REPLIES TO THE QUERIES RAISED BY NATIONAL GREEN TRIBUNAL

ON

THE PROPOSED 4X660 MW COAL BASED THERMAL POWER PLANT NEAR KOMARADA VILLAGE & MANDAL OF VIZIANAGARAM DISTRICT, ANDHRA PRADESH

Proponent:

Alfa Infraprop Pvt Limited

Prepared by :

Hydro-Geo Survey Consultants Pvt. Limited
Jodhpur,
Rajasthan

Vimta Labs Ltd.
142, IDA, Phase-II, Cherlapally,
Hyderabad–500 051
www.vimta.com

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1.0 Preamble

M/s. Alfa Infraprop Pvt. Limited proposes to set up a 4X660 MW coal based power plant near Komarada village & mandal, Vizianagaram district, Andhra Pradesh. Ministry of Environment and Forests (MoEF) granted Environmental Clearance (EC) for the above said project vide letter no. J-13012/13.2009-IA.II(T) dated 15.3.2010.

The EC was challenged in the National Green Tribunal (NGT) by two appellants. NGT, vide its judgment, had directed EAC to discuss five issues again in detail, even if these have already been taken into consideration and add specific mandatory conditions as appropriate. As part of it, the EAC is directed to review its appraisal process with regard to issues raised in the public hearing and give attention to points missed by it, if any, during the earlier process of appraisal and stipulate additional conditions, if so warranted.

Following are the queries raised by the NGT:

1. Impact of the project on drainage and surface hydrology during the normal and monsoon conditions. The specific engineering interventions required to be made to preserve the hydrological integrity of the area should be clearly delineated as a mandatory condition;

2. The EAC is directed to call for an action plan for maintaining the drainage system from the project proponent, scrutinize the same from both engineering and environmental angles and stipulate mandatory conditions, if so required, in the list of conditions;

3. Prior to the issuance of the consent to operate, the APPCB is specifically directed to satisfy itself in terms of design, projected efficiency levels of various treatment units and the quality characteristics with regard to the discharge of treated wastewater into river Janjavathi;

4. The EAC is directed to review its appraisal process with regard to issues raised in the public hearing and give attention to points missed by it, if any, during the earlier process of appraisal and stipulate additional conditions, if so warranted; and

5. The EAC is directed to discuss the ecological aspects of the flood plain of the riverine systems in the vicinity of the proposed project and impose conditions, if required, to be followed by the project proponent.

Point wise replies to the queries are given in subsequent sections.

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AIPL awarded the assignment to Hydro-Geosurvey Consultants Pvt. Ltd (HCPL) to conduct comprehensive hydrological and drainage and hydrogeological studies of the plant area and its buffer zone, geotechnical investigations of ash pond area, pathways of pollutants, flood hazard zonation mapping, designing of rain water harvesting and hydrological net work system. HCPL initiated the investigations at the site during the period from 16th to 26th March, 2014 for collecting the field data pertaining to above mentioned studies and submitted a report covering all the major concerns pertaining to hydrological and drainage studies of the plant area and its buffer zone, impact due to construction of plan in the catchment area of Vanakbadi Gadda reservoir, its command area, existing 17 ponds within the plant area covering 1675 acres and impact of ash pond on the quality of water regime.

A comprehensive hydrological study of two river basins, Nagavali and Jhanjavati were conducted and different watersheds and micro-water sheds were delineated in the plant area and in the buffer zone. Catchment area and catchment yield for each existing ponds (17 in total), pond area etc has been determined. There is no use of these 17 ponds except by stray cattle. With the construction of plant, few ponds will be covered under the plant buildings but 6 major ponds located in open area, particularly in eastern and south-eastern parts of the plant area will survive and will be filled by the roof top rain water from the plant buildings and surface runoff of open and paved roads.

Vanakabadi Gadda irrigation reservoir, which is under construction in the west, is about 2.5 km away from the western boundary of the plant area. It has its own free catchment area in the west with water storage capacity of 1.99 TMC. This irrigation reservoir will not be affected by the plant and can be constructed as designed. Once this dam is constructed, there will not be any flow in Vanakabadi Gedda. However, whenever there is overflow from the dam, the original course of the river, which used to pass through the plant area along its western boundary, will be diverted by constructing diversion drain along the south western boundary of the plant and meet the downstream course of Vanakabadi Gedda without affecting the surface drainage and water regime of the area. The size of the diversion drain, its length, alignment etc have been worked out and is discussed in the report. Vanakabadi Gedda irrigation reservoir project has been discussed in detail indicating its location on the satellite imagery, toposheet, photographs etc along with its type, length, height and area to be irrigated. After the construction of the dam, a large cultivable area on the northern and south western side of the plant will be irrigated. Its irrigation potential will not be affected due to the plant.

All 17 existing water bodies within the plant area have been discussed in detail along with its catchment area, catchment yield, capacity and survival of 6 major water bodies and its recharge program.

Geotechnical studies have been conducted in the ash pond area and in-situ permeability and infiltration tests have been conducted. As the hydraulic conducting was found ranging from 10^{-5} to 10^{-7}cm/sec than the required hydraulic conductivity of 10^{-7} to 10^{-9} cm/sec, it has been proposed that either the clay lining or HDPE lining will be laid so that pollutants do not join the ground water basin of the area. Fly ash will be lifted by cement plants and only bottom ash will remain in the ash pond without contaminating the ground water.

Flood hazard zonation mapping has been done for both the rivers considering the peak flows, elevation of river and the plant etc by remote sensing and modeling. Jhanjavati river flows 1 km south of southern boundary of the plant. It has been found that at the maximum reported peak flow of 6000 cumecs, the water will just touch the boundary of the plant but will not inundate the plant as it is at higher level than the river bed. Nagavali river flows on the eastern side of the plant and is 3.5 km from the eastern boundary. It has been observed that at the maximum reported peak flow of 90,000 cumecs of Nagavali river, the flood water will remain about a km away from the plant.

1.0 INTRODUCTION

M/s. Alfa Infraprop Pvt. Limited proposes to set up a 4X660 MW coal based power plant near Komarada village & mandal, Vizianagaram district, Andhra Pradesh. Ministry of Environment and Forests (MoEF) granted Environmental Clearance (EC) for the above said project vide letter no. J-13012/13.2009-IA.II(T) dated 15.3.2010.

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HCPL initiated the investigations at the site during the period from 16th to 26th March, 2014 for collecting the field data pertaining to above mentioned studies.

The present reports embodies findings of all studies done in the plant area covering 1675 acres and its buffer zone (10 km radius area) and covering all the major and minor concerns expressed in the Judgment of NGT and extends recommendations for diversion program of Vankabadi Gedda so that there is no impact of the surface hydrology and on water regime. A rain water harvesting program by harnessing the roof top rain water from different buildings and surface runoff of paved area has also been designed so that majority of existing 17 village tanks remain filled up within the plant. It is not feasible to artificially recharge the ground water basin of the plant area as the water table in the plant during post –monsoon period remains within 3 m below the ground level otherwise it will create water logging as proposed by Central Ground Water Board. More over, it is also not needed as no ground water abstraction is proposed and the plant and its buffer zone lie in safe category.

2.0 HYDROLOGY

2.1 East Flowing River Basin

The basin spreads over states of Andhra Pradesh and Odisha having an area of 86,643 km^2 and stretches between 78° 40′ to 85° 10′ east longitudes and 14° 34′ to 20° 22′ north latitudes. It is bounded by the Eastern Ghats on the north and west, by Nallamala range and Andhra plains on the south and by the Bay of Bengal on the east. This composite basin comprises of three river systems. The river systems between Mahanadi and Godavari covers an area of 49,685 km^2 and the river systems between Krishna and Pennar extends over an area of 24,669 km^2. In addition, there is also a small area between Godavari and Krishna drained mainly by the small stream of Palleru. This minor portion of the basin has an area of about 12,289 km^2. The independent rivers (directly draining into Bay of Bengal) in the basin from north to south are the *Rushikulya*, the *Bahuda*, the *Vamsadhara*, the ***Nagavali***, the *Sarada*, the *Varaha*, the *Tandava*, the *Eluru*, the *Gundlakamma*, the *Musi*, the *Paleru* and the *Manneru*. The major part of basin is covered with agricultural land accounting to 59.85% of the total area and 3.66% of the basin is covered by water bodies. Buffer zone (10 km radius area) of AIPL thermal plant lies in Nagavali river basin.

2.1.1 Nagavali River Basin

Nagavali river rises in the eastern slopes of the Eastern Ghats near Lakhbahal in the Kalahandi district of Odisha at an elevation of about 1,300 m. The geographic coordinates of the river are north latitudes 18° 10′ to 19° 44′ and east longitudes of 82° 53′ to 84° 05′. The total length of the river is about 256 km, of which 161 km is in Odisha and the rest is in Andhra Pradesh. The catchment area of the basin is 9,510 km^2. Nagavali is an interstate river with 4,462 km^2 and 5,048 km^2 river basin area located in Odisha and Andhra Pradesh, respectively. The river basin receives 1000 mm average rain fall annually. The uplands of the river basin are hilly areas with predominantly tribal populated. It drains parts of the Kalahandi, Rayagada and Koraput districts of Odisha and Srikakulam, Vizianagaram and Visakhapatnam districts of Andhra Pradesh.

The main tributaries of the River Nagavali are ***Jhanjavati***, *Barha*, *Baldiya*, *Satnala*, *Sitagurha*, *Srikona*, *Gumudugedda*, *Vottigedda*, *Suvarnamukhi*, *Vonigedda*, *Relligedda* and *Vegavati*. The Suvarnamukhi river takes its birth in the hills of Salur mandal and takes an eastern direction and finally joins the Nagavali at Sangam village in Vangara mandal of Srikakulam district. Vegavathi originates in Pachipenta hills of Pachipenta mandal.

2.1.2 Jhanjavati River

Janjhavathi river, a tributary to Nagavali river, is an interstate river takes its origin in Orissa, enters A.P. near village Banjakuppa of mandal Komarada and joins Nagavali river near village Gumpa of Komarada. Janjhavathi reservoir project is an ongoing medium irrigation project being constructed across Janjhavathi river near village Rajyalaxmipuram, mandal Komarada of District Vizianagaram. The project is intended to irrigate an ayacut of 24,640 acres (9970 ha) pertaining to 75 villages in 5 mandals of the district.

2.2 Physiography of the Buffer Zone

Physiographically, the buffer zone area is characterized by two distinct natural divisions, i.e. hills and plain region. The hilly area covers northwest and northeast area of buffer zone. Rest of the area of buffer zone is plain. The buffer zone forms the north western part of district Vizianagaram and lies in Nagavali river basin.

The study area drains towards south and south east. The principal rivers of the buffer zone are Nagavali and Jhanjavati. A number of seasonal streams originate in the buffer zone and merge with larger streams and rivers which are tributaries of river Nagavali. These tributaries dissect the buffer zone and finally deposit their load into river Nagavali. Perennial Nagavali river is passing on the eastern side of the AIPL thermal power plant and flows in a southerly direction and perennial Jhanjavati river is passing on the southern side of the thermal power plant and flows in a easterly direction as shown in the digitized elevation map of the buffer zone **(Figure-2.1).**

The elevation within the buffer area varies from 880 m above msl in northwest to 90 m above msl in the southwestern part of the buffer zone.

