestrial ecosystems in the catchment, an institutional mechanism has to be evolved. All these activities will be under the control of the Forest deptt. It is desirable to strengthen the existing infrastructure with clear mandate of ensuring safety and conservation of flora and fauna in the region.

BIODIVERSITY CONSERVATION

It is proposed that the alpine regions of the forest deptt. be declared as non-interference areas for any human activities. No activities should be permitted in these areas except the rights of the local population which must be maintained in a regulated manner. Deptt will continue the existing policy implementation, however an action plan for the preservation and management of these protected areas is indicated below:

1. Deptt will take up the work of biodiversity conservation for the critical areas. User agency has to provide the financial assistance.
2. An independent board under the chairmanship of the CWLW shall govern the conservation work . It shall include two members each from the forest deptt and the user agency, one each from the local NGO, local senior citizens and MOEF, Government of India



ACTIVITIES UNDER CONSERVATION

1. To look after the demarcated conservation area, enforcing regulatory provisions and its monitoring. It should be ensured that the natural ecosystem, structure and functions are not changed or subject to any threat.
2. Conservation efforts will endeavor to conduct the works related to documentation of the existing biodiversity, publish checklist of flora & fauna and accounts of biodiversity time to time. These accounts will be supplemented by detailed surveys on flora and fauna by the competent institutions with the approval and funding support of the board.
3. There will be no anthropogenic activities within the boundaries of the conservation areas, except for the rights and privileges of the local public which will be dealt out by the board.
4. Special attention should be made to overcome the biotic interference on the forests located within the Catchment area. The inhabitants of the area would be encouraged with sustainable forest conservation practices and economic activities. This will ensure habitat continuity, minimum loss of species and fragmentation of wildlife habitats.
5. Required provisions of law will need to be put in place to empower the field personnel of the board within the existing framework of Sikkim Forest, Environment, and Wildlife Management Department.
6. The violators should be punished as per the provisions of the existing Forest and Wildlife laws.
7. In addition to all the conservation measures to be undertaken under this program, an action plan has also been proposed.

ACTION PLAN.

Even though there are no rare or endangered plants or animal species reported, there may be a threat to the surrounding areas. Hence a detailed survey has been undertaken to prepare an accurate inventory of the forest resources wherein details of crop composition and distribution of forest with species, classes, density and economically high yielding stands have been enumerated and documented for the entire project area. This will show the general



condition of the forest and areas requiring regeneration and treatment. The degraded Gaucharan and Khasmal forests should be replenished with vital afforestation program. The demarcation of the R.F and other Forests are highly necessary as the present boundary pillars are in deteriorated condition or not in existence. The wooden boundary pillars should be replaced with RCC posts with proper verification of the line. There are close chances of overlapping Gaucharan and Khasmal Forests in the villages as the boundary of the private forests in most cases are on same line. This requires constant surveillance and protection. State Forest department has taken up these works under Integrated Forest Protection Scheme and others are on their own. Butterfly park in East district is also under consideration by the state Forest department with the funds available under Teesta stage-V Hydel projects. Hence there is a small proposal made for Butterfly park under this scheme with an estimated cost of Rs 25 lakhs for butterfly park.

COMPENSATORY SCHEME FOR REMOVAL OF TREES

To take up the construction around 512 no's of trees have to be removed from the Non forest lands. According to the Sikkim Private and other non-forest land tree felling rules 2001, For every tree felling from private or other non-forest land one has to plant 10 no's of seedlings to minimise the negative impact on the ecology and Bio-diversity of the area, an integrated approach for Afforestation, Protection, Conservation of Environment and ecology is proposed to be adopted. According to the section 13 of the above said rules user agency has to transfer the required funds to carrying out the sapling plantation to the Forest Environment and Wild life management department of the Govt of Sikkim on the basis of the estimate prepared by the Forest Envi. and WL deptt.

Hence, a Scheme for afforestation to plant 5120 (ten times of the proposed trees for felling) on equivalent 3.2 ha. of degraded Forest(1600 seedlings per Hec) land in lieu of 512 no of trees from the acquired private land for the proposed project construction. The scheme is formulated with the components of Afforestation, Protection, Soil and Moisture conservation and other relevant aspects.

**LOCATIONS / SITES FOR AFFORESTATION:**

The proposed location / site for the Afforestation Scheme selected is degraded forest land under Namthang range.

Sl. No.	Item of work	Division/ Range Location/Sites	Area (in ha)	Remarks
1.	Afforestation	<i>South/ Namthang range</i>	3.20	Low Altitude

The fencing/ soil conservation etc would be taken up in the above area.

PROGRAMME / METHODOLOGY OF WORKS FOR EXECUTION**Block Plantation:**

An integrated approach with plantation, Soil & Moisture Conservation and Protection would be adopted on 3.2 Ha. of degraded Forest land. The spacing recommended would be 2.5 x 2.5 mtrs. with pits size of 45 x 45 x 45 cms. depending upon the actual ground condition having an average 1600 Nos. of seedlings per hectare for afforestation.

Fencing and Protection:

The area under the plantation would be fenced with Angle Iron Barbed fencing to be protected from biotic interferences one Chowkidar may also be engaged to prevent grazing, damage to the fencing and control of other biotic interferences in and around the plantation areas.

Soil & Moisture Conservation work :

As the area under question and proposed plantation areas are prone to erosion and some of them are already eroded, the Soil & Moisture Conservation work with vegetative and small engineering measures are proposed to be taken by over 25% of Plantation area i.e on approx one Ha. to minimise the soil erosion and enhancement of water regime in the area.



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Seedling Requirement:

The requirement of seedlings may be met from the existing Nurseries of the Department on payment basis as per the approved rates,

Choice of species:

Mixed plantation of site specific species like Rani Champ (*Michelia excelsa*), Phusrechamp (*Michelia* species), Piple (*Bucklendra populnia*), Tooni (*Cedrella toona*), Phunsey (*Mechilus edulis*), kapasey (*Acer campbelii*), Okhar (*Juglans regia*), Kawla (*Machilus Spp.*), and Katus (*Castanopsis* species) etc, vegetative measures under Soil & Moisture conservation work. Other species may also be grown as per the requirement of the area and the people.

Maintenance:

For better survival and to establish the seedlings, it is proposed to maintain the plantation area for five years including the year of creation which include casualty filling, weeding and other maintenance.

Environmental Monitoring & Evaluation:

To balance the environmental losses proper implementation and protection of the proposed afforestation scheme is necessary. Hence, regular environmental monitoring and evaluation is required to mitigate the negative impact of the project. The Environment Wing of the Department will monitor the Project area annually and submit its report to the State Government and the User Agency as well

Time Schedule:

The work may be executed during the period 2006-07 or 2007-08 depending upon the fund availability/transfer of fund by User agency. Further, the User Agency would require to transfer the fund in one Instalment as once the project implementation start, there should be no obstruction in smooth implementation of the project.



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Executing Agency:

The works under the Scheme shall be executed by the Department of Forest, Environment & Wildlife, Government of Sikkim through South Territorial Division.

Monitoring & Evaluation :

All the activities under the Scheme may be monitored by a committee constituted for the purpose, Divisional Forest Officer (T) South and other representatives from & Forests Environment and Wild life management department, Government of Sikkim concurrently and regularly.

FINANCIAL FORECAST & BUDGETING / ESTIMATION:

A. Advance works & Creation for Afforestation & SMC:

(i) Cost of seedlings for afforestation

Casualty filling

a. Total seedlings 3.2 ha x 2200 = 7040 nos

Cost @ Rs 3/seedling 7040 x 3 Rs 21120=00

(ii) Bock Plantation/ afforestation

@ 12000/ Ha X 3.2 Ha (L.A.) Rs 38400=00

(iii) Soil & moisture Conservation

@ 22,500/ Ha X 1Ha (L.A.) Rs 22500=00

(v) Angle Iron Barbed wire Fencing

a.@ 4,16,000/ km X one km (L.A.) Rs 416000=00

Total A: Rs 498020=00



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B. Maintenance of Afforestation and others:

(i) Bock Plantation/ afforestation

Two weedings in 2nd & 3rd year

a. @ 3188/ Ha/year X 3.2 Ha x 2 (L.A.)

Rs 20400=00

b. @ 3188/ Ha/year X 3.2 Ha x 1 (L.A.)

Rs 10200=00

(ii) Repair of fencing as and when required L.S.

Rs 50000=00

(iii) Watch & ward / Chowkidars

@ Rs.85 X 365X 1X5 (L.A.)

Rs 155125=00

Total B:

Rs. 235725=00

Sub -Total A+ B: = Rs. 733745=00**Total outlay for Biodiversity conservation is Rs 169.12 lakhs**



CHAPTER-V

FREE FUEL PROVISION

INTRODUCTION

While constructing the Teesta stage-VI H.E project, it is likely that a larger number of labourers have to be brought for the construction purpose who will be there till the construction of the project and its other development and to comply the directives of the Ministry of Environment and Forests, Government of India vide their reference of order, the project authorities are mandatory to make sufficient provisions of free fuel arrangement to meet the daily requirement of their worker and staff. The basic purpose of the order of the Ministry is to ensure the following objectives.

- To control illegal felling of trees
- To provide adequate and fuel arrangements to the worker/workmen to ensure eco-friendly environment
- To make the responsibility of the project authority to provide sound amenities for the development of the project.
- To maintain the proper ecology of the project site in particular and the region at larger.
- To restrict entry into the nearby forest area and to maintain proper environment of the area.

