Tamil Nadu Green Energy Corporation Limited (TNGECL), Tamil Nadu

SILLAHALLA PUMPED STORAGE HYDRO-ELECTRIC PROJECT, STAGE-I (4X250 MW)

EXECUTIVE SUMMARY

COMPREHENSIVE ENVIRONMENTAL IMPACT ASSESSEMENT / EMP STUDY REPORT

Consultant :

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EXECUTIVE SUMMARY

1. Introduction

Tamil Nadu Green Energy Corporation Limited (TNGECL) propose to develop Sillahalla Pumped Storage project (PSP) in the Nilgiris District of Tamil Nadu to meet the increase in peak power demand. The proposed Sillahalla PSHEP Stage-I is to be developed by utilizing the water of Sillahalla River, a perennial stream of the tributary of River Kundah in the Nilgiris District of Tamil Nadu by constructing an upper dam across Sillahalla stream and lower dam across Kundah river downstream of existing Kundah Palam Dam. Both the dams shall be interconnected by the tunnel to generate electricity for peak hours and recycle the water from lower to upper dam at the time of non-peak hours.

The proposed upper reservoir is to be developed in Udhagamandalam and Kundah taluk, whereas the lower reservoir is to be developed in Kundah taluk of the Nilgiris district

2. Project Description

2.1 Project Components

The proposed Sillahalla PSHEP Stage-I envisages the following components:

- Construction of concrete upper dam of 75 m height and 560 m length across Sillahalla River.
- Power intake with trash rack.
- 1 no. 2760 m long, 9 m dia. circular head race tunnel.
- 1 no. 95 m high, 20 m dia. circular HRT surge shaft.
- 2 nos. 800 m & 2 nos. 758 m long, 5.65 m dia. inclined pressure shaft.
- 2 nos. 64 m long and 2 nos. 60 m long, 4 m dia. circular Penstocks.
- An underground powerhouse of size of 160m x21m x 50m to house 4 no. Francis reversible pump turbine generating units of 250 MW capacity each.
- 1 no. Transformer cavern 160m x 16m x 21m to house 4 generator transformers.

- 1 no. TRT surge chamber of size 85m x 12m x 88m.
- 1 no. 1672 m long, 9.75 m dia. circular tail race tunnel to carry the water from power house to lower reservoir.
- 1 no. of Tail Race outlet with 1 no gate shaft and trash rack.
- Construction of concrete lower dam of 108 m height and 320 m length across Kundah River.
- 1 no. Main Access Tunnel (MAT) D- shaped of 1583 m long 8m width & 8m height.
- 3 nos. construction adit's.

The layout of the proposed Sillahalla PSHEP, Stage-I is enclosed as Figure-1.

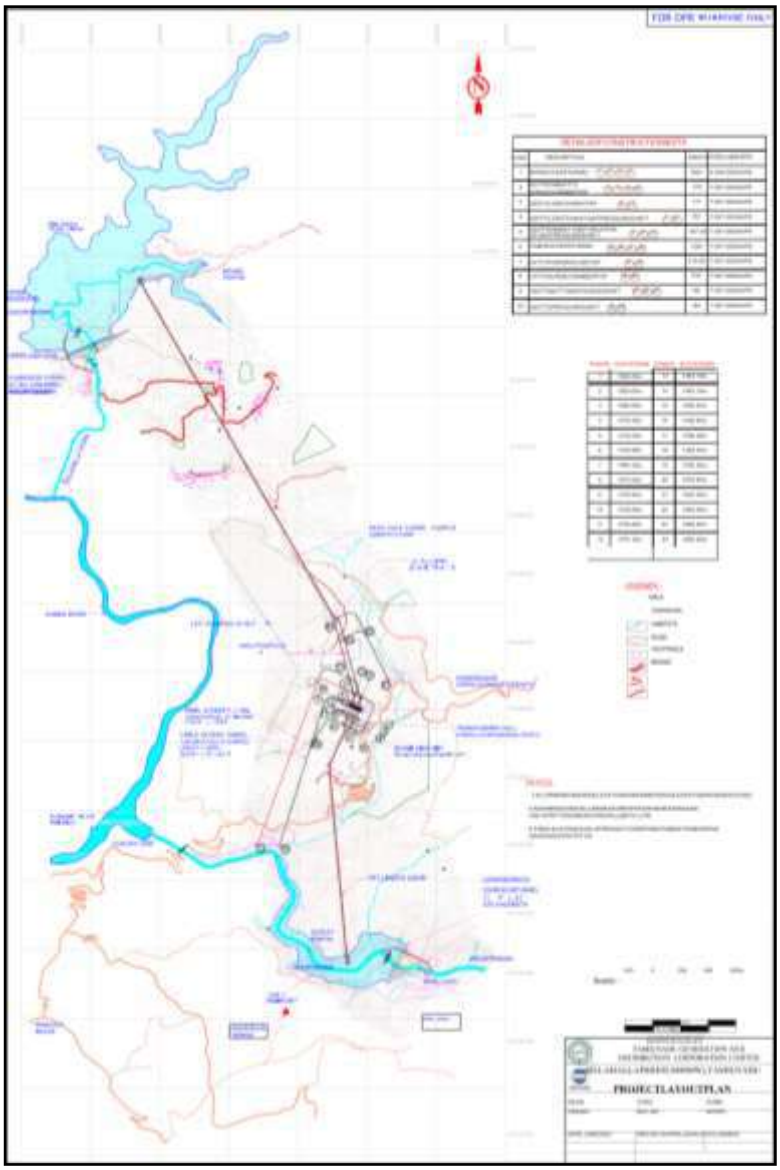

Figure 1 Project Layout of proposed Sillahalla PSHEP Stage-I

2.2 Salient Features

The salient features of the proposed Sillahalla PSP are given in Table-1.

Table 1 Salient Features of Sillahalla PSP

1. Location	
River	Upper Dam - Sillahalla River Lower Dam- Kundah River
Dam Axis (Upper)	Latitude 11°18'53.72", Longitude 76°38'56.34"
Dam Axis (Lower)	Latitude 11°16'25.81", Longitude 76°40'13.00"
2. Project	
Type	Pumped Storage Project
Installed Capacity	4 X 250 MW
Peak Operating Duration	6 Hours Daily
3. Hydrology	
Catchment Area	
Upper Dam	65 Sq. Km.
Lower Dam	183.48 Sq. Km.
Average Annual Run-Off	
Upper Reservoir	113.00 cumec
Maximum Design Flood (PMF)	
Upper Reservoir (Upper Dam)	1054.0 cumec
Lower Reservoir (Lower Dam)	2610.0 cumec
Diversion Flood	
Upper Reservoir (Upper Dam)	295.0 cumec
Lower Reservoir (Lower Dam)	760.0 cumec
4.0 Civil Structure	
4.1 Upper Reservoir	
FRL	1950.00 m
MDDL	1940.00 m
Pondage at FRL	27.836 MCM
Pondage at MDDL	17.218 MCM
Live Pondage	10.618 M MCM
4.2 Lower Reservoir	
FRL	1560 m
MDDL	1520 m
Pondage at FRL	8.048 MCM
Pondage at MDDL	2.044 MCM
Live Pondage	6.004 MCM
4.3 Upper Dam	
Type	Concrete Dam
Top of Dam	El 1952.00 m
Foundation Elevation (Deepest)	El 1877.00 m

Total Length of Dam at Top	560.00 m
Max. Height of Dam above Deepest Foundation Level	75.00 m
Top Width of Dam	7.00 m
4.4 Lower Dam	
Type	Concrete Dam
Top of Dam	El 1562.00 m
Foundation Elevation (Deepest)	El 1454.00 m
Total Length of Dam at Top	320.00 m
Max. Height of Dam Above Deepest Foundation Level	108.00 m
Top Width of Dam	7.00 m
4.5 Upper Dam- Spillway Arrangement	
Type	Ogee Spillway
Crest Elevation	El 1944.50 m
MWL	El 1950.00 m
Design Flood	1054 m^3/s at FRL/MWL 1950.00 m
No. of Bays	3 Bays , 12 m Wide Each
4.6 Upper Dam- Log Bay	
Type	Ogee Spillway
Crest Elevation	El 1946.00 m
No. of Bays	1 Bay , 6 m Wide
4.7 Lower Dam- Spillway Arrangement	
Type	Ogee Spillway
Crest Elevation	El 1552.00 m
MWL	El 1561.00 m
Design Flood	2610 m^3/s at FRL/MWL 1560.00 m
No. of Bays	4 Bays, 12 m wide each
4.8 Lower Dam- Log Bay	
Type	Ogee Spillway
Crest Elevation	El 1556.00 m
No. of Bays	1 Bay, 6 m Wide
4.9 Upper Dam- Diversion Works	
Design Discharge	295 m^3/s
No of Tunnel	1 No.
Length of Tunnel	450 m
Diameter & Shape	7.0 m & Circular
Height of Upstream Coffer Dam	15.60 m
Height of Downstream Coffer Dam	5 m
4.10 Lower Dam- Diversion Works	
Design Diversion Flood	760 m^3/s
No of Tunnel	1 No.

