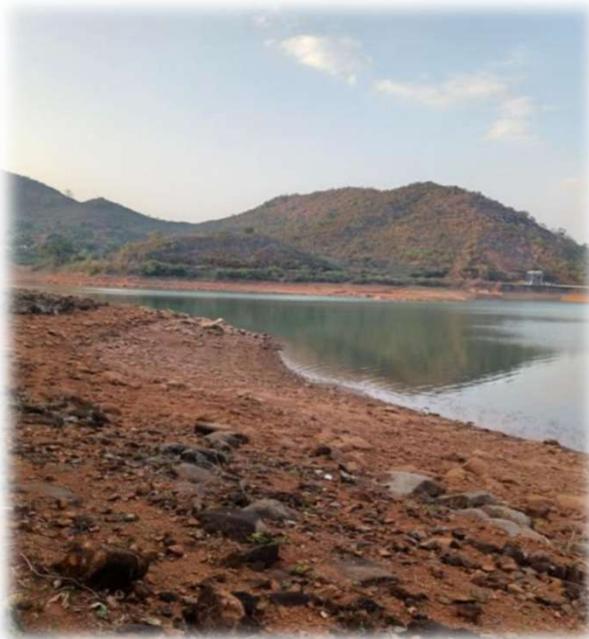




ODISHA HYDRO POWER CORPORATION LIMITED (OHPC)

(A Government of Odisha Undertaking)



ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDY FOR UPPER INDRAVATI PUMPED STORAGE PROJECT (4X150MW), MUKHIGUDA, ODISHA

EXECUTIVE SUMMARY



(भारत सरकार का उपक्रम)

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EXECUTIVE SUMMARY

1. INTRODUCTION

The Upper Indrāvati Hydro-Electric Project (UIHEP) is a large multipurpose project on the Indrāvati River, which spreads over Kalahandi, Koraput and Nabarangpur Districts of South-Western Odisha. The Power house of UIHEP is located near Mukhiguda village in Kalahandi District. The Indrāvati River is one of the major tributaries of the river Godavari. The river originates at an elevation of 914m from MSL at the western slopes of the Eastern Ghats in Thuamula Rampur (Kalahandi District), Odisha.

To harness the hydro power potential of Indravati Reservoir, a 600 MW capacity Hydro Electric Project already constructed and is in operation. The existing HEP is capable of producing average annual energy output of 1,962 MU.

Now, OHPC has planned to construct 600 MW Upper Indravati Pumped Storage (UIPSP) utilising the existing Indravati reservoir as upper reservoir and new lower reservoir will be constructed near Ranibahal village around 0.5 KM away from the existing Upper Indravati Power House at Mukhiguda. The proposed Upper Indravati Pumped Storage Project (PSP) will utilise the existing Indravati reservoir as upper reservoir and a lower reservoir will be constructed, which will store water for pumping it to upper reservoir in a closed cycle operation.

M/s. WAPCOS Ltd. has been appointed as a consultant to prepare the Detailed Project Report (DPR) and Environmental Impact Assessment (EIA) & Environmental Management Plan (EMP) report for Upper Indrāvati Pumped Storage Project” (UIPSP).

The key objective of the EIA-EMP study is to assess the positive and negative impacts that likely to accrue as a result of the construction and operation of the proposed Upper Indrāvati Pumped Storage Project” (UIPSP).

A suitable Environmental Management Plan (EMP) has been suggested to ameliorate the adverse impacts and enhance the positive impacts. A well-designed environmental monitoring programme covering various critical parameters in the project construction and operation phases are also suggested.

2. PROJECT DESCRIPTION

2.1 Project Features

The proposed Upper Indrāvati Pumped Storage Project comprises the following components:

- Power Intake (EL 644.0 m) near the existing intake structure of UIHEP
- 2.392 km long & 8 m dia. Head Race Tunnel (HRT).

- Circular surge shaft with Restricted Orifice type OTC (17 m diameter upto EL 642 m and 25 m diameter upto EL 675 m).
- 2 No. steel lined pressure shafts of each bifurcating to two number unit PS, near the Power House.
- Diameter of each pressure shaft shall be 4.75 m, each bifurcating into two number of 3.36 m Dia Unit PS, near Power House
- Length of Pressure Shaft of 4.75 m diameter, shall be 1043 m and length of 3.36 m diameter pressure shaft shall be 43 m.
- Underground Power House of size 158.525 m (L) x 22 m (W) x 48.20 m (H) to house 4 Nos. generating units of 150 MW each for generation of 600 MW
- Underground Transformer Hall of size 142.025 m (L) x 19m (W) x 27 m (H) located 50 m downstream of the power House with GIS Hall above
- Circular (steel/RCC lined) Draft tube tunnel with 4.5 m diameter and 65 m length
- Circular (PCC & RCC lining) Tail Race Tunnel (TRT) with a total length of 415.4 m
- Diameter of TRT shall vary 4.0 m (127.5 m length), and 5.7 m diameter (164.1 m length)
- Lower dam as rockfill embankment dam with clay core, with a length of 530 m, height of 27.5 m and width varying from 530 m to 534 m.
- Lower Reservoir with a gross storage capacity of 4 MCM and live storage of 3.78 MCM.
- Straight two bell mouth intake converging into TRT.
- Diameter of tail race tunnel at pump intake is 8 m with top deck level at EL 302 m.

The salient features of Upper Indrāvati Pumped Storage Project (UIPSP) are outlined in Table-1 and the project layout map is enclosed as Figure-1.

Table-1: Salient Features of Upper Indrāvati Pumped Storage Project (UIPSP)

RIVER BASIN	NAME	<p>River Indrāvati and its Tributary form an integrated reservoir by construction of four dams and eight dykes.</p> <p>1.Indrāvati Dam : Height : 45m Length : 539m Type: Masonry Gravity Dam with central gated spillway having four nos. of dykes each on the left and right bank</p> <p>2.Podagada Dam : Height : 57.5m Length : 462m Type: Homogeneous Rolled Earth Dam without spillways</p> <p>3.Kapur Dam Height : 64m Length : 537m Type: Homogeneous Rolled Earth Dam without spillways on Kapur Nalla</p> <p>4.Muran Dam Height : 65m Length : 494m Type: Masonry Gravity Dam with central gated spillways on Muram river</p>
LOCATION OF HEAD WORKS		
	Longitude	82° 52.198' E
	Latitude	19° 23.267' N
INSTALLED CAPACITY	MW	600 MW (4 units X 150MW each)
Annual Energy FIRM	MU	1040

UPPER RESERVOIR		
	Live storage capacity (Mm ³)	1455.76
	Spread area(sq. Km)	110
	FRL (m)	El.642.0
	MDDL (m)	El.625.0
POWER INTAKE		
	Shape	Circular With Bell Mouth Intake
	Type	Submerged
	Top deck level (m)	EL.644.00
	FRL (m)	EL.642.00
	MDDL (m)	EL.625.00
BELLMOUTH INTAKE	Centre line	EL.616.0
	Invert level at Bell mouth intake	EL.613.5
Service Gates: Two (2) vertical lift fixed wheel type service gates for two openings of size 5.03m x 5.00 m each.		
Emergency Gates: Two (2) vertical lift fixed wheel type emergency gates for the openings of size 5.03m x 5.00m each.		
TRASH RACK STRUCTURE		
	No. of bays	Eight
	Total height	18.5 metres
	Total width	38.5 metres
HEAD RACE TUNNEL		
	Nos	1
	Shape	Circular
	Length(m)	2392
	Dia. (m)	8.0