The Lanco Energy private Ltd has sufficient experience in the field of construction of Hydel projects especially in the hilly regions like Himachal Pradesh of the country and their expertise exhibits the control of all aspect of any impediment and to ensure adequate measures to check the problems. Keeping in view of the observation, it is the responsibility of the project authority to provide sufficient fuel wood alternative arrangement to their laborers and staff in the project site through out the construction period and this would resolve the pressure on the forest. The facilities should include the items like light, cooking and running the electronic gadgets with the systems.



The project employees and the contract laborers should have access to distribution of electricity on subsidized rate. The contractors should have a mandatory clause to provide proper supply of fuel to their laborers and staff. Common mess should be provided to the laborers on subsidized rates by the contractor. In order to ensure regular supply of LPG gas the supply agency should be established within the work site. With the assistance of the state Food and Civil Supplies department the requisite kerosene depot should be installed near the project site to meet the regular supply of the same to the workers and the staff. However, the safety of the LPG and Kerosene depot should be properly maintained against any incidence.

Provision of free fuel to the laborers.

As these laborers would be working for the project on contract system it is necessary to provide free fuel arrangements by the individual contractors at 50 % of the rate prevailing in the state on kerosene, Electricity and LPG Gas connection so that the laborers do not enter the forest and other areas.

A. Cost estimate for LPG distribution for the construction period in Lakhs

Year	No of employees	Annual requirement @ one cylinder/month	Total cost @ Rs 325 per cylinder	Subsidy to be born by Lanco 50%
1	200	2400	7.80	3.90
2	200	2400	7.80	3.90
3	300	3600	11.70	5.85
4	400	4800	15.60	7.80
5	400	4800	15.60	7.80
Total	1500	18000	58.50	29.25



B. Cost estimate for Kerosene distribution for the construction period in Lakhs

Year	No of labourers	Annual requirement @ 120 ltr per labourer	Total cost @ Rs 20 per litre	Subsidy to be born by Lanco 50%
1	1000	120000	24.00	12.00
2	1000	120000	24.00	12.00
3	1200	144000	28.80	14.40
4	1300	156000	31.20	15.60
5	1300	156000	31.20	15.60
Total	5800	696000	139.20	69.60

Grand Total A+B 98.85 lakhs

Total outley proposed for this purpose is Rs ninety lakh eighty five thousand only.



CHAPTER- VI

SOIL CONSERVATION AND PROTECTION PLAN

RECOMMENDATIONS

- (1) Soil conservation measures, such as, construction of bench terraces in paddy fields, should be adopted by farmers in land capability class III and IV.
- (2) Drainage of excess water should be ensured from paddy fields, proper slope in the bench terraces should be provided.
- (3) For rain fed cultivation of Maize crop, terracing and bunding along the contours, should be encouraged to check soil erosion and to maintain soil depth.
- (4) Suitable field demonstrations, for soil and water conservation, may be laid out by extension wing of the Agriculture Department to educate and convince the farmers about the utility of soil conservation measures.
- (5) For improving the soil fertility, adequate doses of fertilizers should be given on the basis of the soil tests.
- (6) Soil acidity may be checked by application of lime as per lime requirement determined by Soil Testing Lab situated at Tadong. Further farmers should be encouraged to apply lime which will help in releasing available nutrients from soil particles. Response of application of fertility is also assured by the practice in acidic soils and farmers should be given subsidy for purchasing dolomite.

Suggestions for protection provisions.

- a. Bare minimum disturbances on soil formation.
- b. The protection provisions should be simultaneously arranged wherever the land has been disturbed and displaced.
- c. Urgent efforts should be attempted to plant more economically viable horticulture plants mixed with tree species to maintain proper agro-forestry system and to ensure sound economy of the villagers.



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- d.** Control measures with proper technology are taken up in the identified permanent landslide zones.
- e.** Improvement of orange orchards with modern methodology is taken up wherever the orchards exist.
- f.** A research base improvement of cardamom plantation in the catchment area is initiated urgently.
- g.** Fresh landslides adjoining agriculture lands be treated with bioengineering inputs.
- h.** A scientific method of lopping the fodder trees in the catchment area should be introduced.
- i.** Genetically improved and sound seeds of main agriculture crops may be tried.
- j.** Selection of high valued species of fodder should be attempted.
- k.** Proper protective measures in the form of bioengineering inputs should be drawn for area identified as very high priority areas.
- l.** The natural jhoras running in between the holdings should be restructured and provide proper protective walls.
- m.** The practice of irrigation system in the private land require appropriate technology to avoid further aggravation of land cutting and damages due faulty irrigation practices.
- n.** The old laws of the forest for control felling on both flanks of the natural drains must be revitalized to protect the land nearby the drains.
- o.** The local villagers as well as the residents of the sub-watersheds must be given sensitization and awareness program for their faulty approach of cultivation.
- p.** More biological measures may be adopted to stabilize the landslide of Ghati khola which is up stream of barrage.

**COST ESTIMATE****BIOLOGICAL****CREATION OF NURSERY AND UPKEEP.**

The success of any regeneration program lies on the type of nurseries that are available in the project area. As the area of the project site is highly vulnerable and it requires modernization of the nurseries in terms of mechanical inputs, selection of species that are going to plant in the area, regular supply of water, centrally located to feed to the planting area, local labour available, proper fencing and technically sound field officer to supervise the project. The nurseries should be created in advance to the planting period so that during the planting period sufficient seedlings stocks are forthcoming and it should be targeted to supply seedlings minimum of 5 years from the creation period including post maintenance for gap filling and casualty beating the plantation areas. However, the number of the maintenance support should be reduced to requisite number only so that the expenditures can be minimized which can be put to other area.

Sl.No	Item	Rates/ha	Targets		Duration in year
			Physical	Financial	
01	Creation of high tech nursery	319600/ha	1	3.20	1st
02	Maintenance of high-tech nursery	188000	1	9.40	5
	Total			12.60	5+1

The maintenance of the nursery will be continued after the project implementation is over to meet the casualty beating and gap filling of the plantation to achieve cent percent success and to provide and facilitate supply of seedlings to the farmers of their choice.



AFFORESTATION.

The regeneration of eco-fragile open forest blanks, severe to very severe degraded land, waste land of any categories irrespective of their status of land will be brought under the program. The high and very high land slides and soil erosion prone area will be treated under the program of afforestation with proper selection of species for the site condition. The planting program has to be phased out in sequence of break up of in the second year of the project take up. The nursery should be created in time to develop and prepare program for the plantation. The maintenance of the first year plantation should be followed with one weeding in September and two consecutive weeding for each plantation after the second year of the project period till the third year of the project.

The choice of species suggested are, Acer, Quercus, Magnolia, Catanopsis, Toona, Juglans, Xyanthoxylum, Schema, Chakrassia, Terminalia, Duabanga in the temperate and low belt and Abies, Rhododendron, Betula, Sorbus, Ilex, Juniper etc. in the upper elevation of the project area. However, the silviculture of some of the species is very difficult and timely collection of seeds should be promoted for better results of survival. The planting of medicinal plants should be resorted to the local collections to promote the growers in the watersheds and choice of species should be left to the residents and involve the local institutes.

The control and gradual stabilization of slides and erosion the choice of species may be Agave, Broom grass, Erythrina, Viburnum, Bamboo and local grasses. The varied bamboo species are locally available in the site and has been proved to be very important ecologically and economically and propagation of the same is very necessary to promote the bamboo. The rhizomes of the bamboo grass is capable of resting and protecting the soil against any aggravation. The planting of the relevant species should be taken up in time to ensure high standard of survival of rates and checking of land slides. The points raised in the paragraphs should be addressed while taking up the program that the development of natural regeneration can be mitigated with little soil working in the thinly populated forests areas as the seeds can access to the top soil rich in nutrients.



The plantations should be well protected as the area is subjected to open grazing and intensive interferences due to high density of human population. The protection of the area with barbed wire fencing and supported with angle iron barriers should be extended in the plantation boundaries and along the fencing boundaries planting of Agave and Cryptomeria should be carried out to indicate the plantation area on term achievement. The fencing should be erected in the vulnerable area of the site and efforts should be made to reduce the cost on the protection. The project implementing agency should create conducive environment to evolve the local people to encourage social fencing and educational and sensitization of the residents towards the project friendly program should be often organized. The deployment of watch and wards must be considered wherever direly necessary.

Since this activity has already been proposed under the scheme of planting ten saplings for every felled tree which is mandatory to remove the trees from the private / institutional lands as per the provisions(Rule 13) of Sikkim private and other non Forest land tree felling rules-2001. There is also a provision to prepare compensatory afforestation for the required forest land diversion under FCA-1980, hence no separate afforestation scheme has been proposed at this juncture.

FUEL WOOD AND FODDER PLANTATION

The scope of fodder and fuel wood development is very high in the project area to meet the growing demand of the population in the project site. As per the survey of use of other means of cooking arrangement in the village 75-80 % family use LPG cooking mechanism provided by the government and also self arrangement. But the use of wood has not been significantly reduced though some percentage of reduction in the use of wood has been observed. About 50-60 % fuel wood is met from the private forests or holding but the remaining supply is carried out from the nearby forests area. The pressure is quite high on the forests as the extent of forest area is limited in the project site and the condition is very poor. As the high portion of the fuel wood is supplied from the private forests it is pertinent to encourage the stakeholders to grow more forests in their land so that the condition of the forests in the villages may improve in due course of time. The project implementing agency should provide incentives to the farmers to grow more trees in their land for better economy and this can be



achieved by giving training and providing technical inputs for creation of high tech nurseries in the project area.

