1.0 EXECUTIVE SUMMARY

1.1 Existing Tillari Hydro Electric Project Stage-I (THEP-I)

Government of Maharashtra (GoM) has been giving utmost importance for water resources development project for irrigation, hydropower generation and drinking and industrial water supply.

GoM commissioned a 1 X 60 MW Tillari Hydro Electric Project (THEP Stage-I) at Kodali village in Kolhapur district of Maharashtra, in the high rainfall-zone of Western Ghats experiencing annual rainfall from 2410-3175 mm in 1986.

The existing THEP Stage-I consists of the following components:

- Tillari Main Dam (Dhamne Dam) in Maharashtra & Karnataka having a gross storage capacity 113.26 Mcum (4 TMC)
- A 15 Km long Power Canal of 7.90 Cumecs (275 Cusecs) designed discharge capacity for carrying water from Tillari Main Dam to the Fore-bay Dam at Kodali village on right bank of Tillari River
- A 350 m long and 22.74 m high masonry Fore-bay Dam in Kharari valley for a gross storage of 2.124 Mcum/ 74.99 Mcft and live storage of 1.514 Mcum/ 53.45 Mcft, facilitating 42 hours power generation in THEP
- An underground Powerhouse of 1 X 60 MW installed capacity constructed in lower ranges of Sahyadris, at Kodali village in Kolhapur district
- Water Conductor system having Head Race Tunnel, Surge Well, Penstock, Pressure Shaft, Tail Race Tunnel, Tail race Channel to convey waters from the fore-bay dam through the powerhouse and discharging into Kharari Nalla.
- Terwan Medhe Pickup Weir across Kharari Nalla for storage of discharged waters from THEP; and further distribution to the project command area
- A 15 km long Tillari Right Bank Canal between Terwan Medhe Pickup weir and the Link Canal of Tillari Interstate Irrigation Project in Sindhudurg district
- About 827 ha irrigable command area between Terwan Medhe Pickup weir and Link Canal of Tillari Interstate Irrigation Project

As the gross storages of Tillari Main Dam is 113.26 Mcum (4 TMC) it is capable of facilitating power generation only for about 6-8 hours a day at an average. Hence, at the planning stages of THEP Stage-I itself, GoM made a provision for THEP-Stage-II (THEP-II) for increasing the water storages at a future date, by constructing 4 additional subsidiary storages between the dam and THEP. Accordingly the Power Canal was designed to discharge 7.90 Cumecs (275 Cusecs) water for accommodating the requirements of THEP Stage-I as well as Stage-II.

Presently the power house is generating about 132 Million Units (MUs) of power annually at a load factor of 25%, though it has potential for substantially higher power generation capacity, if adequate water is available.

1.2 Description of Proposed Tillari Hydro Electric Project Stage-II (THEP-II) and its Salient Features

GoM now proposes to undertake the previously planned expansion of THEP by undertaking the THEP Stage-II project (THEP-II) for generating full 60 MW by increasing water availability. Under THEP-II GoM proposed to construct only 3 dams of the originally planned 4 dams namely Bandra Nalla, Pale Parmar Nalla and Bhandora Nalla Projects across respective nallas joining Tillari River. The fourth proposed dam namely Deo Nalla Project was dropped out due to its unviable costs. Hence THEP-II comprises of 3 subsidiary storage projects proposed across Bandra Nalla, Pale Parmar Nalla and Bhandora Nalla in Chandgad taluka of Maharashtra and Belgaum taluka of Karnataka at about 5-15 aerial distance from Tillari Nagar. These are proposed in the intermediate area in downstream of the existing Tillari Main Dam at Dhamne in Kolhapur district and upstream areas of the existing Tillari Interstate Project in Sindhudurg district. Locations of the proposed subsidiary storage projects and their catchment and command areas are shown in **Figure-1.1.**

These 3 new storages dams will collectively have a gross storage capacity of 54.17 Mm^3. This would facilitate 10 hours power generation daily, and generate additional 91.29 MUs power annually. Thus altogether a total of about 223.29 MUs of hydropower would be generated annually, after completion of the proposed THEP-II.

Other than construction of 3 earthen dams, 2 linking canals for releasing storages of Bandra Nalla and Pale Parmar Nalla reservoirs into the existing Power Canal by gravity; and a linking tunnel for releasing storages of Bhandora Nalla reservoir into the reservoir of the existing Tillari Main Dam, no new facility or modification of any existing infrastructure is needed in the presently proposed THEP-II.

About 631.286 ha land will be required for all components of subsidiary storage projects. Of this 21.46 ha land has already been acquired. The remaining 609.826 ha required land comprises of about 578.98 ha forest land and 16.10 ha private lands used for agriculture and plantations and falling in Maharashtra and Karnataka states; and 14.75 ha barren land belonging to the GoM.

Brief description of Subsidiary Storages is as follows:

1.2.1 Bandra Nalla Project

Bandra Nalla subsidiary storage dam is proposed across Bandra Nalla in Kalasgade and Gulamb villages of Chandgad taluka in Kolhapur district of Maharashtra. This would be an earthen dam of 40.725 m height and 514 m length. This will have a gross water storage capacity of 12.9 Mm^3 yielding from its 4.35 sq. km catchment area. The FRL and MDDL for this project are 747 m and 732 m respectively. Water from this dam will be discharged into the existing Power Canal by gravity through a proposed a Linking Canal.