	Thickness of lining (m)	0.5 /0.75
	Design discharge (cumec)	EL.210.00
	Centre line at inlet (m)	EL614.50
	Centre line – junction with surge shaft (m)	EL 572.50
	Flow type	Pressure Flow
	Slope	1 IN 56.9
SURGE SHAFT		
	Type	Circular With Restricted Orifice & Open to Sky
	Diameter(m)	17.00
	Height above invert m)	113.5
	Top level/Deck level (m)	677
	Max. up surge (m)	675
	Min. down surge (m)	584.85
	Orifice dia. (m)	3.5
Gates: Two [2] slide type, vertical lift gates are proposed for two openings (3.37 m X 7.52 m) of pressure shaft emerging from surge shaft		
PRESSURE SHAFT STEEL LINER /PENSTOCK		
	Number	Two Numbers Each Bifurcating Near The PH
	Diameter (m)	4.75 Dia. Each Bifurcating into 3.36 Dia. Each
	Length (m)	1043 (4.75 Dia.) & 43 (3.36 Dia.)
POWER HOUSE	Type	Under Ground
Unit spacing	m	24.00

Dimension /size of ph	m x m x m	158.525 (L)*22 (W)*48.20 (H)
Turbine / runner at ph	Centre line (m)	EL.242.00
INSTALLED CAPACITY	MW	150*4 UNITS =600MW
Max. Gross head	m	EL.357.0
Min. Gross head	m	EL.325.0
Average Gross head	m	EL.341.00
System Head Loss	m (Pump mode) m (Generation mode)	5.75 8.61
POWER FACTOR		0.9
TURBINE	Type	Francis–Reversible-Vertical Shaft
	Nos.	4
Turbine Discharge	Cumec	50.68
Net max. head	m	EL.351.0
Net rated head	m	EL.335.0
Net min. head	m	EL.319.0
Efficiency of Turbine		0.92
Efficiency of Generator		0.98
TRANSFORMER CAVERN	m x m x m	142.05 (L)*19 (W)*27 (H)
DRAFT TUBE TUNNEL	Type	Circular (Steel Line)
	Dia.(m)	4.5
	Length (m)	65.0 approx.
Gates: Four slide type bonneted gate (one for each opening) for a clear vent opening of 3.6m x 4.5m		
TAIL RACE TUNNEL	Type	Circular

	Dia. (varies)	4.0 / 5.7 / 8.0
	Length (m)	216
Water Levels	FRL.(m)	EL.300.0
	Min. /MDDL(m)	EL.285.0
PUMP		
Pump discharge	Cumec / unit	38.66
Net max. head	m	EL.363.0
Net rated head	m	EL.347.0
Net min. head	m	EL.331.0
Efficiency of Pump		0.92
PUMP INTAKE		
	Shape	Circular With Bell Mouth Intake
	Type	Submerged
	Dia. of tail race tunnel at pump intake(m)	8.0
	Top deck level (m)	EL.302
	FRL (M)	EL.300.0
	MDDL (M)	EL.285.0
Service Gates: Two (2) vertical lift fixed wheel type service gates for opening of size 5.03m x 5.0m		
Emergency Gates: Two (2) vertical lift fixed wheel type emergency gates for opening of size 5.03m x 5.0m		
TRASH RACK STRUCTURE		
	No. of bays	Eight
	Total height	18.5
	Total width(m)	38.50
	Top deck level (m)	302.00
LOWER RESERVOIR		
	Gross storage capacity (Mm ³)	4.0
	Live storage capacity (Mm ³)	3.78

	Reqd. Capacity(Mm ³) for 5 hrs of peak	3.78
	Spread area	At the foothills adjoining the UIHEP by construction of a Rock Fill Embankment Dam (With Clay Core) : Max. Height : 27 m Length : 590 m Varying Width :475m-540m
	FRL(Metre)	El.300
	MDDL (Metre)	El.285
	Top of rock fill embankment dam	El.302
	Average bottom level of reservoir	El.284.4

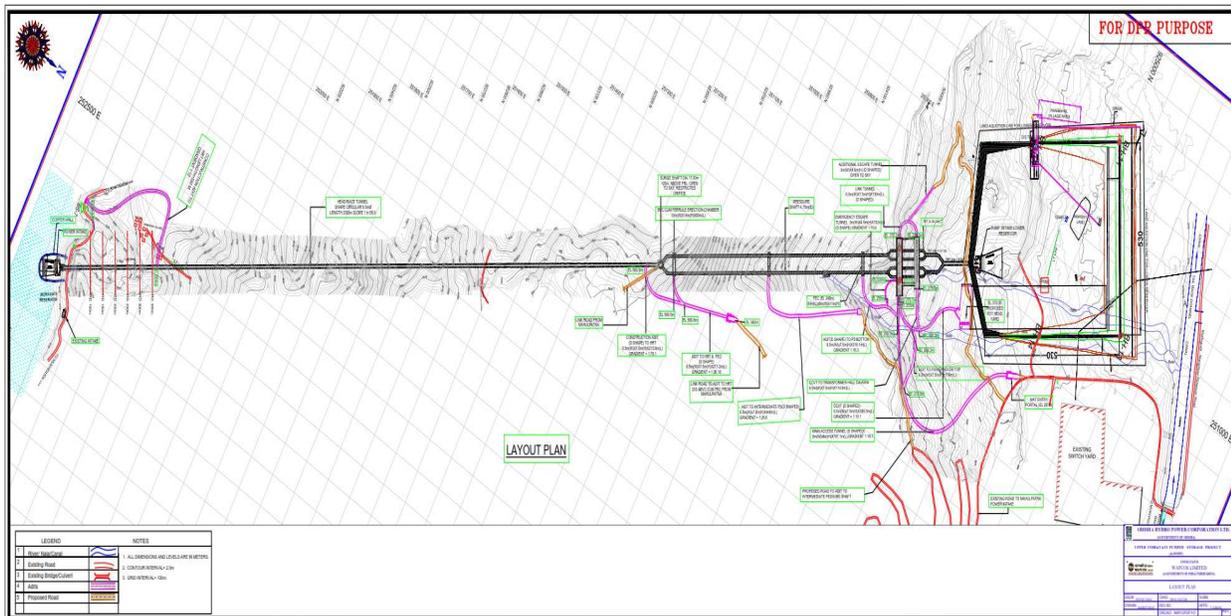


Figure-1: Project Layout Map

2.2 LAND REQUIREMENT

The total land required for the project is 151.927 ha. The details are given in Table-2.