The degraded Khasmal land should be brought under the tree plantation program through community participation and the cases of land identification should be solved through the community involvement. Planting of fodder species in the farmland should be encouraged to grow more biomass through selected species of valued fodder plants trees. Some of the selection of species may improve the quality as well as the quantity of fodder in the area. The following species of fodder are suggested for planting in the holdings and blanks areas in the villages.

- Saurauia napalensis
- Ficus bengalensis
- Terminalia belerica
- Ficus nemoralis
- Boehmeria regulosa
- Butea frondosa
- Ficus cunia
- Morus indica
- Bauhimia purpurea
- Brassaiopsis hainlo
- Thesoleanea sikkimensis

As the fodder plants are susceptible to frequent browsing and damages it is proper to plant tall seedlings so that damages are less and survival are better. The cost of planting should be based on the number of fodder seedlings planted by each farmer. The community land can be planed by the community themselves so that they can own the project and the usufructs can be shared among them.



Sl.No	Items	Rate	Physical targets	Financial targets	Duration in years
01	Broom grass plantation	12350/ha	50/ha	6.18	
02	Fuel wood plantation	12350/ha	50/ha	6.18	
03	Maintenance of fuel wood plantation	2550/ha	50/ha	2.56	2
04	Fodder plantation	12350/ha	50/ha	6.18	
05	Maintenance of fodder plantation	2550/ha	50/ha	2.56	2
06	Social fencing		10 village	-	
	Total		80/ha	23.66	

PASTURE DEVELOPMENT.

The pasture land under the project area is not very significant as the area is confined to the village level and the adjoining forests land and the pasture areas are located in the high elevated area of the project site though the information has been documented in the proposal. However, the degraded land especially local pasture lands and other wasteland have been considered here for the preparation of the environmental management plan of Teesta stage-VI HE project. It is proposed to restock the depleted pasture land with palatable grass of perennial in growth with fast rooting system to support the area with green grass during the pinch period. The following targets have been proposed to mitigate the pasture land.

Sl.No	Items	Rate	Physical targets	Financial targets	Duration in years
01	Pasture development	6250/ha	50/ha	3.10	
02	Maintenance of P.D	2550/ha	50/ha	2.56	2
03	Vegetative fencing	22320/km	4km	0.89	
	Total		50ha& 4km	6.55	

SILVI-PASTURE DEVELOPMENT.

The waste land and the Gaucharan land are suitable for silvi-pasture operations so that the villagers can regulate their small timber and fodder and grass requirement. The spacement of



planting of tree species can be maintained at a wider gap so that broom grass, Guatamala, Cidrenella grass, Nepier grass can be inter-planted as ground storey. The practice of cut and carry operation should be regulated. The following physical and financial targets have been proposed.

Sl.No	Items	Rate	Physical targets	Financial targets	Duration in year
01	Silvi-pasturedevelopment	11750/ha	50/ha	5.88	
02	Maintenance of Silvi-P.D	2550/ha	10/ha	2.55	2
03	Vegetative fencing	23200/km	4km	0.89	
04	Social fencing	Villagers near the SPD area	9 villages	-	
	Total		40ha& 1km	9.32	

Total outlay for biological measures is Rs 52.13 lakhs

ENGINEERING MEASURES.

Major and minor landslides occur in forests land. The extent of forest land in the project area is very limited, but the natural jhoras, drains, nallahs and road side culverts are within the legal status of the Forest Act. However, there are some jhoras and nallas and natural drains running across the private holding which also require necessary protection. The maximum problem is its geological factor indicating heavy depressions widening of the gaps, erosion and landslides especially in the aggravated zone. It is necessary to know how a watershed functions, what factors affect watershed behavior, how they affect the behavior, and the magnitude of their effects. It is also necessary to know which of these factors can be controlled or modified by the planners, how they can be modified and the amount they can be changed. It is a usual principle that watershed reacts to different climatic events characteristic of the area. It would include the reaction to different precipitation amount, types, intensities and distribution. The firm basis of hydrologic knowledge is priority requisite for tackling and treatment of engineering measures of a catchment. The sources of water in the form of spring, runoff, precipitation, percolation and distribution are very important for the treatment of landslide and soil erosion and training of drains and jhoras. Once the sources of hydrological regime are identified the planning of engineering structures can be extended to



contend the problems. The structures of various plans like jhora training, drop structures, Dry stone rubble wall, catch water drain, diversions, guide wall with sausage combined with ccm wall and toe-wall against toe-cutting may be more effective than single structures. The dry stone rubble walls are effective in forest area where the land is severely degraded and soil loss is very high and these walls can be constructed in staggered formations across the contour and this will check the runoff and improve the site quality for regeneration process and support moisture conservation. These engineering structures should be supplemented with biological inputs in the form of seed sowing, bally benching, contour bunds, vegetative barriers, bamboo plantation and regeneration with fibrous rooting species.

The following soil conservation activities are proposed to stabilize the area against the pressure of landslide and erosion with physical and financial targets.

Sl.No	Item of work	Rate	Physical targets	Financial targets	Duration in years.
01	Jhora training with sausage wall	1548/cum	200 cum	3.10	2
02	Catch water drain	1188.6cum	200 cum	2.40	2
03	1:4:8 ccm wall	1806cum	200 cum	3.61	2
04	Dry stone rubble wall	768/cum	200 cum	1.54	2
05	Bally benching	18100/ha	50 ha	9.05	2
06	Soil moisture conservation	23000/ha	20 ha	4.60	2
07	Diversion channel	1188.6/cum	100 cum	1.19	1
08	Contour bunding	19700/ha	20 ha	3.94	2
	Total		900 cum & 90ha	29.43	

All the works proposed under this plan should be taken up in and around the required project areas irrespective of the status of the land, but the priority areas should be approved by the state Forest Environment and Wildlife management Department.

**INFRASTRUCTURE: STAFF QUARTERS AND COMMUNICATION.**

The project has gestation period of six years to execute the works as per the plan and for proper and efficient management of the project it is proposed to purchase field level conveyance and three Bolero's for the officers of the project. There is division office to monitor the project. It is also proposed to construct two Range office quarters, two Block Officer's quarters at Barriage site and Mamring and four F.G quarters at required locations. The provision of these facilities will promote better supervision of the treatment of the work

Sl.No	Items	Physical targets	Financial targets inlakhs
01	Bolero	3	21.00
02	Utility jeep	3	15.00
03	Range officer quarter	2	18.00
04	Construction of Forest checkpostswlth accommodation	3	12.00
05	Upgradation of Forest CP's	4	8.00
05	Block officer qtr	2	14.00
06	F.G qtr	4	12.00
07	Equipment	LS	2.00
		Total	102.00

SUMMARY OF ALLOCATION FOR DIFFERENT ITEM OF WORKS AND COMPONENTS.

SL.No	Items	Outlay inlakhs	Total inlakhs
01	Soil conservation works		
	1) Biological	52.13	
	2)Engineering	29.43	
	Sub total		81.53
02	Infra-structures		
	1) Conveyances	41.00	
	2) Quarters and protection	61.00	
	Sub total		102.00
	Grand total		183.53



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The project will have the following human resources to carry out the implementation and management of the project.

HEAD OFFICE(Monitoring)

PCCF cum Secretary
Add. PCCF Environment
CCF Environment
CF Territorial

FIELD LEVEL(Implementation)

DFO	01
ACF	01
RO	01
BO	02
FG	04

A full-fledged Range office is there at Namthang in South and Singtam in East to keep a good vigil on the works.

LIST OF SUITABLE SPECIES FOR THE PROJECT AREA.

Mixed plantation.

Up to 1500 meters.

Terminalia myriocarpa
Cuppressus kashmeriana
Spondias auxillaris
Shorea robusta
Chakrassia tabularis
Gmelina arborea
GRevellia robusta
Bischofia javonica
Engalhartia spp.

**UP TO 3500 meters**

Juglans regia
 Eleocarpus spp.
 Castanopsis hista
 Betula alnoides
 Quercus spp.
 Bucklanea spp.
 Lacoscertrum canablis
 Michalus spp.
 Michelus excelsa
 Prunus sikkimensis
 Acer spp.
 Juniperus recurva
 Juniperus pseudo sabina
 Abies densa
 Rhododendron spp.
 Salix

FODDER AND FUEL WOOD SPECIES.

Sauranea napaulensis
 Boshmeria rogulosa
 Quercus spp
 Ficus nemoralis
 Butea frondasa
 Castanopsis indica
 Machalus odoratissima
 Ficus clavata
 Ficus bengalensis
 Alnus nepalensis
 Bamboosa spp.
 Bauhinea variegata
 Morus indica
 Ficus cunia



Litsea polytha
 Bahinia parpurea
 Terminalia tomentosa
 Albizzia spp.
 Betula alnoides

ROAD SIDE / AVENUE PLANTATION SPECIES.

Paulenea tomentosa
 Prunus sikkimensis
 Rhododendron spp.
 Baugain vellea
 Plumeria acuminata
 Lagerstromia spp.
 Thysolenea spp.
 Grevellia robusta
 Delonix regia
 Cassia fistula
 Hebiscus spp.
 Polythia spp.
 Ery thenia spp.