About 141.22 ha land from Maharashtra is required for this project, of which 15.09 ha has already been acquired. The remaining comprises of 125.0 ha forest land, 0.16 ha private land having Australian Babul and latex plantations; and 0.97 ha barren land belonging to GoM. Due to land acquisition 5 families would be marginally affected as only a small piece of 0.05 ha land will be acquired from each of these families. No human settlement is affected due to this project. It is

anticipated to generate an additional power of 15.97 MUs annually. Estimated cost of this project is about Rs. 85.41 Crores.

The salient features of Bandra Nalla Project are presented in **Table-1.1.**

TABLE-1.1
SALIENT FEATURES OF BANDRA NALLA PROJECT

Sr. No.	Particulars		Details
1.	**Name of the Project**	:	Subsidiary storage at Bandra Nalla for additional power generation.
2.	**Scope of the scheme**	:	Additional power generation due to subsidiary storage at Bandra Nalla by increasing load factor of the existing Tillari Hydro Electric Project.
3.	**Source**	:	Bandra Nalla, right bank tributary of west flowing river Tillari.
4.	**Location**		
	i) State	:	Maharashtra
	ii) Region	:	Western Maharashtra
	iii) District	:	Kolhapur
	iv) Taluka	:	Chandgad
	v) Village	:	Kodali (Tillarinagar Colony)
	vi) Toposheet No.	:	48 I/1
	vii) Latitude	:	15^0 47’ 55” (N)
	viii) Longitude	:	74^0 13’ 53” (E)
5	**Hydrology**		
	i) Catchments area	:	4.35 Sq. Km 1.70 Sq. Miles
	ii) Average annual Rainfall	:	3441.70 mm.
	iii) Av. Annual yield	:	9.09 Mcum 321.000 (Mcft)
	iv) 90% dependable yield	:	9.96 Mcum. 351.78 (Mcft)
	v) 50% dependable yield	:	14.48 Mcum. 511.50 (Mcft)
	vi) 97% dependable yield	:	9.81 Mcum 346.54 (Mcft)
	vii) Upstream utilization.	:	Nil
6.	**Storage Reservoir**		
	i) Gross storages	:	12.90 Mcum
	ii) Dead storage	:	3.705 Mcum

iii)	Live storage	:	9.189 Mcum
iv)	Evaporation losses	:	1.667 Mcum
v)	Nalla Bed R.L.	:	709.275 m
vi)	M.D.D.L. R.L.	:	732.000 m
vii)	F.R.L. R.L.	:	747.000 m
viii)	M.W.L. R.L.	:	747.000 m
ix)	T.B.L. R.L.	:	750.000 m
x)	Type of dam	:	Earthen dam
xi)	Spillway	:	Side spillway with 2 radial gates of sizes 12.00 m x 5 m on left flank between ch. 93.50 m and 120.00 m.
xii)	Flood discharge	:	172 Cumecs
xiii)	Max. height of dam	:	40.725 m
xiv)	Length of dam	:	514 m
xv)	Annual utilization	:	7.5222 Mcum

7. Head Regulator On left bank

i)	Location	:	Ch. 135 m
ii)	Designed discharge	:	2.095 Cumecs

8. Interlinking Canal

i)	Designed Discharge	:	2.095 Cumecs

9. Spillway : Ogee Type gated spillway in colgrout masonry in CM 1:3

10 Stilling Basin

i)	Type of stilling basin	:	End Weir type
ii)	Length of stilling basin	:	55 m

11 Financial Forecast

i)	Cost of subsidiary storage scheme at Bandra Nalla.	:	8541.77
ii)	O & M and Depreciation charges	:	174.66
iii)	Benefit cost Ratio	:	0.95

1.2.2 Pale Parmar Nalla Project

Pale Parmar Nalla subsidiary storage project area falls in Karnataka and Maharashtra States. In Maharashtra it falls in Kalasgade village of Chandgad taluka; while in Karnataka it falls in Dhamne (S) Bellur an isolated village of Belgaum taluka that resembles an island interlocked by Maharashtra State in all sides; and whose main land i.e. Belgaum Taluka is about 15 km from this village.

This would be an earthen dam of 35.56 m height and 1.2 km length. Its gross storage is 15.46 Mm^3 yielding from its 9.33 sq. km catchment area. The FRL and MDDL are proposed to be 749.0 m and 736.0 m respectively. Water of this dam will be discharged into the existing Power Canal by gravity, through a proposed Linking Canal between the dam and Power Canal.

Storages of this dam would facilitate additional power generation to the tune of about 24.06 MUs, annually.

About 203.986 ha land is required for this project of which 6.37 ha has already been acquired. Of the remaining land 190.396 ha is forest land, 4.76 ha is private agricultural land from Karnataka. About 2.46 ha barren land belonging to Govt. of Maharashtra will also be required. Of the required forest land 70.38 ha is in Maharashtra and 120.016 ha in Karnataka.

Due to land acquisition about 9 landowners would be totally affected and these families would be rendered landless. Also 20 families residing in Dhangarwadi hamlet on forest land of Karnataka falling in Dhamne village will require resettlement as this falls in the dam seat. The estimated Cost of this project is Rs. 98.89 Crores.