Table-2: Component wise Land requirement for Upper Indravati PSP

S. No	Project Components	RF (ha)	Forest Block (ha)	Revenue Forest (ha)	Total Forest (ha)	Non-Forest (ha)	Total (ha)
I.	Overground Structures						
1.	Area For Proposed Road	0.000	10.518	0.000	10.518	0.000	10.518
2.	Drain, Construction Facility, Emergency Escape, CA, etc.	0.000	4.502	0.000	4.502	0.000	4.502
3.	MAT, Pot, Head Yard, Distribution Sub-Station, etc.	0.000	10.900	0.000	10.900	0.000	10.900
4.	Additional HRT & FEC	0.000	0.247	0.000	0.247	0.000	0.247
5.	Borrow Area	0.774	0.058	0.000	0.832	5.290	6.122
6.	Construction Facility	0.000	1.038	0.378	1.416	5.035	6.451
7.	Construction Facility & Muck Disposal	0.000	16.306	0.000	16.306	1.210	17.516
8.	Labour Colony	0.000	0.000	0.000	0.000	1.020	1.020
9.	Lower Reservoir	0.000	21.139	2.191	23.330	23.288	46.618
10.	Muck Disposal	0.000	4.036	0.000	4.036	6.958	10.994
11.	Proposed Road	0.000	1.473	0.000	1.473	1.530	3.003
12.	Rock Quarry	0.000	13.349	0.000	13.349	0.000	13.349
	Sub – Total (I)	0.774	83.566	2.569	86.909	44.331	131.240
II.	Underground Structures						
13.	Head Race Tunnel	0.000	2.751	0.000	2.751	0.000	2.751
14.	PH, TC, Draft Tube & Others Structures	0.000	4.569	0.000	4.569	0.000	4.569
15.	Power Intake	0.000	0.798	0.000	0.798	0.000	0.798
16.	PS, BVC, FEC, SS, Area	0.000	11.772	0.000	11.772	0.000	11.772

S. No	Project Components	RF (ha)	Forest Block (ha)	Revenue Forest (ha)	Total Forest (ha)	Non-Forest (ha)	Total (ha)
17.	TRT	0.000	0.797	0.000	0.797	0.000	0.797
	Sub-Total (B)	0.000	20.687	0.000	20.687	0.000	20.687
	Total (A+B)	0.774	104.253	2.569	107.596	44.331	151.927

2.3 Construction Programme

It is estimated that the construction works will be completed in sixty (60) months.

2.4 Project Cost

The approximate project cost is about Rs. 3394 crore at July 2024 price level, i.e. about Rs. 5.66 crore/MW.

3. STUDY AREA

The study area covered as a part of the EIA study is given as below (Refer Figure-2):

- Submergence area of Upper and Lower Reservoir
- Area within 10 km of the periphery of the submergence area of Upper and Lower Reservoirs
- Area to be acquired for locating the various project appurtenances
- Area within 10 km of various project appurtenances

5.1 Climate

Meteorologically, the year can be divided into three distinct seasons. Winter season sets in from the month of November and continues upto February, followed by summer season from March to June. The area receives rainfall under the influence of south-west monsoons from mid-June to September. The period from mid-September to October is the post-monsoon season or the retreating monsoon season.

The temperature continuously increases from March up to the month of May, which is the hottest month of the year. The mean maximum and minimum monthly temperatures in the month of May are 44.3°C and 22.5°C respectively.

As per approved CWC Hydrology Report the average annual rainfall at Bhawanipatna rain gauge station found to be 1188.7 mm. Majority of the annual rainfall is received under the influence of south-west monsoons.

The humidity in the air is generally low throughout the year except during the rainy season. The summer months are the driest with relative humidity being as low as 35% to 33% at 17:30 hrs.

5.2 Physiography

Physiographically the district comprises diverse landforms consisting of rugged hill ranges, plateaus, undulating plains dotted with residual hills and mounds and fertile erosional plains and valleys. A gently undulating terrain with a vast stretch of cultivable land characterizes the major west parts in the district. In the undulating plains the general topographic slope is towards northeast. The Indravati River is a tributary of Godavari River and originates from the Sinkharan Hills of Eastern Ghats in Kalahandi district. The dam of upper Indravati Hydro-Electric Project is constructed across Indravati river at an elevation of about 620 m above M.S.L.

5.3 Seismicity

The project lies in Zone-II as per seismic map of India. The horizontal seismic coefficient is 0.06 and the vertical seismic coefficient is 0.04. These values have been used for pseudo-dynamic design analysis for rock fill type of dam. Therefore, a suitable seismic factor needs to be adopted for designing the civil structure in the area.

5.4 Soil Quality

The pH in various soil samples ranged from 7.10 to 7.82 in pre-monsoon season, 7.16 to 7.86 in monsoon and 7.05 to 7.81 in post monsoon season, which indicate that neutral range is having slight alkalinity. The low EC values ranging between 351 – 810 $\mu\text{S}/\text{cm}$ in pre-monsoon season indicate lower salt content in soil. It is an important indicator of soil health as it affects

crop yields, crop suitability, plant nutrient availability, and activity of soil microorganisms. Excess salts in soil hinder plant growth by disturbing the soil-water Balance.

5.5 Surface Water Quality

The pH level in the project area of Indravati Pumped Storage project ranged from 6.57 to 7.72 at various sampling sites in the area of the study. The pH level indicates neutral to marginally alkaline nature of the water. All these values fall within the permissible limit specified for drinking water.

The TDS level ranged from 16 to 50 mg/l, 217 to 315 mg/l and 146 to 216 mg/l in monsoon, pre-monsoon and post monsoon seasons respectively, which are well below the permissible limit of 500 mg/l specified for drinking water. The BOD values are well within the permissible limit, which indicates the absence of organic pollution loading.

5.6 Ground Water Quality

The pH level ranged from 6.62 to 7.33 indicating slightly alkaline nature of the water. The electrical conductivity varied from 370.0 to 632.0 $\mu\text{S}/\text{cm}$ with an average value of 448.5 $\mu\text{S}/\text{cm}$, which is well within the permissible limit of prescribed standard limit (600 $\mu\text{S}/\text{cm}$) as recommended by Indian standard. The TDS level ranged from 144 to 316 mg/l in both seasons. The TDS levels were within the permissible limit of 500 mg/l for most of the samples. The chlorides level ranged from 15 to 63 mg/l in pre monsoon season, from 18 mg/l to 35.98 mg/l in monsoon season and from 20 mg/l to 56 mg/l in post monsoon season. The chlorides level in all groundwater samples were below the permissible limit of 200 mg/l.

5.7 Ambient Air Quality

With respect to ambient air quality, concentrations of PM_{10} , $\text{PM}_{2.5}$, SO_2 , NO_2 and CO were monitored at various 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 standard applicable for rural residential area.

5.8 Noise Levels

The day time equivalent noise level at various sampling stations ranged from 44.33 to 45.90 dB(A), 43.66 to 44.22 dB(A) and 43.91 to 44.81 dB(A) in winter, pre monsoon and monsoon seasons respectively. The noise levels were observed to be well within permissible limits specified for residential area.

5.9 Land Use Pattern

The major landuse category in the study area of Upper Indravati PSP is agriculture area and, as it accounts for about 33.6% of the study area followed by Forest area (32.9%). The area under Low dense vegetation and bare land is 16.6% and 10.5% of the study area respectively. The settlement is sparse in the area. Settlements and Waterbodies account for about 1% and 5.4% of the study area respectively. The landuse pattern of the Study Area is presented in Table-2. The breakup of landuse pattern in study area is depicted in Figure-3.