HORTICULTURE PLANT SPECIES.

Orange
 Pine apple
 Guava
 Pears
 Peach
 Plum
 Lemon
 Cardamom
 Banana



SILVI-PASTURE DEVELOPMENT SPECIES

Ficus memoralis
 Ficus bengalensis
 Alnus nepalensis
 Bamboosa spp.
 Bauhinea variegata
 Morus indica
 Ficus cunia
 Litsea polytha
 Bahinia parpurea
 Terminalia tomentosa
 Albizzia spp.
 Betula alnoides
 Saurenia napulensis
 Thysolenia sikkimensis
 Napier grass
 Gautammala
 Citronella grass.

NATURAL REGENERATION SPECIES

Acer spp.
 Betula spp.
 Shorea spp.
 Quercus spp.
 Abies spp.
 Bucklanea spp.

MEDICINAL PLANTS

Picrorrichiza karroa
 Swertia chirata
 Orchis latifolia



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Digitalis purpurea
Aconitum heterophyllum
Asparagus spp.
Onosma spp.
Carthamus spp.
Hibiscus abelmoschos
Acrostichum alatum
Piper longum
Gloriosa superba

BAMBOO

Bambusa tulda
Bambusa nutans
Dendrocalamus spp.
Arundinaria maling



CHAPTER-VII

RESTORATION PLAN FOR SPOIL TIP

The construction of Teesta stage-VI H.E project East Sikkim by Lanco Energy Private Limited has mainly the following components. During the construction of the above project components, it is clear that a substantial quantity of muck/debris/sludge is anticipated. Considering the slope, land gradient, fragile soil types and rugged topography in the construction sites the volume of environmental damages is highly significant. In order to assess the situation of the site a field inspection was conducted and found that the extent and volume of excavation generated out of the construction has been suggested to be reused in preparation of aggregates in the construction, expected quantity of muck from different locations is given below .

S.No	Name of Structures	Quantity in Lakh Cum.
1	Barrage, Intake and Desilting Chambers	17.06
2	Adit – II, Silt Flushing Tunnels and HRT	5.11
3	Adit – II and HRT	8.1
4	Adit – III and HRT	9.1
5	Power House, Transfermer Cavern, Surge Shaft, Pressure Shafts, Downstream Surge Chamber, TRT etc.	14.77
	Total	54.18

Proposed crusher locations

The following locations have been proposed to install crusher machines

1. Barrage and Adit – I site.
2. Adit – II site.
3. Adit – III site.
4. Power House site.



Before installation of these crushers user agency has to obtain prior permission from the state Forest Environment and Wild life Management department.

The muck generated from all the activities is about 54.18 lacs cum. Out of this total around 20% will be re-used for aggregates and concrete purposes, balance shall be disposed off and dumped at the following specified dumping areas, located far from the water bodies, nallas and rivers.

AREA IDENTIFIED FOR DUMPING/SPOIL TIPS.

Dumping Areas

Sl. No.	Location	Purpose	Area
1.	Recape Village	For HRT Dumping	6.0 Hac.
2.	Daring Village in South Sikkim	Barrage, Disilting Chambers	2.0 Hac
3.	Kajel Khola (outside the river reserve)	For HRT Dumping	6.0 Hac.
4.	Mamring Opp. SMIT (outside the river reserve)	For HRT Dumping	3.0 Hac
5.	D/S. of Subin Khor (Power House) near Knon Khola (outside the river reserve)	Power House Area works including PH surage shaft, TRT etc.	8.0 Hac

It has been mentioned that the excavations works were designed by experts in the field of soil mechanics; there should not be any threat of damages on environment, humanlife and property. While considering the safety factors of environment against the consequences of the huge construction, all the relevant factors that are likely to induce environmental damages have been taken into consideration and as far as possible efforts have been made to minimize the effects in these areas with proper biological and mechanical measures are proposed in the plan for restoration of spoils.

AIMS AND OBJECTIVE OF RESTORATION.

The basic objectives of restoring the volume of spoils from the site are.

- To protect and control soil erosion
- To create greenery in the exposed areas
- To improve and develop into recreational sites
- To ensure maximum utilization of sludge /debris/muck for the construction purpose.
- To develop the exposed area in line with the landscape
- To avoid minimum damages due to the spoilage of muck in the project area.



PLANNING FOR RESTORATION OF SPOIL AREAS.

Although there are several working sites and the anticipated quantity of debris/sludge/muck is very high but as per the DPR, out of 54.18 lakhs cum of earth cutting, the quantity proposed to be reused is around 20%. The excavated earth can be dumped/ kept in the open space areas identified for this purpose within the project area till it is sagrigated for reusing purpose. Considering the quantity of excavated spoils and proportionate requirement for construction works the provisional arrangement should suffice the purpose.

It is excepted that the post management of the project site should blend with the natural landscape setting by developing the area with gentle slopes, bunds, terraced and water ponds, patches of greenery in and around the project site. Recreational parks and tourists spots to smoothen the environment with improvement of ornamental plants for Eco tourism purpose . It may be necessary to inoculate the spoil used for development of landscape as the soils have lost their nutrient strength. This can be developed through culture of micro-organism or vermi- culture practices at the project nursery site. The procurement of bio-fertilizer from the National Environment al Engineering Research Institute, Nagpur which is a pioneer institute in the field of reclamation of open cast mining dumps may be sought.

For restructuring, re-strengthening and rejuvenating the spoil areas, different field expertise may provide proper direction and guidance for reclamation measurefor implementation of the restoration plan of the spoil area. The total financial forecast is to the tune of Rs. 81.61 lakhs only for the adoption of mechanical and biological measures under this plan.

PROCESS OF DUMPING AND PROTECTION OF SPOIL AREA.

As Suggested In the DPR, the excavated 20% of spoil will be re-utilized for the construction works, construction of approach road protection filling and soling works. The dumping spoils should be properly carried out in such way that the gravitational forces and movement of dumping is checked at every point of the process. Technically the excavated soils being angular in shape with mixture of crushed particles can easily segregate. All the spoil areas will be developed as per the latest technology of dumping, the effect of rain settle the angle of soil setting, however, if required sprinkling water may be resorted to



avoid dust pollution. A proper drainage has to be provided to ensure flow of runoff without obstruction. Planting with suitable species of trees, shrubs and other biomass should be initiated.

RECLAMATION MEASURES FOR STABILIZATION OF SPOIL AREAS.

The following engineering and biological measures have been proposed for the development of spoil areas.

ENGINEERING.

- Dry stone rubble structure
- RR masonry
- Catch water drain
- Leveling and spreading of soil
- Improvement of drainage

BIOLOGICAL

- ✚ Plantation of suitable tree species and soil binding using Bio-fertilizer technology.
- ✚ Turfing of the exposed area and improvement of environment with ornamental species.
- ✚ Bamboo and broom grass plantation
- ✚ Protection with mechanical support
- ✚ Social fencing through the mass public awareness.

The spoil area will be protected with grass turfing and close planting of soil binding plants to achieve maximum growth rate within short gestation period. The planting of fast growing species should be the choice of the managers to restrict rapid wash of runoff and reduce the velocity of runoff.

CHOICE OF SPECIES.



The following species are suggested to raise in the spoil area.

Panisaj
 Gokul
 Champ
 Cuppressus
 Delonix
 Lagrrstroemia
 Silver oak
 Broom grass
 Bamboo
 Ficus spp.
 Citronella grass
 Local Dhobo grass
 Erythana
 Lemon grass
 Paulanea

The plantation should be followed with trial of using bio-fertilizer from recognized institute.

PHASING OF WORK PROGRAM.

First Phase

Land acquisition
 Construction of protective work
 Dumping of muck
 Leveling of area
 Advance soil working
 Technological inputs
 Protection social fencing

2nd Phase.

Predatory for plantation
 Maintenance
 Improvement of site
 Construction of drainage
 Supervision



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3rd Phase

Regular maintenance of
Plantation
Protection

The maintenance of the assets will be extended to over five years to achieve high rate of success of all restoration program.

COST ESTIMATE FOR RESTORATION OF SPOIL AREA.**ENGINEERING MEASURES.**

SL.No	Name of the work	Qty.	Unit	Rate (Rs)	Amount in lakhs.
01	Dry stone rubble wall	900	cum	768	6.90
02	RR masonry	300	cum	1548	4.62
03	Catch water drain	300	cum	1188.6	3.42
04	Filling of Good Earth	02	Lakh Cum	20 Lakh	40.00
05	Leveling	25	ha	30400	7.60
06	Improvement of drainage	150	cum	1806	2.70

Rs.65.24 lakhs**BIOLOGICAL MEASURE.**

SL.No	Name of the work	Qty.	Unit	Rate in Rs	Amount in lakhs.
01	Plantation	45	ha	12350	5.56
02	Turfing	100	-do-	2550	2.56
03	Bamboo/broom plantation	30	-do-	11950	3.59
04	Protection	3 no's of labourers for Five years		85 /day	4.66

Rs.16.37 lakhs**Grand total Rs.81.61 lakhs*****(Rupees Eighty One lakhs Sixty One Thousand) only***



CHAPTER -VIII RESTORATION PLAN FOR QUERY SITES

INTRODUCTION:

For the construction of Teesta stage VI hydel project huge quantity of quality construction material supply is required in mass as the piece meal supply will not meet the actual requirement. The extraction of huge quantity of material may cause major pollution of water, air and overall environment at large.