The salient features of Pale Parmar Nalla Project are presented in **Table-1.2.**

TABLE-1.2
SALIENT FEATURES OF PALE PARMAR NALLA PROJECT

Sr. No.	Particulars		Details
1.	**Name of the Project**		Subsidiary storage at Pale Parmar Nalla for additional power generation.
2.	**Scope of the scheme**		Additional power generation due to subsidiary storage at Pale Parmar Nalla by increasing load factor of the existing Tillari Hydro Electric Project.
3.	**Source**	:	Pale Parmar Nalla, right bank tributary of west flowing river Tillari.
4.	**Location**		
	i) State	:	Maharashtra & Karnataka
	ii) District	:	Kolhapur & Belgaum
	iii) Taluka	:	Chandgad & Belgaum

iv) Village	:	Kalasgade & Dhamne	
v) Toposheet No.	:	48 1/1	
vi) Latitude	:	15 46’ 45” (N)	
vii) Longitude	:	74 16’ 30” (E)	

5. Hydrology

i)	Catchment area	:	9.33 Sq. Km	3.60 Sq. miles.
ii)	Average annual Rainfall	:	3175 mm.	
iii)	90% dependable yield	:	15.17 Mcum.	535.92 Mcft.
iv)	50% dependable yield	:	23.08 Mcum.	815.02 Mcft.
v)	Upstream utilization.	:		Nil

6. Storage Reservoir

i)	Gross storages	:	15.033 Mcum.	531.602 Mcft.
ii)	Dead storage	:	2.417 Mcum.	85.347 Mcft.
iii)	Live storage	:	12.636 Mcum.	446.259 Mcft.
iv)	Evaporation losses	:	2.235 Mcum	78.944 Mcft.
v)	Nalla Bed R.L.	:	717.44 m.	
vi)	M.D.D.L. R.L.	:	736.00 m.	
vii)	F.R.L. R.L.	:	749.00 m.	
viii)	M.W.L. R.L.	:	750.00 m.	
ix)	T.B.L. R.L.	:	753.00 m.	
x)	Type of dam	:	Earthen dam	
xi.	Spillway	:	Ogee un-gated.	
xii)	Flood discharge	:	358 Cumecs.	
xiii)	Max. height of dam (from foundation RL)	:	35.56.56 m.	
xiv)	Length of dam	:	1200 m.	

7. Head Regulator

i)	Location	:	Ch. 1650 m. on right side bank.
ii)	Designed discharge	:	0.6176 Cumecs.

8.	**Interlink canal**			
	i)	Length	:	130 m.
	ii)	Designed Discharge	:	108.96/ 3.71 cusecs.
9.	**Stilling Basin**			
	i)	Type of stilling basin	:	End Weir type
	ii)	Length of stilling basin.	:	53 m.
10	**Financial Forecast**			
	i)	Cost of subsidiary storage scheme at Pale-Parmar Nalla.	:	Rs. 9577.24 Lakhs.
	ii)	O & M and Depreciation charges	:	Rs. 193.23 Lakhs (P. 36)
	iii)	Benefit cost Ratio	:	1.29

1.2.3 Bhandora Nalla Project

Bhandora Nalla subsidiary storage dam will be earthen dam of 40 m height and 868 m length. This will have a gross water storage capacity of 25.81 Mm^3 yielding from its 14.15 sq. km catchment area. The FRL and MDDL of this project are 763 m and 747 m respectively. Water stored in this project reservoir will be transferred by gravity into the existing reservoir of Tillari Main Dam through a 1.97 km long interlinking underground tunnel of 2.13 m dia. Thereafter, the combined waters of Tillari Main Dam and Bhandora Nalla dam will be conveyed to Power house through the existing Power Canal. Bhandora Nalla Storage water is anticipated to facilitate additional hydropower generation to the tune of about 51.27 MUs annually.

This project falls in Maharashtra and Karnataka States. About 286.08 ha land is required for this project which includes 255.08 ha land from Maharashtra and 31.0 ha from Karnataka. The land required from Maharashtra includes 232.58 ha forest land, 11.18 ha private agricultural land and 11.32 ha barren land belonging to Govt. of Maharashtra. Entire 31.0 ha land required from Karnataka is forest land. The private land proposed for acquisition is owned by about 30 project affected families. After land acquisition 8 PAFs would be rendered landless while the remaining 22 PAFs would lose only part of their land, hence would possess some more land after land acquisition for the project. No human settlements, houses, farm-sheds, cattle sheds or any religious structures exist in the proposed dam seat and submergence area. Estimated Cost of this project is about Rs. 91.40 Crores.

The salient features of Bhandora Nalla Project are presented in **Table-1.3.**

TABLE-1.3
SALIENT FEATURES OF BHANDORA NALLA PROJECT

Sr. No.	Particulars		Details	
1.	**Name of the Project**		Subsidiary storage at Bhandora Nalla for additional power generation.	
2.	**Scope of the scheme**		Additional power generation due to subsidiary storage at Bhandora Nalla by increasing load factor of the existing Tillari Hydro Electric Project.	
3.	**Source**	:	Bhandora Nalla, left bank tributary of west flowing river Tillari.	
4.	**Location**			
	i) State	:	Maharashtra	
	ii) Region	:	Western Maharashtra	
	iii) District	:	Kolhapur	
	iv) Taluka	:	Chandgad	
	v) Village	:	Kolik	
	vi) Toposheet No.	:	48 1/1	
	vii) Latitude	:	15^0 47′ 55″ (N)	
	viii) Longitude	:	74^0 13′ 53″ (E)	
5	**Hydrology**			
	i) Catchment area	:	14.15 Sq. Km	5.45 Sq. miles.
	ii) Average annual Rainfall	:	3110.00 mm.	
	iii) Av. Annual yield	:	30.67 Mcum	1083.32 Mcft.
	iv) 50% dependable yield	:	46.37 Mcum.	1637.43 Mcft.
	v) 75% dependable yield	:	40.19 Mcum.	1419.39 Mcft.
	vi) 90% dependable yield	:	32.23 Mcum	1138.82 Mcft.
6.	**Storage Reservoir**			
	i) Gross storages	:	25.8144 Mcum.	
	ii) Dead storage	:	3.7612 Mcum.	
	iii) Live storage	:	22.0532 Mcum.	