2.3 Irrigation Projects

There are four irrigation projects across Nagavali river and its tributaries to provide irrigation in the buffer zone. Salient features of these irrigation projects are as follows (**Figure-2.2**).

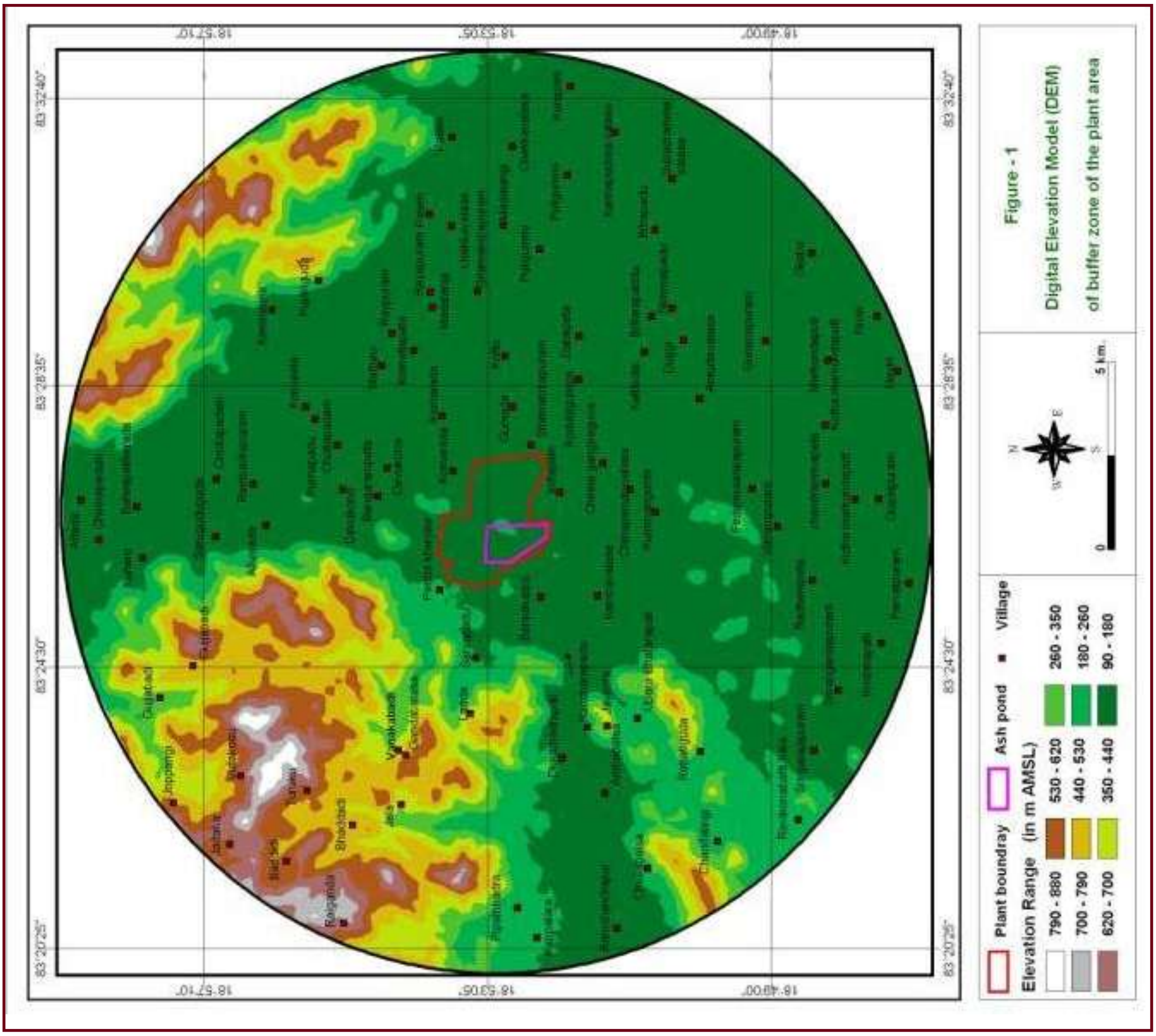


FIGURE-2.1

DIGITAL ELEVATION MODEL (DEM) OF BUFFER ZONE OF THE PLANT AREA

FIGURE-2.2
STUDY AREA

Figure-2.2.
Irrigation projects in buffer zone

2.3.1 Thotapalli Barrage Scheme (Major Irrigation Project)

The existing Thotapalli regulator is the first diversion work on Nagavali river constructed in the year 1908 and has become old and showing sign of deterioration. In order to save the existing ayacut of 25,910 ha (64,000 acres), it is proposed to construct a barrage with pond of +105.00 m at about 460 m upstream side of existing old regulator. The total yield available from catchment area at site is 44 TMC and the yield proportionally allocated to Andhra Pradesh state as per Inter State agreement dated: 15.12.1978 is 16.00 TMC. The utilization is 15.895 TMC:

Irrigation : 13.985 TMC
Drinking water : 0.320 TMC
Industrial demand : 0.640 TMC
Evaporation : 0.950 TMC

The scheme provides in addition to 25,910 ha (64,000 acres) stabilization of old ayacut, irrigation facilities to a new ayacut of 48,583 ha (1,20,000 acres) in 10 mandals covering 155 villages in Vizianagaram district and 7 mandals covering 132 villages in Srikakulam district. Besides, the scheme provides water to feed 42 nos. of tanks for drinking water supplies in 24 villages enroot the proposed right main canal of 107.00 km.

FIGURE-2.3
GOOGLE IMAGE SHOWING THOTAPALLI RESERVOIR AND BARRAGE

TABLE-2.1
SALIENT FEATURES OF THOTAPALLI BARRAGE PROJECT

Barrage		
1	Source	River Nagavali
2	Location	Thotapalli village
3	Catchment area	4455 km^2
4	Latitude	18 °47’30’’
5	Longitude	83 ° 25’24’’
6	Total available yield from catchment area	44.00 TMC
7	Yield allocated for A.P. as per Interstate agreement	16.00 TMC
8	Proposed yield to be utilized in this Thotapalli Barrage Scheme	15.895 TMC
9	Storage capacity of Barrage at FRL/MWL (+105.00 m)	2.509 TMC (71.05 M.Cum)
10	C.C.A. under this project	1,84,000 acres
(i)	Existing Ayacut (Khariff Paddy)	25,910 ha (64,000 acres)
(ii)	Proposed additional Ayacut (groundnut in Khariff)	48,583 ha (1,20,000 acres)
Spill Way		
1	Type of spill way	Ogee
2	Total length	117 m
3	No. of radial gates	8
4	Size of vent	12.00 m x 7.00 m
5	Crest level	+98.00 m
6	Designed discharge	3234 Cumecs
7	Foundation level	+87.50 m
Earth Dam		
1	Total length	8.20 km (Both side)
2	Top width	6.00 m
3	Maximum height	20.20 m (R/S Earth dam)
4	F.R.L./M.W.L.	+105.00 m
5	T.B.L.	+109.00 m
6	M.D.D.L.	+100.00 m
Left Head Sluice		
1	Sill level	+97.00 m
2	No. of vents	1 No. (size 2.40 m x 3.50 m)
Right Head Sluice		
1	Sill level	+97.40 m
2	No. of vents	2 (size 4.30 m x 2.50 m)
3	Discharge	34.23 Cumecs
4	Length of right main canal	107.00 km

PHOTOPLATE-2.1. THOTAPALLI BARRAGE

PHOTOPLATE-2.2. THOTAPALLI BARRAGE

2.3.2 Thotapalli Regulator (Medium Irrigation Project)

Status: Completed

River	**Basin**	**Sub Basin**	**Allocated Water (TMCs)**	**Updated Cost (Rs. Crores)**	**SSR Year**
Nagavali	Nagavali	Nagavali	0.0	20.74	1908

Covered Districts	IP Contemplated (in Acres)	IP Created (in Acres)	IP Balance (in Acres)
SRIKAKULAM	30485	30485	0
VIZIANAGARAM	6617	6617	0

Length of Masonry Dam	131.21	(meters)
Height of Dam	7.95	(meters)
Catchment Area at Dam site	4303.0	(Sq.Km)
Max. Designed Flood Discharge	113200	(Cusecs)
Max. Observed Flood Discharge	93000	(Cusecs)
Number of vents	9	Nos
Size of vents	12.2	metres each
Height of Shutter	2.29	metres
Catchment flood area	106	m^2
Crest level of regulator	+235.50 (+71.83 m)	
Sill-level of rear apron	+231.00(70.46 m)	
Observed M.F.L.	+256.20 on 24/09/1911	
Observed M.F.D.	75,306 c/s on 24/09/1911	
Observed M.F.L.	+256.50 on 29/07/1991	
Observed M.F.D.	93,000 c/s on 29/07/1991	
Observed M.F.L.	+255.00 on 27/07/1992	
Observed M.F.D.	72,576 c/s on 27/07/1992	
Observed M.F.L.	+291.50 on 03/07/2006	
Observed M.F.D.	1,67,004 c/s on 03/07/2006	
Left Side Sluice		
Sill-level of head sluices	+237.00 (+72.285 m)	
Designed discharge	414 cusecs	
Ayacut	31,200 acres	
Right Side Sluice		
Sill-level of head sluices	+237.00 (+72.285 m)	
Designed discharge	106 cusecs	
Ayacut	3643 ha (9,000 acres)	

FIGURE-2.4
GOOGLE IMAGE SHOWING TOTAPALLI BARRAGE AND REGULATOR

REAL TIME DISCHARGE DATA OF THOTAPALLI PROJECT HEADWORKS ACROSS NAGAVALI BARRAGE AT THOTAPALLI (V), GARUGUBILLI (H), VIZIANAGARM (DIST)

Division	:	Srikakulam
Subdivision	:	Palakonda
Circle	:	Bobbili
Section	:	Veeragattam

Month	Discharge (MCuM)
July-13	237.47
August-13	375.03
September-13	293.50
October-13	491.28
November-13	223.73
December-13	74.87
January-14	51.11
Feburary-14	22.42

PHOTOPLATE-2.3. THOTAPALLI REGULATOR

PHOTOPLATE-2.4. THOTAPALLI REGULATOR

2.3.3 Janjhavati Poject (Medium Irrigation Project)

The Janjhavathi reservoir project is a medium irrigation project across Janjhavathi river in Vizianagaram district, A.P., to irrigate an ayacut of 9,975 ha (24,640 acres). The project is contemplated to utilize a yield of 113.28 Mcum out of total available yield of 226.56 Mcum as per the Inter State agreement with Odisha State. The project was commenced during 1978 with an estimated cost of Rs.51 crores. The project envisages an earth dam in the right flank 3.15 km, a concrete non-over flow section of 278 m length (including the river gap portion), 6 bays of spillway block of 15 m length in the left flank, and left earthen dyke of 850 m length. The earth dam portion including the canal outlet (HR) and concrete non-overflow section of 218 m out of total of 278 m is has been raised up to 15 to 25 m. The spillway potion has been raised up to the bridge level. In the river gap portion, for a length of 60 m where the present construction is stopped at RL 122.3 m due to non-settlement of issues between Odisha and Andhra Pradesh regarding submergence of 420.48 ha (1038.60 acres as stated) of land in the Odisha territory. Reportedly, the canal system is complete. But as the reservoir has not been constructed fully, irrigation could not be provided.

