EXECUTIVE SUMMARY FOR THE PROPOSED

STANDALONE PUMPED STORAGE COMPONENT (1200 MW) OF PINNAPURAM INTEGRATED RENEWABLE ENERGY PROJECT

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EXECUTIVE SUMMARY

1. INTRODUCTION

India is leading the world's renewable energy revolution and is on track to achieve 175 GW of RE capacity by 2022. Today, Wind & Solar, are the lowest cost source of new energy, however their inherent infirm nature & non-schedulability presents a huge challenge for integrating large RE capacities, while maintaining grid stability.

Wind-Solar-Storage Hybrid Projects present a viable solution to the problem at hand and also for future wherein large RE capacities are being planned to be added to National grid. While battery storage solutions are still evolving, **integrating Wind & Solar** with time tested and proven **Pumped Storage** solutions presents an **optimal, economically viable & scalable solution to supply Schedulable Power On-Demand (SPOD)** with both base load and peak load capabilities to the Nation.

Andhra Pradesh has the largest hydro power potential among all the states of the southern region. The need for implementing new hydroelectric schemes in the region for providing peak power besides energy at competitive rates therefore needs no further emphasis. The most reliable option for energy storage is development of Pumped storage schemes. Pumped hydroelectric energy storage (PHES), is a type of hydroelectric energy storage used by electric power systems for load balancing.

Greenko Group has been in the process of evaluating for such integrated projects and has identified Pinnapuram, Kurnool District, Andhra Pradesh for the proposed **Pinnapuram Integrated Renewable Energy Project (IREP)**. Pinnapuram IREP has been conceived as the World's First & Largest Gigawatt Scale integrated project with solar, wind and pumped storage components that can supply Schedulable Power on Demand (SPOD) which is Dispatchable & Schedulable Renewable Energy for the first time to consumers across India.

2. STANDALONE PUMPED STORAGE COMPONENT OF PINNAPURAM IREP

'Standalone pumped Storage component of Pinnapuram IREP' is located in Kurnool district of Andhra Pradesh. Project envisages construction of upper and lower reservoir near Pinnapuram village in Panyam Mandal of Kurnool District. The existing Gorakallu balancing reservoir is under operation with a live storage capacity of 12.44 TMC. The filling of the proposed Pinnapuram upper reservoir will be taken up from Gorakallu Reservoir. The Geographical coordinates of the proposed Pinnapuram upper reservoir are at longitude 78° 15' 13" East and latitude is 15° 36' 26" North and that of lower reservoir are 78° 15' 30" E and 15° 37' 26" N.

Proposed Scheme will involve construction of Rock fill embankments of average height of around 12m to 14m with maximum of 33m height in lower reservoir and 35m in upper reservoir for very short reach for creation of Pinnapuram IREP reservoirs. Intake structure and trash rack for Five numbers of independent penstocks and one number of independent penstock bifurcated into two will be taking off from Power block of Pinnapuram IREP upper reservoir. A surface Power House will be located on the downstream of the power block and shall be equipped with five vertical-axis reversible Francis type units composed each of a generator/motor and a pump/turbine having generating/pumping capacity of 200MW/244MW and two units of 100MW/130MW respectively.
The location of the project is shown in **Figure 1.**

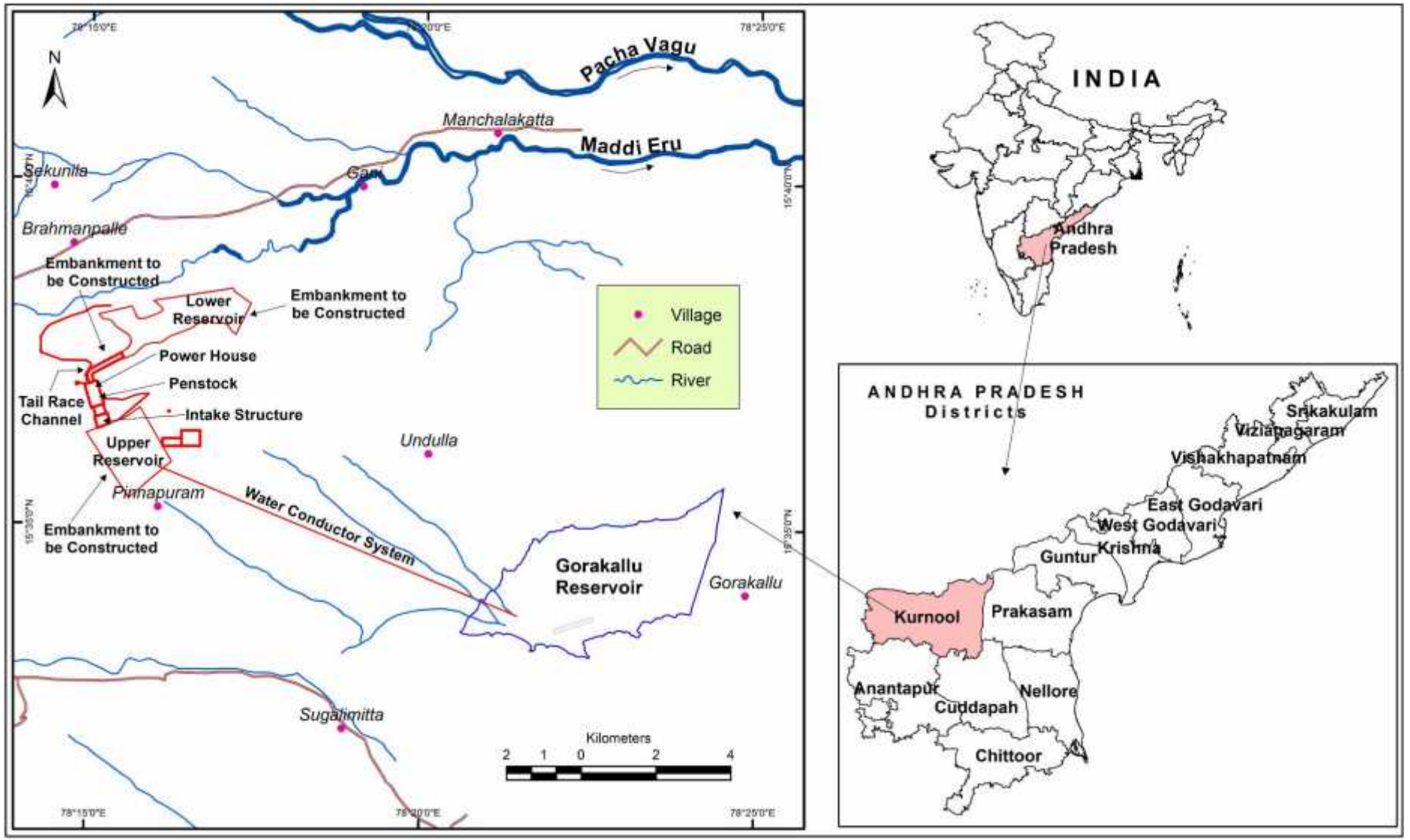

Figure1.1:
Location Map of Standalone Pumped storage component of **Pinnapuram IRE Project**

The salient features of the project are given in **Table 1**. The layout map of the project is given at **Figure 2**.