ESTIMATED REQUIREMENT OF CONSTRUCTION MATERIALS.

The requirement of materials for the construction of the proposed hydel project is very huge as it is not available near the project site. The material requirement should grade one in quality to ensure all safety measure. The following sites require different grade of materials.

PROPOSED QUARRY SITE SELECTED BY THE PROJECT DEVELOPERS.

Sl.No	Description	From	Remark
01	Stone aggregate	20 th Mile, Dipudara, 47 th Km, Rangpoo, Kopchey, Tarkhola and Singtam quarry etc.	Existing quarry site under operation.
02	Coarse sand	20 th Mile, Dipudara, Kopchey, 47 th Km Rangpoo Nala, Tarkhola, Kopchey and Singtam etc.,	Existing quarry site under operation
03	Fine sand	20 th Mile, Dipudara, Ladakhey, Kopchey, Khanitar, 47 th Km Rangpoo Nala, Tarkhola quarry, etc.,	-do-
04	CC Blocks	Near to Barrage site	-
05	Cement POC43/53	Siliguri or any other identified locations	-



The quantity of different grades of construction materials for each type of structures.

Sl.No	Structure	Quantity in(cum)
01	Sand	15000 m ³
02	Stone	48000 m ³
03	Cement	1.75 Lakh MT
04	Steel	30000 MT

It is observed that there are scientific studies carried by the project authority regarding the specific requirement of different types of construction materials in the area. However, they have contacted a few sites close to the project area as below.

LOCATION AND AREA OF FINALLY SELECTED QUARRY SITE FOR PROJECT CONSTRUCTION.

A team of engineers and different group of experts in the field of construction material selection carried out extensive studies in and around the project area and on ocular examination of the materials in the field, suggestions have come up in different locations along the Teesta River bed and other areas. The team has suggested final site for stone aggregate, coarse sand, fine sand both within the state and part in West Bengal. Areas proposed for dumping will also be utilized for quarry purposes before dumping the muck. The supply of cement has been identified from Siliguri and other locations outside the state. The selected quarry sites have been shown in the map enclosed in the DPR. The detailed list of sites identified only for quarry purpose is mentioned below

Sl.no	Location	Area in Ha
1	Subin khore	3
2	Khanitar	2
3	Near to Ladhaki Quarry site	2
4	Kalej Khola site	2
	Total	9



STONE AGGREGATE QUARRY.

The existing open quarry operations carried out along the river beds at 20th mile, Dipudara, Kopchey, Tarkhola, Singtam and Rangpo do not handle any mechanical operations. The practice of hand breaking river boulder is predominant all along the river beds. The aggregate is hand broken product of river shingles, boulders etc. On close visual examination of the chips, it was found that it contained high amount of MICA and the deposits of the same were predominant. The stones were porous and contained pinch holes which indicate weak physical property and strength and are likely to crush under load application. Besides this, information was gathered from the locals about the distribution of construction materials nearby the project site. A strata of hard rock was found along the Teesta river of the project sites in private owned and forest small quarry which is suitable for the construction material. There is also scope of extraction of quarry along this quarry area in forest land which can be acquired through proper permission of the Forest Department. The selection of the site was considered as it is near to the project area which will reduce the cost and bring construction material from outside the state will increase the rate of cost of stone chips. However, while extracting the quarry it may be necessary to resort to blasting operations with proper operational licenses.

COARSE SAND SUPPLY.

The field survey was conducted to assess the distribution vis-a-vis quality and quantity of coarse sand supply available along the existing river bed quarry sites at Rorathang-Rangpo road, Singtam-Rangpoo road which are located in the other side of the river of the project site. All the sites inspected by the team have the similar type of quarry operations and quality as well as the quantity which will not meet the huge requirement of the construction of the project. The construction of the project is within time schedule and it is necessary to have proper qualitative quarry area to meet the regular demand of the construction. Therefore, it is proposed to carry out mechanical quarrying and loading operation in consultation with the Forest Department.



FINE SAND SUPPLY

Although fine sand component is available along the River Teesta beds, but operation of the quarry is same that of the other areas visited. There are huge local commitments for supply to other agencies within the state and supply of the project construction is not feasible from the river bed on huge supply, however, some quantity may be met here too. In view of the scarce supply of the fine sand it is worthwhile to promote an independent quarry area for mechanical operation and loading system to extract superior quality with the permission of the concerned department in the state.

CEMENT SUPPLY

As the state does not have a cement manufacturing factory it is proposed to get the supply from Siliguri, West Bengal and recommended type of brand is Port-land Pozzalana cement (PPC) and Ordinary Portland Cement (OPC) 43/53 grade in ratio of 90-95 % and 5 to 10 % respectively. If required, low alkali cement will also be used. It is deemed necessary to have proper storage of cement godown near each work site to avoid air pollution in the areas.

CEMENT CONCRETE BLOCKS.

A thorough survey of brick manufacturing kiln was conducted in the state and observed that there is no sign of any manufacturers in the state. The normal supply of the same is met from Siliguri and to reduce cost of carriage and inbuilt cost on the bricks, it has been proposed to use the supply from the Central Building Research Institute as they supply both load bearing and non-load bearing blocks. This will enhance the speed of construction and suggested to maintain all possible sources of pollution in the area while carrying out the supply and dumping in the work site. All precautionary measures should be ensured in operation of these items of construction.

LAND REQUIRED FOR QUARRY SITES

The proposed area for quarry sites is 11 ha distributed at different locations including Sirwani, Kalej khola, Mamring, Subinkhor, out of which, six hectares is falling within the



forest land and the remaining are in the private lands. As compared to other projects in the state the total land required for quarry is not very significant. As far as the private land is concerned, the site is proposed to lease out to the user agency on payment of mutual understanding. The extent of forest land earmarked is very low and actual requirement/availability is depending on the quantity of supply from the private area which will be known after one year of the construction work commencement.

ENVIRONMENTAL IMPACTS.

The impact of excavation of construction materials in the form of coarse sand, stone aggregates, fine sand and preparation of concrete block of project construction on environment depend on various factors of operational process (a) excavation, (b) water regime,(c) climate,(d) topography (e) size and operation,(f) rock type and other factors related with the extraction of quarry. It is also subject to various stages at varied level of work progress on each site as there is less impact on development of working platform as compared to excavation of aggregates and sand. There is direct or indirect phenomenal changes in biological environment associated with the operation of quarry sites.

The extent of land involved for the same is not very significant and the quality of land being leased out by the private party is marginal land with rocky out crops without qualitative biomass. There is no rehabilitation or displacement of villagers .The water sources are away from the quarry site and hardly any disturbances seen. The private land proposed to be acquired are partially marginal land without much yield and other land are rocky out crop which falls under land classification (viii) and suitable for stone extraction purpose only as it does not produce any economically beneficial crop. Thus the effect on agriculture yield is minimal and impact on land use can be considered as very low.

In general, extraction is over the surface of the land on rocky out terrain and the sand quarry are proposed along the bank of the river, it appears that there is no change in the water regime in the adjoining local area and type of subsistence due to quarry is also not visible. The surface drainage is marginally affected due to the exposed out crop debris over the surface of the land under operation. Small poles, tree and scrub stands have to be removed in the forest area for clearance which may render disturbances on the environment and to



meet the mitigation of the removal compensatory afforestation scheme program has been prepared. As far as the other areas are concerned appropriate mitigative measures under the restoration plan have been reflected which shall provide proportionate improvement of landscape and the environment.

AIMS AND OBJECTIVES OF RESTORATION OF QUARRY SITES.

- To prevent further land degradation soil erosion
- To create and improve soil cover
- To enhance forest cover by matching plantation
- To stabilize the degraded land area.

TREATMENT MEASURES

The following treatment measures have been proposed for implementation under the Restoration Plan for quarry sites.

BIOLOGICAL MEASURES

The over use land on the quarry site with very poor coverage will be treated with fast growing plantation on slopes along the periphery in the initial stage followed by planting in the patches of degraded land due to excavation. The small portion of land in between the quarry pits will be taken up with fast growing plantation of grass in the initial stage and tree species in the following schedule. As the selection of plant species depends on the general site conditions, climate of the area, altitude and other factors, selection will be carried on accordingly. The consultation of local community may be very useful in selection of species and their participation must be considered before choice of species is decided for better impact and result. The effort should be made to improve the general out look of the site with proper landscape and beautification. The local residents of the area should benefit from the project in terms of fuel wood and fodder requirement effected by the quarry operations. The following species are suggested for planting.



Terminalia spp., Gravelia robusta, Bouganvella spp, Delonix regia, Toona, Alnus, Rubinea spp., Cassia fistula, Bamboo, etc., in addition to these species the consultation of local residents must be adhered to for their participation.

ENGINEERING MEASURES

The following mechanical measures are proposed to encounter the problem of quarry operation for implementation under Restoration plan. The fresh quarry site is susceptible to heavy soil loss and rapid land degradation. The area of land should be provided with mechanical protection in the form of barbed wire fencing to refrain any entry of biotic interference.

FILLING AND LEVELING

The pits and holes and cracks formed by the quarry operation will be filled up with debris and sludge and muck generated out of the site. The unused stone chips, gravels, sand mud and soil will be converted into proper natural setting mount comprising with the topography. Bunds and small rubble stone wall should be erected to check the surface runoff and improve the quality of water retention. As soon as the exposed land is brought under different stages of decoration the moisture regime will be improved and the process of rejuvenation takes place and indication of environmental augmentation becomes visible. Thus in due course of time the site will be a very pleasant place for eco-tourism.