This situation led to make an alternative temporary arrangement for providing irrigation to a part of the ayacut by providing a flexible water retaining structure, the rubber dam over the partly constructed dam base in the river gap portion (60 m). By this provision, the water could be stored up to 3.1 m height, i.e., up to RL 125.44 m and the water is released through the construction sluice to a diversion canal of 3.5 km length which joins the already constructed canal system at about 2.56 km on the down stream of the HR. By this, an area of 3643 ha (9,000 acres) is being irrigated in the proposed ayacut. In Janjhavathi dam, water filled Rubber Dam has been manufactured and installed by M/s Hydro-Construct Ges.m.b.H, Steyr, Austria.

SALIENT FEATURES OF JHANJAVATHI RESERVOIR PROJECT NEAR VILLAGE RAJYALAXMIPURAM, MANDAL KOMARADA, DISTRICT VIZIANAGARAM

1. Name of the Project	:	Janjhavathi Reservoir Project
2. Sector	:	Medium Irrigation Sector
3. Districts to be benefited	:	Vizianagaram district
4. Year of commencement	:	1976
5. Ultimate Irrigation Potential	:	24,640 acres
6. Catchment area	:	325 Sq. Miles
7. Maximum Flood Discharge	:	6200 Cumecs
8. Gross Storage	:	3.40 T.M.C.
9. Dead Storage	:	0.626 T.M.C.
10. Live Storage	:	2.774 T.M.C.
11. Number of fillings	:	1.02 No's
12. Length of Bund	:	4.28 km
13. Length of Spill Way	:	89.50 m
14. No. of vents and Size	:	6 No's of 12.00 m X 11.00 m
15. Crest Level	:	+ 135.20 m
16. Type of Gates	:	Radial
17. Designed M.F.D. of Spill Way	:	5585 Cumecs
18. F.R.L. / M.W.L.	:	+ 146.20 m
19. Top Width	:	5.00 m.

20. T.B.L. : + 149.20 m
21. No' of Sluices : 1 (Right Side)
22. Sill Level : + 134.80 m
23. Ayacut : 24,640 acres
24. Low Level Canal : Length: 27.15 km
Ayacut: 12,320 Acres
25. 1R Distributary : Length: 27.50 km
Ayacut: 12,320 Acres.
26. Link Canal : Length: 3.60 km
Start Bed Level: + 121.070 m
FSL: + 122.725 m
Ending Bed Level + 120.670 m
Ending F.S.L. + 122.325 m
Bed width: 6.400 m
FSD: 1.655 m.

FIGURE-2.5
GOOGLE IMAGE SHOWING JHANJAVATHI PROJECT

PHOTOPLATE-2.5. JANJHAVATI PROJECT (RUBBER DAM)

PHOTOPLATE-2.6. EMBANKMENT OF JANJHAVATI PROJECT

2.3.4 Vanaka Badi Gedda project

Name of the Dam : Vanaka Badi Gedda Dam

District : Vizianagaram
State : Andhra Pradesh
Basin Name : East flowing rivers between Mahanadi and Pennar
River/stream : Vanaka Badi Gedda
Dam Type : Earthen / Gravity / Masonry
Length of dam : 630 m
Dam height : 13 m
Total Volume content of dam : 1.99 TMC
Status of project : Under construction

FIGURE-2.6
GOOGLE IMAGE SHOWING VANAKABADI GEDDA PROJECT AND NORTHWESTERN BOUNDARY OF THE PLANT

FIGURE- 2.7
GOOGLE IMAGE SHOWING VANAKABADI GEDDA PROJECT

PHOTOPLATE-2.7. VAKAKABADI GEDDA AT IRRIGATION PROJECT SITE

PHOTOPLATE-2.8. EMBANKMENT OF VAKAKABADI GEDDA PROJECT (UNDER CONSTRUCTION)

2.4 Climate

There is no IMD meteorological station near the Komarada thermal power project. The nearest meteorological station is at Koraput, which is about 75 km in West from the plant.

The climate in the region may be divided into four seasons. The period from December to February is the dry, comparatively cool season. The summer season is from March to May which is followed by the southwest monsoon season from July to September. October and November constitute the post monsoon or the retreating monsoon season.

In October and November, storms originating in the Bay of Bengal, sometimes cross the east coast of India and move in westerly to northwesterly direction across Peninsula and affect the area causing wide spread rain. Thunder storms occur in summer and post monsoon months.

2.4.1 Temperature

Temperature is the lowest at the beginning of January and increases thereafter gradually at first and then rapidly after the middle of February or the beginning of March. The area falls in tropical region. The annual mean temperature in the area ranges from 16.7° C to 28.1°C.

2.4.2 Rainfall

Average annual rainfall based on rainfall data recorded at Rayagada station, for last 21 years has been observed as 1060 mm. Rains are received almost in all the months of the year but rains are minimum to nil during summer months. The yearly rainfall as recorded at Rayagada station is shown in **Table-2.2.**

TABLE-2.2
ANNUAL RAINFALL RECORDED AT RAYAGADA (ODISHA)
(YEAR 1993-2013)

Year	Rainfall (mm)	Year	Rainfall (mm)
1993	1037.70	2004	1304.50
1994	1312.50	2005	1222.90
1995	1430.20	2006	1977.20
1996	944.20	2007	791.00
1997	1101.10	2008	650.00
1998	1323.30	2009	862.00
1999	886.00	2010	334.00
2000	876.80	2011	614.00
2001	1200.80	2012	720.00
2002	903.30	2013	1452.30
2003	1317.20	**Average Annual**	**1060**

2.4.3 Humidity

High humidity of 80 to 84 per cent prevails in the morning over region from July to October. The humidity is about 66 to 73 per cent in the morning and 49 to 65 per cent in the afternoon from November to February, March is the most dry month when the relative humidity drops down to less than 42 per cent in the afternoon.

2.4.4 Cloudiness

Skies are generally moderately to heavy clouds during southwest monsoon season, being overcast on some days. During the rest of the year, the skies are normally clear to light clouds. During the months of June-July, the mean cloudiness (in Oktas) is usually more than 5, being generally higher in the evenings than the mornings.

TABLE-2.3
METEOROLOGICAL DATA AS RECORDED AT IMD KORAPUT

Month	Temperature		Relative Humidity		Mean Cloudiness	
	Mean Daily Max °C	Mean Daily Min °C	08:30%	17:30%	08:30 Oktas	17:30 Oktas
January	24.6	10.0	70	53	1.5	1.7
February	27.8	13.1	66	49	1.2	1.7
March	31.5	17.2	58	41	1.3	2.1
April	33.1	20.4	60	44	2.0	3.8
May	34.3	21.4	59	47	2.6	4.1
June	30.9	20.4	71	66	5.1	5.3
July	25.5	18.6	84	83	5.9	6.0
August	26.0	18.4	84	82	5.4	5.3
September	26.8	18.8	84	81	4.4	4.6
October	27.2	17.7	80	73	2.9	3.4
November	25.3	13.6	73	65	2.4	2.4
December	24.4	10.4	71	60	1.7	1.7
Annual Mean	28.1	16.7	72	62	3.0	3.5

2.4.5 Isopluvial Maps

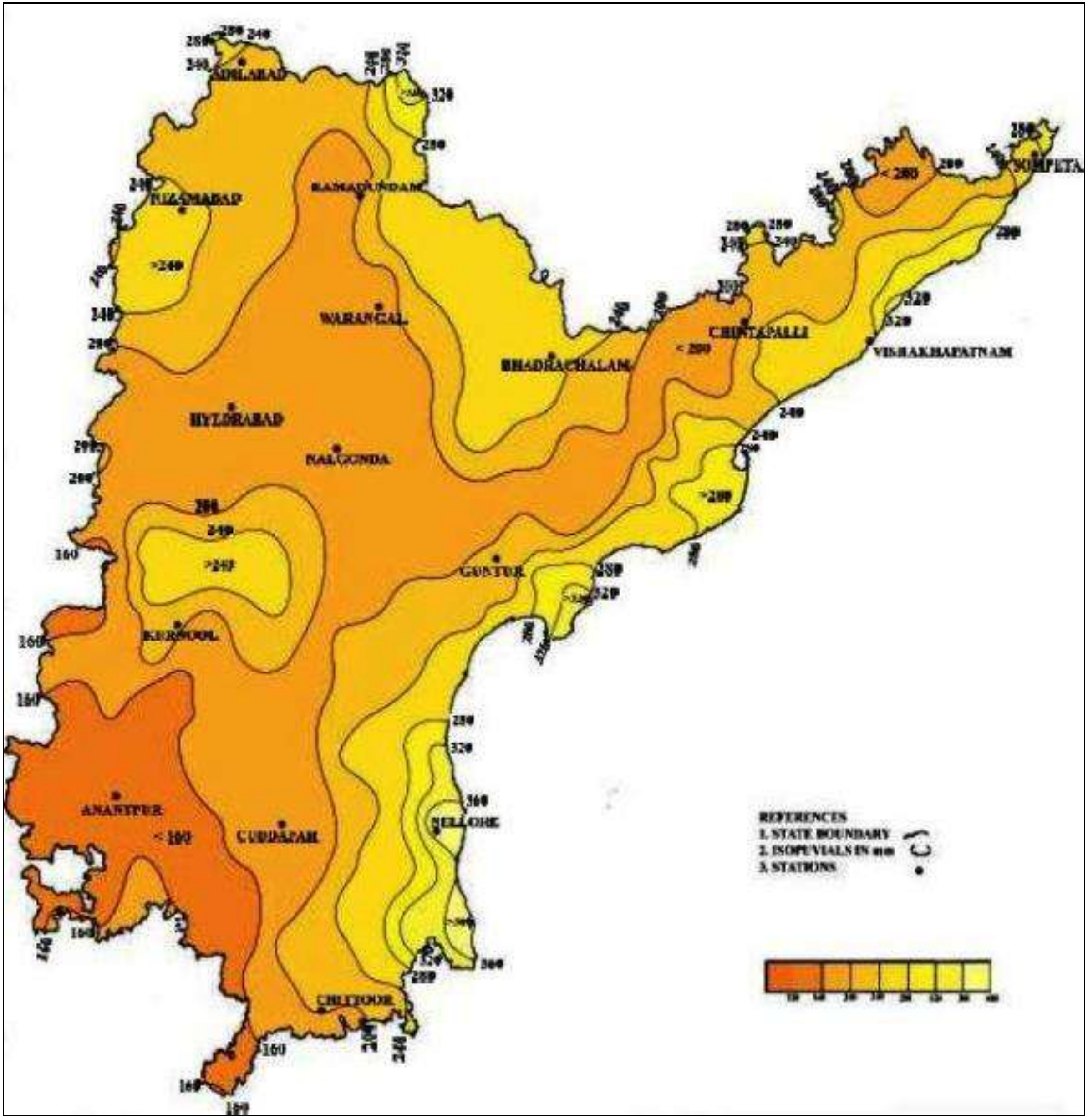
Extreme point rainfall values of different durations and for different return periods have been evaluated by IMD and the iso-pluvial (lines connecting equal depths of rainfall) maps covering the entire country have been prepared. These are available for rainfall durations of 15 min, 30 min, 45 min, 1 hr, 3 hr, 6 hr, 9 hr, 15 hr and 24 hr for return periods of 2,5,10,25, 50 and 100 years.