Length Of Tunnel	425 m
Diameter & Shape	7.2 m (Finished) & Circular (Concrete Lined)
4.11 Power Intake	
Type	Horizontal Type With Anti-Vortex Louvers
Design Discharge	297.12 m^3/m
W X H X No.	13 M (W) X 13.5m (H) X 2 No.
Invert Level	El 1922 m
Transition Length	63.25 m
4.12 Headrace Tunnel (Concrete Lined)	
No. of Tunnel	1 No.
Diameter & Shape	9.0 m (Finished) & Circular (Concrete Lined)
Length	2760 m
Slope	1 In 64.5
Invert Level (Start /End)	El 1922 m (At Inlet) & El 1885 m (At Surge Shaft)
Design Discharge	297.12 m^3/s
Velocity	4.67 m/s
4.13 HRT Surge Shaft & TRT Surge Chamber **4.13.1 HRT Surge Shaft**	
Diameter	20 m
Height	95 m
No. of Surge Shaft	1 No.
Type	Circular (Concrete Lined)
Invert Level	El 1885 m
4.13.2 TRT Surge Chamber	
Size	85 m (L) X 12 m (W) X 88 m (H)
Invert Level	El 1477.50 m
4.14 Pressure Shaft (Steel Lining)	
No. of Tunnels	2 No.
Diameter & Shape	5.65 m (Finished) & Circular (Steel Lined)
Length	800 m & 758 m
Design Discharge	148.56 m^3/s (each)
Velocity	5.92 m/s
4.15 Unit Pressure Shaft (Steel Lining)	
No. of Tunnel	4 No.
Diameter & Shape	4.00 m (Finished) & Circular (Steel Lined)
Length	2 No. 64 m & 2 No. 60 m
Design Discharge	74.28 m^3/s (each)
Velocity	5.91 m/s

4.16 Tailrace Tunnel	
No. of Tunnel	1 No.
Diameter & Shape	9.75 m (Finished) & Circular (Concrete Lined)
Length	1672 m
Slope	1 In 51
Invert Level (Start /End)	El 1500.50 m (At Outlet) & El 1477.50 m (At Surge Chamber)
Design Discharge	297.12 m^3/s
Velocity	3.98 m/s
4.17 Tailrace Outlet	
Type	Horizontal Type With Anti-Vortex Louvers
Design Discharge	297.12 m^3/s
W X H X No.	13 m (W) X 13.5 m (H) X 2 Nos.
Invert Level	El 1500.50 m
Transition Length	63.25 m
4.18 Powerhouse	
Type	Underground Cavern
Dimensions	160 m (L) X 21 m (W) X 50 m (H)
Installed Capacity	4 X 250 MW
No. of Units	4 Nos.
Turbine Center Line	El 1466.00 m
Service Bay Level	El 1479.50 m
5.0 Electromechanical Equipment	
5.1 Pump Turbine	
Type	Francis Type, Vertical Shaft Reversible Pump-Turbine
Number of Units	Four (4) Units
Rated Turbine Head	387.00 m
Turbine Output at Rated Head	253.81 MW
Rated Pump Head	406.00 m
Pump Input at Rated Head	240.92 MW
Rated Turbine Discharge	74.28 m^3/s
Rated Pump Discharge	55.65 m^3/s
5.2 Generator-Motor	
Type	Three (3) Phase, Alternating Current Synchronous, Generator-Motor, Vertical Shaft, Rotating Field, Enclosed Housing, Rim-Duct Air-Cooled and Suspended Type
Number of Units	Four (4) Units (Fixed Speed)
Rated Capacity	Generator; 250 MW

	Motor ; 285 MW
Rated Voltage	18.0 KV
Over Load Capacity	110 % Rated Capacity
5.3 Main Transformer	
Type	Indoor, Oil-Immersed, 3 Single Phase Transformers With On-Load Tap Changer (Oltc) For Generation / Pumping Operation, ODWL Cooled
Numbers	4 Sets I.E. (4 X 3 Sets For Each Unit) = 12 + 1 (Spare) (Total 13 Nos.)
Rated Capacity	110 MVA Single Phase
Span	20 m
5.4 Transmission Line	
Type	Single / Double Circuit, Twin Moose Conductors
Capacity Voltage Level	400 KV
Length	About 32 km, 54 km, 103 km (For 3 Different Substations)
5.5 Project Benefits	
Levelized Tariff	Rs. 6.48 ₹/kwh (Without Pumping Cost)
	Rs. 9.98 ₹/kwh (Including Pumping Cost 2.5 ₹/kwh)
First Year Tariff	Rs. 7.37 ₹/kwh (Without Pumping Cost)
	Rs. 10.87 ₹/kwh (Including Pumping Cost 2.5 ₹/kwh)

2.3 Land Requirement

The total land required for the project is approximately 310.157 ha. The details of component wise land requirement is given in Table-2. About 239.2444 ha of private land and 8.912 ha of forest land is proposed to be acquired for the Sillahalla Pumped Storage Project. Balance land (62.001 ha) to be acquired for the project is government land.

Table 2 Land requirement for the proposed Sillahalla PSHEP Stage-I (Unit : ha)

S.No.	Project Component	Forest land	Govt land	Private land	Total Land
1	Upper Reservoir		40.457	93.501	133.958
2	Lower Reservoir		12.359	16.032	28.391
3	HRT	0.391	0.708	1.877	2.976
4	TRT		0.162	1.818	1.98
5	Power House	1.8		0.2	2
6	MAT, CAT, ADIT	1.52	0.396	2.7814	4.6974
7	Surge Shaft			0.45	0.45
8	Upper Dam Axis		0.436	2.289	2.725
9	Lower Dam Axis		0.1	2.236	2.336
10	HRT Intake			2	2
11	TRT Outlet			2	2
12	Diversion Tunnel/Coffer Dam		0.068	0.655	0.723
13	Potheadyard/CCVT			0.8	0.8
14	Project Colony		2.295	17.526	19.821
15	Labour Colony			7.155	7.155
16	Baching Plant		0.159	2.276	2.435
17	Contractor Facilities			6.5	6.5
18	Fabrication Yard/Store	4.242		3.655	7.897
19	Dumping Zone		1.947	54.863	56.81
20	Pressure Shaft	0.778		0.222	1
21	Roads	0.181	2.914	20.408	23.503
	Total	**8.912**	**62.001**	**239.2444**	**310.157**

About 287.202 ha of land is required for overground works and 22.9554 ha of land is required for underground works.

2.4 Project Cost

The total cost required for construction of the project is Rs. 5843 crore (as June 2022 price level and excluding IDC cost).

3. Study Area

The Study Area covered as a part of the CEIA study is as below:

- Land to be acquired for various project appurtenances including reservoir submergence
- 10 km on either side from the periphery of reservoir submergence
- Area within 10 km on either side of various project appurtenances

The Study Area map is enclosed as Figure - 2.