CREATION OF BENCH TERRACES THROUGH LEVELING

The concreted and unconsolidated rock materials scattered everywhere in the site will be combined and terraces by leveling them will be constructed in staggered lines to improve the quality of site. This will accelerate the condition of water availability and increase the growth of plantation. The flow of soil erosion will be checked effectively.



DRAINAGE CHANNELS

As soon as the quarry operation is over the land becomes very poor and the surface runoff spreads and they become uncontrollable. Hence, it is necessary to provide proper water channels by converting the quarry pits and holes. The construction of water channels will promote proper reclamation of land for better green cover. With the implementation of the ameliorative measures the following values can be achieved.

The degraded sites and pits will be reclaimed with vegetative cover

The forest cover will develop

The availability of fodder and fuel will increase.

The natural regeneration can be enhanced by protection.

Water distribution will be better and uniform

In-si-tu water conservation may gain proper volume.

Sl.No	Item	unit	Quantity	Rate in Rs	Amount in lakhs.
01	Regeneration	Hectare	45	12350	5.56
02	Protection	Km	5	132000	6.60
03	Filling and Leveling	Cum	500	1548	7.74
04	Bench terraces	Ha	20	19700	3.94
05	Drainage channels	cum	500	1806	9.03
06	Watch and ward	No's	2	85	3.10
07	Total				35.97

The rates of Engineering measures and biological items are as per the approved schedule of rates of Forest, Environment and Wildlife Management Department, Government of Sikkim. as on 01.4.2004.



CHAPTER-IX

LANDSCAPE PLAN

INTRODUCTION

Tourism is one of the main economic sources of revenue in the state and the rate of flow of tourism in the state has been multiplying year after year. There are beautiful natural landscapes in the state with exiting mountains peaks, fresh water lakes, green hills added with allure of ethnic tradition and culture with pleasant people of the Himalayas.

With the construction of the Teesta Hydro Electric Project at a distance of 45 km from the state capital, this will not only promote the socio economic conditions but it will add additional attraction to the tourism development. Since, the project is located in the entrance of the state, its landscaping plays major role in the first impression of the visitors, the Tourists visiting the state of Sikkim. In order to ensure better impression and the tourism development it is the responsibility of the project authority to improve and mitigate the loss generated from the construction of the project through enchanting landscape delineation and proper arrangement of greenery and recreational and aesthetic development in the area which will lure the incoming tourist as well as the locals. Besides the development of tourism it is predominant to provide protection of the exposed area with proper landscape development blending with the existing local topography and natural settings. This can be achieved only through consorted efforts of land development with sense of recreation, aesthetic beauty and tourism at the back of the mind. The land development of the project site will bring changes in the local area in the form of beautification, recreation and stability and will provide opportunities to the local youths to promote their energetic powers to earn more income from the area by opening shops, guiding the tourists, selling local products and may be pony riding etc.

The implementation of environmental ameliorative and mitigative action plans for treatment of the project area and other area operated for the purpose of the construction should have these elements such as recreational type of plantations, with all round perpetual flowering genetics, landscaping with avenue type of species blending with the natural setting as well as rendering gradual stabilization of the distorted and displaced landscape,



installation of water sprinkling gardens, small benches within the garden to facilitate the resting place for locals as well as the tourists. It is also proposed to develop the Sirwani reservoir area as boating place for the tourists and the localers by the Forest Environment and Wild Life management department since all the Rivers are under the control of this department. Steps proposed in the Reservoir rim treatment chapter should be taken care off to develop this area as a major tourist attraction since it has a major scope due to its location almost adjoining to the National Highway(0.5Km) towards Singtam Dikchu road.

Post management of the assets shall be entrusted to the local bodies that would benefit from the area by regular maintenance and upkeep on sharing the revenue through plough back system for environmental conservation.

LANDSCAPING, BEAUTIFICATION AND ITS UTILITY.

The landscaping and beautification of the project complex will enhance intangible as well as tangible benefits on long run as all the in-fractural vis-à-vis environmental development has been planned to redo the loss created to the areas in the following aspects.

It shall provide recreational and aesthetic look. It shall bring harmony between the natural environment and man made environment. It shall develop a new tourist spot. It shall generate more greenery within the complex and provide sound environment. It shall promote the socio-economic condition of the locals in particular and state in general. It shall provide birds, butterfly and other fauna with planting fruit bearing species and flowering plants.

AREA FOR LANDSCAPING AND BEAUTIFICATION

There are mainly three specific locations in the project area one within the barrage area, Power house area and the spoil tip areas for the purpose of landscaping and beautification.



PROJECT SITE AREA.

The area available within the project site is very limited as the whole area is occupied for the construction of the project. The areas adjoining to the power house i.e colony area and the periphery have been selected for the implementation of the landscaping and beautification purpose. The small patches of land in between the staff quarters and other infra-structure will be also considered for the same purpose. The approach roads leading to the different components of the project will be taken for improvement and beautification. The requisite inputs for landscape and beautification has been included in the plan.

The land from approach bridge at Sumin Khore area to the project has greater scope for the development of landscaping and beautification as this will be the second look of the Sikkimese typical town in the hills and it has to be upgraded and improved properly. The requisite planning has been proposed. There are significant disturbances likely to be occurred in the spoil tip area and it is necessary to provide ameliorative measures against the threat by providing proper landscaping and beautification before it becomes a mess. As the concept of landscaping and beautification require proper knowledge and input, it is suggested to avail such experts by the management committee while implementing the schemes. So that suitable landscaping and beautification works with proper selection of quality planting materials are selected.

AVENUE PLANTATION

The proposed Hydel project is one of the developmental activities of the state government and to keep the spirit of the same the communication of it should be properly maintained by proper protection and control of soil erosion, rill erosion and accumulation of debris along the existing road sides and the newly proposed roads. The planting of soil binding with aesthetic value species of flora will support the stabilization of loosen soil and erosion caused by road side cuttings. The selection of the species requires proper experience and knowledge and the implementing agency should consult the same. The entire stretches of the road in the project area should be supplemented with beautiful flowering plants to improve the quality of the avenue plantation. Some of the species which may serve the purpose are suggested here. The broom grass, Silver oak, Paulonea spp, Lagerstromia



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spp, Prunus sikkimensis, Erythraea sobrosa, Magnolia grandiflora, Boganvelia, Plumaria acuminata. Besides the avenue plantation the protection of soil on both sides of the road must be stabilized and proper treatment should be attempted with bio-engineering works. The total length of the road is around 22.15 km (5.5 km old + 16.65 km new) only. Old roads already have substantial plantation, however, the aesthetically valued species are to fill up the gaps so that conducive environment is developed. The following physical and financial targets are recommended.

A. AVENUE PLANTATION CUM IMPROVEMENT OF ROAD SIDE PLANTATION

Sl.no	Items	Rate	Physical Targets	Financial target in lakhs	Duration in years.
01	Creation of nursery	25000	1.00ha	2.5	1
02	Maintenance of nursery and plantation of seedlings in and around project in suitable areas	1.86 lakhs	1.00ha	3.72	2
03	Avenue plantation @ state Green Mission Rates	Rs39785/km	22.15 km	8.81	
04	Three years maintenance of avenue plantation including tree guards if necessary	50% of the cost i.e. Rs39785/km/three years	22.15km	4.40	
05	Development of block plantations and gardens	Rs79294/- per ha	10.00ha	7.93	
06	Three years maintenance of avenue plantation including tree guards/fencing if necessary	50% of the cost i.e. Rs 79294/ ha	10.00ha	3.96	
07	Social fencing	All the project labourers on both side of road to be engaged	All the project labourers on both side of road to be engaged	--	Till the plantation is established.
08	Watch and ward	Rs 85/-	3 no's	4.65	5 years
09	Total		22.15 km + 10 ha	35.97	

Out lay is Rs 35.97 lakhs

**SELECTION OF SPECIES FOR LANDSCAPING AND BEAUTIFICATION.**

Delonix regia
Polythelia spp.
Jacoranda spp.
Lagerstroemea spp.
Bougainvella spp.
Plumeria spp.
Cuppressus spp.
Gravellia robusta
Magnolia grandiflora
Cryptomeria
Prunus sikkimensis
Tree fern
Cycas spp.
Bamboo local
Chinese bamboo
Burmise bamboo
Cassia fistula
Durantha spp.
Bottle brush

The above species are suggested for the landscaping and beautification of the area, however efforts should be resorted to explore more beautiful plants.

B. COST ESTIMATE FOR LANDSCAPING AND BEAUTIFICATION.

Sl.No	Item	Area	Unit	Amount in Lakhs
01	Nursery	0.5	Hectare	0.94
02	Plantation (ornamental and mixed)	10	- -do-	1.23
03	Creation of recreational park cum habitat development	2	-do-	10.42
04	Awareness camp	3	-	0.35
	Total			12.94

Outlay is Rs 12.94 lakhs

Total outlay (A+B) is Rs 48.91 lakhs



CHAPTER-X

GREEN BELT AROUND THE PROJECT AREA

INTRODUCTION

The survey of the floral distribution and different forest types vis-à-vis vegetation composition around the project site including proposed infrastructural development area was conducted by the Territorial Division of South and the report of the division was incorporated in the Environmental Impact Assessment Report. On the basis of the report the proposal for creation of Green Belt around the Project area has been formulated.