Isopluvial (Return Period) maps provide fairly reliable estimates of rainfall at a particular point / area. The return period is the average time in which a given magnitude of the event is equaled or exceeded.

The value of peak rainfall (**Figure-2.8)** used for the present study based on 25 years return period for 24 hrs = 200 mm.

2.5 Quality of Surface Water

The quality of surface water is good as the formation is alluvium. The rainfall being moderate and having adequate drainage, the surface water remains free from salinity. Water samples from stream/ponds have indicated low salts content, less than 100 mg/l and all constituents within permissible limits of drinking, industrial and irrigation purposes.



Source : – Atlas of state wise generalized isopluvial (return period) maps of India, Indian Meteorological Department

FIGURE-2.8

ANDHRA PRADESH-25 YEARS - 24 HOURS ISOPLUVIAL MAP (MM)

2.6 Design Storms

While designing the storm water management plan of plant, the concerned consultant must have considered a particular value of peak rainfall of last few years. In absence of non-availability to HCPL, peak storm water has been estimated by HCPL as under:

2.6.1 Strange's Run-off

The dependability has been calculated on the basis of 21 years rainfall, as indicated in Table**-2.4** where water availability has been considered for arriving at 50% dependability.

TABLE-2.4
RAINFALL DATA (ARRANGED IN DESCENDING ORDER, MENTIONING SERIAL NUMBER /ORDER NUMBER M) OF EACH YEAR'S RAINFALL

Sr.No., i.e. Order Number (m)	Rainfall in Descending Order in mm	Sr.No., i.e. Order Number (m)	Rainfall in Descending Order in mm
1	1037.70	12	944.20
2	1977.20	13	903.30
3	1452.30	14	886.00
4	1430.20	15	876.80
5	1323.30	16	862.00
6	1317.20	17	791.00
7	1312.50	18	720.00
8	1304.50	19	650.00
9	1222.90	20	614.00
10	1200.80	21	334.00
11	1101.10		

Using the following equation, the order number (m) was computed for the given dependability percentage p=50%, as:

$$m = N \times p/100$$

where,

m = Order number

N = The available rainfall data of the past N years is first of all arranged in the descending order of magnitude

p = Dependability percentage

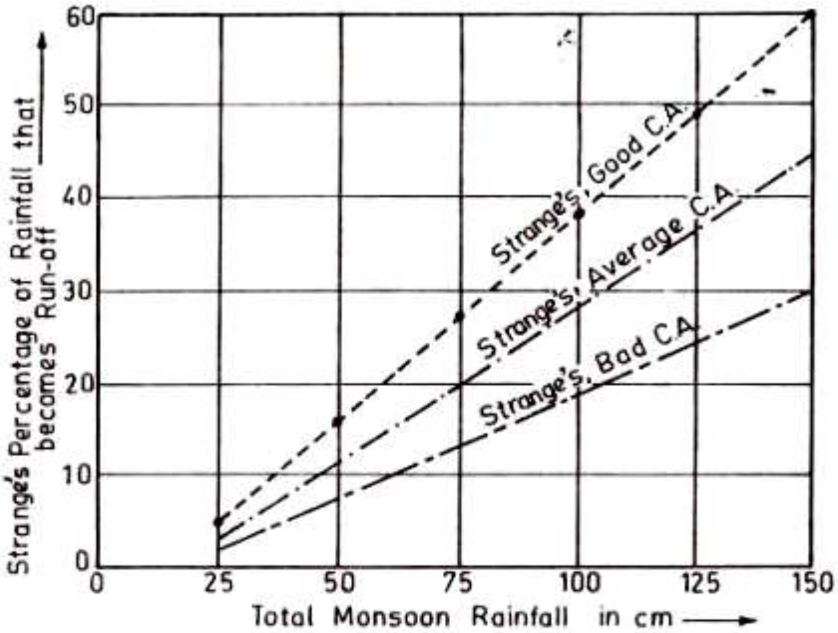
$$= 21 \times 50/100 = 10.5 \text{ or } 11$$

The rainfall value tabulated above in Table -2.4, the Order No. 11 has the values of 1101.10 mm or 110.11 cm; and hence the required dependable rainfall = 110.11 cm.

$$\text{So, } P_{50\%} = 110.11 \text{ cm.}$$

Average value of Strange's Run off percentage is calculated from Strange's monsoon rainfall-runoff curves considering the catchment area as good and the runoff % for the area is found as 42% **(Figure-2.9).**

FIGURE-2.9. STRANGE'S MONSOON RAINFALL-RUNOFF CURVES



2.7 Water Sheds in the Buffer Zone

The buffer zone (10 km radius area from plant boundary) is covered by two water sheds. One watershed (Jhanjavati river watershed) located in the northwestern part of the buffer zone while other water shed (Nagavali river watershed) cover rest of the buffer zone (**Figure-2.10)**.

2.7.1 Jhanjavati River Watershed

Jhanjavati river watershed lies in the northwestern part of the buffer zone. Jhanjavati river watershed covers an area of 136.30 km^2 with gradient of 2.48 m/km. The catchment yield of Jhanjavati river water shed within buffer zone is estimated as 63.03 million m^3 taking 42% as average runoff coefficient of the water shed and average rain fall of 1101 mm.

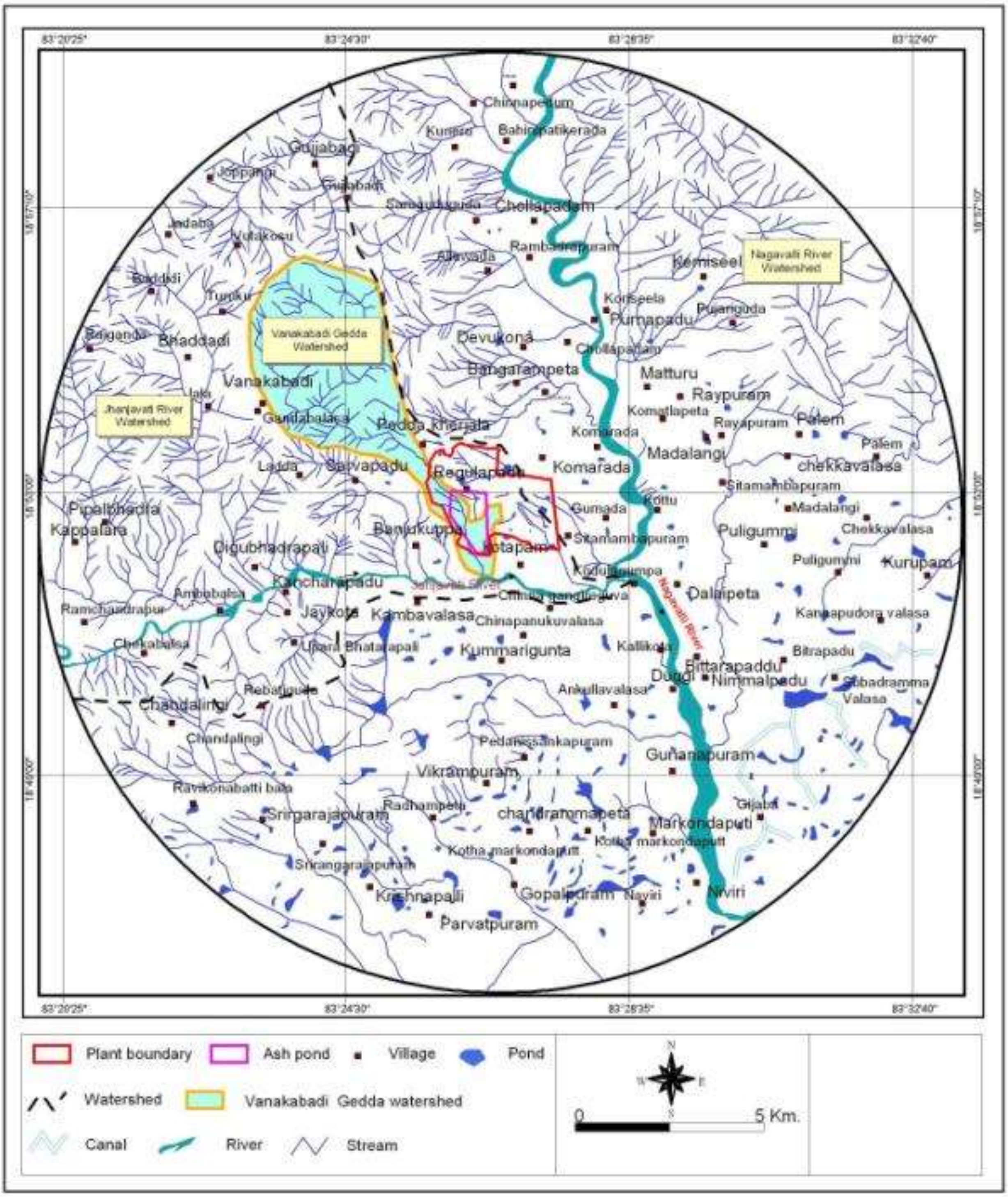


FIGURE-2.10
DRAINAGE AND WATERSHED MAP OF THE BUFFER ZONE

2.7.2 Nagavali River Watershed

Nagavali river watershed lies in the northwestern part of the buffer zone. Nagavali river watershed covers an area of 350.10 km^2 with gradient of 1.70 m/km. The catchment yield of Nagavali river water shed within buffer zone is estimated as 161.89 million m^3 taking 42% as average runoff coefficient of the water shed and average rain fall of 1101 mm.