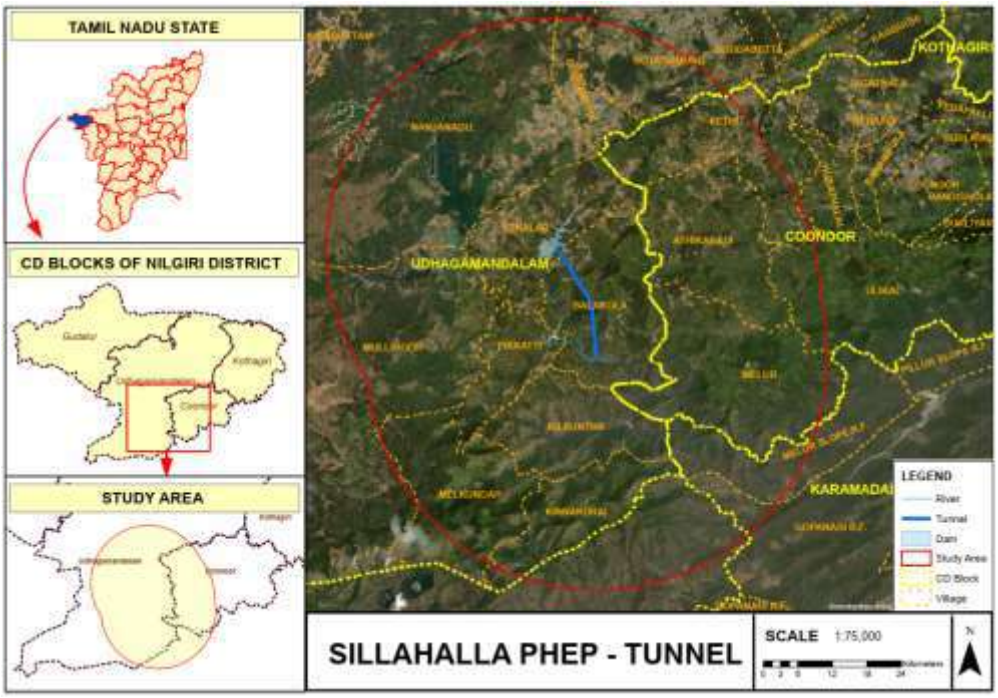

Figure 2 Study Area Map

4. Environmental Baseline Status

Environmental quality of the region helps to assess the level of pollution and prediction of impacts of the region. The baseline status of the environmental quality has been monitoried with respect to air, water, soil and noise in the study area. The monitoring was carried out for three seasons' viz. pre-monsoon, monsoon and winter season.

4.1 Climate

The project area experiences semi-arid climate characterized by mild summer and mild winter. The summer season lasts from March to middle of June, followed by the south-west monsoon season from mid June to the end of September. October to December constitute the north-east monsoon season. The winter season lasts from December to February.

The maximum temperature observed throughout the year ranges from 22.6ºC to 27.4ºC. April and May are the hottest months of the year. The minimum temperature ranges from 5.6ºC to 13.3ºC. The mean annual rainfall is 1590.7 mm. Maximum rainfall is observed in the months of October to December, under the influence of north-east monssons. Some rainfall is also received under the influence of south-west monsoons. Mean yearly relative humidity is 69%. The monthly average humidity is lowest in March (56%) and highest in November (79%).

4.2 Geology

The Sillahalla Pumped Storage Project is located in Nilgiris district, located in Charnockite Group for the period Archean to Proterozoic. It consists of Hypersthene bearing minerals and blue Quartz imparts the blue colour to the rock and hence called Blue Metal. This rock types occur in Gneissic terrain in most parts of Tamil Nadu predominantly in the Nilgiris and Palani Hills.

4.3 Geomrphology and Geohydrology

Geo-hydrologically the area forms a part of the Cauvery River Basin, having two sub-basins i.e. Moyar sub-basin in the north and Bhavani sub basin in the south. Ground water occurs under discontinuous, unconfined to semi confined aquifers, down to 200m b.g.l. in the charnockitic terrain and 150m b.g.l. in the gneissic country and is restricted to weathered mantle and fractures. The quality of ground water is generally good for both irrigation and domestic purposes.

4.4 Seismicity

Sillahalla Pumped Storage area falls under seismic zone-II as per Seismic Zone Map of India.

4.5 Landuse Pattern

The major landuse category in the submergence area of Upper Reservoir of Sillahalla PSP is Agriculture Area, as it accounts for about 56.4% of the submergence area, followed by bare area (34.3%). The area under vegetation is 6.3% of the submergence area. Settlements and water bodies account for 0.3% and 2.0% respectively of submergence area. About 0.8% of the submergence area is under Tea Plantation.

The major landuse category in the submergence area of Lower Reservoir of Sillahalla PSP is Forest Area, as it accounts for about 47.2 of the submergence area, followed by bare area (40.7%). The area under agriculture is 1.1% of the submergence area. Water bodies account for 10.9% of submergence area.

The major landuse category in the Study Area of Sillahalla PSP is Forest Area, as it accounts for about 43.8% of the Study Area, followed by bare earth (31.0%). The area under agriculture is 11.1% of the Study Area. Built-up area and water bodies account for 1.3% and 2.2% respectively of the Study Area. About 10.5% of the Study Area is under Tea Plantation.

4.6 Soil Quality

The pH in soils of the study area lies within the neutral range, i.e. 6.1 to 7.6. The concentration of Available Nitrogen and Available Phosphorus ranged from 122 to 472 kg/ha, 8.7 to 36 kg/ha. The concentration of various nutrients indicate low to moderate productivity. The organic carbon in various samples indicates low to moderate productivity. The bulk density ranged from 1.21 to 1.51g/cc.

4.7 Hydrology

The dependable flows for river Sillahalla estimated at Upper Dam site are:

- 50% dependable flow = 27.19 MCM (1992-93)
- 75% dependable flow = 23.22 MCM (2006-07)
- 90% dependable flow = 13.29 MCM (1986-87)

The dependable flows for river Kundah estimated at Lower Dam site are:

- 50% dependable flow = 28.44 MCM (1992-93)
- 75% dependable flow = 24.29 MCM (2005-06)
- 90% dependable flow = 13.90 MCM (2001-02)

4.8 Water Quality

There are no major sources of pollution in the catchment intercepted at the project site. The water quality was assessed by collecting water samples at various locations and analyzed for physico-chemical parameters. The BOD and COD levels are quite low, which indicate the absence of organic pollution loading. This is mainly due to the low population density and absence of industries in the area. The heavy metal concentration in the study area is below the permissible limit used for drinking purposes.

4.9 Ambient Air Quality

With respect to ambient air quality, concentrations of PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO were monitored at 6 locations in the study area covering three seasons viz. Pre-monsoon, monsoon and winter seasons. The maximum concentration at all the attributes are observed within the prescribed limits of National Ambient Air Quality Standards applicable for rural residential area.

4.10 Noise Levels

The noise levels were recorded at 6 locations during environmental monitoring. The parameters like Lmax, Lmin and Leq were recorded. The day time equivalent noise level at various sampling stations were well within the permissible limit (55 dB(A)) specified for residential areas.

4.11 Flora

According to Champion & Seth (1968) classification of Forest, Nilgiris district forests are classified into various types, including:

- Tropical Evergreen Forests
- Montane Sholas
- Semi-Evergreen Forests
- Moist Deciduous Forests
- Dry Deciduous Forests

Ecological studies were conducted during three seasons within study area. From the floristic survey and secondary sources such as published literature, Interviews with local residents, and stakeholders, during three seasons (Post- Monsoon, Pre-monsoon & Monsoon), a total of 187 plant species belonging to 71 families were recorded. The dominant plant families recorded during three seasons (Post-Monsoon, Pre-Monsoon & Monsoon) were Asteraceae (20) followed by Lauraceae (12), Poaceae (13), Cyperaceae & Rubiaceae (9), Acanthaceae, Rosaceae, Myrtaceae & Solanaceae (6), and Fabaceae, Lamiaceae, & Piperaceae (5).

The dominant tree species recorded were *Acacia mearnsii*, *Achyranthes aspera*, *Adiantum* sp., *Ageratina adenophora* and *Ageratum conyzoides*. Most of the the species recorded in the study area are common, few are scarce and rare. As per IUCN Red Data List, none of the species fall in threantened category.

4.12 Fauna

As per the field studies conducted for three seasons, 23 mammals recorded from study areas. The commonly observed mammal species reported in the study area were Indian Hedgehog, House (Grey Musk) Shrew, Short-nosed Fruit Bat, Indian Flying Fox, Wild Boar, Indian Pipistrelle, Bonnet Macaque, etc.

The common avi-faunal species were recorded in study areas were Grey Francolin, Rain Quail, Rock Bush Quail, Little Egret, etc.

4.13 Aquatic Ecology

A total of 17, 14 and 15 phytoplnakton species were observed during field studies conducted in monsoon, post-monsoon and pre-monsoon seasons respectively. A total of 11, 6 and 8 zooplankton species were observed in monsoon, post-monsoon and pre-monsoon seasons respectively. A total of 14, 8 and 14 fish species were observed in monsoon, post-monsoon and pre-monsoon seasons respectively.