iv)	Evaporation losses	:	3.3278 Mcum
v)	Nalla Bed R.L.	:	727.00 m.
vi)	M.D.D.L. R.L.	:	747.00 m.
vii)	F.R.L. R.L.	:	763.000 m.
viii)	M.W.L. R.L.	:	764.50 m.
ix)	T.B.L. R.L.	:	767.00 m.
x)	Type of dam	:	Earthen dam
xi.	Spillway	:	Ogee type side spillway with 2 Nos of 12 x 5 m size radial gates on R/S
xii)	Max. height of dam	:	40.00 m.
xiii)	Length of dam	:	868.00 m.
xiv)	Annual utilization	:	32.23 Mcum

7. Head Regulator

i)	Location	:	At tunnel entrance Ch. 210 m.
ii)	Designed discharge	:	3.109 Cumecs.

8. Stilling Basin

i)	Type of stilling basin	:	End Weir type
ii)	Length of stilling basin.	:	60 m.

9 Additional Power Generation

i)	Existing installed capacity of Tillari Hydro Electric Project.	:	60.00 M.W.
ii)	Annual Unit generation.	:	50.18 Mus.
iii)	Annual unit generation @ 50% dependable yield	:	11.42 Mus.
iv)	Deduct 0.5% for station consumption.	:	0.25 Mus.
v)	Secondary generation.	:	11.42 Mus.

10. Financial Forecast

i)	Cost of subsidiary storage scheme at Bhandora Nalla.	:	Rs. 9140.36 Lakhs.
ii)	O & M and Depreciation charges	:	Rs. 184.13 Lakhs
iii)	Annual revenue	:	Rs. 2608.12 Lakhs.
iv)	Cost per unit of generation.	:	Rs. 181 Paise.
v)	Percentage of return.	:	31.70%
vi)	Benefit cost Ratio	:	3.01

1.3 Benefits of THEP-II

The following are the anticipated benefits from this project:

- Project would generate about 91.29 MUs and provide immense benefits to the beneficiary area while using the existing infrastructure;
- Percolation of additional surface water into subsurface
- groundwater resources will be recharged to some extent due to percolation of surface water into subsurface;

1.4 Necessity of EIA & EMP

THEP-II is a hydroelectric project; hence this requires an Environmental Impact Assessment (EIA) report and Environmental Management Plan (EMP); and environmental clearance. Being this is an interstate project falling in Maharashtra and Karnataka this project requires Environmental Clearance from Ministry of Environment and Forests, Government of India. In order to meet the statutory requirements, the EIA and EMP have been prepared by covering the following major aspects:

1. Establishing the existing environmental and socio-economic conditions in the project area through review of literature and also conducting primary environmental monitoring, covering 3 seasons of year 2012-13;
2. Environmental Impact Assessment i.e. assessing the anticipated impacts of THEP-II on various environmental parameters;
3. Environmental Management Plan for outlining mitigation measures for limiting any likely adverse environmental and social impact due to the project and to ensure the environmental conditions in the project area would improve further for environmentally sustainability and in no-circumstances, these would deteriorate;
4. Social Assessment for assessing the socio-economic impacts of the project on the project affected persons due to land acquisition from them;
5. Resettlement Plan for resettling the displacing families affected due to Pale Parmar subsidiary project; and rehabilitation Plan for the land affected families for improving the socio-economic conditions of the project affected persons;
6. Compensatory Afforestation Plan in lieu of the forest lost due to the project;
7. Bio-Diversity Plan for Conservation and Rehabilitation of Wildlife and their habitats getting affected due to project;
8. Catchment Area Treatment Plans for reducing soil erosion from project catchment areas;
9. Muck Disposal Plan for stacking the surplus muck arising from dam foundations, linking canal and linking tunnel;
10. Identification of critical environmental and socio-economic attributes requiring monitoring during operational phase; and developing a suitable post-project monitoring program;
11. Providing a framework for institutional strengthening and implementation of the suggested mitigation measures.

1.5 Baseline Environmental Status

The existing baseline environmental conditions and social aspects pertaining to the project area are established through review of secondary data and also by conducting primary field surveys covering environmental components of ambient air quality, noise levels, soil quality, groundwater table fluctuations, aquatic and terrestrial ecology during pre-monsoon, monsoon and winter seasons during EIA period. Land use pattern and socio-economic conditions of project affected persons have been studied once during the study period.

1.5.1 Physiography of the Project Area

The catchment and downstream areas of projects are in rugged hilly terrain of Western Ghats having steep to moderate slopes.

1.5.2 Geology

Basalt is the only geological formation in the entire project area. No other geological formations or minerals are known to occur in any part of the project area.

1.5.3 Seismicity

In the seismic zoning map of India, the THEP-II sites fall in Zone-II, which is not considered to be prone for severe earthquakes.

1.5.4 Meteorology & Climate of Project Area

The climate of project area is characterized by pleasant weather throughout the year except during the southwest monsoon season. The project area falls in the 'Heavy Rainfall Area' experiencing rainfall of about 2410-3175 mm per annum.

The cold season prevails from December to February. This is followed by hot season which lasts till the end of May. June to September is the south-west monsoon season and the two months October and November, constitute the post-monsoon representing the retreating-monsoon.

May is the hottest month while December is the coldest month. Based on the IMD, Belgaum observatory monitored data during 1997-06 the lowest temperature recorded was at 7.2^0 C on 7th February 1998 while the highest temperature was recorded at 40^0 C on 22nd April 1998 and also on 3rd May 2003.