2.8 Drainage Pattern in Plant Area

The power plant areas fall in Jhanjavati river water shed. The drainage pattern of the plant area is shown in **Figure-2.11** where one perennial stream (*Vanakabadi Gedda*) of fourth order originates outside the plant area, and passes through south western part of the plant area. The catchment area of this stream originating outside the plant area is about 18.2 km^2 (except catchment area of *Vanakabadi Gedda* within plant area). The catchment yield of *Vanakabadi Gedda* watershed (outside the plant area) is estimated as 8.42 mcm taking 42% as average runoff coefficient of the watershed and average rain fall of 1101 mm. This stream carries lot of water and is required to be channelized within plant area. However as a dam is being constructed, there will not be major flow in the stream, downstream of the dam except when it overflows. It has been proposed that over-flow of *Vanakabadi Gedda* will pass through the plant by a diversion drain. The overflow of the dam through the drain will ultimately continue to flow and go out of the plant area, later joining the natural stream **(Figure-2.12).** Also, seventeen number of ponds are existing in the plant area, the details of which are shown in **Table-2.5.**

TABLE-2.5
LIST OF EXISTING PONDS WITHIN PLANT AREA

Sr. No	Pond Name	Longitude	Latitude	Pond Area (ha)
1	Bulli Bandha	83°26'22.3"	18°53'21.7"	0.56
2	Yaddlavani Cheru	83°26'21.5"	18°53'18.6"	0.91
3	Regulapadu- I	83°25'51.6"	18°53'20.1"	0.53
4	Regulapadu -II	83°26'10.7"	18°53'15.2"	3.37
5	Pedda Bandha	83°26'54.8"	18°52'45.2"	1.24
6	Bella Bandha	83°26'22.8"	18°53'00.1"	0.98
7	Killadi Bandha- I	83°26'49.3"	18°53'03.8"	0.40
8	Killadi Bandha-II	83°27'05.7"	18°52'58.4"	0.76
9	Chaki Cheru-I	83°27'23.8"	18°53'00.7"	1.12
10	Mogla Cheru	83°27'20.2"	18°52'49.6"	3.83
11	Ganne Cheru-I	83°26'52.0"	18°52'32.9"	0.48
12	Ganne Cheru-II	83°27'09.5"	18°52'31.7"	0.30
13	Ethamann Bandha	83°27'22.7"	18°52'35.9"	0.48
14	Changunaidu Cheruvu	83°27'28.8"	18°52'19.2"	1.41
15	Koneru-I	83°26'17.0"	18°53'43.2"	0.56
16	Koneru-II	83°26'31.4"	18°53'37.6"	0.57
17	Mogili Bandha	83°25'51.3"	18°53'38.9"	0.75
			Total	**18.25 ha**

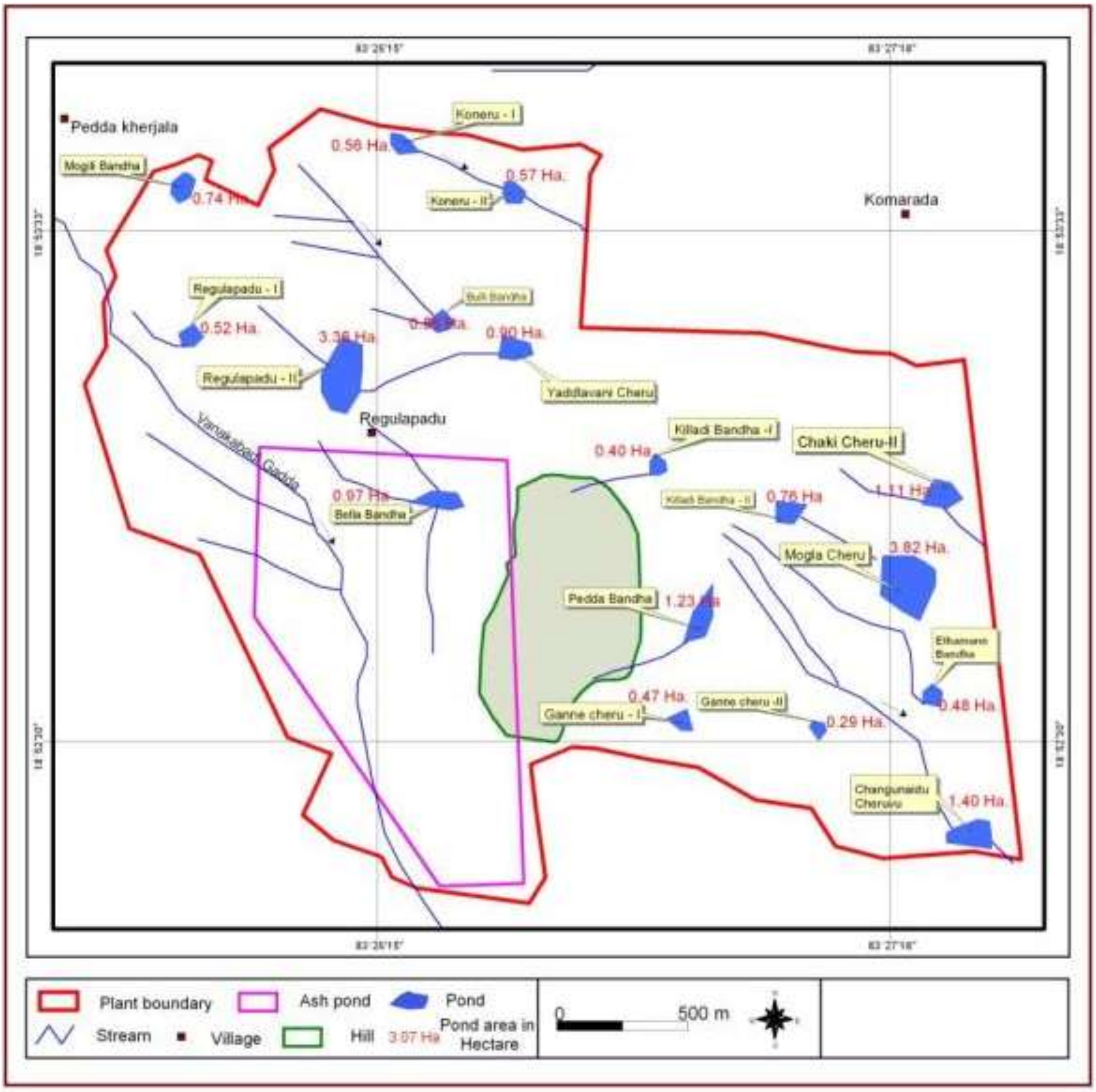


FIGURE-2.11
DRAINAGE MAP OF THE PLANT (BEFORE CONSTRUCTION)

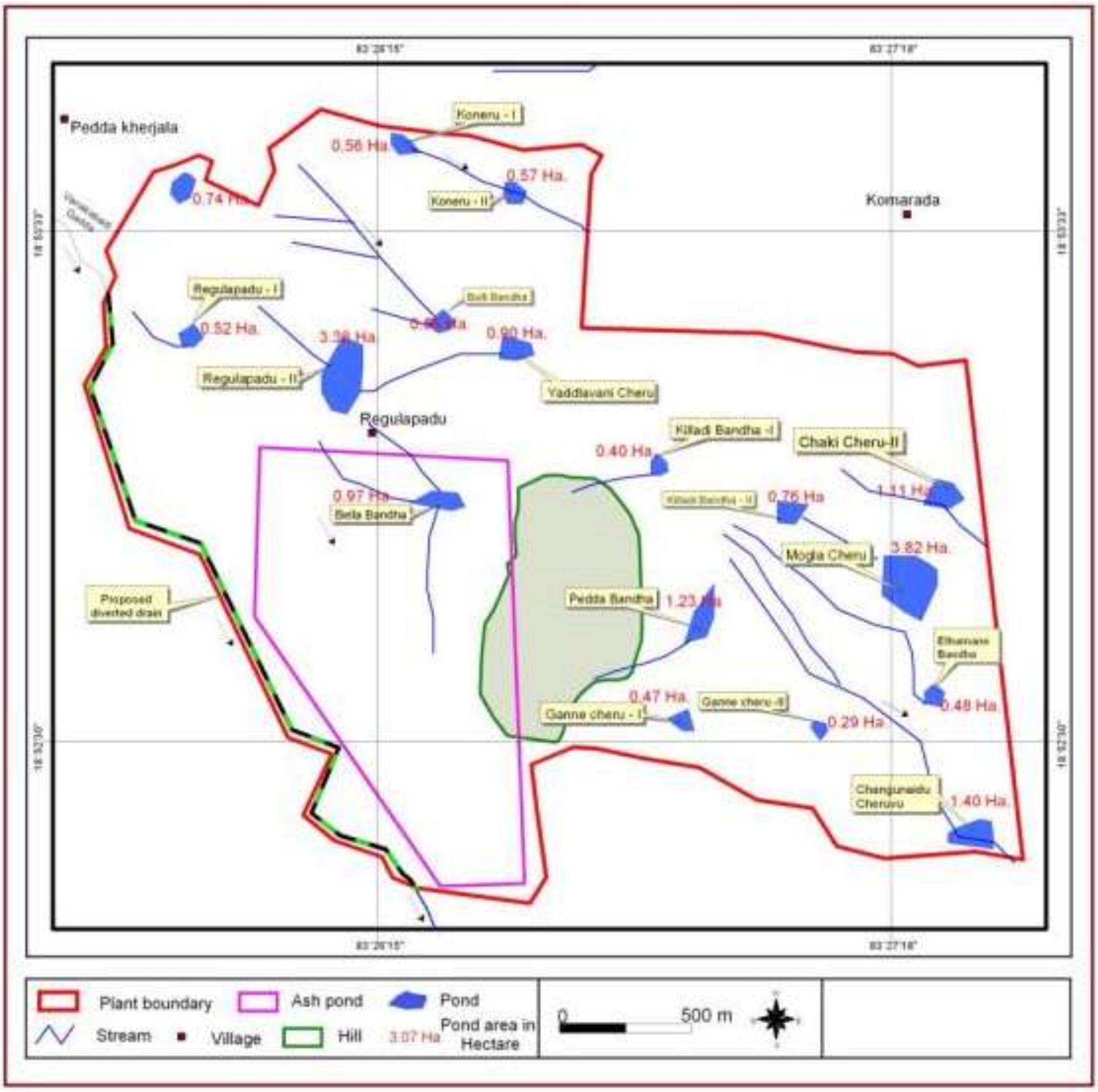


FIGURE-2.12

DRAINAGE MAP OF THE PLANT (AFTER CONSTRUCTION)

2.9 Micro Watersheds within Plant Area

In total, seventeen micro - watersheds have been delineated in the plant area **(Figure-2.13).** These micro -watersheds are catchment areas of existing ponds, except Vanakabadi Gedda watershed. These micro-water sheds have been prepared on the basis of latest satellite imagery of high resolution and survey of India toposheet and computer aided drainage analysis system.