Table-2: Landuse pattern of the Study Area

S.No.	LULC Category	Area sq (km ²)	% Area Coverage
1	Agriculture Area	139.90	33.6%
2	Bare Earth	43.84	10.5%
3	Built-up	4.07	1.0%
4	Forest	136.98	32.9%
5	Industry	0.12	0.0%
6	Low Dense Vegetation	69.00	16.6%
7	Water bodies	22.61	5.4%
	Total	416.52	100.0%

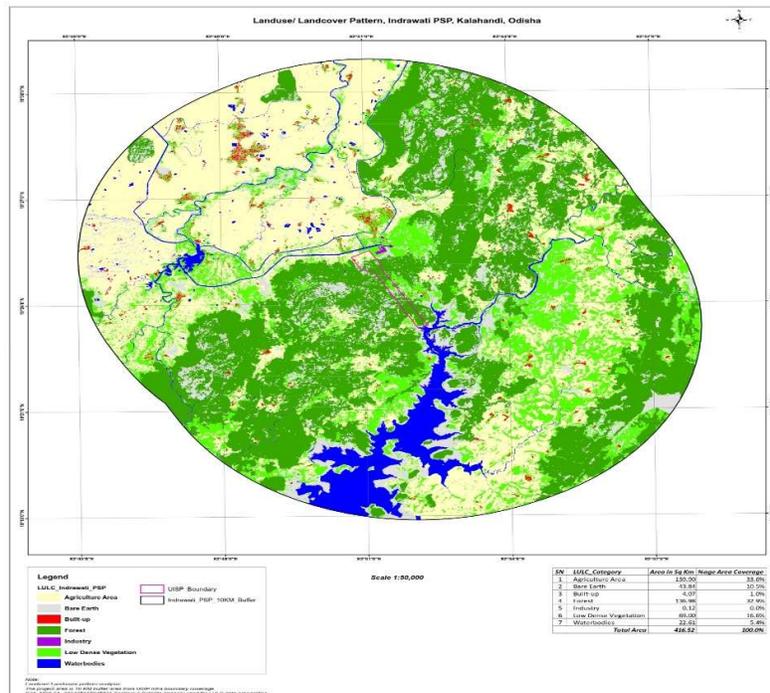


Figure-3: Land use pattern of Study Area

5.10 Flora

The major forest type present in the Study Area as per the classification of Champion & Seth (1968) is Dry Sal Bearing Forest (5B/ C1). This Forest type is further classified into:

- Dry Peninsular sal forest (5B/ C1c)
- Northern Dry Mixed Deciduous Forest (5B/ C2)

Ecological studies were conducted during three seasons within study area. The floristic composition in terrestrial ecology includes tree, herbs, shrubs, lianas and parasites.

A total of 200 plant species were documented from field study for at Upper Indravati pumped storage Project over three seasons: pre-monsoon, monsoon, and post-monsoon within 10 km radius, details are given in Table-3. The species recorded included, climbers (19), herbs (44), shrubs (30), trees (80), ferns (1), bamboos (2) and grasses (24).

Table-3: Habitats of various species observed in the Study Area

Habitat	Number of plant species
Climbers	19
Herbs	44
Shrubs	30
Ferns	1
Trees	80
Bamboos	2
Grasses	24
Total	200

The dominant tree species recorded at various sampling sites included *Azadirachta indica*, *Butea monosperma*, *Albizia procera*, *Balanites roxburghii*, *Neolamarckia cadamba*, *Mangifera indica*, *Dalbergia latifolia*, *Annona reticulata*. The density of tree species in the study area ranged from 240 to 520 individuals per hectare. The number of tree species recorded across various sites ranged from 7 to 17. Thus, in the forest land to be acquired for the project, the tree density can be considered low to moderate. 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 threatened category.

5.11 Fauna

Mammalian fauna in the Study Area area comprises of more than 19 species belonging to nearly 12 families. The hill ranges of Upper Indravati Pumped Storage Project were found to

be good habitat of Sloth Bear, Leopard, Stripped Hyena, Common Mongoose, Fox, Langur, Hare and Barking Deer. Family Cercopithecidae in study area is represented by two species namely Rhesus Macaque and Common Langur.

The most common and relatively abundant bird species observed in the forest ecosystem were the Greater Coucal (*Centropus sinensis*), Spotted Dove (*Spilopelia chinensis*), Black Drongo (*Dicrurus macrocercus*), Jungle Babbler (*Turdoides striata*), Rufous Treepie (*Dendrocitta vagabunda*), Asian Pied Starling (*Gracupica contra*), and Red-vented Bulbul (*Pycnonotus cafer*).

In reptilian fauna, Garden Lizard (*Calotes versicolor*), Common House Gecko (*Hemidactylus frenatus*) and Blanford's Rock Agama (*Psammophilus blanfordanus*) were sighted in the vicinity. Mahapatra et al. (2009) reported two species of turtles namely Indian Softshell Turtle (*Nilssonia gangetica*) and Indian Flapshell Turtle (*Lissemys punctata*) from Upper Indravati reservoir.

A total of 19 species of 5 families were recorded during the primary survey. Indian Cabbage White (*Pieris canidia*), Common Grass Yellow (*Eurema hecabe*), Common Jezebel (*Delias eucharis*) and Nigger (*Orsotriaena medus*), Blue Tiger (*Tirumala limniace*) were relatively common species of the study area.

5.12 Fisheries

The commonly observed fish species were Katla (*Catla catla*), Mrigal (*Cirrhinus mrigala*), Rohu, (*Labeo spp.*) Catfish Magur, Kantia, *Channa spp.* *Wallago balia* are also available in the reservoir.

5.14 Socio-Economic Impacts

The study area has 12 villages with a total population of 35324 comprising 50.12% male and 49.88% of female population. The General caste is the dominant caste in the study area accounting for about 47.39% followed by Schedule Tribes for about 33.44% of the total population.

The population comprising of children below the age of 6 years accounts for about 13.47% of the total population in the study area villages. About 49.95% of the total population in the study area villages are literate. It was observed that 47.69% of the total population are engaged in some form of economically productive activity or vocational activity, and have been designated as, "Total Working population". On the other hand, Non-workers or persons who are dependent on the population is about 52.31% of the total population.

Among the population that is working about 52.55% has been designated as Main workers while the remaining 47.45% has been designated as Marginal workers.

6. 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 Upper Indravati Pumped Storage project have been identified. The likely impacts on various aspects of environment are covered in the following Sections.

6.1 Impacts on Water Environment

a) Construction Phase

i) Sewage from labour camps

Construction of proposed project is likely to last for a period of 5 years. The domestic water requirement of the staff/labour colony is 0.22 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 0.181 MLD. The BOD load contributed by domestic sources is about 144 kg/day. A Sewage Treatment Plant is proposed to be installed in labour camps to treat the sewage.

ii) Effluent from crushers

A stone crusher will be installed at the project site. Water sprinkling system will be installed near the crusher to arrest the fugitive dust generated during operation. The effluent 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. Thus, wastewater shall be treated in settling tank to remove suspended solids from the wastewater prior to 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.

iv) Effluent from 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 50 technical staff alongwith their families 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 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

Generally, the river which flows through a steep gradient would carry a significant amount of sediment load, depending on the degradation status of the catchment. The proposed project is envisaged as a Pumped storage scheme. Thus, in the proposed project, sedimentation problems are not anticipated.