The area remains moist during the pre-monsoon and winter, whereas during the monsoon and post monsoon season it becomes wet with increased moisture levels in air taking place. The morning relative humidity levels varied from the lowest 41% during pre-monsoon to the highest 92.0% during monsoon. The evening relative humidity ranged from least 19% during pre-monsoon to the highest of 87.0% during monsoon.

The average annual rainfall of project area during 2000-2013 was 3869 mm. The highest rainfall of 5274 mm was recorded in 2006 and the lowest 2679 mm in 2004. The heaviest rainfall during any 24 hours duration was about 425 mm received on 9.7.2009.

Winds are light to moderate in other seasons and during south-west monsoon these become stronger. The mornings are calm as compared to the evenings.

1.5.5 Air Environment

THEP-II is a hydroelectric project hence the impacts related with air pollution are minimal; and exclusively prevail during construction phase. Baseline ambient air quality monitoring was conducted at 5 locations covering vicinities of dam sites and nearby villages in different directions from the dam site was conducted during 3 seasons of 2012-13. This revealed that all tested air quality parameters such as Particulate Matter of less than 10 micrograms (PM_{10}), $PM_{2.5}$, Sulfur dioxide (SO_2), Oxides of Nitrogen (NO_2) and Carbon Monoxide (CO) were within permissible limits conforming to the National Ambient Air Quality Standards prescribed by Central Pollution Control Board (CPCB) for rural/residential areas.

1.5.6 Noise Environment

Noise monitoring was carried out at 14 locations of the study area during 3 seasons. This revealed the maximum Leq ambient noise levels at different locations of the study area varied from 44.7 to 54.3 dB(A) during day time. These were found to be within the permissible levels for rural and residential areas.

1.5.7 Soil Environment

Very few agricultural lands are present in project submergence areas. These are red soils and lateritic soils. These are good in fertility.

During EIA period, 12 soil samples were collected from different locations of the project area during 3 seasons and were tested for their physic-chemical characteristics. The analysis revealed that all soil quality parameters are well-within permissible limits. This indicates that the area is free from pollution, but deficient in some nutrients.

1.5.8 Water Environment

Tillari River is the only river flowing through the project area and Dhamne Dam is constructed across this river. The 3 project subsidiary Nallas viz. Bandra Nalla, Pale Parmar Nalla and Bhandora Nalla join this river. These nallas are non-perennial and their flows are confined to monsoon and some part of post-monsoon and some portion of winter. During pre-monsoon season all nallas go practically dry.

Groundwater is available in limited quantities at shallow to moderate depths. As assessed by Groundwater Surveys and Development Agency, GoM, very few wells are feasible in this region.

During EIA period, primary water table fluctuations have been measured at 9 available open wells during Pre-monsoon and Post-monsoon seasons of 2013. Though groundwater occurs in deeper depths all over the area, in valley portions ground water occurs even at shallower depths ranging from 1-5 m below the ground level (BGL). In these monitored wells located in valley portions, only moderate groundwater table fluctuations ranging between 1-3 m were noticed during Pre-monsoon and Post-monsoon seasons. The subsidiary storage reservoirs are proposed in watersheds areas away from these existing wells, agricultural lands and villages. Hence after construction of projects these storages would not result in sharp rise in groundwater tables in far away areas where villages and agricultural fields are situated. Hence no problems associated with water logging or its induced soil salinity is anticipated.

Groundwater quality in the project region is found to be good. For establishing water quality, 9 groundwater samples from different locations of project area and its vicinities were collected during three seasons of EIA period. Also 23 surface water samples were collected during monsoon and winter seasons when water was available in water bodies. No sampling was possible during pre-monsoon as these water bodies went dry. Water quality of all surface water bodies revealed neutral conditions. Due to absence of any industrial activity in the project area there is no interference of industrial or chemical pollution which is established due to non-detectible levels of heavy metals in surface as well as groundwater.

1.5.9 Land Use Pattern

Land use pattern of the area falling within 10 km radius around the project location has been established based on digital interpretation of satellite imageries by deploying GIS techniques.

It is revealed that forest and open scrubs are the most predominant land uses within this area accounting to about 66% total area, followed by about 16% rocky outcrops or covered with grasses.

In most agricultural lands crops are grown only during monsoon. Paddy is the main crop grown in Kharif season in comparatively low lying areas adjacent to nallas having more moisture content in soils. These are left as fallows during Rabbi Season. Most of the dry lands are used for growing sweet potato. The conducted field surveys and ground-truthing in project area revealed that almost all current fallows are agricultural lands and cultivated in one or the other season though left as fallows, at times. Inclusive of these current fallows the agricultural land works out to about 15% of the area covered within 10 km radius from project site.

1.5.10 Ecology

The project area is covered with forests and thickly vegetated areas. These are rich in wildlife. However, there are no wildlife sanctuaries or protected areas within 10 km from any subsidiary project area.

Baseline ecological conditions in project area were established based on review of secondary information; and also by conducting primary field surveys at 10 terrestrial and 5 aquatic sampling sites during 3 seasons of year. These represented different physiognomic and habitat categories. Altogether 537 plant species consisting of trees (190), herbs (168), shrubs (76), climbers (63), pteridophytes (30), aquatics (5), bamboos (4) and gymnosperm (1) were recorded from this study area during the EIA period.

Biotic interferences and anthropogenic disturbances resulted in destruction of forests to some extent, although major cutting of trees was not found. The natural tree cover is thick consisting of native species; while the plantation areas have both native and exotic varieties. Some endangered or threatened species having conservation value are found in these forests of project area, its vicinities and also in submergence areas of the proposed projects.