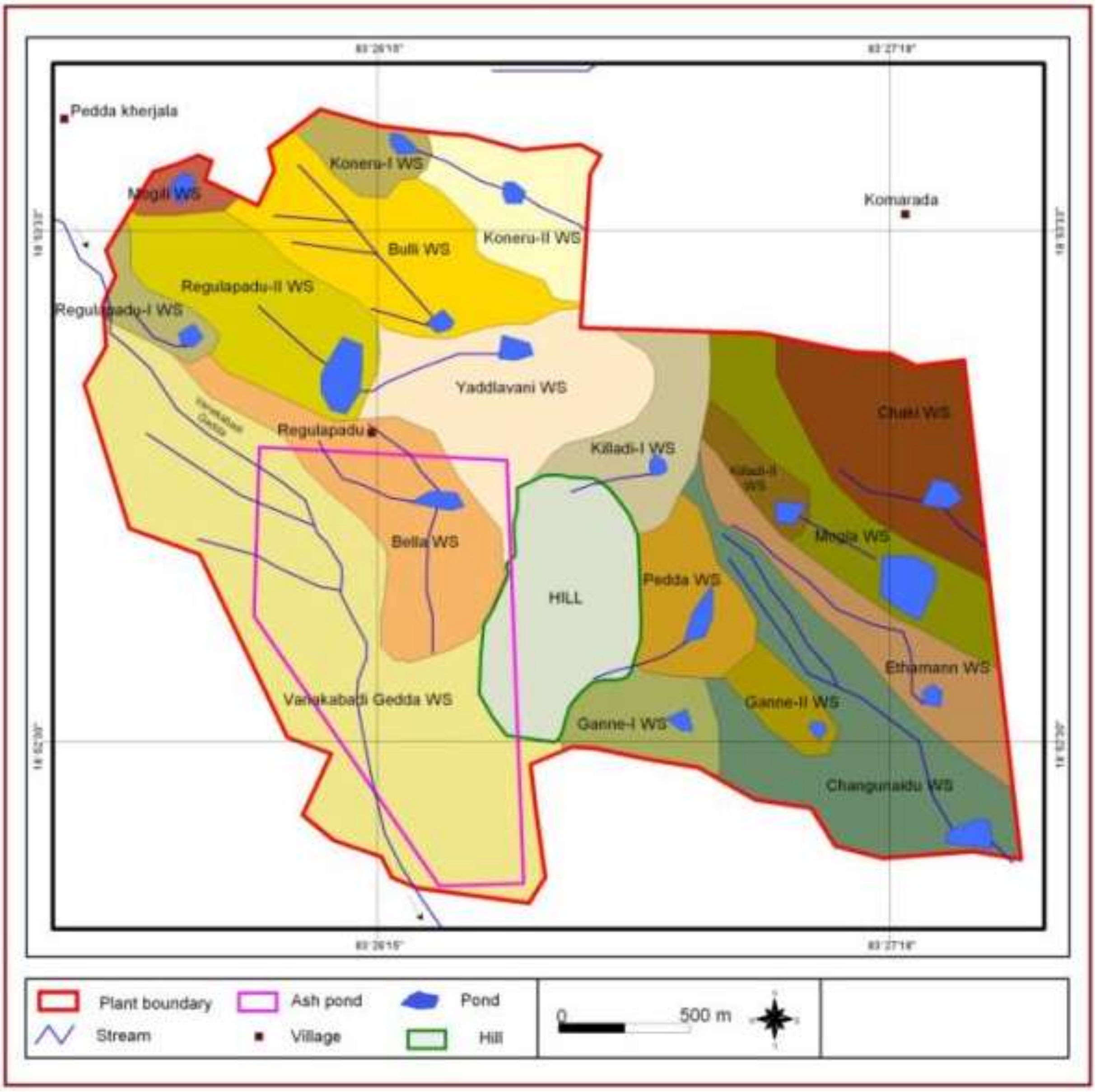


FIGURE-2.13
MICRO - WATERSHED MAP OF PLANT AREA

2.9.1 Mogili Micro - Watershed

Mogili micro-watershed covers the extreme north western part of the plant area.

Mogili micro-watershed covers an area of 0.06 km^2 with gradient of 0.019 m/km towards SE. The catchment yield of Mogili watershed is estimated as 0.03 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.2 Koneru-I Micro - Watershed

Koneru-I micro-watershed covers the northern part of the plant area. Koneru-I micro-watershed covers an area of 0.11 km^2 with gradient of 0.016 m/km towards SE. The catchment yield of Koneru-I micro- watershed is estimated as 0.05 mcm taking 42% as average runoff coefficient of the micro-water shed and average rain fall of 1101 mm.

2.9.3 Koneru-II Micro - Watershed

Koneru-II micro-watershed covers the northern part of the plant area. Koneru-II micro watershed covers an area of 0.26 km^2 with gradient of 0.015 m/km towards SE. The catchment yield of Koneru-II micro-watershed is estimated as 0.12 mcm taking 42% as average runoff coefficient of the watershed and average rain fall of 1101 mm.

2.9.4 Bulli Micro - Watershed

Bulli micro-watershed covers the north central part of the plant area. Bulli micro-watershed covers an area of 0.46 km^2 with gradient of 0.017 m/km towards SE. The catchment yield of Bulli micro-watershed is estimated as 0.21 mcm taking 42% as average runoff coefficient of the micro-water shed and average rain fall of 1101 mm.

2.9.5 Regulapadu-I Micro - Watershed

Regulapadu-I micro-watershed covers the western part of the plant area. Regulapadu-I micro -watershed covers an area of 0.09 km^2 with gradient of 0.018 m/km towards SE. The catchment yield of Regulapadu-I micro-watershed is estimated as 0.04 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.6 Regulapadu-II Micro - Watershed

Regulapadu-II micro-watershed covers the western central part of the plant area. Regulapadu-II micro- watershed covers an area of 0.42 km^2 with gradient of 0.010 m/km towards SE. The catchment yield of Regulapadu-II micro -watershed is estimated as 0.19 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.7 Yaddlavani Micro - Watershed

Yaddlavani micro-watershed covers the central part of the plant area. Yaddlavani micro -watershed covers an area of 0.52 km^2 with gradient of 0.016 m/km towards SE. The catchment yield of Yaddlavani micro-watershed is estimated as 0.24 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.8 Bella Micro - Watershed

Bella micro-watershed covers the central western part of the plant area. Bella micro-watershed covers an area of 0.48 km^2 with gradient of 0.006 m/km towards SE. The catchment yield of Bella micro-watershed is estimated as 0.22 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.9 Killadi-I Micro - Watershed

Killadi-I micro-watershed covers the central eastern part of the plant area. Killadi-I micro-watershed covers an area of 0.32 km^2 with gradient of 0.06 m/km towards SE. The catchment yield of Killadi-I micro-watershed is estimated as 0.15 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.10 Killadi-II Micro - Watershed

Killadi-II micro-watershed covers the central eastern part of the plant area. Killadi-II micro-watershed covers an area of 0.09 km^2 with gradient of 0.022 m/km towards SE. The catchment yield of Killadi-II micro-watershed is estimated as 0.04 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.11 Chaki Micro - Watershed

Chaki micro-watershed covers the north eastern part of the plant area. Chaki micro-watershed covers an area of 0.44 km^2 with gradient of 0.014 m/km towards SE. The catchment yield of Chaki micro-watershed is estimated as 0.20 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.12 Mogla Micro - Watershed

Mogla micro-watershed covers the eastern part of the plant area. Mogla micro-watershed covers an area of 0.36 km^2 with gradient of 0.01 m/km towards SE. The catchment yield of Mogla micro-watershed is estimated as 0.17 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.13 Ethamann Micro - Watershed

Ethamann micro-watershed covers the south eastern part of the plant area.

Ethamann micro-watershed covers an area of 0.30 km^2 with gradient of 0.007 m/km towards SE. The catchment yield of Ethamann micro-watershed is estimated as 0.14 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.14 Pedda Micro - Watershed

Pedda micro-watershed covers the south central part of the plant area. Pedda micro-watershed covers an area of 0.27 km^2 with gradient of 0.014 m/km towards SE. The catchment yield of Pedda micro-watershed is estimated as 0.13 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.15 Ganne-I Micro - Watershed

Ganne-I micro-watershed covers the southern part of the plant area. Ganne-I micro-watershed covers an area of 0.20 km^2 with gradient of 0.025 m/km towards SE. The catchment yield of Ganne-I micro-watershed is estimated as 0.09 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.16 Ganne-II Micro - Watershed

Ganne-II micro-watershed covers the southern part of the plant area. Ganne-II micro-watershed covers an area of 0.09 km^2 with gradient of 0.018 m/km towards SE. The catchment yield of Ganne-II micro-watershed is estimated as 0.04 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.9.17 Changunaidu Micro - Watershed

Changunaidu micro-watershed covers the south eastern part of the plant area. Changunaidu micro-watershed covers an area of 0.64 km^2 with gradient of 0.009 m/km towards SE. The catchment yield of Changunaidu micro-watershed is estimated as 0.30 mcm taking 42% as average runoff coefficient of the micro-watershed and average rain fall of 1101 mm.

2.10 Vanakabadi Gedda Watershed

Vanakabadi Gedda watershed covers the south western part of the plant area. Vanakabadi Gedda watershed covers an area of 1.74 km^2 with gradient of 0.015 m/km towards SE. The catchment yield of Vanakabadi Gedda watershed is estimated as 0.81 mcm taking 42% as average runoff coefficient of the water shed and average rain fall of 1101 mm.

2.11 Proposed Diversion of Vanakabadi Gedda

The proposed design of the diversion drain for the overflow of Vanakabadi reservoir has been done in such a way that it caters to the highest possible overflow from the reservoir getting surface runoff from its catchment area of 17.35 Km^2 covering entering point of Gedda in plant area and up to exit point. Total length of diversion drain is 2470 m. The invert level (bed level) at the entry point has been observed at 170.100 m. Net level difference in the bed level is 37.0 m.

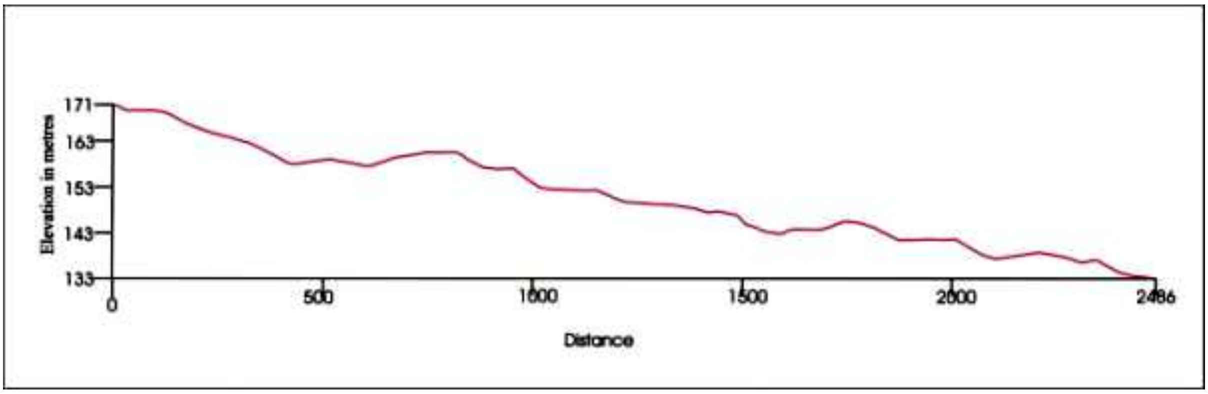


FIGURE-2.14 EXISTING PROFILE OF THE VANAKABADI GEDDA/ STREAM BETWEEN THE ENTRY POINT TO EXIT POINT

The cross-section of proposed drain is trapezoidal (Fig.2.14) with base width of 16.0 m and side slope of 1V:1.5H. Bed of the drain is unlined whereas the sides will have boulder pitching with grass in the intervening space.