Table 1: Salient features of Standalone Pumped storage component of **Pinnapuram IRE Project**

1		**NAME OF THE PROJECT**	**Standalone Pumped Storage Component of Pinnapuram IREP**
2		Location	
	a	Country	India
	b	State	Andhra Pradesh
	c	District	Kurnool
	d	Village near Power House	Pinnapuram
3		Geographical Co-Ordinates	
	a	Standalone Pumped Storage Component of Pinnapuram IREP Reservoir - Upper (Now Proposed)	
		Latitude	15° 36' 26" N
		Longitude	78° 15' 13" E
	b	Standalone Pumped Storage Component of Pinnapuram IREP Reservoir - Lower (Now Proposed)	
		Latitude	15° 37' 26" N
		Longitude	78° 15' 30" E
4		Access To Project Site	
	a	Airport	Hyderabad
	b	Rail head	Kurnool – 81 Kms
	c	Road	Gorakallu
	d	Port	Krishnapatnam
5		Project	
	a	Type	Pumped Storage Project
	b	Storage Capacity	9600 MWH
	c	Rating	1200 MW
	d	Peak operation duration	8.00 Hours daily
6		Pinnapuram Reservoir - Upper	Upper Reservoir
	a	Live Storage	1.20 TMC
	b	Dead Storage	0.17 TMC
	c	Gross Storage	1.37 TMC
	d	Top of Dam	EL +466.00 m
	e	Full Reservoir level (FRL)	EL +463.00 m
	f	Min. Draw Down Level (MDDL)	EL +441.50m
	g	Height of RCC Intake Structure	45.0 m
	h	Max Height of Embankment	35.0m
	i	Top Width of Embankment	10.0 m
7		Pinnapuram Reservoir - Lower	Lower Reservoir
	a	Live Storage	1.20 TMC
	b	Dead Storage	0.22 TMC
	c	Gross Storage	1.42 TMC
	d	Top of Dam	EL +343.00 m
	e	Full Reservoir level (FRL)	EL +340.00 m
	f	Min. Draw Down Level (MDDL)	EL +321.00 m
	g	Max Height of Embankment	33.0 m
	h	Top Width of Embankment	10.0 m
8		RCC Intake Structure	
	a	Type	Open Semi Circular
	b	Elevation of Intake center line	EL +429.24 m
	c	Elevation of bell mouth bottom	EL +423.71 m
9		Penstock /Pressure Shafts	
	a	Type	steel lined - circular
	b	Number of Penstocks	5 Nos Independent Penstocks and 1 No of

			Independent Penstock bifurcated in to 2
	c	Diameter of penstock	7.0 m
	d	Length of penstock	760.0 m each
10		Powerhouse	
	a	Type	Surface Powerhouse
	b	Dimensions	L 240.00m x B 24.00 m x H 58.00 m
11		Tail Race Channel	Trapezoidal Channel - Lined
	a	Lenth of the channel	1300 m
	b	Bed Width	70 m
	c	Full supply depth	6.00 m
	d	Bed slope	1 in 5000
12		Tailrace Outlet	
	a	Type	Open Semi Circular
	b	Elevation of outlet centre line	EL +305.70 m
13		Hydro-Mechanical Equipment	
	a	RCC Intake Structure	
		Trash Rack	
		No of bays in each trash rack	6 Nos – 21.0m high
		Intake Service Gate - 6 Nos	W5.77 m X H7.00 m (Vertical lift fixed wheel)
		Intake Stop log Gate - 6 Nos	W5.77 m X H7.00 m (Vertical lift fixed wheel)
	b	Draft Tube Gates	High pressure steel type slide gates
		No of gates per unit	2 per unit - W 6.5 m X H 7.0 m (Vertical lift fixed wheel type)
	c	Tailrace Outlet Structure	
		No. of bays in each trash rack	6 Nos – 18.0m high
14		Electro Mechanical Equipment	
		Pump Turbine	Francis type, vertical shaft reversible pump-turbine
		Total No of units	7 no's (5 X 200MW & 2 X 100 MW)
		Total Design Discharge (Turbine Mode)	1162.85 Cumec
		Rated Head in Turbine mode	119.27m
	a	200MW Turbines	
		Total No of units	5 Units (2 Nos with Variable speed & 3 Nos with Fixed Speed)
		Turbine Design Discharge	193.81 Cumec for each unit
		Pump Capacity	244 MW
		Rated Pumping Head	125.77 m
		Rated Pump Discharge	178.42 Cumecs
		Synchronous speed	136.36 rpm
	i	Generator-Motor	
		Type	Three (3) phase, alternating current synchronous, generator motor semi umbrella type with vertical shaft
		Number of units	5 Units
		Rated Capacity	Generator – 200MW; Pump Input – 244MW
		Rated Voltage	18.0 KV
	ii	Main Power Transformer	
		Type	Indoor, 3-Ph transformers with Off-Circuit tap changer (OCTC)
		Number of units	5 Units
		Rated Capacity of each unit	280 MVA
		Rated Voltage	Primary – 18.0 kV; Secondary - 400 kV adjustable range of the secondary voltage: -10% to +10%(3kV/tap)
	b	100MW Turbines	
		Total No of units	2 Units (1 Nos with Variable speed & 1 Nos with Fixed Speed)

		Turbine Design Discharge	96.90 Cumec for each unit
		Pump Capacity	130 MW
		Rated Pumping Head	125.77 m
		Rated Pump Discharge	94.37 Cumec for each unit
		Synchronous speed	187.5 rpm
	i	Generator-Motor	
		Type	Three (3) phase, alternating current synchronous, generator motor semi umbrella type with vertical shaft
		Number of units	2 Units
		Rated Capacity	Generator – 100MW; Pump Input - 130MW
		Rated Voltage	18.0 kV
	ii	Main Power Transformer	
		Type	Indoor, 3-Ph transformers with Off-Circuit tap changer (OCTC)
		Number of units	2 Units
		Rated Capacity of each unit	150 MVA
		Rated Voltage	Primary – 18.0 kV; Secondary - 400 kV adjustable range of the secondary voltage: -10% to +10%(3kV/tap)
17		420KV Gas Insulated Switchgear	(GIS)
	1	Type of GIS	Indoor Type
	2	No. of GIS units	One No.
	3	Location	Inside GIS Building above ground
	4	Scheme	Double Busbar Arrangement with bus sectionalize
18		POWER EVACUATION	
	a	Voltage Level (KV)	400 KV
	b	No. of Transmission lines	Two Nos for each connecting point
	e	Conductor	Moose
	h	Total Length	Line 2: 20 Kms to PGCIL 765/400 KV SS near Orvakallu
	i		6 Km up to Central Pooling Substation of IREP
19		Estimated Cost	
	a	Civil Works & Other works	2258.27 Cr.
	b	E & M Works incl transmission	1920.00 Cr.
	c	I DC	1289.75 Cr.
		Total Project Cost with IDC	5468.03 Cr.