4.14 Socio-Economic Impacts

The study area comprises of 2 community development blocks in Niligiris district. The male and female population in study area villages comprises about 50.01% and 49.98% respectively of the total population. The population comprising of children below the age of 6 years accounts for 10.9% of the total population in the study area villages. The sex ratio (no. of females per 1000 males) and average family size in the study area villages is 1055 and 3 persons per family respectively.

The General castes account for 58.21% of the total Study Area Popopulation. The Schedule Castes and Schedule Tribes population of Study Area Villages accounts for 39% and 2.29% of the total population respectively.

It is observed that about 75.24% of the total population in the study area villages is literate, while about 24.76% are illiterate. The literacy rate among male and female population is 82.74% and 68.11% respectively.

5. Impacts and Mitigation Measures

Based on the project details and the baseline environmental status, potential impacts as a result of the construction and operation of the proposed Sillahalla Pumped Storage Project have been identified. The likey impacts and on various aspects of environment and mitigation measures are covered in the following Sections.

5.1 Impacts on Water Environmental

a) Construction Phase

i) Sewage from labour camps

Construction of proposed project is likely to last for a period of 61 months. The domestic water requirement of the staff/labour colony is 0.45 mld at the rate of 70 lpcd. It is assumed that about 80% of the total water supplied is generated as sewage. Thus, total quantum of sewage generated is in order of 0.36 mld. A Sewage Treatment Plant is proposed to be installed in various labour camps to treat the sewage, prior to disposal.

ii) Effluent from crushers

A stone crusher is installed at the project site. Water sprinkling system is installed in the crusher to arrest the fugitive dust generated during operation. The effluent thus generated in the crusher would contain high-suspended solids. The effluent, if disposed without treatment can lead to marginal increase in the turbidity levels in the receiving water bodies. The wastewater shall be treated in settling tank to remove suspended solids from the wastewater before disposal.

iii) Effluent from Batching Plants

During construction phase, batching plants will be commissioned for production of concrete. Effluent containing high suspended solids shall be generated during operation and cleaning of batching plants. It is proposed to treat the effluent before disposal to ameliorate even the marginal impacts likely to accrue on this account. The effluent from batching plants shall be treated in settling tanks, prior to disposal.

iv) Effluent from Fabrication Units and Workshops

As a part of infrastructural development for the project, workshops would be set up during construction phase. The effluent from workshops will have high oil & grease levels and suspended solids as well. The effluent if disposed without treatment can lead to unsightly conditions in the receiving water bodies on account of high oil & grease levels.

The effluent from the workshops will be treated in Oil & Grease Separator Units, prior to disposal.

b) Operation phase

i) Effluent from project colony

During project operation phase, due to absence of any large-scale construction activity, the cause and source of water pollution will be much different. Since, only a small number of O&M staff i.e. about 40 to 50 technical staff will reside in the area in a well-designed colony with sewage treatment plant and other infrastructure facilities, the impact of water pollution due to disposal of sewage will be insignificant.

The sewage generated will be treated in a Sewage Treatment Plant (STP), prior to disposal. Thus, no impact on receiving water body is anticipated.

ii) Impacts on Reservoir water quality

The proposed project is envisaged as a pumped storage scheme, with significant diurnal variations in water level. In such a scenario, significant re-aeration from natural atmosphere would take place, which will maintain Dissolved Oxygen in the reservoir. Thus, in the proposed project, no significant reduction in D.O. level in reservoir water is anticipated.

iii) Sediments

The construction of the reservoir would reduce the velocity of flowing water converting a lotic system to lentic system. The reduction in velocity would lead to sedimentation at the dam site. Increased levels of soil erosion are not anticipated at the dam site due to the project. As a part of DPR, a sediment rate of 1.79 mm/sq.km/year has been adopted based on the average sediment rate of Kundah Palam Forebay and Emerald- Avalanche reservoir. Both the reservoirs are in the vicinity of the proposed Upper and Lower reservoirs.

5.2 Impacts on downsream Water Users

The Gross Storage capacity of the Upper Reservoir is around 27.836 MCM. The dead storage capacity of Lower Reservoir is 2.044 MCM. The gross water storage will be 29.88 MCM. It is proposed to fill the Upper and Lower reservoirs by storing 70% of yield in monsoon months from June to November. No water will be used for storage of reservoir in non-monsoon months. The yield of river Sillahalla for 90% dependable year (1986-87) as approved by CWC 132.29 MCM. The gross storage capacity of Upper Reservoir on river Sillahalla at FRL is 27.836 MCM. The dead storage of Upper Reservoir at MDDL is 8.048 MCM. The live storage is 19.788 MCM.

The total water to be stored in the Upper Reservoir (Gross Storage capacity) is 27.836 MCM. Thus, time required to fill the Upper Reservoir upto FRL shall be (27.836/7.845) 3.54 years or 3 years and 7 months. After filling of Upper reservoir, the entire discharge shall be released into the river Sillahalla.
The gross storage capacity of Lower Reservoir on river Kundah at FRL is 17.218 MCM MCM. The dead storage of Lower Reservoir at MDDL is 2.044 MCM. The live storage is 15.174 MCM.

The Lower Reservoir needs to be filled upto Dead storage, which would require 2.044 MCM of water. The yield of river Kundah for 90% Dependable Year (1986-87) is 13.87 MCM. Thus, time required to fill Lower Reservoir upto MDDL shall be less than 1 year. After filling of Lower Reservoir, the entire discharge shall be released in river Kundah.

Since main storage is at Upper dam Sillahalla site, the water as available therein would be utilized for one time filling only and subsequently during operation of pumping operation, the stored water would be recycled thereby ensuring no consumptive use.

5.3 Projects in Cascade Development

There are no projects in cascade development on river Sillahalla. On river Kundah, one power house, namely, Kundah Power House - I project upstream of Lower Dam site is existing. The distance between the two projects is 1.4 km.

5.4 Impacts on Air Environment

a) Construction Phase

i) Pollution due to fuel combustion of various equipment

The operation of various construction equipment requires combustion of fuel. Normally, diesel is used in such equipment. The major pollutant which gets emitted as a result of combustion of diesel is SO_2. The SPM emissions are minimal due to low ash content in diesel. The short-term increase in SO_2, even assuming that all the equipment are operating at a common point, is quite low, i.e. of the order of less than 1$\mu g/m^3$. Hence, no major impact is anticipated on this account on ambient air quality.

ii) Emissions from crushers

The operation of the crusher during the construction phase is likely to generate fugitive emissions, which can move even up to 1 km in predominant wind direction. During construction phase, one crusher each is likely to be commissioned near proposed dam and proposed power house sites. During crushing operations, fugitive emissions comprising mainly the suspended particulate will be generated. Since, there are no major settlements close to the dam and power house sites; hence, no major adverse impacts on this account are anticipated.

During layout design, care shall be taken to ensure that the labour camps, colonies, etc. are located on the leeward side and outside the impact zone. (say about 500 m on the wind direction) of the crushers.

iii) Fugitive Emissions from various sources

The fugitive emissions i.e. mainly dust pollution is contributed by the vehicular traffic and storage of sand and other aggregates. During construction phase, there will be increased vehicular movement. Lot of construction material like sand, fine aggregate are stored at various sites, during the project construction phase. Normally, due to blowing of winds, some of the stored material can get entrained in the atmosphere. However, impacts on this account are generally, insignificant in nature.

iv) Dust emissions from muck disposal

The loading and unloading of muck is one of the source of dust generation. Since, muck will be mainly in form of small rock pieces, stone, etc., with very little dust particles. Significant amount of dust is not expected to be generated on this account. Thus, adverse impacts due to dust generation during muck disposal are not expected.

b) Operation Phase

In a water resources project, no major impacts on air environment are envisaged during project operation phase.

5.5 Impacts on Noise Environmental

a) Construction phase

i) Impacts due to operation of construction equipment

A cumulative effect of surface excavation activities at Dam complex generates enormous noise and vibration in the project and its surrounding areas. Controlled blasting shall be adopted to reduce the noise. With these measures the noise levels are attenuated significantly.

Regular servicing and maintenance of these of various construction equipment shall control the noise levels. The DG sets shall be provided with adequate enclosures to attenuate the noise levels. Controlled blasting is adopted to reduce the noise. With these measures the noise levels are attenuated significantly.

Notification will be given to residents within 300 feet (about 90 m) of major noise generating activities. The notification will describe the noise abatement measures that will be implemented.