Channel Design Data

i. Longitudinal Slope of Channel 1 in 67
ii. Bottom Width = 20.0
iii. Depth of HFL = 2.07 m
iv. Side Slope = 1(V) : 1.5 (H)
v. Free Board = 300 mm (MIN)
vi. Provide Boulder Lining 150mm thick at side slope of channel
vii. The existing drain shall be guided at the entry point and the exit point.
viii. Diversion Channel Analysis

Parameter	Value	Unit
Flow	242.0	cms
Depth	2.071	m
Area of Flow	47.853	m^2
Wetted Perimeter	27.467	m
Hydraulic Radius	1.742	m
Average Velocity	5.057	m/s
Top Width (T)	26.213	m
Froude Number	1.195	
Critical Depth	2.317	m
Critical Velocity	4.449	m/s
Critical slope	`0.01017	m/m

Parameter	Value	Unit
Critical Top Width	26.952	m
Calculated Max Shear Stress	303.286	N/m^2
Calculated Avg Shear Stress	255.138	N/m^2

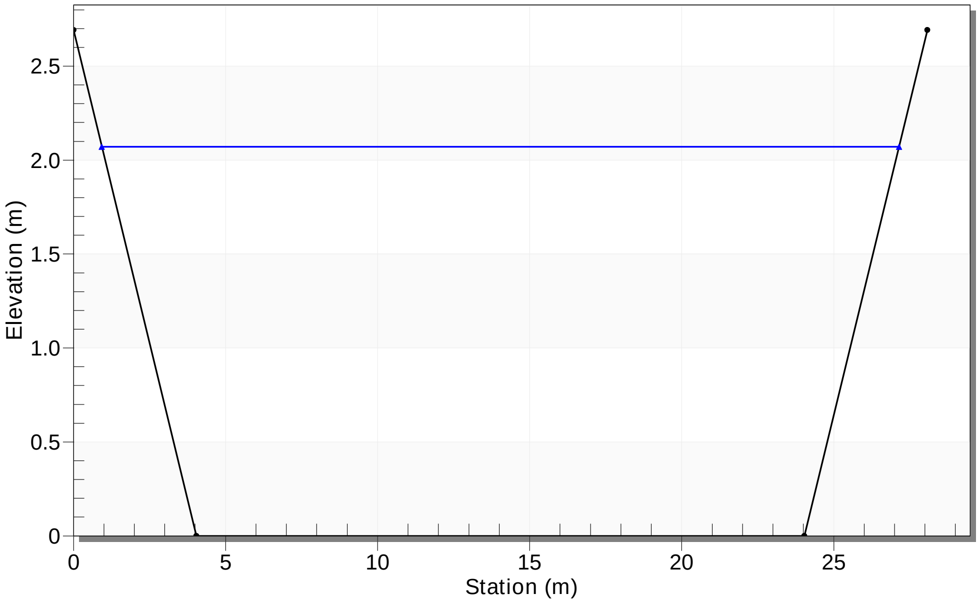


FIGURE-2.15
PROPOSED DIVERSION (TRAPEZOIDAL) CHANNEL –VANAKABADI GEDDA

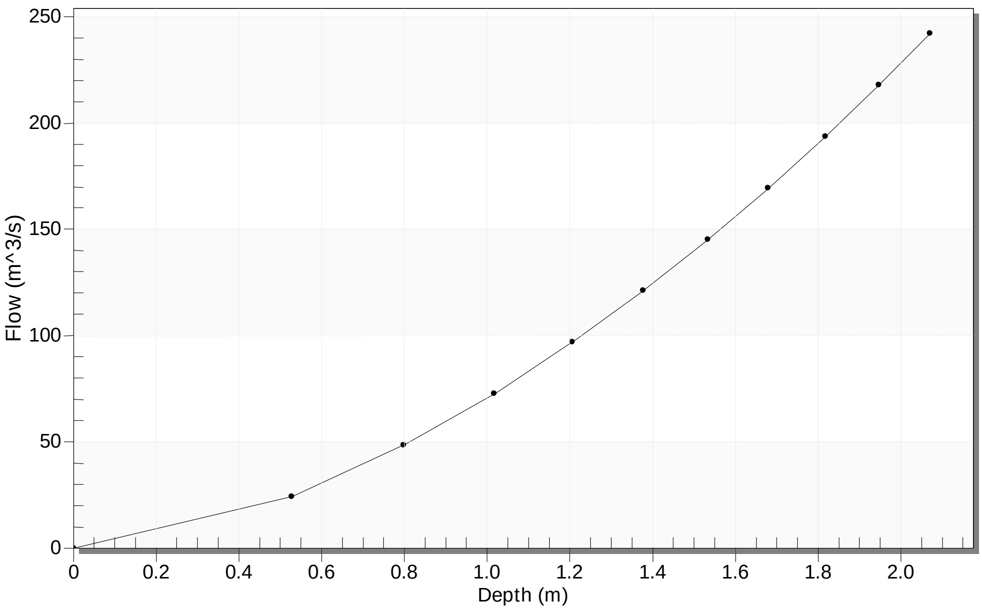


FIGURE-2.16
PROPOSED DIVERSION OF VANAKABADI GEDDA (FLOW VS DEPTH)

Basis for Design

For the design of proposed drain, calculation of catchment area has been done using Dickne's formula

$$\mathbf{Q_p = C.A^{3/4}}$$

Where Q_p is peak flood discharge in cumec, C is a constant depending upon nature of catchment intensity of rain fall. For eastern India (Orissa and Andhra Pradesh region) C = 28.0, A is the catchment area in sq.km.

Based on the calculated peak discharge, the cross-section of drain has been worked out. Manning formula has been used for this purpose. Average slope of drain along its length is 1 in 67 (S = 0.01494). The Roughness Coefficient has been considered as 0.0225 for unlined channel. The velocity of flow has been fixed in such a way that it is above sub-critical velocity to avoid silting and below maximum allowable velocity to avoid erosion of unlined channel.

Calculation of Catchment Area

Estimation of discharge in Vanakabadi Gedda

Dicken's formula for Run off Discharge is $Q_p = CA^{3/4}$

Q_p = Peak flood discharge

C = A constant, depending upon nature of catchment, Intensity of rainfall etc. in different provinces for Orissa/AP. value of C = 28.0

A = is the catchment area in Km^2 = 17.35 Km^2

Peak Flood Discharge **Q_p = 239.57 Cumec**

Comparison of Discharge

The peak discharge estimated in Vanakabadi Gedda upto the boundary of thermal power plant is 239.57 cumecs. The design discharge of diverted stream is 242.0 cumecs which is more than the peak overflow discharge.

3.0 HYDROGEOLOGY

3.1 Regional Geology

The geology of the area is mainly composed of alluvial cover; belonging to Sub-Recent to Recent of Quaternary Period followed by high grade foliated metamorphic rocks of Khondalite of Khondalite Group of Eastern Ghat Supergroup of Archaean age. Geological succession summarized as follows:

Age	Super group	Group	Lithology
Quaternary			Alluvium
Archaean	Eastern Ghat	Khondalite	Khondalite

Khondalite: The term Khondalite was introduced by T.L. Walker to refer to a foliated metamorphic rock composed of garnet, sillimanite and graphite. Feldspar occurs in some cases. The name is coined in honour of a hill tribe “Khonds” in whose mountains this rock is well developed. The Khondalite has been derived from high alumina clay which were also rich in iron. Some varieties rich in feldspar, such as those seen in the Eastern Ghats near Vizianagaram, owe their feldspar content to granitization. In some cases, feldspar occurs as phenocryst too. On weathering, these rocks give rise to laterite and bauxite.

3.2 Hydrogeology of 10 km Area (Buffer Zone)

Both core and buffer zones have mainly alluvium as aquifer zone. There are two major rivers in the buffer zone, i.e. Nagavali and Jhanjavati rivers, both are perennial in nature. The hills constitute nearly 33% area of the buffer zone and rest of area is composed of alluvium **(Figure-3.1)**.

3.3 Nature of Occurrence of Groundwater

Ground water occurs under water table conditions in alluvium, and is transmitted through pore spaces. Alluvium is pervious in nature and has primary porosity.

The depth to water table in plant area ranges from 2.00-3.00 m below land surface during post monsoon period and 4.00-5.00 m during pre-monsoon period. The depth to water in buffer zone ranges from 2.00 to 8.00 b.g.l. during post-monsoon period while it is deeper ranging from 3.00 to 10.00 m b.g.l during pre-monsoon. However, the water levels are shallow near streams, ponds and low lying areas in buffer zone where it ranges from 0.5 to 2.00 m.

3.4 Movement of Ground Water

Ground water movement is controlled mainly by the hydraulic conductivity of the aquifer and hydraulic gradient. The ground water movement in alluvium is mainly through the pore spaces.

A review of the topography and drainage pattern in the major part of the buffer zone reveals that the general slope of the area is towards south east. The ground water flow in this part of the buffer zone is also towards southeast with hydraulic gradient as 6-7 m/km. as calculated from the monitoring of wells of the area **(Figure-3.2).**