AIMS AND OBJECTIVES

The following points will be considered while preparing the green belt around the project site.

- To create environment friendly surroundings around the project area.
- To reduce and prevent process of land degradation
- To promote and enhance forest cover
- To improve habitat for local fauna
- To maintain pollution control and enhance air quality
- To contend soil dust and erosion
- To create greenery with grass around the landing surface of the airport

METHODOLOGY

Planting of selected suitable species relevant to the locality will be carried out as per the space available in between the built up area spacing out with sufficient place for the residents to use. A maximum of 2-3 lines of ornamental species at a stretch of 5-10 meters will be covered.

The interconnecting road as well as the footpath between the staff quarters and residence of the officers and the office area will be considered for the development of green belt. The approach road from the road head will be covered with green belt program and



beautification of the same will be taking up in the project by planting selected species as avenue plantation. Besides this program, other area of the project will be taking up for development of green belt plan.

SELECTION OF QUALITY PLANTING MATERIAL

Considering the soil condition, humidity, temperature, rainfall, elevation and aesthetic point of the project site, the following species are recommended for green belt project.

a. TREE.

- Silver Oak *Gravellia robusta*
- Ashoka tree *Polyathea longifolia*
- Dhupi *Cuppressus cashmeria*
- Cherry *Prunus sikkimensis*
- Cherry *Prunus densa*
- China teak *Paulonea spp.*
- Casia *Casia fistula*
- Bottle brush -
- Bamboo Murli bans

b. FRUIT TREES.

- Orange
- Banana
- Peach
- Plum
- Guava
- Cherry
- Pears

c. GRASS

- *Andropogon munroi*
- *Apocopis paleacea*
- *Brachiaria villosa*
- *Cenchrus biflorus*
- Maxican grass
- Local grass

In addition to the selected species indicated above suitable local ornamental climbers, shrubs and herbs will be supplemented.

**GREEN BELT INFRASTRUCTURE DEVELOPMENT.**

As the project is not very far, the creation of nursery for the development of greenbelt deemed not necessary as creation of nursery for Landscaping, catchment area treatment have been included in the proposal and the requirement should be met from these nurseries which are located in almost the same area.

FINANCIAL FORECAST**THE DETAILS OF EXPENDITURE UNDER GREEN BELT PLAN AS FOLLOWS.**

Sl.No	Item of work	Quantity	Unit	Rate	Amount (Rs.in lacs)
1	Plantation	60	hectare	12350	7.42
2	maintenance	60x2	hectare	2550	3.06
3	Watch and ward	02	hands	85/day for 5 years	3.10
4	Total				13.58

The total financial implication of Rs.13.58 lakhs has been projected for green belt project plan. The rates for different item of works are the rates of the Forest, Environment and Wildlife Management Department government of Sikkim.



CHAPTER – XI

ENVIRONMENTAL MONITORING PROGRAMME

Monitoring is an essential component for sustainability of any water resources project. It is an integral part of any environmental assessment process. Any water resources development project introduces complex inter-relationships in the project area between people, various natural resources, biota and the many developing forces. Thus, a new environment is created. It is very difficult to predict with complete certainty the exact post-project environmental scenario. Hence, monitoring of critical parameters is essential in the project operation phase. Monitoring of environmental indicators signal potential problems and facilitate timely prompt implementation of effective remedial measures. It will also allow for validation of the assumption and assessments made in the present study. Monitoring becomes essential to ensure that the mitigation measures planned for environmental protection function effectively during the entire period of project operation. The data so generated can also serve as a data bank for prediction of post-project scenarios in similar projects as well.

In the monitoring point of view, water quality, erosion, siltation, landuse, and afforestation, etc., are the important parameters. After careful observations the following parameters have been proposed for early warning of indicators of stress on the environment. Details are mentioned in the following subheads.

WATER QUALITY

Construction Phase

It is proposed to monitor the effluent before and after treatment from sewage treatment plant. The frequency of monitoring could be once per month. A total of 24 samples need to be analysed every year. The parameters to be monitored include pH, Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS) and Total Dissolved Solids (TDS). The cost of treatment of one sample is expected to be about Rs.1,500/-. Thus,



total cost for analysis over a period of 5 years works out to Rs1.8 lakhs.

OPERATION PHASE

The surface water quality of the proposed reservoir and river Teesta can be monitored thrice a year (summer, pre- and post-monsoon seasons). The proposed parameters to be monitored include; pH, temperature, electrical conductivity I turbidity, total dissolved solids, calcium, magnesium, total hardness, chlorides, sulphates, nitrates, DO, COD, BOD, Iron, Zinc and Manganese.

The sampling sites shall be:

- One km upstream of the barrage site.
- Reservoir water.
- One km downstream of the confluence of the tail race discharge.

The total cost of analysis will be Rs 0.36 lakhs per year. During project operation phase, a Sewage Treatment Plant (STP) is proposed to be set up to treat the effluent from the project colony. Once in every month, it is envisaged to analyse a sample each before and after treatment from the STP. The parameters to be analysed include pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS) and Total Dissolved Solids (TDS). The cost of analysis of 24 samples @ Rs.1500/- sample works out to Rs 0.036 lakhs/year.

Thus, total cost for analysis in project operation works out to Rs1.80 lakhs /five year.

EROSION AND SILTATION

PROJECT CONSTRUCTION PHASE

No monitoring programme is suggested for project construction phase.



PROJECT OPERATION PHASE

Soil erosion rates, slope stability of embankments of barrage, efficacy of soil conservation measures, need to be closely monitored twice a year. The staff at the project site can do the study. The study should be undertaken throughout the life of the project so as to design the soil erosion prevention measures and also for the rehabilitation of the project. The various parameters to be monitored include soil erosion rates, stability of bank embankment, etc.

ECOLOGY

PROJECT CONSTRUCTION PHASE

No monitoring programme is suggested for project construction phase.

PROJECT OPERATION PHASE

Status of afforestation programmes, changes in migration patterns of the aquatic and terrestrial fauna species should be studied. The study could be undertaken with a frequency of five years or till the entire design life of the barrage. A provision of Rs 0.40 lakhs per year can be kept for this purpose. Thus, the total expenditure can be taken as Rs 2.00 lakhs/five years. Forest Department can conduct the study.

FISHERIES

PROJECT CONSTRUCTION PHASE

No monitoring programme has been suggested for the project construction phase.

PROJECT OPERATION PHASE

Monitoring of fisheries in the reservoir will be essential to achieve sustainable yield of fish. Some of the parameters to be monitored are phytoplanktons, zooplanktons, benthic life and fish composition, etc. Based on human resources and facilities available, monthly observations in time and space need to be made. The parameters can be monitored twice at



the water sampling sites. The monitoring can be conducted by Fisheries Department. An amount of Rs 1.25 lakh /five years can be earmarked for this purpose.

INCIDENCE OF WATER – RELATED DISEASES

During project construction phase, the incidence of various water-related diseases can be monitored. The various parameters to be covered include various diseases cause and control measures. The monitoring can be conducted once in a year by the medical staff posted at the dispensary near construction site. The monitoring can be done in project colony and settlements within 2-3 km of the project site.

METEOROLOGICAL ASPECTS

It is recommended that a meteorological laboratory be set up at site to monitor various meteorological parameters, instruments for continuous monitoring of following parameters need to be commissioned: Rainfall

- Humidity
- Cloud cover
- Wind Speed
- Wind direction

An amount of Rs 2.00 lakhs can be earmarked for commissioning of laboratory for monitoring various meteorological aspects. The project authority will undertake the installation and recording works.

AIR QUALITY

CONSTRUCTION PHASE

The ambient air quality monitoring during construction phase can be carried out by the State Pollution Board or an external agency, approved by State Pollution Control Board at stations near barrage site, power house site. Every year monitoring is to be done in the following three seasons:



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- Winter
- Summer
- Post – monsoon

The frequency of monitoring could be twice a week for four consecutive weeks at each station for each season. The parameters to be monitored are Respirable Particulate Matter (RPM) and Suspended Particulate Matter (SPM), Sulphur dioxide (SO²) and Nitrogen Oxides (NO_x).

Every year, ambient air quality is to be monitored for (2 stations 2 days/week 4 weeks x 3 seasons) 48 days. A Total cost of Rs. year @ Rs. 1000/day can be earmarked for this purpose. For a construction phase of 5 years the total cost works out to Rs 2.4lakhs.

MINIMUM RELEASES

It is proposed to continuously monitor release of minimum discharge from the dam through an electronically operated system. An amount of Rs 1.00 lakhs is proposed to be earmarked for this purpose.

NOISE

CONSTRUCTION PHASE

Noise emissions from vehicular movement, operation of various construction equipment may be monitored during construction phase at major construction sites. The frequency of monitoring could be once every three months. For monitoring of noise generators an Integrating Sound Level Meter will be required for which an amount of Rs. 1.0 lakh can be earmarked.

Total outlay for environmental monitoring is Rs 13.25 lakhs

**SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMME**

Summary of environmental monitoring programmes are given in Tables 1 and 2 respectively.

TABLE –1**Summary of Environmental Monitoring Programme during
Project Construction Phase**

S.no	Items to be monitored	Parameters	Frequency	Location
1	Effluent from STPs	pH, BOD,COD,TSS,TDS	Once in every month	Before and after treatment from the STPs at various labour camps
2	Water-related	Identification of water related diseases, adequacy of local control and curative measure, etc.	Once in every four months	Labour camps and colonies
3	Air quality	SPM, RPM,SO ₂ and Nox	Once in every season	At all the construction sites
4	Noise	Equivalent noise level (lLeg)	Once in three months	At all the construction sites.