6.2 Impacts on Air Environment

a) Construction Phase

i) Emissions from DG sets

The power requirement for construction activities is estimated about 15 MW. Construction power will be availed from Jaypatna grid. Where ever required DG set will be utilized. The operation of DG sets would lead to air pollution on account of increased SO₂ emissions from DG stack.

It is proposed to install scrubber in DG sets, and use river water as a washing medium to clean the exhaust gas. In scrubbers, the exhaust gases are sprayed with liquid in order to remove the SO_x; before it will be emitted to the air. Scrubbers are capable of removing up to 95% of the SO_x in the exhaust gases. The exhaust gases when sprayed with water at a high

flow rate, and the SO_x in the exhaust gas is converted to sulphurous acid (SO₃²⁻) and sulphuric acid (SO₄²⁻).

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.

Proper care has been taken to locate the labour camps, colonies, 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 increase in vehicular movement. Large quantity of construction material like sand, fine aggregate are to be stored at various sites. Normally, due to blowing of winds, some of the stored material can get entrained in the atmosphere. However, such impacts are visible only in and around the storage sites. The impacts on this account are generally, insignificant in nature.

The fugitive emissions i.e. mainly dust pollution is contributed by the vehicular traffic and storage of sand and other aggregates. During crushing of the muck, moisture content will be maintained in the rock and other aggregates by spraying water to arrest the entrainment of dust. Due to wet condition of stored material, fugitive emissions will be controlled.

iv) Dust emissions from muck disposal

The loading and unloading of muck, sand and clay are the source of dust generation. Since, muck will be mainly in form of small rock pieces, 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 pumped storage project, no major impacts on air environment are envisaged during project operation phase.

6.3 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.

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. 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 be 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.

6.4 Impacts on Land Environment

a) Construction phase

i) Impacts due to Road Construction

The existing road network would be utilized as approach road to the pumped storage project. However, construction of some link roads (9.3 km in length) would be needed to connect various project appurtenances with existing roads. 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.

Management Measures

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

Construction

- Area for clearing of Forest shall be kept to 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 after taking due measures.

Drainage

- All artificial drains shall be linked with the existing natural drainage system.
- Surface drains shall have gentle slopes. Where falls in levels are to be negotiated, check Wiers with silting basins shall be constructed and that soil is not eroded and carried away by high velocity flows.
- Location and alignment of culverts should also be so chosen as 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 will be planted and if necessary, separate additional land will be acquired for this purpose.
- Afforestation of roadside land should be carried out to a sufficient distance on either side of the road.

ii) Impacts due to location of construction equipment

Various types of equipment will be brought to the site, including crushers, batching plant, drillers, earthmovers, rock bolters, etc. The siting of this construction equipment would require significant amount of space. Similarly, space will be required for storing of various other construction equipment.

Efforts shall be made to site the contractor's working space in such a way that the adverse impacts on environment are minimal, i.e. to locate the construction equipment, so that an impact on human and faunal population is minimal.

iii) Impacts due to Muck disposal

A total quantity of 3673331.19 cum of excavated material (muck) would be generated due to excavations for the construction of power intake, head race tunnel, primary surge shaft, pressure shaft, power house, surge shaft, etc. Considering 63 % swell factor quantity of muck will be 5987529.84 cum.

Muck generation and disposal could lead to various adverse impacts. The muck needs to be disposed at designated sites. This could lead to following impacts:

- loss of land
- problems regarding stability of spoil dumps
- access to spoil dump areas

Out of 3673331.19 cum of excavated muck, 1429016.03 cum of muck will be used for filling and various following construction activities:

- Use of suitable rock from the excavation as aggregate in the mixing of concrete.
- Use of muck for maintenance of roads.
- Use as backfill material in quarry and borrow pits.

The remaining quantity of muck (5987529.84 - 1429016.03) 4558513.81 cum shall be disposed suitably at desired locations. The muck will be disposed at 3 (Three) pre- designated muck disposal sites.

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.

Engineering Measures

- Wire crate wall
- Boulder crate wall
- R.C.C
- Catch water Drain

Biological Measures

- Plantation of suitable tree species and soil binding species
- Plantation of ornamental plants
- Barbed wire fencing

iv) Impacts due to Quarrying

The following rock quarries shall be used for extraction of construction materials:

- Chatbandguda rock quarry
- Kumudasil rock quarry

A permanent scar is likely to be left, once quarrying activities are over. With the passage of time, rock from the exposed face of the quarry under the action of wind and other erosional forces, get slowly weathered and after some time, they become a potential source of landslide. Appropriate slope stabilization measures shall be implemented to prevent the possibility of soil erosion and landslides in the quarry sites.

6.5 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 accommodated in well planned colony within the 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 baseline environmental quality monitoring indicated that all the environmental attributes are within the permissible standards. The baseline ecological study also indicates, the 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 land to be acquired for the project shall be 151.927 ha, of which about 107.596 ha of forest land is to be acquired.

As a part of field studies, ecological survey was conducted at dam site and within proposed submergence area. The details of floral species at various sampling sites are given in Table-4.

Table-4: Details of tree and shrub community at various study sites

Study Sites	Trees	No. of tree species	Density (Individuals/ha)
Site-1 (Contractor facility area-Rani Bahal, downstream of Indravati reservoir and adjoining area)	<i>Azadirachta indica</i> , <i>Butea monosperma</i> , <i>Albizia procera</i> , <i>Balanites roxburghii</i> , <i>Neolamarckia cadamba</i> , <i>Mangifera indica</i> , <i>Dalbergia latifolia</i> , <i>Annona reticulate</i> , <i>Alangium salvifolium</i> , <i>Terminalia tomentosa</i> and <i>Syzygium cumini</i>	14	520
Site-2 (Muck disposal site near existing)	<i>Butea monosperma</i> , <i>Cleistanthus collinus</i> , <i>Ficus</i>	7	240

Study Sites	Trees	No. of tree species	Density (Individuals/ha)
switchyard of old power house and adjoining area)	<i>auriculata</i> , <i>Mallotus philippinensis</i> and <i>Lannea coromandelica</i>		
Site-3 (Proposed lower reservoir- Rani Bahal, downstream of Indravati reservoir and adjoining area)	<i>Tectona grandis</i> , <i>Tamarindus indica</i> , <i>Cassia javanica</i> , <i>Syzygium cumini</i> , <i>Eucalyptus globules</i> , <i>Zizyphus jujuba</i> and <i>Terminalia arjuna</i>	13	340
Site-4 (Proposed power house site- Rani Bahal, downstream of Indravati reservoir and adjoining area)	<i>Holarrhena pubescens</i> , <i>Albizia procera</i> , <i>Lagerstroemia parviflora</i> , <i>Cassia fistula</i> , <i>Azadirachta indica</i> , <i>Glochidion lanceolarium</i> , <i>G. velutinum</i> , <i>Diospyros melanoxylon</i> , <i>Tectona grandis</i> and <i>Aegle marmelos</i>	14	400
Site-5 (Intake site- Kumdasil, left bank of Indravati reservoir and adjoining)	<i>Holarrhena pubescens</i> , <i>Ficus auriculata</i> , <i>Mallotus philippinensis</i> , <i>Terminalia tomentosa</i> , <i>Wrightia arborea</i> , <i>Artocarpus integrifolia</i> , <i>Melia azedarach</i> , <i>Cassia fistula</i> , <i>Schleichera trijuga</i> , <i>Macaranga indica</i> , <i>Albizia procera</i> and <i>Bombax ceiba</i>	16	310
Site-6 (HRT road crossing- mahulpatna and podapadar and adjoining area)	<i>Diospyros melanoxylon</i> , <i>Lagerstroemia parviflora</i> , <i>Careya arborea</i> , <i>Haldina cordifolia</i> , <i>Terminalia tomentosa</i> , <i>Casearia tomentosa</i> , <i>Aglaia spectabilis</i> ,	17	370