Monitoring of noise levels will be conducted during the construction phase of the project. In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing construction.

ii) Impacts on labour

The effect of high noise levels on the operating personnel needs to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB (A) affects the hearing acuity of the workers/operators and hence, shall be avoided.

The ear muffs or plugs shall be provided to the workers operating in the high noise areas. The working hours of the laborers working on dredgers will decided considering the guidelines of Occupational Safety and Health Administration (OSHA).

b) Operation phase

There will be no high noise generating equipments/operations during operation phase.

5.6 Impacts on Land Environment

a) Construction phase

i) Impacts due to acquisition of land

The total land required for the project is approximately 310.157 ha. About 239.2444 ha of private land and 8.912 ha of forest land is proposed to be acquired for the Sillahalla Pumped Storage Project. Balance land (62.001 ha) to be acquired for the project is government land.

About 287.202 ha of land is required for overground works and 22.9554 ha of land is required for underground works.

The proposed project involves construction of Upper and Lower Reservoirs, and would lead to formation of a reservoir of area 162 ha. The land cover of the area likely to be submerged in pre-project scenario is river, vegetal cover, agriculture land, etc. Similarly land cover of the area proposed to be used for muck disposal and

quarry sites will be changed and detailed measures have been recommended to be undertaken to stabilize such sites are suggested in the EMP for their reclamation.

ii) Impacts due to Quarrying

The key construction materials like stone pitching, Coarse Aggregate & fine aggregate will be transported from quarries in Coimbatore district. The muck generated from Headrace Tunnel (HRT), Tailrace Tunnel (TRT) and Underground Caverns shall also be used for fill material, coarse aggregates and fine aggregates. The key construction materials, e.g., stone pitching, coarse aggregates and fine aggregates will be transported from quarries in Coimbatore district and shall also be derived using muck from Headrace Tunnel (HRT), Tailrace Tunnel (TRT) and Underground Caverns. Since, no new quarries are to be used for extraction of construction materials. Hence, no impacts are anticipated due to quarrying activities.

iii) Impacts on Construction Areas

During construction phase, construction siites will be degraded, with undulations, left over construction debris, construction materials, etc. This can lead to soil erosion, formation of stagnant pools of water, etc.

The construction of the project is expected to lead to certain changes in the area, as the construction of the proposed project requires excavations. Also approach roads have been proposed to access these construction areas.

Mitigation measures

The working area of dam site, power house complex colony area shall be beautified, on completion of construction activities. The reservoir created as a part of the project, especially Upper Reservoir can be developed as a tourist attraction. Thus, there is a need to construct benches for sitting, development of resting sheds and footpath. The beautification would be carried out by developing flowering beds for plantation of ornamental plants and flower garden.

The open space in power house complex and colony area shall be used for development of plantation of ornamental plant, creepers, flower garden and a small park, construction of benches for sitting, resting sheds, walk way and fountain.

A garden with local ornamentation plants and trees will be created near dam site in areas left after the construction activities. All plants will be properly labeled with scientific and/or common names. Viewpoints can be created at suitable places along the periphery of the reservoir.

iv) Impacts due to muck disposal

The project envisages construction of dams (upper & Lower), headrace tunnel, Upper surge shafts, pressure shafts, TRT surge chamber, underground power house, tailrace Tunnel, Transformer hall, inlet outlet, etc., will generate enormous quantities of muck. It is estimated that about 5.05 MCM muck will be generated from various components of the project.

Mitigation measures

For disposal of above muck, 14 (fourteen) muck disposal sites have been identified in the vicinity of project area. The capacity of each muck disposal yard has been calculated based on the average cross-sections generated using available 20m contour interval topographical map. The total estimated capacity of identified muck dumping yards is about 5.05 MCM. A total of 14 muck dumping sites have been identified, with a total area of 59 ha. The sites identified for muck disposal are away from HFL of rivers.

Various activities proposed as a part of the management plan are given as below:

- Land acquisition for muck dumping sites
- Civil works (construction of retaining walls, boulder crate walls etc.)
- Dumping of muck
- Levelling of the area, terracing and implementation of various engineering control measures e.g., boulder, crate wall, masonry wall, catch water drain.
- Spreading of soil

- Application of fertilizers to facilitate vegetation growth over disposal sites.

For stabilization of muck dumping areas following measures of engineering and biological measures have been proposed.

v) Impacts due to Road Construction

A network of project roads would be constructed to improve access to various work sites. These roads would be linked either to existing roads or to the project roads themselves. The roads are required to ensure easy transportation of construction material, equipment at site. A total of 25 km of new roads are to be constructed.
The key impacts due to road are listed as below.

- Removal of trees on slopes and re-working of the slopes in the immediate vicinity of roads can encourage landslides, erosion gullies, etc.
- Construction of new roads increases the accessibility of a hitherto undisturbed areas resulting in greater human interferences and subsequent adverse impacts on the ecosystem.
- Increased air pollution during construction phase.

Mitigation Measures

The various aspects to be considered while making the project roads are briefly described in following paragraphs.

Construction

- Area for clearing shall be kept minimum subject to the technical requirements of the road.
- Where erosion is likely to be a problem, clearing operations shall be so scheduled and performed that grading operations and permanent erosion control of features can follow immediately thereafter.
- Method of balanced cut and fill formation shall be adopted to avoid large difference in cut and fill quantities.

- Cut slopes shall be suitably protected by breast walls, provision of flat stable slopes, construction of catch water and intercepting drains, treatment of slopes and unstable areas above and underneath the road, etc.
- Landslide prone areas shall be treated with location specific engineering protection measures.
- Where rock blasting is involved, controlled blasting techniques shall be adopted to avoid over-shattering of hill faces.
- Excavated material shall be disposed afer taking due measures.

Drainage

- All artificial drains shall be linked with the existing natural drainage system.
- Surface drains shall have gentle slopes.
- Location and alignment of culverts should chosen to avoid severe erosion at outlets and siltation at inlets.

Grassing and Planting

- Tree felling for road construction/works should be kept bare minimum and strict control must be exercised in consultation with the Forest Department. Equivalent amount of new trees should be planted as integral part of the project within the available land and if necessary, separate additional land may be acquired for this purpose.
- Afforestation of roadside land should be carried out to a sufficient distance on either side of the road.

vi) Changes in Land Use

The construction of Upper and Lower reservoirs with a total area of about 162 ha would lead to acquisition of private, forest and government land, which is a significant change in land use. Likewise, river stretch within submergence area, with moving water condition will be converted into quiescent conditions. New roads of about 25 km length are proposed to be constructed to connect the various project components.

The storage of scrap materials, used containers, cement bags, domestic and construction wastes, etc. in scrap yards will degrade the land quality. After the completion of the project, temporarily acquired land will be returned to the owners.

The construction sites would be adversely affected on account of large scale construction activities. The construction sites will have to clear of waste construction material, solid waste from various sources, leading to adverse impacts.

Mitigation Measures

Appropriate mitigation measures have been suggested for mitigation of asverese impacts.

vii) Impacts due to Blasting on Springs

There are no known springs in the project area, hence, impacts due to blasting on springs or water bodies is not anticipated due to construction and operation of the proposed Sillahalla Pumped Storage Project.

viii) Solid waste generation from labour camps

During construction phase, about 1600 labour and technical staff is likely to congregate, and increase in population is expected to be order of 6400 including family members of the individuals. The solid waste likely to be generated from labour camps shall be of the order of 0.70 tons/day.

Mitigation Measures

A solid waste management covering the following aspects has been prepared:

- Reuse/Recycling
- Refuse storage
- Collection and Transportation
- Disposal

The degradable portion of the solid waste would be disposed off by vermin-composting. The non- degradable portion such as plastic bottles, cans, etc. shall be segregated and disposed of at separate sites identified by the district administration.

A suitable landfill site can be identified and designed to contain the municipal waste from all the Project Township, labour colonies, etc.

ix) Hazardous Waste

Hazardous waste like used/waste oil is generated from the DG sets and other construction machinery. In addition, waste paints, grease etc. is also generated during construction activities. Hazardous waste shall be sent or sold by the occupier to an authorized actual user or disposed in an authorized disposal facility only. Occupier shall transport wastes through an authorized or certified transporter to an authorized actual user or to an authorized disposal facility as per the provisions of these rules.

x) E- Waste Management

E-waste generated at site shall be channelized through collection center or dealer of authorized producer or dismantler or recycler or through the designated take back service provider of the producer to authorized dismantler or recycler. The collection, storage, transportation, segregation, refurbishment, dismantling, recycling and disposal of e-waste shall be in accordance with the procedures prescribed in the guidelines published by the Central Pollution Control Board from time to time.

b) Operation Phase

No additional land will be procured during operation phase. No additional muck dumps/ storages/installation of additional machineries will be established. No tree felling is envisaged. With these mitigation measures, the impact on the land will be insignificant.