Aquatic ecological studies of 5 water bodies revealed the predominance of Bacillariophyceae, Cyanophyceae, Protozoa and Chlorophyceae classes indicating Mesotrophic and Oligotrophic nature of water bodies revealing the water bodies are moderate in nutrients and absence of pollutants.

Rich fauna has been found and reported from the project area. While most of these are commonly occurring species, there are some species falling under rare, endangered, endemic and threatened categories. About 44 species of mammals, 50 species of reptiles, 13 species of amphibians, 115 species of birds, 53 species of butterflies, 5 species of dragon flies and 16 types of fishes are observed or reported from the study area and its surrounding areas. While majority of them are common varieties, some of these fall in endangered, threatened and vulnerable categories.

1.5.11 Healthcare Systems

Chandgad town, the taluka headquarters town has a Rural Hospital. A Primary Health Centre (PHC) is located at Here village at about 15 km from Bandra Nalla and Pale Parmar Nalla Projects. Another PHC is located at Tudiye village about 12 km from Bhandora Nalla Project. Larger villages have health sub-centres. Private clinics are not reported from any village. As a whole, the prevailing healthcare conditions are reasonable.

Few malarial diseases are reported from the project area, mainly due to stagnation of water in dirty pools near the existing bore-wells in villages; and also water-storage habits of people. More occurrences of malaria have been reported during May and November representing the monsoon and post monsoon seasons. No epidemics such as JE have been reported during the past five years.

Regular anti-malarial activities such as spraying are regularly taken-up. For preventing mosquito breeding, biological control measures such as culturing Guppy fish in hatcheries in some selected locations is being practiced.

Besides administering medicine to the patients, Passive Surveillance by collecting blood smears and undertaking intensive mass surveillance activities are carried out regularly.

1.5.12 Demography and Socio-Economics

The total population of project area as per 2001 Census was 3606 souls residing in 697 households. This reveals an average family size of slightly more than 5 (5.17) persons per family. The females outnumbered the males by forming about 53.74% of population. Male population worked out to only 46.26% of total population. The sex ratio, which is expressed as the number of females per 1000 males, was observed to be 1162, which is considered as very high.

About 1.69% of population belonged to Scheduled Castes (SC) while no Scheduled Tribes (ST) persons are reported by the Census. This indicates that socially most-weaker section people constituted to about 1.69% of total population. There are many households belonging to very backward castes like Dhangar and Salgar communities who are considered as NT. These are considered under 'Nomadic Tribes', which have no mention in 2001 Census.

The project area experienced a low literacy rate of only 46.62%. The male literacy rate, i.e. the percentage of literate males to the total literates worked out to be 61.03%. The female literacy rate, which is an important indicator for social change, was observed to be only 34.21%, which is very low.

The occupational structure and general employment patterns of people reveal that about 58.18% of total population is engaged in one-or-the other income-earning activities and fall under the category of workers; while the remaining

41.82% are unemployed or in the categories of children and the old. Main workers and marginal workers constitute worked-out to about 45.15% and 13.03% of total population, respectively.

Occupational structure of people indicates that cultivators are the most predominant category of workers with about 36.22% of population engaged in cultivation followed by agricultural labourers who worked out to about 11.56% of population. A mere 1.06% population is engaged in household industrial works. About 9.35% of population is engaged as other workers involved in different types of works.

1.5.13 Land Acquisition & Rehabilitation Issues

For various components of subsidiary storage projects about 631.286 ha land will be required. Entire land required for Bandra Nalla project is in Maharashtra, while for Pale Parmar and Bhandora Nalla Projects land from Maharashtra and Karnataka is required. About 157.866 ha land belongs to Karnataka while the remaining land to Maharashtra state. Of this 21.46 ha land has already been acquired and presently under possession of Water Resources Department of GoM. The remaining 609.826 ha required land comprises of about 578.976 ha forest land and 16.10 ha private agricultural & plantation lands falling in Maharashtra and Karnataka states; and 14.75 ha barren land belonging to the Government of Maharashtra. These government lands will be transferred from Revenue Department of GoM to Water Resources Department of GoM. The private land will be acquired as per the provisions of the 'Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013'.

The required private from Maharashtra is owned by about 35 landowners (PAFs) while the private land in Karnataka is owned by about 9 landowners. Thus altogether 44 land owners would lose their lands for the project. Of these 15 PAFs would lose their entire landholding while becoming landless. The remaining 29 would lose only part of their total land. These PAFs would still possess some extent of lands even after land acquisition for the project.

A hamlet namely Dhangarwadi situated in Karnataka State forest in Dhamne village of Belgaum taluka and district having 20 katcha houses and 12 cattle sheds near the proposed Pale Parmar Nalla Project would be affected due to this project. Hence these families would require evacuation and resettlement in outside the submergence area. In other storage projects no human settlement will be affected.

The land losers in Maharashtra would be provided rehabilitation benefits in accordance with the Maharashtra Project Affected Persons Rehabilitation Act, 1999; and the PAPs of Karnataka would be given these benefits under provisions of Karnataka State rehabilitation policies.

1.5.14 Places of Historical and Archaeological Importance

No religious place or monument notified by Archaeological Survey of India or by Maharashtra and Karnataka State Archeology Departments exists in any part of the project area.

1.6 Environmental Impact Assessment

THEP-II will provide immense benefits to its beneficiaries and boost infrastructural development in the region. All adverse environmental and social impacts would be felt only during construction phase of the project. During this phase impacts due to forest loss, land loss and disturbances to wildlife will be involved. During operational phase this project is not anticipated to cause any adverse environmental impact; and only positive impacts will be resulted.