Study Sites	Trees	No. of tree species	Density (Individuals/ha)
	<i>Lannea coromandelica</i> , <i>Mallotus philippinensis</i> , <i>Syzygium cumini</i> , <i>Cassia fistula</i> , <i>Dalbergia latifolia</i> and <i>Aegle marmelos</i>		

The total land to be acquired for the project has already estimated. Compensatory afforestation is proposed in lieu of acquisition of this land. It is decided to afforest the degraded forest patches and non-forest land as per Forest Conservation Act (1980). The same shall be estimated by the Forest Department, as a part of Forest Clearance.

As a part of Biodiversity Conservation Plan, emphasis 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
- Site Specific Wild life management plan

b) Operation Phase

i) Impacts due to increased accessibility

During project operation phase, accessibility to the area will improve due to construction of roads, which in turn may increase human interferences leading to adverse impacts on the terrestrial ecosystem viz. flora and fauna of the area, due to human interferences.

During construction and operation phases; to prevent poaching in forest area around the project area, it is recommended that check posts shall be installed near major construction sites and labour camps to control poaching activities.

6.6 Impacts on Terrestrial fauna

a) Constuction phase

i) Disturbance to wildlife

The total land required for the project is 151.927 ha of which about, 46 ha comes under submergence area of Lower Reservoir. The Lower Reservoir is not located on main river. It is will be constructed by raising embankments. The existing reservoir of UIHEP shall serve as the Upper Reservoir for UIPSP. The project area and its surroundings are not reported to serve as habitat for wildlife nor do they lie on any known migratory route. Hence, no impacts are anticipated on this account. Thus, creation of lower reservoir due to the proposed project is not expected to cause any significant adverse impact on wildlife movement.

ii) Impacts on migratory routes

The proposed Upper Indravati Pumped Storage project envisages construction of new lower reservoir, which will be filled by abstracting water from reservoir of Upper Indravati HEP, which is operational since 1999. The lower reservoir is not located on migratory route of any fauna. The proposed project would not lead to impact on fauna due to upper reservoir. Hence, no impacts on migratory routes are anticipated.

iii) Impacts on Avi-Fauna

The project area and its surroundings are quite rich in avi-fauna. With the damming of the river, a reservoir of an area of about 46 ha of lower reservoir will be created, with quiescent/tranquil conditions. The reservoir banks will have wet environment throughout the year which can lead to proliferation of vegetation e.g. grass, etc. along the reservoir banks. Such conditions are generally ideal for various kinds of birds, especially, water birds. This is expected to increase the avi-faunal population of the area,

A strategy of improvement of habitat for birds is to avoid nest predation or brood parasitism through maintenance of large contiguous forest tract. These areas have the ability to support the largest number of forest interior birds and will also be more likely to provide habitat for area sensitive species. As a part of the project, following measures have been recommended.

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

Besides all above measures a , “ Site Specific Wild Life Management Plan” has been prepared as suggested by MoEF & CC and submitted to DFO, Kalahandi South Division for further necessary action at his end.

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.

6.7 Wildlife Conservation Plan

6.7.1 Details of Endemic, Threatened & Scheduled Species

During the field study, no endemic flora or fauna within the core or Zone of Surface Area was sighted. However, from local enquiry and sign surveys, following Schedule-I and important species like Leopard (*Panthera pardus*), Sloth Bear (*Melursus ursinus*), Indian Pangolin (*Manis crassicaudata*), India Grey Mongoose (*Linva edwardsii*), Indian crested Porcupine (*Hystric indica*), Jungle Cat (*Felis chaus*), Indian Rock Python (*Python molurus*), Indian Cobra (*Naja naja*), Indian Rat Snake (*Pythas mucosa*), Indian Chameleon (*Chameleo zeylanicus*) & Peacock (*Pavo cristatus*) are present in the ZoI.

As regards the IUCN Status of the aforesaid species, leopard is listed as Vulnerable, Indian Pangolin is enlisted in endangered category. Sloth Bear, Sambhar & King Cobra are also in vulnerable category, Peacock, Indian crested Porcupine, Mongoose, Indian Chameleon and Indian Cobra in the category of least concern & Indian Rock Python and Striped Hyaena as near threatened species.

6.7.2 Probable Impacts of the Project on Flora and Fauna

There will be direct and indirect impacts of the project due to habitat loss, habitat fragmentation to a limited scale, loss of biodiversity and anticipated forest fire. No mega herbivore (wildlife) with long ranging movement behavior, is present in the project area or in the zone of influence and hence the project is in no way going to impact them. Kalrapat sanctuary and nearest elephant corridors are far away from the project to pose any threat. Very small area of Nawarangpur Division is in the zone of influence and hence impacts and mitigation measures will be outlined for Kalahandi South Division and Rayagad division in this plan. There is no National park, Biosphere reserve, Wildlife sanctuary, Elephant corridor, Archaeological site, airport and defense installation located within 10 km of the periphery of the project area. That is, there is no protected area or Eco-sensitive zone present within 10 km of the periphery of the lease cluster area. The key negative impacts are given as below:

- Degradation In The WL Habitat
- Habitat Loss
- Habitat Fragmentation
- Destruction by Illicit Felling
- Loss of Biodiversity
- Forest Fire
- Accidental Fall In Pits And Channel
- Litter Generation
- Pollution Of Surface Runoff
- Road Accidents Due To Increase In Vehicular Traffic

6.7.3 Management Measures

A Wildlife Conservation Plan covering the following has been suggested:

- Renovation and construction of water holes/water bodies
- SMC Structures:
- Provision of glow-signate on the road
- Meadow and grassland development
- Integrated Forest Fire Management
- Capacity Building Training of the Forest staff
- Purchase of fire Blowers
- Forest Fire awareness and IEC activities
- Publicity, Awareness, Entry-point and IEC activities
- Installation of Solar Lights
- T-Fencing of Open Wells
- Monitoring
- Animal Passage Plan

6.7.4 Budget for Implementation of Wildlife Conservation Plan

The total budget for implementation of Wildlife Conservation Plan is Rs. 541.42 lakh and the abstract is given in Table-5.