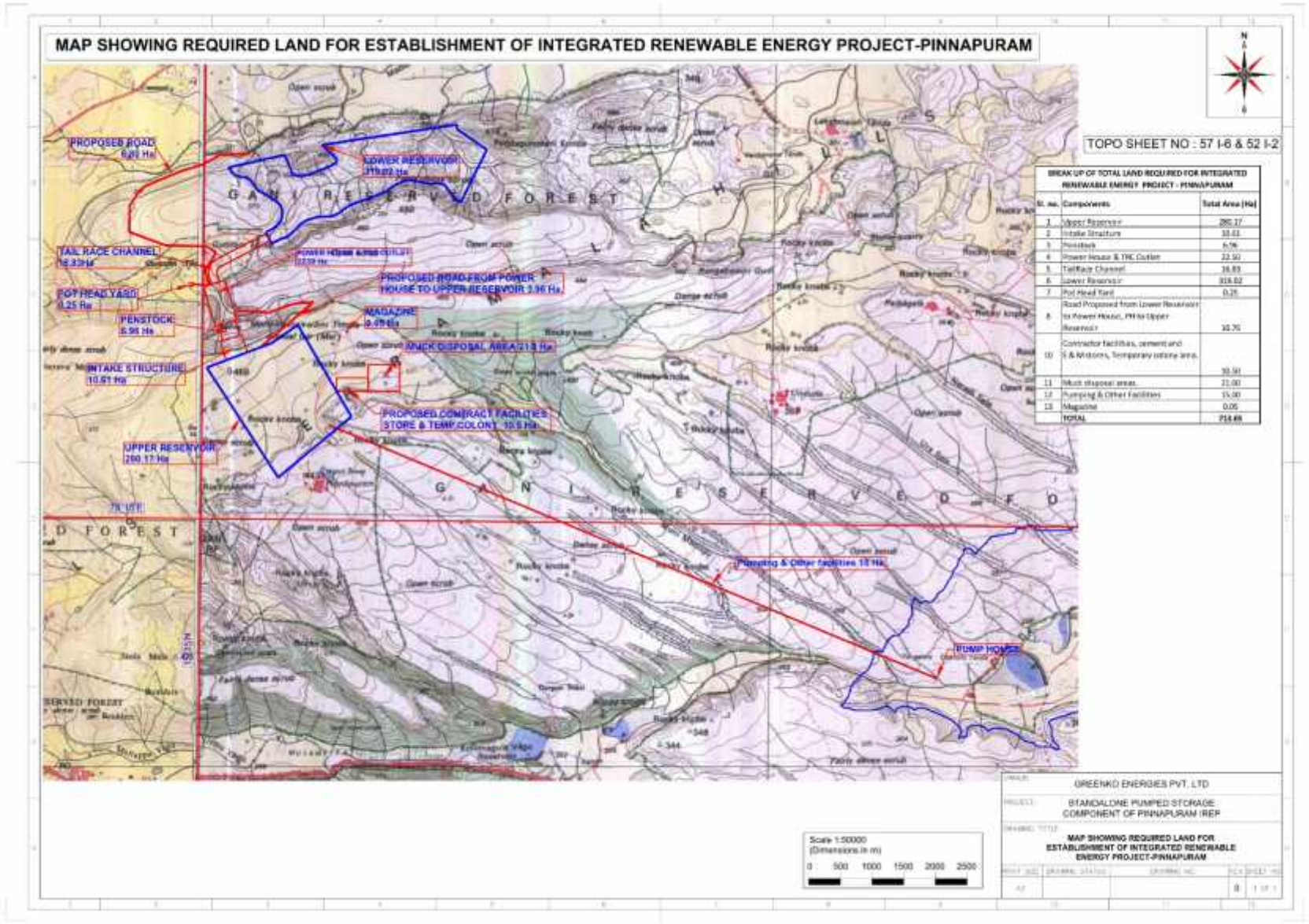

Figure 2: Layout map of Standalone Pumped storage component of Pinnapuram IRE Project

3. ENVIRONMENTAL BASELINE STATUS

Data on the existing environmental parameters in the study area delineated as per the approved Terms of Reference (TOR) for EIA studies by Ministry of Environment, Forests & Climate Chang (MoEF&CC), Government of India was collected to understand the present setting of the environment at the project site. The base line status is described briefly in the following sections:

3.1 Physiography

The study area of the proposed project is comprised of moderately sloping, exposed rocks, and scrub vegetation. The study area ranges from El. 200 to 500 m above msl. The denudation landforms are visible in the form of scree slope, scarps ridges valleys, etc.

The slope in the area falling under various slope categories, nearly 68% of the study area is under moderately sloping followed by the area under Strongly Sloping category with 16.15% and Gently Sloping with 10.33% of the total area.

3.2 Soil

The description of soil type in study area is based upon the soil map of the study area prepared using the Soil Map prepared by Atlas of Andhra Pradesh by National Bureau of Soil Survey & Land Use Planning (NBSS & LUP). The dominant soil types in the district are black soils and red loamy soils. The majority of project study area i.e. more than 64% of soil is characterized by Red loamy soil.

The bulk density of soil varied from 1.25 to 1.52 (gm/cc). The dry bulk density of a soil is inversely related to the porosity of the same soil: the more pore space in a soil the lower the value for bulk density. Water holding capacity was recorded highest (45.3) from the soil sample collected from sampling site S1 and lowest was from (22.4) sampling site S5. Electrical conductivity ranged between 300 µmho/cm and 868 µmho/cm. Soil pH is normal in nature with pH values ranging from 7.7 to 8.2. Organic matter an important indicator of soil health is in Low range with exception of soil sample collected from an orchard (Site S4) from Panyam village where it is in Medium range (0.53%). The soil fertility rating in terms of nitrogen concentration is in low range varies from 145 kg/ha to 180 kg/ha and the concentration of potassium is in medium range (135 kg/ha to 160 kg/ha), whereas the concentration of phosphorus ranges between 23.5 kg/ha and 30.5 kg/ha with fertility rating in low to medium range.

The soil fertility based upon Nutrient Index in terms of NPK as above in case of Nitrogen is Low (1.00), in case of Potassium and Phosphorus is Medium i.e. NI is 2.00 and 1.67, respectively.

3.3 Ambient Air Quality

The sources of air pollution in the study area are vehicular traffic, dust arising from unpaved village roads and domestic fuel burning. The air environment around project site is free from any significant pollution source. Air quality monitoring was carried out as per the new air quality parameters conforming to the National Ambient Air Quality Standards for Industrial Residential, Rural & Other Areas.

a. $PM_{2.5}$ levels

In the study area maximum level of $PM_{2.5}$ was observed during pre-monsoon season. The maximum $PM_{2.5}$ levels were observed at Kalava village (B) with 35.3 $\mu g/m^3$ during pre-monsoon season and minimum levels at Pinnapuram village (A) with 15.6 $\mu g/m^3$ during monsoon season. The $PM_{2.5}$ levels at monitoring were below the permissible limits (60 $\mu g/m^3$) specified for industrial, residential, rural and other areas.

b. PM_{10} levels

The $PM_{10.0}$ values ranged from minimum 50.2$\mu g/m^3$ at Pinnapuram village (A) to 68.4 $\mu g/m^3$ at Undulla village (B). The maximum PM_{10} levels was observed during pre-monsoon season while minimum level of PM_{10} was observed during Monsoon season. The $PM_{10.0}$ level observed at various sampling stations was much lower than the permissible limit of 100 $\mu g/m^3$ for industrial, residential and rural areas.

c. SO_2 levels and NOx levels

The SO_2 and NO_x levels observed during the study was much lower than the permissible limit of 80 $\mu g/m^3$ and for industrial, residential and rural areas. The SO_2 values ranged from 6.0$\mu g/m^3$ to 8.4 $\mu g/m^3$ at various stations covered as a part of the ambient air quality monitoring study. Similarly, the NO_x values ranged from 5.8$\mu g/m^3$ to 11.2 $\mu g/m^3$ at various stations covered as a part of the study.