1.6.1 Impacts during Construction Phase

Project activities to be undertaken during construction phase such as levelling of site, construction of dam, excavation of linking canal/ linking tunnel, transportation and stacking of excavated material from the project sites, etc. will cause some short-time adverse impacts, as described below.

- Impact on Ambient Air Quality

During construction period, on account of construction activities, operation of DG sets and plying of heavy earth moving vehicles dust levels in atmosphere get increased. Also the gaseous emissions from vehicles and DG sets cause increase in gaseous pollutants at the project sites. These impacts are felt only for a short-time hence purely temporary in nature.

After shifting the existing Dhangarwada tribal hamlet from forest area of Dhamne village to outside areas, Bandraiwadi hamlet of Kalasgade village located at about 1.0 km from Bandra Nalla Project area will be the nearest human settlement from any dam site. Dhangarwada in Mhalunge village near the proposed tunnel outlet will be the nearest human settlement within a distance of about 0.6 km. As distances between dam sites and human settlements are more, dam construction activities will not have much impact on these settlements.

Burning of firewood/fuel by the construction workers for their cooking might cause some impacts in the villages where they are residing.

- Impact on Noise Levels

The major noise generating activities during construction phase are excavation, blasting, drilling for dam foundations, linking canal and linking tunnel; and operation of construction equipment, plying of construction vehicles, etc. The anticipated noise levels are about 80-100 dB(A) at active construction sites during active construction period, hence would have some impacts on construction workers at the construction site and wildlife in their vicinities. These would cause temporary shifting of wildlife from vicinities of the dam sites and tunnel areas. Noise impacts due to construction of dams are not anticipated on nearby human settlements. However, blasting would have its impacts on nearby settlements.

- Impact on Wildlife

Due to disturbances during construction period, the prevailing wildlife at dam sites and their vicinities will move away from their original habitats to nearby areas having similar or better habitat conditions. Though this is an adverse impact, this would have only a temporary impact as the habitat requirements of local wildlife are general and ample similar or better areas for their habitats are available in nearby areas.

The proposed reservoir and Link canal would act as barriers for free movement of wildlife and people which are freely crossing the nallas from one side to the other side; hence an adverse impact. Wildlife may get confused initially, but subsequently these would get accustomed for the new environment and move without any confusion. Hence this would be a temporary impact.

1.6.2 Impact during Operational Phase

All adverse environmental impacts associated with project construction stage would be ceased after completion of the project.

1.6.2.1 Positive Impacts

- Impact on Social Environment

During operational phase, THEP-II would generate 91.29 MUs additional hydro power through primary power generation in the existing power house and secondary power generation at Terwan Medhe Pickup Weir. This enhanced power would provide immense benefits to power consumers. With assured/ improved power supply, this project will boost industrial and infrastructural development in the region.

Fisheries development in project reservoir would lead to enhanced income to the fisher-folk having access to the fisheries.

Thus the project will lead to overall economic development with a multiplier-effect and provide direct and indirect benefits to a larger number of people by enhancing their income levels and enriching their quality of living, besides enhancing revenue accruals to the State exchequer.

- Impact on Land Use

The project will submerge the existing forest and forms 3 smaller reservoirs, thus the forest area would be altered as a water bodies. These reservoirs within the forest areas would enhance scenic beauty. The proposed ornamental type tree plantations in downstream of dams will improve aesthetic beauty in the area.

- Impact on Surface & Groundwater Resources

Tillari Main Dam at Dhamne in Kolhapur district and Tillari Interstate Project in Sindhudurg district are integrated as a composite project for water utilization point of view. Presently yields of Bandra Nalla, Pale Parmar Nalla and Bhandora Nalla are discharged through Tillari River and subsequently carried to command area through TLBC. After completion of the proposed projects these waters would be conveyed to the power house for power generation; and thereafter the entire water would be diverted to Tillari River through Kharari Nalla. As consumption of water from these subsidiary storage projects is not involved, the entire water stored in them will be diverted to Tillari River as per the power generation schedules. Hence no adverse impact would be felt on water users in downstream areas and their riparian-rights.

Due to presence of water in project reservoir percolation of water into the sub-surface would take place. This would recharge the subsurface by raising the groundwater tables marginally; and helps in vegetative growth.

- Impact on Groundwater Quality

Due to presence of virgin areas in the project area, the quality of ground water is good. Even after completion of the storage projects, groundwater quality is not likely to be affected.

- Impact on Ecology and Bio-Diversity

Due to formation of reservoir and storing of water, ecological conditions of the reservoir area will be improved with presence of aquatic life. The terrestrial ecological conditions along the reservoir peripheries will be substantially improved by providing feeding and nesting facilitate for the wildlife. Also due to the anticipated groundwater recharge, vegetation in the area will be enhanced, which is a positive impact. Availability of water in reservoirs and power canals would attract more birds and enhance presence of avifauna in the region.

Presently no aquatic life is present in Pale Parmar Nalla and Bhandora Nalla in downstream areas of the proposed subsidiary storage projects, due to prevailing steep slopes and exposure of basalts throughout the Nalla course. Though the same phenomenon is prevalent even in Bandra Nalla at upstream portions some water is available in deep gorge below the Bandra Nalla Waterfalls. Hence some aquatic life is anticipated here. After construction of dams, due to seepages and regeneration flows from the storage dams, the downstream areas would always possess some water, hence will be congenial for growth of aquatic life, which is beneficial due to this project. No adverse impacts are anticipated on downstream areas and prevailing aquatic life, if any.