Table-5: Budget allocation for Wildlife Conservation Plan

S. No.	Executing Agency	Amount (Rs. lakh)
1.	Works to be implemented by User Agency in the Project Area as outlined above	As per actuals
2.	Kalahandi (South) Forest Division	452.4
3.	Rayagada Forest Division	63.24
	Total-I	515.64
	With 5% charge for wild life society- II	25.78
	Grand Total (I+II)	541.42

6.8 Impacts on Aquatic Fauna

a) Construction phase

i) Impacts due to sewage disposal

During peak construction phase, waste water, mostly from domestic sources will be generated from various camps of workers engaged in the project area. The sewage generated from various sources shall be treated prior to disposal. Thus, no impacts are anticipated on this account.

ii) Increased turbidity level

Extraction of gravel and sand during construction phase would have deleterious effect on fish stocks. Such activities cause destabilising of river sub-strata, increasing the turbidity of water, silting up the channel bottom and modifying the flow which in turn may result in erosion of the river banks. The turbidity could increase upto 100 ppm due to suspended solids which may chokes the gills of young fish.

The effluent generated from crushers, batching plants and workshops shall be treated prior to disposal. This will ensure that there are no adverse impacts due to disposal of effluent generated from various sources.

b) Operation phase

The Lower Reservoir is not located on main river Indravati and will require one time filling of water, using water from upper reservoir. No water will be diverted from river Indravati or existing reservoir of UIHEP during project operation phase. Thus, no impacts on downstream ecology, hydrology or river ecology is expected. Since the Upper Reservoir is already under operation for more than 25 years and lower reservoir is not located on main river, hence no impacts on riverine ecology and fisheries is anticipated.

The storage capacity of existing reservoir of UIHEP, which will serve as upper reservoir is 1576 MCM. There will be daily abstraction of 4 MCM for hydro power generation, which will

be recycled back. This diurnal withdrawal and addition of water will vary the water level by 30 cm only. Thus, no impact on fisheries of existing reservoir of UIHEP is anticipated.

6.9 Increased Incidence of Water-related Diseases

The construction of the proposed 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 is in direct proportion to the length of the shoreline. 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.

7. ENVIRONMENTAL MANAGEMENT PLAN

7.1 Labour Management Plan

Construction projects, engage large number of contract workers, are highly prone to hazards pertaining to site activities. The proposed project like any other construction project has significant impact on health and safety during project construction and its operation stage, which need to be adequately addressed.

It is recommended that the contractors involved in project construction activities prepare a Health and Safety Plan, which shall cover 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

7.2 Occupational Health Management Plan

Before the work is initiated every day, the routine check-up especially with regard to its hydraulic systems, mechanical conditions, and other operating systems shall be performed. Initial medical examination for all workers must be arranged during the first year of appointment and the periodical check-up during subsequent years as per the requirements. Implementation of safety and health management system, Provision of necessary personal protective equipment and checking the efficacy measures through audits at regular intervals. 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. Lungs 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.

7.3 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

7.4 Greenbelt Development

Green belt around the reservoir would be created to avoid erosion of soil and prevention of land slips from the banks. The main objectives of creating a green belt around a reservoir are to:

- Check soil erosion around the reservoir
- Check landslides and slips around the reservoir
- Develop the habitat for wildlife particularly avi-fauna

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

7.5 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.

7.6 Solid Waste Management

i) Municipal Solid Waste

The labour colonies will generate substantial amount of municipal solid wastes. Most likely the solid wastes will contain majority of vegetable matter followed by paper cans and glasses. About 3700 persons are likely to congregate during the construction phases resulting in

generation of about 0.88 tonnes of solid waste/day. Adequate facilities for collection, conveyance and disposal of municipal waste generated from labour camps shall be developed. The degradable portion of the solid waste would be disposed off by vermi-composting. The non-degradable portion such as plastic bottles, cans, etc. shall be segregated and disposed of at separate sites. A suitable landfill site can be identified and designed to contain the municipal waste from all the project township, labour colonies, etc.

ii) 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 rules.

iii) E- Waste Management

Under clause 9 (1) of E-Waste (Management) Rules, 2016, consumers or bulk consumers of electrical and electronic equipment listed in Schedule I shall ensure that e-waste generated by them is 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. Implementation of e-waste (Management and Handling) Amendment Rules, 2016 shall be in accordance with the guidelines prescribed by the Central Pollution Control Board from time to time.

8. RESETTLEMENT AND REHABILITATION PLAN

. The important adverse impact during construction phase will be that, pertaining to land acquisition. About 151.927 ha. of land is to be acquired for the proposed Upper Indravati Pumped Storage project. For the proposed Upper Indravati Pumped Storage Project (UIPSP), a total of 20.505 hectares of private land is planned to be acquired across four villages in the Kalahandi district. This includes 17.520 hectares in Ranibahal and 0.219 hectares in Mangalpur, both situated in Jayapatna tehsil, and 0.803 hectares in Mahulpatna and 1.963 hectares in Sukuli, both located in Thuamula Rampur tehsil. The acquisition of private land would lead to 227 PAFs losing land in varying proportions.

The total land required for the project is 151.927 ha. About 107.596 ha of forest land and 44.331 ha of non-forest land to be acquired.

Land will be acquired in accordance with provisions of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 and corresponding rules. The cost for land acquisition is estimated as Rs. 1360.04 lakh and is summarized in Table-6.

Table-6: Summary of Cost for Land Acquisition

S. No.	Component of compensation package	Amount (Rs. lakh)	Remarks
1.	Value of Land	340.01	As per land rates of Revenue Department
2.	Factor by which market value is to multiplied	680.02	As per RFCTLARR' 2013, rural land acquisition multiplier = 2x
3.	Solatium (Under Section 30(1))	340.01	100% of Land value
	Total	1360.04	

An amount of Rs. 483.42 lakh has been earmarked for R&R assistance. The details are given in Table-7.

Table 7: Budget for R&R Assistance

S. No.	Component of compensation package	Quantity/ No.	Unit Rate	Amount Rs.(lakh)	Remarks
1.	Each affected family shall be given Resettlement Allowance	227	Rs. 50,000	113.50	As per LARR,2013
2.	Additional Assistance to SC/ST families	127	Rs. 50,000	63.50	As per LARR,2013
3.	Subsistence allowance losing Livelihood	227	Rs. 60,000	136.20	Rs.5,000 per PAFs
4.	Special assistance to	127	Rs. 25,000	31.75	As per LARR,2013

S. No.	Component of compensation package	Quantity/ No.	Unit Rate	Amount Rs.(lakh)	Remarks
	Vulnerable Families				
6.	Training/Skill Development of the affected persons, so as to enable such persons to take on suitable jobs	227	Rs. 36,000 (@ 3000/- per month for 12 months)	81.72	One eligible member from each PAFs
7.	Assistance for cattle Shed	227	Rs. 25,000	56.75	As per LARR,2013
	Total			483.42	

The total estimated budget for the Rehabilitation and Resettlement (R&R) Plan is Rs. 2027.80 lakh. The details are presented in Table-8.