5.7 Impacts on flora

a) Construction phase

i) Impacts on Terrestrial flora due to increased human interferences

During project construction phase, labour population is likely to congregate near various construction sites. It can be assumed that the technical staff likely to

congregate will be of higher economic status and will live in a more urbanized habitat, and will not use wood as fuel.

All the labours/staff are accomodated in well planned colony within project area. Well designed kitchen and dining hall is provided in the colony. It is recommended that the project contractor shall provide alternate source of fuel be provided to the labour population, so that they do not cut trees to meet their fuel wood requirements. The workers may also cut trees to meet their requirements for construction of houses and other needs. Thus, if proper measures are not undertaken, adverse impacts on terrestrial flora is anticipated.

The noise generated due to construction activities can lead to some disturbance to wildlife population. Various measures like enclosures to DG set, controlled blasting technique etc. helped to attenuate noise levels. The quarterly environmental quality monitoring indicates all the environmental attributes are within the permissible standards. The baseline ecological study indicates absence of endangered species/National Parks close to project site.

ii) Acquisition of Forest Land

During project construction phase, land will be required for location of construction equipment, storage of construction material, muck disposal, widening of existing roads and construction of new project roads. The total forest land to be acquired for the project is 8.712 ha. It is proposed to cover double the area of degraded forest land under compensatory afforestation.

iii) Impacts on Rare Endangered and Threatened Species

As per IUCN Red list of threatened plant, no rare, endangered and threatened species are reported from the project area.

Mitigation Measures

As a part of Biodiversity Conservation Plan, empathizes is on Habitat improvement programme, which is an integral part of biodiversity management. This programme consists of bringing into useful association of those condition needed by a species to reproduce and survive. The following measures are proposed:

- Afforestation
- Eco-Development Works
- Establishment of botanical gardens
- Publicity and awareness

5.8 Impacts on Terrestrial fauna

a) Constuction phase

i) Impacts due to labour population and construction activities

Based on the field survey and interaction with locals, it was confirmed that, no major wildlife is reported in the area, proposed to be acquired for the project. The submergence area is not reported to serve as habitat for wildlife nor do they lie on any known migratory route. Thus, no impacts are anticipated on this account.

During construction phase, large number of machinery and construction workers shall be mobilized, which may create disturbance to wildlife population in the vicinity of project area. The operation of various equipment will generate significant noise, especially during blasting which will have adverse impact on fauna of the area. The noise may scare the fauna and force them to migrate to other areas. Likewise, siting of construction plants, workshops, stores, labour camps etc. could also lead to adverse impact on fauna of the area.

During construction phase, accessibility to area will lead to influx of workers and the people associated with the allied activities from outside will also increase, which can lead to illegal hunting and poaching. The increase in human interference could have an impact on terrestrial ecosystem.

The project area is not known to be on wildlife route. Hence, no major impact on habitat fragmentation or disruption to wildlife routes is anticipated due to Sillahallla pumped storage project.

ii) Impacts due to blasting

The impacts due to on account of high noise levels are expected during construction phase. This impact needs to be mitigated by adopting controlled blasting and strict surveillance regime and the same is proposed to be used in the project. This will reduce noise level and vibrations due to blasting to a great extent.

iii) Impacts on Avi-Fauna

The damming of the river will create quiescent/tranquil conditions. The reservoir banks will have wet environment throughout the year which can lead to proliferation of vegetation e.g. grass, etc. along the reservoir banks. Such conditions are generally ideal for various kinds of birds, especially, water birds, and and can increase their population in the area.

Mitigation Measures

A detailed Wildlife Protection Plan comprising of the following aspects shall be implemented:

- Habitat improvement for avi-fauna
- Anti-poaching Measures
- Creation of drinking water facilities
- Training and Awareness Programme

For Avi-fauna, nest predation or brood parasitism shall be avoided through maintenance of large contiguous forest tract. It is recommended to install artificial nest boxes in the influence zone and catchment area of the project after consultation with the forest department as well as local NGOs.

iv) Impacts on Eco-Sensitive Areas

Mukurthi National Park was established in the year 2001 in the Nilgiris Districts and covers an area of 7,846 ha. It is located in Tamil Nadu, India, is part of the Nilgiri Biosphere Reserve. The area was declared as a Wildlife Sanctuary in 1980, and later a National Park in 1990, mainly for the protection of the endangered Nilgiri Tahr (*Hemitragus hylocrius).* The vegetation of this site can be classified as Southern

Montane Wet Temperate Forest (shola) as classified by Champion and Seth (1968), Grassland and Plantation. The proposal for declaration of ESZ around Mukurthi National Park was taken up for consideration by the State Government representative. The Upper Dam site and Lower Dam Site are located about 11.4 and 4.78 km respectively from the boundary Mukurthi National Park (refer Figure-3.)

Figure 3 Location of Upper and Lower Reservoirs w.r.t Mukurthi National Park

No area of Mukurthi National Park is being acquired for the proposed Sillahalla Pumped storage Project. However, increased human interferences due to labour congregation could lead to adverse impacts on this Eco-Sensitive Area.

Mitigation Measures

- Strict restrictions shall be imposed on the workers at project sites to ensure that they do not harvest any species/produce from the forests and cause any harm to wildlife.
- The fuel wood to the labourers shall be provided by the project proponents so that there is no pressure for cutting of trees to meet fuelwood requirements.
- Interference of human population would be kept to a minimum in the adjacent forest areas and it would be ensured that the contractors do not set up labour colonies/camps in the vicinity of forests and wilderness areas.
- Only well maintained/new equipment that produces lesser noise would be installed at the work sites.

- Equipment that need to be placed permanently at one place like generators, etc. would be housed in enclosed structures to cut off the noise.
- Heavy equipment like rotating or impacting machines will be mounted on anti-vibration mountings.
- Wherever combustion engines are required they will be fitted with silencers.
- Traffic (trucks, etc.) used by the project works will be managed to produce a smooth flow instead of a noise producing stop and start flow. Necessary training/orientation will be provided to the traffic operators/drivers.
- Sounding of loud horns, etc. in the forested areas shall be banned. Project authorities will use water sprinklers on the road to avoid dust from construction activities.
- While clearing the land of vegetation for any project work, the project authorities will ensure that the work area has sufficient layer of tree cover around it. It will act as an effective noise absorber and dust barrier.

b) Operation phase

i) Increased accessibility

The increased accessibility to the area can lead to increased human interferences in the form of illegal logging, lopping of trees, collection of non-timber forest produce, etc. Since significant wildlife population is not found in the region, adverse impacts of such interferences are likely to be marginal.

5.9 Impacts on Aquatic Flora

a) Construction phase

During construction phase wastewater from domestic source will be discharged mostly from various camps of workers actively engaged in the project area. It is proposed to treat the same prior to disposal. In addition, effluents from Batching Plants, Crushers, workshops, shall also be treated so as to minimize the adverse impacts on river water quality and aquatic flora.

b) Operation phase

The completion of Sillahalla Pumped Storage Project would bring about significant changes in the riverine ecology, as the river transforms from a fast-flowing water system to a quiescent lacustrine environment. The micro-biotic organisms especially diatoms, blue-green and green algae before the operation of project, have their habitats beneath boulders, stones, fallen logs along the river, where depth is such that light penetration can take place. But with the damming of river, these organisms may be affected due to increase in depth.

5.10 Impacts on Aquatic Fauna

a) Construction phase

i) Impacts due to Construction Activities

The construction of the proposed Sillahalla Pumped Storage Project would lead to increased pollution levels due to congregation of labour population during construction phase. The waste water or effluent from various sources shall be treated prior to disposal. Appropriate mitigation measures shall be implemented for the same.

b) Operation phase

i) Impacts on fish fauna due to damming and reservoir formation

The submergence of the present fish habitat and the obstruction of migration upstream and downstream movement of the fishes due to the construction of the dam. Damming will create deeper and wider water body which could provide suitable habitat for fisheries. Since, it is a pumped storage project, with daily fluctuations in reservoir water level from MDDL to FRL, will not allow reservoir fisheries to develop. The migratory route of fish species like *Catla catla, Cyprinus carpio, Lebeo rohita* will be affected due to construction of the project.