3.4 Noise & Traffic

Unwanted sound that is loud and unpleasant or unexpected is termed as noise pollution. It has adverse impact on the daily activities of the human being and animals. The adverse impact of the noise on human and animals also depends upon time, season and the quality of sound. Noise levels were monitored during the studies at various locations in the Direct Impact Area of the project.
The sound levels in the study area was observed well within the prescribed Ambient Noise Standards ranged from 48.9 to 56.7 dB(A) (day time observations). Main source of noise pollution in the study area are observed from the flow of river and vehicular movement.

Traffic density data was recorded by physically counting the number of different types of vehicles passing through a particular point in a fixed time interval. Traffic density was recorded maximum at near Somayajulapalle Village along the NH18 (Kurnool-Chittoor highway) and Gorakallu village (near Gorakallu reservoir area).

3.5 Water Quality and Aquatic Ecolog y

Water quality of both surface and ground water was assessed in the study area.

3.5.1 Ground Water

Ground Water samples were collected from hand pumps, dug well and tube wells from the 5 locations in the study area.

According to BIS standards for Drinking Water (2012) all the water samples collected from the study area fall within permissible limits of the same.

In addition to the above Water Quality Index developed for ground water quality by Tiwari & Mishra (1985) and Singh and Hussian (2016) was also used to assess the ground water quality in the study area. It is based upon key parameters like Total Dissolved Solids, Chlorides, Sulphate, Nitrate, Calcium, Magnesium, Sodium, Potassium and pH. Based upon WQI range calculated based formula using parameters they have categorized the ground water into different groups as follows:

WQI range	Water Quality
<50	Excellent water
50-100	Good water
100-200	Poor water
200-300	Very poor water
>300	Water unsuitable for drinking purpose

The WQI calculated for ground water samples collected from different locations in the study area is given in table below.

Ground Water Quality Index

Season	GW1	GW2	GW3	GW4	GW5
Winter	27.52	28.51	29.26	30.25	28.75
Pre-monsoon	28.98	29.64	29.53	28.26	28.07
Monsoon	32.95	32.58	32.19	33.23	30.57

According to WQI tabulated in table above all the ground water samples fall in Excellent ground water quality class.

3.5.2 Ground Water

For analysis of surface water quality samples were collected from three sites. Results of water samples taken from Ponds and Gorakallu reservoir in the study area.

Surface water quality of all the samples collected during winter, Pre-Monsoon and monsoon season was compared with the Water Quality Criteria of Central Pollution Control Board (http://www.cpcb.nic.in/Water_Quality_Criteria.php). None of the samples fall under Class 'A' with designated best use as drinking water source due to total coliform is more than 50 MPN/100 ml in all samples collected during different season. All the samples of surface water qualify for **Class 'B'** i.e. designated best use of outdoor bathing (organized). This is due to total coliform less than 500 MPN/100 ml, DO of more than 5 mg/l and BOD less than 3 mg/l.

A commonly-used water quality index (WQI) developed by the National Sanitation Foundation (NSF) in 1970 by Brown *et al*. (www.water-research.net/watrqualindex/waterqualityindex.htm) and Washington State Department of Ecology, Environmental Assessment Programme was used for assessing the surface water quality. The NSF WQI was developed to provide a standardized method for comparing the water quality of various bodies of water. Water quality index is a 100-point scale that summarizes results from a total of 9 different parameters listed below in the table.

pH	Delta Temperature Change ^0C	Total Phosphates mg/L
Dissolved Oxygen (DO) Saturation (%)	Total Coliforms MPN/100ml	Nitrates mg/l
Turbidity NTU	Biochemical Oxygen Demand (BOD) mg/l	Total Suspended Solids (TSS) m/l

The analysis of water quality therefore is based upon 9 parameters as defined for WQI above and based upon the score at each sampling site water quality has been designated as Excellent, Good, Medium, etc. as per the range defined in the table below.

Water Quality Index	
Range	**Quality**
90-100	Excellent
70-90	Good
50-70	Medium
25-50	Bad
0-25	Very bad

Water quality index based upon the above parameters is given in table below.

Sampling Site	**Winter**			**Pre-Monsoon**			**Monsoon**		
	SW1	**SW2**	**SW3**	**SW1**	**SW2**	**SW3**	**SW1**	**SW2**	**SW3**
WQI	75.46	77.35	77.24	73.52	75.39	77.58	74.46	80.92	79.68

According to WQI values obtained for different samples surface water quality in general is in Good category throughout the study area.

3.6 Land use/ Land cover

The land use/ land cover pattern of the study was interpreted from latest satellite data and the classified land use/ land cover categories interpreted. Nearly half of the area (48.97%) of the study area is comprised of agricultural fields and settlements. Forests constitute 12.47% of the area. A detail of the area under different land use in the study area is given in table below.

S. No.	**Land Use/ Land Cover**	**Area (Sq km)**	**Area (%)**
1	Forest	8425.54	12.47
2	Scrub	12646.73	18.71
3	Agriculture/ Fallow Land	33098.03	48.97
4	Settlement	356.77	0.53
5	Mining	514.05	0.76
6	Barren Rocky	9679.47	14.32
7	Waterbody	2867.65	4.24
	Total	**67588.25**	

3.7 Forest Types

The project area falls in Kurnool Forest Division of Kurnool Circle under Andhra Pradesh Forest Department. The forests occurring in the study area of Standalone pumped storage component of Pinnapuram IRE Project are classified as per classification given by Champion and Seth (1968). Forest types of study area are under Group 6 - Tropical Thorn Forest type and belong to Subgroup 6A/C1, 6A/DS1 and 6A/DS2.

3.8 Floristics

3.8.1 Taxonomic Diversity

During the field surveys an inventory of 133 species of flowering plants belonging to different plant groups was compiled. This list includes 50 species of trees, 28 species of shrubs and 55 herbaceous species. Most of the vegetation is found mainly in the forest area, along and nearby the crop fields, as weeds of the agricultural fields and nearby the roads, etc. wherever little moisture is available. Trees are found mainly as plantations in the forest area. Dominant families in the area are Fabaceae, Malvaceae and Asteraceae followed by Sterculiaceae, Rubiaceae and Verbenaceae.

Pteridophytes are very scarce. These are mainly species like *Adiantum capillus-veneris, Adiantum caudatum, Pteris biaurita* and *Dryopteris cocheiata*. Among byryophytes only Riccia discolor and Plagiochasma sp. which can be seen occasionally only after rains.