- Impact on Climate

Due to presence of water in reservoirs for more duration of year, relative humidity levels in atmosphere in local areas around them will be increased to some extent. This would result in slight fall in temperature levels.

- Impact on Aesthetics

Formation of reservoirs will create water fronts in project area and will improve aesthetic values in this area. These reservoirs may serve as a picnic spots. The proposed ornamental tree plantations in downstream of dam will enhance scenic beauty in the area.

1.6.2.2 Likely Adverse Impacts

- Impact on Human Health

With presence of water in reservoirs for more duration, humidity levels in atmosphere will be slightly increased. This may lead to some vector borne diseases in the area. Also due to possible proliferation of mosquitoes and snails, some water borne diseases are likely to result when water is present in reservoirs.

1.7 ENVIRONMENT MANAGEMENT PLAN

THEP-II would have some adverse environmental and social implications. To minimize the environmental losses and negating these adverse impacts to the possible extent through technical judgment; and implementation of appropriate mitigation measures, an Environmental Management Plan is developed.

1.7.1 Environment Management Plan during Pre-Construction Phase

- Undertaking Compensatory Afforestation Plans in the identified Compensatory forest areas;
- Undertaking Corridor Development in degraded forest areas around the project sites for free movements of wildlife;
- Resettling the Displacing Families of Dhangarwada in a new resettlement colony by providing full-fledged infrastructure as per the National Policy for Rehabilitation and Resettlement (NPRR)/ Karnataka Resettlement Act;
- Providing rehabilitation benefits to the land losers of Maharashtra and Karnataka in accordance with the Rehabilitation policies of respective states;
- Developing a Biodiversity Plan for conservation of wildlife; and their rehabilitation;
- Developing a Muck Disposal Plan for stacking the surplus muck generated from dam foundations, linking canals and linking tunnel.

1.7.2 Environment Management Plan during Construction Phase

The following mitigation measures during construction period are needed:

- Undertaking excavations and construction activities at project sites while giving utmost care to the environmental aspects and safety measures;
- Carrying out construction activities only during daytime in order to avoid noise impacts on the surrounding areas;
- Undertaking dust control measures such as water sprinkling on haul roads and on trees covered with dust;
- Maintaining the diesel powered construction vehicles properly, for minimizing smoke emissions;
- Adopting appropriate noise attenuation measurers for minimizing noise levels in the area;
- Providing noise protection devices like earmuffs and earplugs to the workers operating the high noise generating equipment;
- Using the generated earthen material (muck) from project sites and tunnel for construction of earthen dam to the possible extent;
- Stacking the surplus material in identified muck disposal sites, with appropriate slopes, in a systematic manner;
- Compacting the muck dumps and undertaking plantations on them for minimizing erosion;
- Providing cooking fuel to construction workers through contractors to prevent felling of trees for fire wood for their cooking; and
- Providing adequate sanitation facilities for male and female workers separately and connecting them to septic tanks.
- Undertaking tree plantations at foot of the dam in its downstream side;
- Growing grasses and undertaking plantations on muck dumps for their strengthening and preventing their erosion;
- Undertaking Catchment Area Treatment Plans for reducing soil erosion.

1.7.3 Management Plan during Operational Phase

The following mitigation measures would be required during operational phase of the project:

- Nurturing the plants on the muck dumps at least for 3 years through Social Forestry Department, GoM till the plants become self-sufficient;
- Undertaking periodic water quality testing of project nallas; and taking appropriate measures if the water quality is not meeting the standards;

- Ensuring no illegal felling of trees takes place in vicinities of project sites;
- Minimizing movement of inspection vehicles and excessive blowing of horn and lighting during night time to avoid disturbances to wildlife in project area;
- Undertaking strict law enforcement measures for conservation of wildlife near dams;
- Undertaking appropriate measures for development of fisheries and aquatic life in reservoirs;
- Preventing excessive growth of aquatic weeds in reservoirs controlling nutrition levels; and
- Creating fisheries hatcheries and culturing fish in project reservoirs for creating employment to people and also improving water quality in reservoirs.

1.7.4 Public Health Management

Public Health management measures include:

- Undertaking adequate curative and preventive measures for eliminating the risk of outbreak of any water borne and parasitic disease in the area;
- Strengthening the existing Primary Health Centres at Here and Tudiye and other healthcare facilities by appointing adequate number of medical and paramedical staff;
- Maintaining good environmental, health and sanitation conditions at construction areas; and
- Carrying out regular surveillance and health improvement programs by the Health Department for preventing health disorders in project area.

1.8 Post-Project Monitoring and Management

During post-project monitoring period, for effective environmental management in terms of ecological conditions and water quality in the project area some representative areas need to be monitored. Developing an Environmental Management Program under the Coordination Committee of Water Resources Departments of GoM and implementing the identified mitigation measures in problematic areas would safeguard environmental conditions in the project area.

1.9 Organization for Environment Management

The Superintending Engineer of Konkan Irrigation Circle, Ratnagiri would implement the proposed Environment Management Plan in coordination with various other departments of GoM.

1.10 Budgetary Allocation for Environmental Measures

The total cost of THEP-II is estimated to be Rs. 295.3574 Crores. Of this about Rs. 3.09 lakhs will be used for tree plantations in vicinity of dam.

1.11 Conclusions

THEP-II will generate 91.29 MUs additional power in the existing power house without making any modifications or up-gradation in the existing THEP-I. This additional power generation would lead to industrial and infrastructural development in the region; and provides an impetus for overall development of the region with multiplier effect. By supplying enhanced power to a multitude of people, this project would enrich quality of living of its beneficiaries and lead to overall socio-economic development in the region.