Mitigation Measures

I. Provision of minimum flow

The proposed project is a pumped storage scheme. The water will be diverted for storage of Upper and Lower Reservoirs for a period of 46 months. During filling phase, 30% of flow in 90% Dependable Year shall be released in monsoon season. In non-monsoon months, 100% flow will be maintained in the intervening stretch.

II. Sustenance of fisheries

The stocking program shall comprise of the following:

- Acclimatization stocking (a new fish species is introduced in a water course)
- Supplementary stocking (a species already living in a water body)
- Transfer stocking (transportation of mature fish from one water body to another)
- Repetitive stocking (species which do not propagate in natural conditions).

A hatchery for producing fingerlings shall be developed and implemented by the Fisheries Department, State Government of Tamil Nadu at an appropriate site.

5.11 Increased Incidence of Water-related Diseases

The construction of the propsed dam would convert riverine ecosystem into a lacustrine ecosystem. The vectors of various diseases may breed in shallow parts of the impounded water. The magnitude of breeding sites for mosquitoes and other vectors is in direct proportion to the spread area of impounded water and to the length of the shoreline.

Mitigation Measures

Adequate measures for supply of potable water and sewage treatment have been recommended as a part of Environmental Management Plan. A proper surveillance, immunization schedule and medical facilities would be provided for the labour population migrating into the project area.

5.12 Impacts on Social Environment

a) Construction Phase

About 239 ha of prvate land is to be acquired, and 818 families will be losing land. No family shall lose homestead. The acquisition of private land would lead to PAFs losing land in varying proportions. A suitable Rehabilitation Plan has been formulated for compensation of families in lieu of acquisition of land.

The other impacts likely to accrue due to the proposed project include:

- Increased employment opportunities
- Increased Business opportunities
- Influence on social services (Educational, Health, Communication, Water Supply, Consumer Goods, and Sanitation etc.)
- Improved access facilities in the project area

b) Operation Phase

The key impacts are listed as below:

- Community health improvement
- Increased employment opportunities
- Increased Business opportunities

6. Environmental Management Plan

6.1 Labour Management Plan

The contractors involved in project construction activities shall prepare a Health and Safety Plan, covering the following aspects:

- Project specific health and safety objectives, targets and programmes in line with health and safety policy
- Resources, roles, responsibility and authority for implementation of health and safety rules
- Health and safety requirements to be followed by sub-contractors
- Operation control procedures (SOPs)
- Access control of employees
- Safety of visitors
- Management of critical activities such as work at a height, material handling and working with plant and machinery
- Fire prevention and firefighting plan
- Emergency preparedness and response plan
- Traffic management plan
- Provision of Personal Protective Equipment as per work requirement
- Health and safety performance monitoring measures such as Inspection, Audit Incident reporting and investigation procedure

6.2 Occupational Health Management Plan

The key aspects to be covered under Occupational Health Management Plan are listed as below:

- Health and safety performance monitoring measures such as Inspection, Audit Incident reporting and investigation procedure
- Safety of Machine Use at Project Site
- Occupational Health & Safety (OHS)
- Occupational Health & Safety Measures to Control Dust Inhalation
- Noise Induced Hearing Loss (NIHL)
- Occupational Lung Diseases (OLD)

There will be regular health camps for all the workers and nearby rural people. Lung function tests, chest X-rays etc. shall be carried out and any health disorders will be evaluated. The budget shall be earmarked for the necessary protective devices and training needs.

6.3 Safety Practices during Construction Phase

The information on following aspects pertaining to safety have been presented in this Section:

- Personal Safety Equipment
- Rescue Team
- Illumination and Earthing
- Maintenance of Traffic and Safety on Public Roads
- Blasting
- Management of Explosives
- Traffic management during construction phase
- Measures to be taken during excavation of earth
- Safety practices during construction phase
- Fire protection in labour camp and staff colonies

6.4 Catchment Area Treatment Plan

Silt Yield Index' (SYI), method has been used. In this method, the terrain is subdivided into various watersheds and the erodibility is determined on relative basis be applied to larger areas like sub-watersheds, etc.

The following measures have been recommended for treatment of catchment area intercepted at Upper and Lower Dam Sites:

- Enrichment Plantation
- Pasture development
- Nursery development
- Vegetative fencing
- Watch and ward for 2 years average 10 persons per month
- Rim Plantation
- Social Forestry

In addition, following measures too have been recommended as part of Catchmnet Area Treatment Plan:

- Soil & Water Conservation Works

- Silt Observation points
- Research Training and Capacity Building
- Infrastructure Development

An amount of Rs.1774.15 lakh has been earmarked for implementation of various measures outlined as part of part of Catchmnet Area Treatment Plan.

6.5 Greenbelt Devlopment

Green belt around the reservoir would be created to avoid erosion of soil and prevention of land slips from the banks. The green belt will start from the immediate vicinity of the reservoir rim on both the banks, where moderate slopes are available for plantation. The average width of the green belt will be around 10 m varying depending upon the physiographic and land features.

The tree plantation will be done at a spacing of 2.5 x 2.5 m. About 1600 trees per ha will be planted. The maintenance of the plantation area will also be done by the project proponent. The treated waste water and the manure generated by composting of solid waste generated for labour camps will be used for the greenbelt development. The species for greenbelt development shall be selected in consultation with Forest Department.

6.6 Energy Conservation Measures

To provide an alternate for the energy requirement of the workers, contractor/s will be made responsible to provide subsidized kerosene/LPG to their workers which will in turn discourage them from illegal tree felling and removal of fuel wood and timber from the adjoining forests. A key component of achieving energy conservation would be the development of an Energy Management Action Plan. This plan would be included as part of the Construction and Operational EMPs.

7. Resettlement and Rehabilitation Plan

The total land required for the project is approximately 310.157 ha. About 239.2444 ha of private land is proposed to be acquired for the Sillahalla Pumped Storage Project. About 818 families are likely to lose land, and no homesteads shall be acquired (refer Table-3).

Table 3 Summary of Villagewise Project Affected Families

S. No.	Village	Number of PAFs
1	Balacola village	499
2	Ithalar village	86
3	Kil Kundah village	233
	Total	**818**

The R&R plan has been devised using the norms and guidelines of the "Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013". The cost of land is given in Table-4. The total budget for implementation of the Rehabilitation and Resettlement Plan is Rs. 36731.74 lakh**.** (Refer Table-5).

Table 4 Cost of Private Land to be acquired as a part of the project

S. No	Description	Amount (Rs.)
1	Guideline Amount of Land for Acquisition of **239.2444 ha**	₹ 78,70,04,379.60
	Add for Variation during field survey by Revenue Department @ 10%	₹ 7,87,00,437.96
2	Total Guideline Amount of Land for Acquisition	₹ 86,57,04,817.56
3	Multiplication factor to be applied for Project area beyond 30 km and within 50kms from Urban Area	1.5
4	Value of Land (Guideline Value of Land x Multiplication Factor)	₹ 1,29,85,57,226.34
5	Solation (100% on Total Value of Land)	₹ 1,29,85,57,226.34
6	Final Award Value (Value of Land + Solation)	₹ 2,59,71,14,452.68
7	Provision towards Interest on Basic Value @ 12% per annum for 5 years on 25% of land properties	₹ 51,94,22,890.54
8	**Total Compensation**	**₹ 3,11,65,37,343.22**
9	Establishment Charges related to revenue department and marking etc @ 5% on Guideline Amount of Land	₹ 4,32,85,240.88

S. No	Description	Amount (Rs.)
	for Acquisition	
10	Charges for Fixing Demarcation stones @ 1% on Guideline Amount of Land for Acquisition	₹ 86,57,048.18
11	Provision for Legal Charges @ 5% on Guideline Amount of Land for Acquisition	₹ 4,32,85,240.88
12	Unforessen Items @ 2% on Guideline Amount of Land for Acquisition	₹ 1,73,14,096.35
	Total	**₹ 3,22,90,78,969.50 say 32290 lakh**