3.8.2 Density, Diversity and Dominance

The density of trees varied from site to site depending upon elevation, land use pattern and the extent of area subjected to road construction in the area. The overall tree density throughout the study area ranged from minimum of 120 number of trees/ha to maximum of 240 trees/ha. The shrub layer was quite prominent at all sampling sites and the density of shrub layer varied from 1800 plants/ha to 3520 plants/ha, lowest density was found at sites located near Undulla village and highest at sampling site located near Gorakallu village. The density of herbaceous plant species varied from season to season amongst all sampling sites. In monsoon season herb density is highest at all sampling site.

Amongst the trees the diversity Index ranged from low of 1.33 at sampling site V7 (near Gorakallu village) to highest of 2.03 at sampling site V3 (near Kalava village). For shrubs the highest diversity was recorded at sampling site V2 (near proposed lower reservoir area) i.e. 2.27 and lowest at sampling site V7 located near Gorakallu village (1.75). The species diversity in herbs was observed higher during pre-monsoon period and varied from 2.00 (site V2) to 2.75 (site V6) at different sampling location. During winter diversity index varied from low of 1.91 at Site-V7 to 2.05 at Site-V5. During monsoon highest diversity value 2.25 was recorded from site V3 and lowest 1.92 was recorded from site V7.

Based upon the Importance Value Index (IVI) the trees in the project area given in table below species like *Azadirachta indica, Bauhinia racemosa, Holoptelia integrifolia*, and *Ziziphus mauritiana* are most dominant trees in the project area. *Azadirachta indica* is generally found in association with *Bauhinia racemosa.*

3.8.3 RET Species

The conservation status (Rare, Endangered and Threatened) of all 133 species of plants recorded from the study area was assessed. Their conservation status following IUCN Red list of Threatened Species Version 2018.1 downloaded from www.iucnredlist.org on 04 September 2018 is listed in table below. *Borassus flabellifer* is listed under Near Threatened (NT) category, *Chloroxylon swietenia* and *Jacaranda mimosifolia* in Vulnerable (VU) category, *Gardenia gummifera* and *Wrightia tinctoria* are under Low risk/least concern (LR/lc) category. 11 species reported from the area are under Least Concern (LC) category.

3.9 Faunal Elements

3.9.1 Mammals

During the surveys 4 mammalian species viz; *Lepus nigricollis* (Common Hare)*, Herpestes auropunctatus* (Small Indian Mongoose), *Semnopithecus entellus* (Grey Langur) and *Macaca radiata* (Bonnet monkey) were sighted in the study area (**Table 4.41**). According to the list prepared based upon secondary data 21 species of mammals are reported from the area.

3.9.2 Avi-fauna

23 species of birds were recorded during field survey. House sparrow, Jungle Babbler, crow, Common Myna, Red-wattled Lapwing and Cattle Egret were most frequently sighted bird species in the study area. A total of 47 species of bird species belonging to 16 Orders and 30 families was compiled based upon sighting as well as secondary data.

3.9.3 Insects and Butterflies

The insects including butterflies are common in the area are sighted throughout the study period. The presence of the insects was abundant in post monsoon and pre-monsoon season however their availability was less in winter months.

Total of 13 species of butterflies belonging to 5 families were recorded from the surroundings of proposed project area. Nymphalidae family was represented by 5 species followed by Lycaenidae, Libellulidae, Papilionidae and Pieridae respectively. Among the butterflies, Indian Large Cabbage White (*Pieris brassicae*), Plain Tiger (*Danaus chrysippus)* and Blue Pansy (*Precis orithya)* were most frequently sighted speices in the study area.

3.9.4 Herpetofauna

The herpetofauna were sampled on the same transects marked for mammals. The sampling also carried along river banks and the sampling was repeated during evening following the time constrained Visual Encounter Rates (VES) method. Varanus, Garden lizard, Chameleons and skinks are commonly sighted species in the area.

3.9.5 Threatened & Endangered Fauna

Only two of the mammals in the study area fall under the category RET fauna. *Cuon alpinus* (Wild Dog) is falls under Endangered (EN) category as per IUCN Red list of Threatened Species. Version 2018.1

According to WPA (1972) *Antilope cervicapra* (Black Buck) is Schedule-I species reported from the area. Six species fall under Schedule-II, and one species under Schedule-III. Among rest of the species two are under Schedule-IV and 11 under Schedule-V.

Among the avifaunal species *Ephippiorhynchus asiaticus* is reported under Near Threatened (NT) category of IUCN Red list of Threatened Species. Version 2018.1, rest of the species fall under Least Concern category of IUCN. As per the Wildlife (Protection) Act 1972 two bird species falls under Schedule I viz. Black-shouldered Kite and Indian Peafowl.

3.10 SOCIAL ENVIRONMENT

3.10.1 Socio Economic Profile of the Study Area

The Study Area for the collection of data on socio-economic status has been delineated as the area within 10 km radius of the main project components like proposed reservoir area, powerhouse, muck dumping site etc. Study area consists of 5 tehsils (Mandal), of which 2 are i.e. Midthuru and Orvakallu of Kurnool division and remaining 3 are i.e. Panyam, Gadivemula and Banganapalle of Nandyal division of Kurnool district.

Total households in study area tehsil are 67815. The total population of study area is 295279, of which 148980 are male and 146299 are female. Sex ratio in study area is 982 females per 1000 males. Nearly 18.21% of the population of the Kurnool district area belongs to Scheduled Castes, while the population of Scheduled Tribes is only 2.04%. In study area, 18.4% and 3.4% of the total population belongs to Scheduled Castes and Scheduled Tribes, respectively.

Average literacy rate in in Kurnool district is 60.4% of which 72.9% are males and 51.8% are females. The total literacy rate in the tehsils falling under study area is 62.4%, with 72.9% males and 51.8% females.

51.4% of the total population of study area is working population. Of this working population 88.6% are main workers and 11.4% are marginal workers. 48.6% of the total population of the study area population is considered as non-workers.

4 ASSESSMENT OF IMPACTS

4.1 Impacts during Construction Phase

Majority of the environmental impacts attributed to construction works are temporary in nature, lasting mainly during the construction phase and often do not extend much beyond the construction period. However, as the construction phase of the Project is large and extend into 3 years, if these issues are not properly addressed, the impacts can continue even after the construction phase for longer duration. Even though the impacts due to construction are temporary in nature, they need to be reviewed closely as they could be significant due to the nature and intensity of the impacts.

4.1.1 Impacts due to immigration of Construction Workers

At the time of peak construction work in the project, around 2000 persons may be engaged, Out of 2000 the majority of about 1100 nos (800 will be labour and 300 will be Technical) will be from the local population/surrounding Villages and balance persons about 900 (600 will be labour and 300 will be technical) will be migrate from other area. All the local persons will up/down from their home only. Only the migratory manpower i.e. about 1200 will stay at site camp only. Immigration of such a large population for a long duration in remote area can cause serious impact on various environmental resources including socio-economic profile of local population.

The congregation of large number of construction workers during the peak construction phase is likely to create problems of sewage disposal, solid waste management, tree cutting to meet fuel requirement, etc. Appropriate mitigating measures have been suggested in EMP, which needs to be implemented to minimize such impacts. This population is expected to reside in the project area at any given time.