Table -8: Budget for Rehabilitation and Resettlement Plan

S No.	Description	Amount Rs.(lakh)
1.	Cost for Land Acquisition	1360.04
2.	Budget for R&R Assistance	483.42
	Sub Total (A)	1843.46
	Contingency (10% on sub- total A)	184.34
	Total	2027.80

9. LOCAL AREA DEVELOPMENT PLAN (LADP)

The objective of the plan is to empower the families of the study area villages and partially affected villages.. The total estimated cost of the project Rs. 3394 crore. Therefore, a budget of 0.5% i.e. Rs. 16.97 crore (Say Rs.17 crore) of project cost has been earmarked for implementation of LADP.

The cost and heads as outlined in the Local Area Development Plan (LADP) are tentative and shall be finalized in consultation with district administration, based on the outcomes of the

Public Hearing. The budget for implementation of Local Area Development Plan (LADP) is outlined in Table-9.

Table-9: Budget for implementation of LADP

S. No.	Items	Budget (Rs. lakh)
1.	Core Infrastructure	350.0
2.	Public Health Care Facilities	450.0
3.	Up- gradation of Educational Facilities	925.0
	Total	1725.0

10. 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 Waters
- Village Level Incidence Response Team

The budget for different activities required to be carried out for mitigation and prevention of dam break has been estimated as Rs 205.0 lakh as per details given in Table-10.

Table-10: Budget earmarked for implementation of Disaster Management Plan

S. No.	Particular	Cost (Rs. lakh)
1.	Installation of alert system in control room	50.0
2	Setting up of communication between nearby projects	50.0

S. No.	Particular	Cost (Rs. lakh)
3	Setting up of communication system between project and d/s settlements	55.0
4	Public information system	25.0
5	Training and miscellaneous expenses	30.0
	Total	205.0

11. 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-11 and 12 respectively.

Table-11: Environmental Monitoring Programme during Construction Phase

S. No.	Item	Parameters	Frequency	Locations
1.	Effluent from STPs	pH, BOD, COD, TSS, TDS	Once every month	Before and after treatment from STP
2.	Ambient Air quality	PM ₁₀ , PM _{2.5} , SO ₂ and NO ₂	Three seasons in a year	At major construction sites
3.	Noise	Equivalent noise level (L _{eq})	Once in three months	At major construction sites
4.	Meteorological aspects	Wind direction & velocity, temperature, humidity, rain	Once every season	At one of the ambient air quality sampling sites
5.	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

Table-12: Summary of Environmental Monitoring Programme during Project Operation Phase

S. No.	Items	Parameters	Frequency	Locations
1.	Water quality	pH, Calcium, DO, Free Ammonia, BOD, Total Kjeldahl Nitrogen, COD, Boron, TDS, Percent Sodium, Total hardness, Chlorides, Magnesium, Sulphate	Thrice a year	<ul style="list-style-type: none"> • 1 km upstream of the Upper reservoir. • Upper Reservoir area near intake. • Lower Reservoir area. • 1, 3 and 5 km
2.	Effluent from STP	pH, BOD, COD, TSS, TDS	Once every week	Inlet and outlet of STP
3.	Terrestrial Ecology	Status of afforestation Programmes, greenbelt development	Thrice a year	Afforestation, greenbelt development sites
4.	Aquatic ecology and fisheries	Phytoplankton, Zooplanktons, benthic fauna, fish composition etc.	3 season a year	<ul style="list-style-type: none"> • 1 km upstream of Upper reservoir. • Upper Reservoir area near intake. • Lower Reservoir. • 1, 2 and 5 km downstream
5.	Water-related diseases	Identification of water-related diseases, sites, adequacy of local vector control measures, etc.	Three times a year	Villages adjacent to project sites in the Study Area
6.	Project Affected Families	Changes in growth of population, income levels and distribution, occupation profile, electrification of the area, adequacy of	2 nd , 4 th and 6 th year from the completion of the R&R activity.	Project Affected Families

12. COST ESTIMATES

12.1 Budgetary Allocation for Environmental Management Plan

The total budget earmarked for implementation and Environmental Management Plan is Rs. 1165.96 lakh. The details are given in Table-13.

Table-13: Budget earmarked for Implementing Environmental Management Plan

S. No.	Item	Cost (Rs. lakh)
1.	Implementation of Safety Measures	165.0
2.	Cost estimate for Medical Check-up	414.0
3.	Greenbelt Development	181.96
4.	Public Awareness Programme	100.0
5.	Disaster Management Plan	205.0
6.	Conservation Plan for Schedule-I Faunal Species	100.0
	Total	1165.96

12.2 Implementation of Various Mitigation Measures

The cost for implementation of mitigation measures is Rs. 9146.67 lakh. The details are given in Table-14.

Table-14: Cost for Implementing Mitigation Measures

S. No.	Item	Cost (Rs. lakh)
1.	Stabilization of quarry sites	212.46
2.	Restoration of Construction Areas	121.60
3.	Stabilization of Muck Disposal Sites	3247.37
4.	Municipal Solid Waste Management	165.84
5.	Hazardous Waste Management	50.0
6.	E-waste Management	30.0
7.	Construction & Demolition Waste Management	50.0
8.	Environmental Management in Road Construction	365.0
9.	Sanitary facilities in labour camps	136.0
10.	Treatment of Effluents from Crushers	50.0
11.	Treatment of effluent from tunneling	30.0
12.	Treatment of effluents from batching plants	30.0
13.	Treatment of effluent from fabrication units and workshops	75.0
14.	Noise Control Measures	25.00
15.	Air Pollution Control Measures	239.08

S. No.	Item	Cost (Rs. lakh)
16.	Provision of Free Fuel for labour and technical staff during construction phase	824.19
17.	Compensatory Afforestation	1016.27
18.	Biodiversity Conservation Plan	300.00
19.	Wildlife protection Measures	638.82
20.	Habitat Improvement for Avi-Fauna	131.96
21.	Wildlife Conservation Plan	541.42
22.	Public Health Delivery System	866.66
	Total	9146.67

12.3 Budget Allocation for implementation of Additional Studies

The total estimated cost for the implementing additional measures is Rs. 3752.80 lakh. The details are given in Table-15.

Table-15: Budget earmarked for Implementing Additional Measures

S. No.	Item	Budget (Rs. lakh)
1.	Resettlement and Rehabilitation Plan	2027.80
2.	Local Area Development Plan	1725.00
	Total	3752.80

12.4 Budget Allocation for implementation of Environmental Monitoring Programme

The cost required for implementation of Environmental Monitoring programme during project construction phase is Rs. 124.21 lakh. The details are given in Table-16.

Table-16: Cost for implementing Environmental Monitoring Programme during project construction phase

S. No	Item	Budget (Rs. lakh)
1.	Effluent from labour camps	11.09
2.	Ambient air quality monitoring	70.27
3.	Set up of meteorological laboratory	10.0
4.	Purchase of Noise meter	3.0
5.	Incidence of water related diseases	30.5
	Total	124.41

12.5 Budget for Implementation of various measures

The total budget earmarked for implementation of various measures is Rs. 14189.84 lakh. The details are given in Table-17.

Table-17: Summary of Budget earmarked for implementation of various measures

S. No.	Activity	Budget (Rs. lakh)
1.	Environmental Management Plan	1165.96
2.	Mitigation measures	9146.67
3.	Measures outlined in Additional studies	3752.80
4.	Environmental Monitoring Programme during construction phase	124.41
	Total	14189.84