**Summary of Environmental Monitoring Programme during
Project operation Phase.**

S.no	Items to be monitored	Parameters	Frequency	Location
1	Water	pH, Temperature, EC, Turbidity, Total Dissolved Solids, Calcium, Magnesium, Chlorides, Sulphates, Nitrates, DO, COD, BOD, Iron, Zinc, Manganese	Summer, pre and post monsoon seasons	<ul style="list-style-type: none">• 1 km upstream of barrage site• Reservoir water• One km down stream of Tail race discharge
2	Effluent from STP	pH, BOD,COD,TSS,TDS	Every month	<ul style="list-style-type: none">• Before and after treatment from STP
3	Erosion & Siltation	Soil erosion rates, stability of bank embankment, etc	Summer & pre and post monsoons	Above the reservoir and powerhouse locations in the catchment area
4	Ecology	Status of afforestation programmes	Once in every years	Where ever the plantations taken up.
5	Fisheries	Phytoplankton's, Zooplanktons, benthic life, fish composition	Quarterly	<ul style="list-style-type: none">• One km upstream of barrage site• Reservoir water• One km downstream of tail race discharge
6	Incidence of water – related diseases	Cause and control measures for various diseases.	Once in six months	<ul style="list-style-type: none">• Project colony• Settlements in and around the project site.
7	Meteorologic al aspects	Temperature, rainfall, humidity, cloud, cover, wind speed and direction	Continuous	<ul style="list-style-type: none">• Project office
8	Flow monitoring	Discharge in river Teesta	Continuous	<ul style="list-style-type: none">• Just downstream of barrage site



CHAPTER-XII

ENVIRONMENT MANAGEMENT CELL

INTRODUCTION

In the present scenario, with growth of development prospects, the role of environment management has achieved a great importance. With this concept the awareness towards environment has increased and the implementation and monitoring of environmental safeguards at the development project has become mandatory. The Lanco Energy Pvt Ltd is renowned company of the country having proper infra structure and management, skilled manpower in all sectors. The management of environment is one of the priorities of the project and it is expected that in order to address the problem of environment the necessary Environment Management Cell under Planning Division of the company should be constituted for implementation and monitoring of environmental safeguards at the company level and project level. The requirement of this is to strengthen and improve the quality of safeguard measures for environment within the company and at the project level through broad base understanding of it. Keeping in view of the guidelines of Ministry of Environment and Forests, Government of India, has given directions to create an Environment Management Group at the project Level besides having one at the Company Level with the following aims and objectives.

Over all planning and formulation of environment management plans.

Co-ordination at the state Forest, Environment and Wildlife management Department, Land Revenue department and other allied sectors in the state with respect to implimentation of the catchment area treatment plan, compensatory afforestation schemes and conservation of flora and fauna. Implementation of Environment Management Plan in true spirit along with the other construction activities of the project in scheduled time.

Monitoring of Environment Management Plan, Periodic field visit to verify the implementation of the activities concerning environmental safeguards has to be taken up.



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Preparation of status report in respect of various on going environmental protection measures is required for the information and appraisal of MoEF.

Keeping in view of the above responsibilities and duties of the project developers to ensure proper safeguards of environment, the following organizational management cell is proposed for Teesta stage-VI Hydel project construction by Lanco Energy Private limited which is to be constituted by them at the levels indicated.

AT THE MAIN OFFICE OF PROJECT AUTHORITY.

Senior Manager /CEO
Manager Environment
AM/DM (Env.)

AT PROJECT LEVEL.

Manager Environment
Dy. Manager /Asst. Manager (Environment)
Environment officer - Environment inspector
- Environment supervisor
- Surveyor
- Office staff

Environment Engineer - Junior engineer
- Office staff

Besides the above management infra structure development, adequate scientists as well as field managers should be supported with modern environmental gadgets to ascertain and monitor the changes in environment at different levels and stages of the implementation of the project. For effective management and monitoring of the project, requisite field oriented facilities with communication, conveyance, infra structure should be arranged.



CHAPTER-XIII

SUMMARY OF COST ESTIMATES

An amount of Rs. 2003.58 lakhs has been estimated for the implementation of different components in the Environment Management Plan. The summary of total cost estimates are mentioned below for execution.

COST ESTIMATES FOR THE IMPLEMENTATION OF EMP:

Sl.No	Particulars	Amount in Lakhs
1	Relocation and Rehabilitation plan	-
2	Public health and solid waste management	179.00
3	Catchment area treatment plan	1231.73
4	Biodiversity conservation plan	169.12
5	Free fuel provision	98.85
6	Soil conservation and protection plan	183.53
7	Restoration plan for spoil tips	81.61
8	Restoration plan for quarry areas	35.97
9	Land scape plan for the project area	48.91
10	Green belt around the project area	13.58
11	Environmental Monitoring scheme	13.25
	Grand Total	2055.55

(Rupees Twenty Crores Fifty five Lakh fiftyfive Thousand only).



IMPLEMENTATION AND FUNDING AGENCY.

The Forests, Environment and Wildlife Management Department, government of Sikkim will carry out the execution and implementation as well as management as per the approved plan. The above amount shall be paid by the User Agency i.e. Lanco Energy private Ltd to the Department of Forest, Environment & Wildlife Management, Government of Sikkim after Environmental Clearance in four instalments for the smooth and timely implementation of the scheme. The project has been phased out to five years of gestation period commencing from 2006-2007 or 2007-08.

MONITORING

The proper inspection and monitoring of the project is very important to confirm the quality and quantity of the work and it is the responsibility of the people implementing and sponsoring the project. Therefore, it is suggested that in addition to the departmental monitoring there should be two tier system of monitoring comprised of the implementing divisions and the environment officer of the project authority at the field level as they are highly responsible at that level. The second level of monitoring and evaluation may be of representations of central government, the Additional Principle Chief conservator of Forests, Environment sector, Forest, Environment and Wildlife Management Department, Government of Sikkim. The other members of this committee should have a representation from Agriculture, Horticulture, Animal Husbandry and one NGO may be WWF, Sikkim branch, Gangtok. The inspection and monitoring of the project by the forest officers should be as per the actual execution of the project, however, the monitoring and evaluation of the project by the Central Level Committee should be twice in a year. The monitoring through the satellite will be the part of the monitoring and evaluation of the project as the information generated out this technology would be more authentic and relevant if proper ground truthing work is carried out. Every monitoring committee shall submit their report to the government with suggestions, improvement and technical inputs especially in the beginning of the project.



CHAPTER-XIV

CONCLUSION AND RECOMMENDATIONS

In the observations of the Environmental Impact Assessments of Teesta stage-VI H.E Project, certain findings have been encountered and to counter the likely predicaments and consequences of the project, the Environment management Plan has been formulated to ameliorate and mitigate the adverse effect due to the project. Further, the following studies and actions have been recommended for continuation for judicious implementation of the environment management plan.

- ✓ Periodic water quality studies to analyze the physio- chemical and limnological data and parameters of the drainages
- ✓ To study the aquatic environment of the river system and to experiment the migration of fish population.
- ✓ To monitor the critically degraded areas of the project site and the catchment
- ✓ To conduct time schedule monitoring by the Central and State Monitoring Committees mentioned in the environment monitoring scheme.
- ✓ Any additional costs of environment management studies and monitoring should be placed in the inbuilt cost of the project.
- ✓ All the points mentioned in the management plan should be given due respect by proper and timely implementation.
- ✓ All concern or connected with the project at all stages should judiciously carry out the observations and findings of the EIA and procedures laid in the EMP.
- ✓ Air quality tests should be conducted periodically

As per the studies of the EIA and forecasts thereof, it is clear that the recommendations made in the foregoing lines, paragraphs and chapters would help in mitigating the likely impacts of the project on overall environment of the area in particular and state in general.

**ENVIRONMENT CHECK LIST FOR TEESTA STAGE-VI H.E. PROJECT**

SI	Project activities	Check items	Extent of effect		Action and counter measures plan	Remarks
			Major	Minor		
1	Acquisition of land & other properties for project construction	Affected families		*	Necessary compensation has to be paid by the project authority	The acquisition of land unavoidable
2	Acquisition of forest land falling within the project site	Forest loss and soil erosion	*		Compensatory afforestation schme with ten times of seedlings against the felled trees required	Due to site specific condition
3	Construction of infrastructures such as buildings and approach road	Effect of construction on surrounding environment	*		Checking erosion intensity, control of spring water sources and monitoring dust density.	
4	Construction of other project components	Effect on landscape and adjoining residents and forest area.	*		To mitigate and reduce the effect on landscape and surrounding environment, the restoration and various plans for site specific areas identified for muck disposal, green belt creation plan and quarry restoration site proposed.	To remove the disruption and scars due to construction and muck and debris generated from it has been proposed.
5	Execution of project	a. Effect on historical and cultural heritage b. Effect on existing built up areas c. Effect on	*		The catchment area treatment combined with	The provision has been made to



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		over all environment due to the construction of the project.			biological and mechanical measures will supplement the construction	reduce the silt yield.
6	Project implementation	Environmental monitoring	*		Monitoring committee with representatives of MoEF, user agency, State government to ensure effective implementation of environmental protection measures.	