4.1.2 Construction of Main Project Components

Construction work is required for the construction of following main project components:

- Rockfill embankments varying from 12 to 14m with maximum of 33m height in lower reservoir and 35m height in upper reservoir for very short reach creation of Pinnapuram upper & lower reservoir with 1.20 TMC live storage capacity
- 45m RCC Intake structure. 56m high concrete power block
- Power Intake Structure
- 5 nos. of 760 m long and 7.0m dia. inclined circular steel lined Penstock tunnel /Pressure Shaft each for each unit of 200 MW
- 1 no 760m long and 7.0m dia. inclined circular steel lined Penstock tunnel/ Pressure shaft bifurcated to 2 penstocks to feed 2 units of 100 MW
- A surface Power house having an installation of five nos. reversible Francis turbine each of 200 MW capacity (2 units of fixed speed and 2 units of variable speed turbines) and two nos. reversible Francis turbine each of 100 MW capacity (1 unit of fixed speed and 1 unit of variable speed turbines) operating under a rated head of 119.27m in generating mode and 125.77m in pumping mode.
- 70m wide concrete lined Tail race channel with Full Supply Depth (FSD) of 6.00m and 1300m long connecting Tail race channel to the lower reservoir.

For construction of main project components major activities are excavation and concreting. Excavation will have impact in terms of muck generation. Excavation and concreting process will require use of various construction equipments such as batching plants, aggregate processing plants, dumper trucks, excavators, dozers, shotcrete machines, jack hammers, generators, pumps, etc leading to generation of pollution in terms of emissions, wastewater, noise and solid waste.

4.1.3 Operation of Construction Plant and Equipment

During the construction phase, various types of equipment will be brought to the site and construction plants and repair workshops will be set up. These include crushers, batching plant, drillers, earth movers, rock bolters, etc. The siting of these construction equipments would require significant amount of space. In addition, land will also be temporarily acquired, i.e. for the duration

of project construction; for storage of the quarried material before crushing, crushed material, cement, steel, etc.

The siting of these construction plant/equipments would require clear piece of land. About 10.5 ha has been estimated for the contractors activities and colony. Proper siting of these facilities will reduce the impact due to their location. Their locations have been identified, keeping in view the technical and economic criteria; however, same can be further refined during set up, keeping in view:

- Proximity to the site of use
- Sensitivity of forests in the nearby areas
- Wildlife, if any, in the nearby area
- Proximity from habitations
- Predominant wind direction
- Natural slope and drainage

Such activities are planned on private and government land and completely avoiding the forest area; to minimize the impacts of tree cutting. Land will be restored once the project construction is complete.

4.1.4 Muck Disposal

The construction would involve about **9.73 Mcum** of soil and rock excavation. About **7.61 Mcum** of excavated muck is expected to be utilized for rockfill and aggregate for construction. Total quantity of muck proposed to be disposed in designated muck disposal area, after considering 40% swelling factor would be **2.97 Mcum**. This muck would requires disposal, with minimum environment impacts. Muck, if not securely transported and dumped at pre-designated sites, can have serious environmental impacts, such as:

- Can be washed away into the natural water bodies which can cause negative impacts on surface and ground water quality.
- Can lead to impacts on various aspects of environment. Normally, the land is cleared before muck disposal. During clearing operations, trees are cut, and undergrowth perishes as a result of muck disposal.
- In many of the sites, muck is stacked without adequate stabilisation measures. In such a scenario, the muck moves along with runoff and creates soil erosion like situations.
- Normally muck disposal is done at low lying areas, which get filled up due to stacking of muck. This can sometimes affect the natural drainage pattern of the area leading to accumulation of water of some area which can provide ideal breeding habitat for mosquitoes.

A detailed Muck Disposal Plan has been prepared to minimize the impact and is given in Environmental Management Plan.

4.1.5 Road Construction

A network of roads would be required to approach various project components for construction, operation and maintenance. It has been assessed that about 7.2 km length of new road is required to be constructed to access the power house from the lower reservoir and Upper reservoir. The total land required for the construction of new road is 10.76 ha.

The major impacts likely to accrue as a result of construction of the roads are:

- Loss of forest and vegetation by cutting of trees
- Geological disturbance due to blasting, excavation, etc.
- Soil erosion as the slope cutting operation disturbs the natural slope and leads to land slips and landslides.
- Interruption of drainage and change in drainage pattern
- Disturbance of water resources with blasting and discriminate disposal of fuel and lubricants from road construction machinery
- Effect on flora and fauna
- Air pollution due to dust from debris, road construction machinery, etc.
- Noise generation due to construction activities

The indirect impact of the construction of new roads is the increase in accessibility to otherwise undisturbed areas, resulting in greater human interference and subsequent adverse impacts on the ecosystem. Appropriate management measures required to mitigate adverse environmental impacts during road construction have been recommended.

4.1.6 Impact due to Acquisition of Land

For the development of Standalone Pumped storage component Pinnapuram IRE Project, land would be required for construction of project components, reservoir area, muck dumping, construction camps and colony, etc. Total land required for the construction of proposed activities is approximately 713.65 ha. break up of land required for different components is given below.

Land requirement for Standalone Pumped storage component of **Pinnapuram IRE Project**

Sl. no.	Components	Total Area (Ha)	Forest Land Area (Ha)	Non-Forest Land Area (Ha)	
				Pvt	Govt/Assigned
1	Upper Reservoir	280.17	0.00	107.00	173.17
2	Intake Structure	10.61	8.02	0.00	2.59
3	Penstock	6.96	6.96	0.00	0.00
4	Power House & TRC Outlet	22.50	22.50	0.00	0.00
5	Tail Race Channel	16.83	2.43	0.48	13.92
6	Lower Reservoir	319.02	319.02	0.00	0.00
7	Pot Head Yard	0.25	0.00	0.00	0.25
8	Proposed roads: from Lower Reservoir to Power House (PH), PH to Upper Reservoir	10.76	6.73	0.00	4.03
9	Contractor facilities, cement and E&M stores, Temporary colony area.	10.50	0.00	4.93	5.57
10	Muck disposal areas	21.00	0.00	7.24	13.76
11	Pumping & Other facilities	15.00	0.00	0.00	15.00
12	Magazine	0.05	0.00	0.00	0.05
	TOTAL	**713.65**	**365.66**	**119.65**	**228.34**

Major impact of land acquisition is permanent change of landuse, which is unavoidable. Additionally, land acquisition has impacts on local population by way of loss of their agriculture land and hence livelihood and also impact on flora and fauna by way of loss of forest land and clearing of vegetation on acquired land. These impacts will be mitigated by implementing Landscaping Restoration and Green Belt Development Plan and Biodiversity Conservation and Wildlife Management Plan, as discussed in EMP.

4.1.7 Impact on Water Quality

Sewage from Construction worker Camps

The disposal of untreated sewage can lead to water pollution, resulting in increase in coliforms and other various pathogens, which can lead to incidence of water borne diseases. Therefore, project authorities would be taking appropriate measures to check such disposal into the natural water bodies. In order to avoid any deterioration in water quality due to disposal of untreated sewage from labour camps, appropriate sewage treatment facilities will be commissioned in the labour camps.