Table 5 Provisions for Rehabilitation Plan for families losing land

S. No.	Description	Unit	Assumed Provision	Cost (Rs. lakh)
1a.	Total Market Value of the private land (A) (Rate to be finalized at the time of land acquisition by District Collector or District Magistrate) 239.24 ha Private land			32290
	Total (A)			
2.	**Rural artisans / Self-employed**			
	One-time financial assistance of a minimum of Rs. 25,000/- to each affected family of an artisan, small trader or self-employed person or an affected family which owned non-agricultural land or commercial, industrial or institutional structure in the affected area, and which has been involuntarily displaced from the affected area due to land acquisition	818	Rs. 25,000/ PAF	204.5
3.	**Choice of Annuity or Employment**			
	a) At least one member per affected family will be provided job (either in the project or arrange for a job in such other project), after providing suitable training and skill development in the required field Or **b)** Onetime payment of Rs. 500,000	818	Rs. 500,000/ PAF	4090

S. No.	Description	Unit	Assumed Provision	Cost (Rs. lakh)
	per affected family Or **c)** Annuity policies that shall pay not less than Rs. 2000 per month per family for 20 years, with appropriate indexation to the Consumer Price Index for Agricultural Labourers			
4.	Training of the affected persons, so as to enable such persons to take on suitable jobs	818	818 PAFs x Rs.500/month x 6 months for each PAF	24.54
5.	Scholarships and other skill development opportunities to the eligible persons from the affected families as per the criteria as may be fixed by the appropriate Government	818	818 PAFs x Rs.500/month x 12 months for each PAF	49.08
6.	Skill development opportunities to the eligible persons from the affected families as per the criteria as may be fixed by the appropriate Government	818	818 PAFs x Rs.500/month x 6 months for each PAF	24.54
7.	Affected persons shall be offered the necessary training facilities for development of entrepreneurship, technical and professional skills for self-employment	818	818 PAFs x Rs.1000/month x 6 months for each PAF	49.08
Total				**36731.74**

8. Local Area Development Plan (LADP)

The objective of the plan is to empower the families of the study area villages and partially affected villages. Villages that would be fully affected, which need to be relocated, shall be provided R&R benefits as per the Policy and also other resettlement benefits. About 0.5 % of the project cost is to be earmarked for Local Area Development Plan. The total project cost is Rs. 5843 crore and a budget of 0.5% (Rs. 29.215 crore say Rs. 29.22 crore) of the project cost has been earmarked for implementation of Local Area Development Plan (LADP). The details are shown in Table-6.

Table 6 Budget for implementation of LADP

S. No.	Items	Budget (Rs. lakh)
1.	Construction/ Up-gradation schools in Study Area	1685.0
2.	Scholarships to students in the Study Area	240.0
3.	Improvement of Public Health Facility	1000.0
	Total	**2925.0**

9. Disaster Management Plan

The key features of Disaster Management Plan are:

- Dam Safety and Maintenance Manual
- Emergency Action Plan (EAP)
- Administration and Procedural Aspects
- Preventive Action
- Communication System
- Evacuation Plans
- Evacuation Team
- Public Awareness for Disaster Mitigation
- Notifications
- Notification Procedures
- Management after receding of Flood Wates
- Village Level Incidence Response Team

10. Environmental Monitoring Programme

An Environmental Monitoring Programme shall be undertaken during construction and operation phases of the project. The details of Environmental Monitoring Programme are given in Tables-7 and 8 respectively.

Table 7 Summary of Environmental Monitoring Programme during Project Construction Phase

S.No.	Aspect	Parameters	Frequency	Location
1.	Effluent from STPs	pH, BOD, COD, TSS, TDS	Once in a month	Before and after treatment from each STP
2.	Water-related diseases	Identification of water related diseases, adequacy of local vector control and curative measure, etc.	Three times a year	Labour camps and colonies
3.	Noise level	Equivalent noise level (L_{eq})	Once in three months	At major construction sites.
4.	Ambient Air quality	$PM_{2.5}$, PM_{10}, SO_2 and NO_2	Once in a season	At major construction sites
5.	Meteorological aspects	Wind direction & velocity temperature humidity, rain	Once in a season	At one of the ambient air quality sampling sites
6.	Terrestrial Ecology	Status of afforestation programmes of green belt development, Terrestrial Flora and fauna	Once in a season	Afforestation sites, forest area in and around the project site
7.	Aquatic Ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Once in a season	Water bodies located in proximity to the construction sites

Table 8 Summary of Environmental Monitoring Programme during Project Operation Phase

S. No.	Aspect	Parameters	Frequency	Location
1.	Water	pH, Temperature, EC, TSS, Turbidity, Total Dissolved Solids, Calcium, Magnesium, Total Hardness, Chlorides, Sulphates, Nitrates, DO. COD, BOD, Iron, Zinc,	Once in a season	• 1 km upstream of Upper Reservoir site • Upper Reservoir. • 1km downstream of the proposed Upper Dam site

S. No.	Aspect	Parameters	Frequency	Location
		Manganese		• 1 km upstream of Lower Reservoir site • Lower Reservoir. • 1km downstream of the proposed Lower Dam site
2.	Effluent from Sewage Treatment Plant (STP)	pH, BOD, COD, TSS, TDS	Once in a week	Before and after treatment from Sewage Treatment Plant (STP)
3.	Terrestrial Ecology	Status of afforestation programmes of green belt development, Terrestrial Flora and fauna and aquatic ecology	Once in a season	-
4.	Water-related diseases	Identification of water-related diseases, sites, adequacy of local vector control measures, etc.	Once in a season	Villages adjacent to project sites
5.	Aquatic ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Once in a season	• 1 km upstream of Upper Reservoir site • Upper Reservoir. • 1km downstream of the proposed Upper Dam site • 1 km upstream of Lower Reservoir site • Lower Reservoir • 1km downstream of the proposed Lower Dam site
6.	Landuse	Landuse pattern using satellite data	Once in a year	Catchment area

11. Cost Estimates

An amount of Rs. 46721.0 lakh or Rs. 467.21 crore has been earmarked for implementation of various Environmental measures outlined in chapter. The details are given in Table-9.

Table 9 Total Budget for implementing various Environmental Measures

S. No.	Aspect	Cost (Rs. lakh)
I.	**Cost for Implementing Mitigation Measures**	
1.	Landscaping and Restoration of Construction Areas	100.00
2.	Stabilization of Muck Disposal Sites	1020.00
3.	Environmental Management in Road Construction	800.00
4.	Solid waste Management	108.92
5.	Sanitary facilities in labour camps	188.00
6.	Treatment of Effluents from Crushers	50.0
7.	Treatment of effluents from batching plants	50.0
8.	Treatment of effluent from fabrication units and workshops	50.0
9.	Air Pollution Control Measures	256.30
10.	Provision of Free Fuel	419.75
11.	Compensatory Afforestation	46.34
12.	Biodiversity Conservation Plan	250.00
13.	Wildlife protection Plan	407.12
14.	Habitat Improvement for Avi-Fauna	88.30
15.	Development of Hatcheries	146.48
16.	Public Health Delivery System	514.60
	Sub-Total (I)	**4495.81**
II.	**Cost for Implementing Environmental Management Plan**	
1.	Energy Conservation Measures	40.0
2.	Public Awareness Programme	50.0
3.	Disaster Management Plan	60.0
4.	Greenbelt Development Plan	50.0
5.	Hazardous Waste Management	30.0
6.	E-Waste Management	20.0
7.	Budget for Conservation of Schedule-I Species	350.0
	Sub-Total (II)	**600.0**
III.	**Cost for Implementing Measures outlined in Additional Studies**	
1.	Catchment Area Treatment Plan	1774.15
2.	Resettlement and Rehabilitation Plan	36731.74
3.	Local Area Development Plan	2925.00
	Sub-Total (III)	**41430.89**

S. No.	Aspect	Cost (Rs. lakh)
IV.	**Cost for Implementing Environmental Monitoring Programme during construction Phase**	
1	Water quality	7.32
2	Ambient air quality	31.25
3.	Ecology	117.18
4.	Incidence of water related diseases	32.55
5.	Purchase of meteorological instruments and noise meter	6.0
	Sub-Total (IV)	**194.30**
	Total (I+II+III+IV)	**46721.0**

In addition, an amount of of Rs. 29.26 lakh/year has been earmarked for implementing Environmental Monitoring Programme in operation phase. The details are given in Table -10.

Table 10 Cost for Implementing Environmental Monitoring Programme during operation phase

S. No.	Item	Cost (Rs. lakh/year)
1.	Water quality	1.26
2.	Ecology	18.00
3.	Incidence of water related diseases	5.00
4.	Landuse pattern	5.00
	Total	**29.26**

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