Effluent from Construction Plants and Workshops

Discharge of untreated wastewater will adversely affect the water quality of receiving water body. Turbidity and oil & grease levels will increase substantially in small tributaries, especially, in lean season. To minimize the impact, such effluent needs to be treated in situ before discharge to any water body or for land application.

Disposal of Muck

The project authorities have identified suitable muck disposal sites which are located near the Upper Reservoir area. The muck will essentially come from the tunneling, road-building activity, and other excavation works. The unsorted waste going into the channel may contribute to the turbidity of water continuously for long time periods. The high turbidity is known to reduce the photosynthetic efficiency of primary producers in the water and as a result, the biological productivity will be reduced.

4.1.8 Impact on Terrestrial Flora

Impact on the flora in and around the project area would be due to increased level of human interferences. The workers may also cut trees to meet their requirements for fuelwood, construction of houses, furniture. Normally in such situations, lot of indiscriminate use or wastage of wood is also observed, especially in remote or inaccessible areas. Thus, it is necessary to implement adequate surveillance to mitigate the adverse impacts on terrestrial flora during project construction phase.

4.1.9 Impact on Terrestrial Fauna

Disturbance to Wildlife

During the construction period, 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 equipments 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 the construction phase, accessibility to area will lead to influx of workers and the people associated with the allied activities from outside will also increase. Increase in human interference could have an impact on terrestrial ecosystem.

The other major impact could be the blasting to be carried out 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 the noise level and vibrations due to blasting to a great extent.

4.1.10 Impact on Noise Environment

Sources of noise will be the vehicles and equipment for excavation and stationary equipment, including concrete batch plant located at the construction sites. Other sources of noise will be the use of explosives for blasting purposes for construction activities, drilling machines and quarrying and crushing activities.

4.1.11 Impact on Air Quality

In general, Pumped storage projects do not affect the air quality in a significant manner. The sources and activities that might affect air quality in the project area are vehicular traffic, dust arising from unpaved village roads and domestic fuel burning. The air environment around project site is free from any significant pollution source. Therefore, ambient air quality is quite good in and around the project area.

4.1.12 Traffic Analysis

Traffic analysis is carried out by understanding the existing carrying capacity of the roads near to the project site and the connecting main roads in the area. Then depending on the capacity of the muck generation, the number of trucks that will be added to the present scenario will be compared to the carrying capacity.

4.1.13 Impact on Socio-economic Environment

a) Positive Impacts on Socio-Economic Environment

The following positive impacts are anticipated on the socio-economic environment of the local people of villages of project area during the project construction and operation phases:

i) A number of marginal activities and jobs would be available to the locals during construction phase.
ii) Developer bringing large scale investment to the area will also invest in local area development and benefit will be reaped by locals. Education, medical, transportation, road network and other infrastructure will improve.
iii) The availability of electricity in the rural areas will reduce the dependence of the locals on alternative energy sources namely forest.
iv) With increased availability of electricity, small-scale and cottage industries are likely to come up in the area.
v) The proposed project site is well connected by road. Efforts to be made to develop eco-tourism, which could earn additional revenue.

b) Negative Impacts on Socio-Economic Environment

Such projects, in addition, to positive impact on socio-economic environment may also bring certain negative impact due to influx of outside population. Workforce will reside in that area for around three years and also there will be influx of drivers and other workers on temporary basis. This influx of people in otherwise isolated area may lead to various social and cultural conflicts during the construction stage. Developers need to take help of local leaders, Panchayat and NGOs to ensure minimum impact on this count.

c) Increased incidence of Diseases

Large scale activity in the area due to the proposed project may become a cause of spread different types of diseases in the project area due to following reasons:

- Project requires long-term input of labour from outside the area.
- Project requires that significant numbers of project employees be separated from their families for long periods of time
- Project involves the creation of large, temporary construction camp(s).

4.2 Impacts during Operation Phase

On completion of the construction of the project, the land used for construction activities will be restored. Construction workers who have resided in that area will move to another project site. By ensuring all the mitigation and management measures, as planned for this project, are implemented to minimize the impact of construction phase, large part of the area will go back to its original form. However, there will be some permanent changes such as reservoir formation, powerhouse and project colony. The project is planned as a clean source of renewable energy as there are no significant pollution generation during project operation. There is no air and water pollution from the project operation. Similarly generation of solid and hazardous waste is also insignificant.

Other impacts of the construction phase include formation of reservoir impacting the water quality, pollution generation from colony and plant and positive as well negative impacts on socio-economic environment mainly due to improved infrastructure in the area.

Proposed pumped storage component of Pinnapuram IRE project is not planned on any natural water body/river; the project will create artificial upper and lower reservoirs and water will remain in circulation from upper to lower during power generation and vice versa during non-generation hours on daily basis. Reservoir water requirement will be met once and thereafter only small quantity will be added to compensate for evaporation losses/leakages. Therefore, no direct impact on natural water bodies during operation are envisaged.

During the operation phase, due to absence of any large scale construction activity, the cause and source of water pollution will be much different. Since, only a small number of O&M staff will reside in the area in a well-designed colony with sewage treatment plant and other infrastructural facilities, the problems of water pollution due to disposal of sewage are not anticipated. The treated sewage will be reused for gardening and green belt around the colony.

5 ENVIRONMENTAL MANAGEMENT PLAN

5.1 Biodiversity Conservation & Wildlife Management Plan

Keeping in view of the anticipated impacts, the main objectives of biodiversity conservation and wildlife management plan are as follows:

i. Maintenance of ecological balance through preservation and restoration of wherever it has been disturbed due to project developmental activities,
ii. Conservation and preservation of natural habitats in catchment and project area
iii. Rehabilitation of critical species (endangered, rare and threatened species), with provisions for In-situ or Ex-situ conservation,
iv. Mitigation and control of project induced biotic and/or abiotic pressures/ influences that may affect the natural habitats,
v. Habitat enhancement in project area and catchment area by taking up afforestation and soil conservation measures,
vi. Creating all round awareness regarding conservation and ensuring people's participation in the conservation efforts and minimizing man-animal conflict like human-wild dog; human-elephant etc.

Following are the measures suggested for the said plan:

i. Wildlife Habitat Preservation & Improvement
ii. Establishment of Eco Park
iii. Sowing of Grass
iv. Biodiversity monitoring
v. Awareness promotion
vi. Strengthening of Infrastructural Facilities of Forest Department
vii. Biodiversity Management Committee (BMC)

The estimated cost of implementation of various activities envisaged in the Biodiversity Conservation and Management Plan would be **Rs. 310.00 lakh**.

5.2 Muck Dumping Plan

The project would generate substantial quantity of muck from excavation of various structures. The total quantity of muck likely to be generated from excavation including construction of roads is about **9.73 Mcum**. However after the utilization of muck for different project components and also considering the swell factor total estimated quantity to be disposed of is about **2.97 lakh cum**. For the disposal of 2.97 MCum of muck an area of 21 Ha has been identified. Total capacity of these sites is about **3.29 Mcm**.

The estimated cost of the relocation and rehabilitation of excavated material will be **Rs. 480.85 lakhs.**

5.3 Solid Waste Management Plan

The project authority shall, within the territorial area of the project complex/ colony, be responsible for the implementation of the provision of Solid Wastes Management. Adequate facilities for collection, conveyance and disposal of solid waste will be developed. Any solid waste generated in the project complex/ project colony/ labour colony, shall be managed and handled appropriately. Various aspects of solid waste management include:

- Reuse/Recycling
- Storage/Segregation
- Collection and Transportation
- Disposal

The total budget in order to manage the solid waste generated from the construction camp/colony, and also during operation phase has been proposed to **Rs. 201.16 lakh.**

5.4 Public Health Delivery System

Medical services at secondary level play a vital and complimentary role to the tertiary and primary health care systems and together form a comprehensive district based health care system. Following activities are proposed:

- Ambulance: 2 no. with all the basic Medicare facilities and small DG set, etc. to cater for villages in the project area.
- Budget for running the ambulances including driver, fuel and maintenance for 3 years
- First aid posts including sheds, furniture and basic equipment.
- Budget for running the first aid post including cost of medico, para-medico/Nurses and attendant, consumables, etc. for 3 years.
- Budget for strengthening existing medical facilities.
- Budget for Health Awareness/ Vaccination Camps for 3 years.

Budgetary estimates for public health delivery system to be implemented have been worked out as **Rs. 168.00 lakh.**

5.5 Energy Conservation Measures

With an estimated migrant population of 1200 persons in the area, the existing facilities will become insufficient for supply of kitchen fuel for the migrant population during the construction of the project. Fuel for cooking and space is an essential requirement and in the absence of adequate fuel availability they will resort to tree cutting for use of fuel wood. Therefore, the project authorities would make adequate arrangements such as Community kitchen, Supply of Kitchen fuel, efficient cooking facilities and Solar Lantern.

A total grant of **Rs. 180.00 lakh** has been assigned towards the provision of kitchen fuel, and other facilities including establishment of community kitchen or canteens for the migrant workers.

5.6 Landscaping, Restoration & Green Belt Development Plan

The proposed project would involve construction of artificial reservoirs, power house, residential and staff colonies, roads, batching plants, etc. These activities will result either in the modification or destruction of the existing landscape of the area. It is therefore imperative that after the project work and related activities are over restoration work should be carried out in these disturb areas to bring them back to their similar or near-similar pre-construction conditions and land use.

Green belt development will comprise of plantations at various places like alongside roads, around the periphery of reservoir rim, and at different project offices and colonies.

The estimated cost for the restoration works, landscaping of areas, road side plantations, and creation of green belt around reservoir and colonies and working sites would be **Rs. 167.50 lakh**.

5.7 Compensatory Afforestation Plan

The Pumped Storage component of Pinnapuram IREP is being constructed in the jurisdiction of Kurnool Forest Division in Kurnool district, Andhra Pradesh. The total land required for the construction of proposed project activities is approximately **713.65 ha** with **365.66 ha** of forestland, **119.65 ha** of private land and **228.34 ha** government land.

The Forest Conservation Act, 1980 stipulates strict forest protection measures and procedures (Guide Line 1/08-1 (ii)) for compensatory afforestation on acceptance of diversion of forestland for non-forestry purposes.

i. If non-forest land is not available, compensatory plantation is to be raised on degraded forest land to the extent of twice the affected or lost forest area, and
ii. If non-forest land is available, the extent of compensatory plantation will be equivalent of the affected or lost forest area.

As per the above guidelines plantations are to be taken up in equal extent of Non-forest land of forest land diversion **[365.66 ha]**, it is also proposed to have avenue plantation along the proposed roads with iron guard fencing work around the new plantation with angle iron in the diverted land to maintain the ecological balance of the areas.

The compensatory afforestation is proposed to be undertaken on Non-forest land identified in consultation with the State Forest Department and District administration. The estimated cost of Compensatory Afforestation programme with cost of non-forest land acquired for afforestation programme is **Rs. 7879.71 lakh**.

Total forest land requirement for diversion for non-forest use i.e. for the construction of proposed project activities is **365.66 ha**. As the forest in the project area fall in the **Eco Class IV** as being of type **Consisting of Tropical Thorn Forests and Tropical Dry Evergreen Forests** therefore NPV @ Rs. 6.26 lakhs/ha would be required to be deposited in the Compensatory Afforestation Fund. The total cost of NPV has been computed as **Rs. 2289.03 lakh**.

The total cost of the compensatory afforestation plan, NPV, compensation of trees and cost of damage to fence and infrastructure is **Rs. 10168.84 lakh.**

5.8 Air & Water Management Plan

Various mitigation and management measures have been planned to reduce the impacts of air, noise and water pollution and implement safety measures to ensure that impacts on these counts are reduced to minimum possible during the entire construction phase. To implement such measures, it is important to prepare a budget of such measures and include in the project cost so that lack of fund should not constrain their implementation.

Some of the measures suggested have been covered under other heads of environmental Monitoring plan.

5.9 Environmental Monitoring Plan

Monitoring shall be performed during all stages of the project (namely: construction and operation) to ensure that the impacts are no greater than predicted, and to verify the impact predictions. The monitoring program will indicate where changes to procedures or operations are required, in order to reduce impacts on the environment or local population. The monitoring program for the proposed project will be undertaken to meet the following objectives:

- To monitor the environmental conditions of the project area and nearby villages;
- To check on whether mitigation and benefit enhancement measures have actually been adopted and are proving effective in practice;

A sum of **Rs. 163.20 lakh** has been allocated to implement various activities and programmes envisaged under EMP.

5.10 Corporate Environment Responsibility (CER)

Greenko Group is committed to sustainable development at all its facilities and work to the satisfaction of all stakeholders through Corporate Environment Responsibility (CER) Policy. The aim of CER Plan is to improve the quality of life of our neighborhood communities through equitable and proactive smart initiatives in spheres of education, health, rural development, environment and livelihoods resulting in improvement of the overall local social, economic and environmental conditions.

A total grant of **Rs. 1053.50 lakh** has been assigned for implementing the various activity and program envisaged under CER activities in project affected and surrounding villages

5.11 Cost Estimates of EM P

An amount of **Rs. 12893.05** lakh has been allocated for the implementation of different environmental management plans. The summary of total cost estimates for the execution of different plans is given in table below.

S. No.	Management Plans	Amount (Rs. in lakh)
A	**Environmental Management Plan**	
1	Biodiversity Conservation & Wildlife Management Plan	310.00
2	Muck Disposal and Management Plan	480.85
3	Solid Waste Management Plan	201.16
4	Public Health Delivery System	168.00
5	Energy Conservation Measures	180.00
6	Landscaping, Restoration & Green Belt Development Plan	167.50
7	Compensatory Afforestation & NPV*	10168.84
8	Air & Water Management Plan**	163.20
	Environmental Monitoring Program	
	Total EMP Cost	**11839.55**
B	Corporate Environment Responsibility (CER)	1053.50
Grand Total (A+B)		**12893.05**

**Actual cost of Compensatory Afforestation will be finalized by forest Department*.

***Cost of Air, Water & Noise Management Plan is given in Environmental Monitoring Plan*