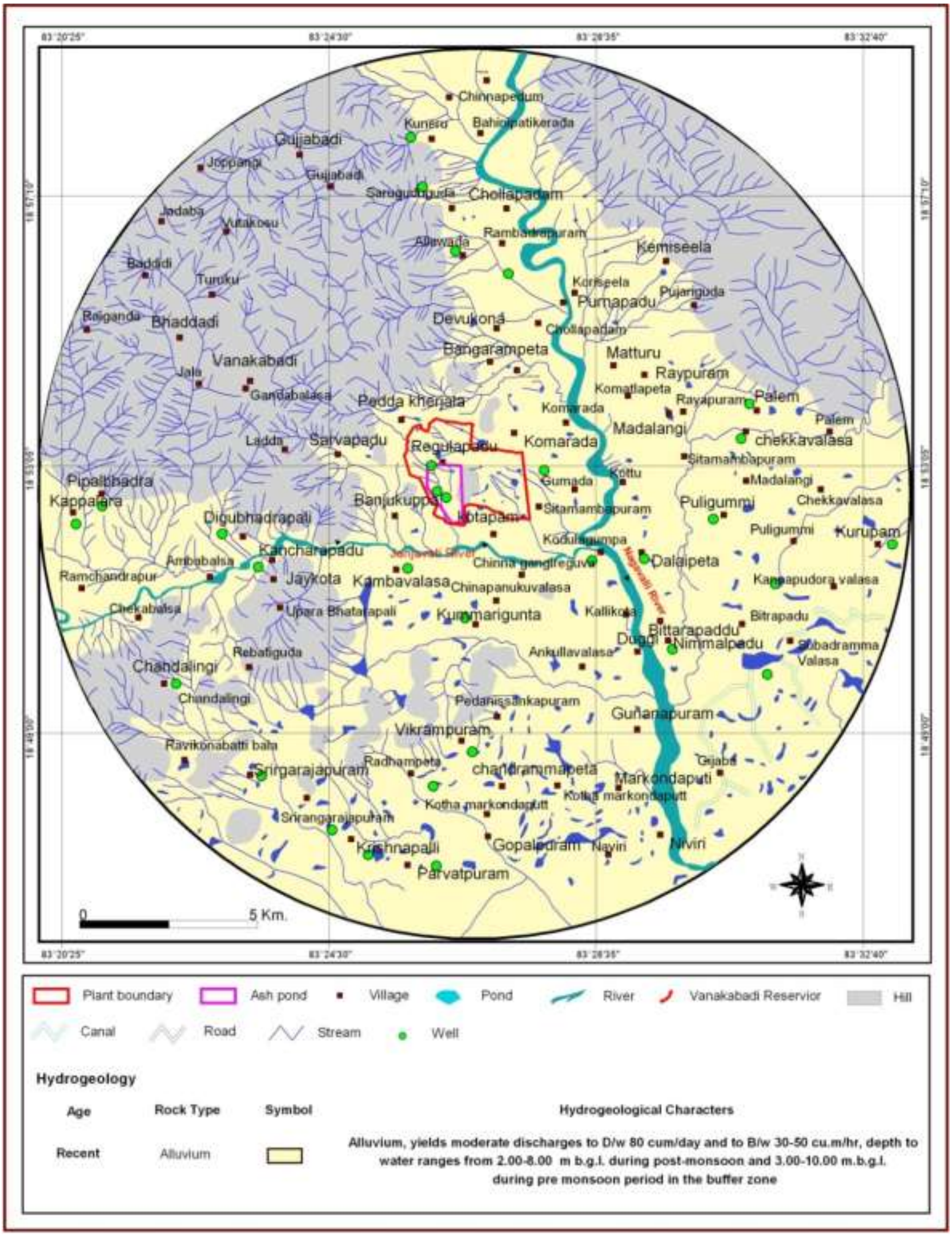


FIGURE-3.1
HYDROGEOLOGICAL MAP OF BUFFER ZONE

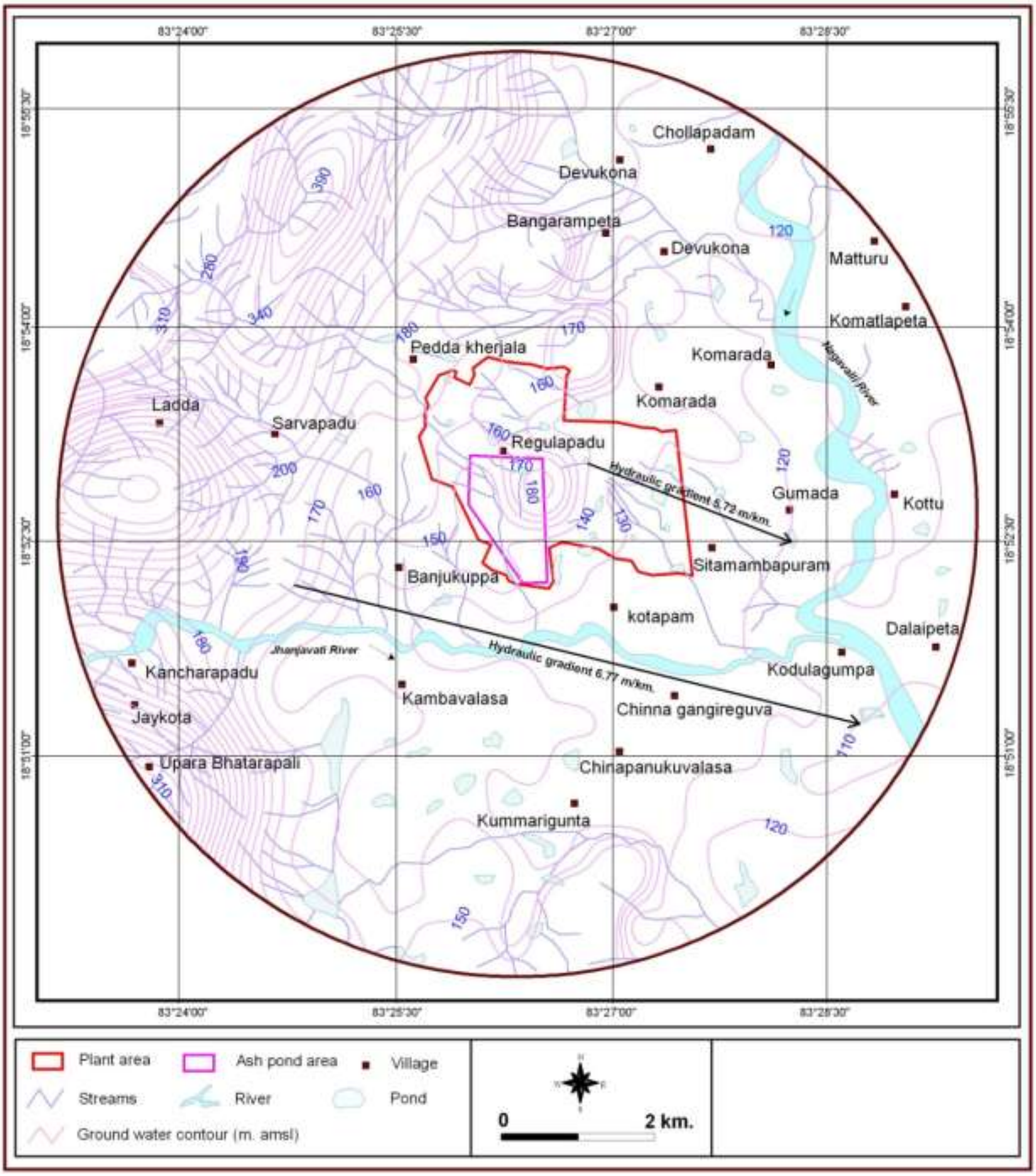


FIGURE-3.2

GROUND WATER CONTOUR MAP WITH HYDRAULIC GRADIENT

3.5 Nature of Hydraulic Conductivity

The principal aquifer of the area is mainly alluvium having high hydraulic conductivity which is mainly developed due to interstitial openings of granular material.

Although, there are few bore wells in the area, pump tests to find out hydraulic conductivity had not been conducted. Pump tests carried by out in nearby areas on a bore well tapping alluvium has indicated hydraulic conductivity (K) of 50 m/day which can be classified as high.

3.6 Yield of Wells

There are few open dug wells and bore wells in the buffer zone tapping alluvium for irrigation and hand pumps mostly used for drinking purpose in villages. The yield of such hand pumps is just sufficient to meet the drinking water requirement. The yield of such hand pumps range from 500-1,000 litres per hour of potable quality of water. Although, open wells can yield more water, limited quantity of water; hardly 80 m^3/day is drawn. Bore wells yield about 30 to 50 m^3/hour.

3.7 Quality of Groundwater

Quality of ground water is potable having total dissolved salts less than 500 mg/l, the acceptable limits of Indian Drinking Water Standards (IS 10500-2012). All other constituents are also within acceptable limits.

3.8 Comprehensive Hydro-Geological Assessment of Core & Buffer Zones

3.8.1 Ground Water Recharge

The main source of ground water recharge is by the rainfall by direct percolation to the zone of saturation. There is well developed drainage in the area due to moderate rainfall and loamy soils. A significant part of the rainfall is lost as runoff from the area while a limited percentage of rainfall therefore reaches zone of saturation and becomes the part of ground water storage after meeting the evaporation and evapo-transpiration losses. There is also ground water recharge from the return flow of irrigation water pumped from bore wells and open well operated by the cultivators. The ground water recharge from return flow of irrigation is normally taken as 20% of the total water applied for irrigation this percentage has been suggested by the Ground Water Estimation Committee for ground water assessment for this part of the state.

3.8.2 Ground Water Recharge of Core Zone (Plant Area)

The core zone covers 678 ha (1675 acres) area of thermal plant, mainly composed of alluvium. There are no operational dug wells or bore wells with pump in the plant area. The recharge from rainfall infiltration as per the guidelines of the Ground Water Estimation Committee, Govt. of India (1997) has also been calculated just for counter check.

3.8.3 Increment in Ground Water Storage

The ground water recharge can be computed by multiplying the increment in ground water storage by measuring the water level fluctuation during pre and post monsoon periods with area of assessment and specific yield. The equation can express as under:

$$R = h \times Sy \times A$$

Where h is the rise of water level due to monsoon, Sy is the specific yield of the aquifer, and A is the area of computation of recharge, while R is ground water recharge.

Increment in the ground water storage in the core zone was determined by recording the water levels in the wells close to the plant area during pre and post-monsoon periods of 2013 as enquired by the cultivators while the well inventory was being done during the field investigations. Average rise of water level in the alluvium due to rainfall was found as 2.10 m. Taking the specific yield value of 10% for this zone, ground water recharge is estimated as under:

$$6.78 \times 1000 \times 1000 \times 0.10 \times 2.10 = \quad 1.43 \text{ mcm}$$

Plant area x specific yield of alluvium x Increment in groundwater storage = Recharge

This ground water recharge has taken place due to rainfall of 1452 mm for the year 2013 but when normalized to average annual rainfall of 1060 mm, it amounts to **1.04 mcm.**

3.8.4 Rainfall Infiltration

The Ground Water Resource Estimate Committee (1997), formed by Govt. of India has proposed rainfall infiltration factor to be used for estimation of ground water recharge for the areas where monitoring of wells can not be done or has not been done.

The recharge can be estimated by the following equation:

$$R = Rf \times A \times r$$

Where Rf is rainfall infiltration factor, A is area and r is annual rainfall while R is ground water recharge.

The committee has suggested 15-25% as the rainfall infiltration factor for unconsolidated alluvium. Taking the value of rainfall infiltration as 15%, the ground water recharge from rainfall for core zone has been estimated as **1.08** mcm.

$$6.78 \times 1000 \times 1000 \times 0.15 \times 1.060 = \mathbf{1.08\ mcm}$$

Plant area x rainfall infiltration of alluvium x Av. Annual rainfall = Recharge

This value of ground water recharge calculated from rainfall infiltration matches very well with the value calculated on the basis of actual increment in ground water storage by rainfall.

3.8.5 Ground Water Recharge of Buffer Zone (10 km Radius Area)

Buffer zone has mainly alluvium as water bearing formation. The total area of the buffer zone is 479.62 km^2 {(486.40 – 6.78) km^2 of the plant area} **(Figure-3.1)** in the district of Vizianagaram including 162.80 km^2 areas of hills. The area of buffer zone, after deducting the areas occupied by hills, amounts to 316.82 km^2. There is canal irrigation and major part of the cultivable area is dependent on rainfall while some area is irrigated by open wells and bore wells.

The ground water fluctuation of water table during pre and post-monsoon periods were recorded for the year 2013 from the 30 key wells (Appendix-I) as per the guidelines of the Ministry of Environment & Forests and taking specific yield values of 10% for alluvium, the ground water recharge by rain fall has been calculated as under:

3.8.6 Increment in Ground Water Storage

Ground water recharge from rainfall for the year 2013, which was more than the average rainfall year for the area, has been calculated by measuring the rise of water levels in the key wells of the 316.82 km^2 area of buffer zone **(Appendix–I).**

The water levels were checked with the well owners as during pre-monsoon period and again during post monsoon period of the year 2013 when the field investigations were done. The rise of water level indicates the quantity of water percolated to zone of saturation due to recharge from rainfall.

The aerial rise of water has been computed by contour method for water bearing formation and rise was noted as 2.10 m in alluvium. Such a high value of rise of water level is due to more rainfall in 2013. Taking specific yield value of 10% for alluvium, the ground water recharge has been calculated for the area covered by alluvium. The alluvium covers an area of 316.82 km^2.

$$316.82 \times 1{,}000 \times 1{,}000 \times 0.10 \times 2.10 = 66.53 \text{ mcm}$$

Buffer area x specific yield of alluvium x Increment in groundwater storage = Recharge

The total ground water recharge of the buffer zone has been calculated as 66.53 mcm against the rainfall of 1452 mm recorded during the year 2013 which when normalized for average rainfall of 1060 mm amounts to **48.57 mcm.**

3.8.7 Rainfall Infiltration

The Ground Water Resource Estimate Committee, formed by Govt. of India has proposed rainfall infiltration factor to be used for estimation of ground water recharge for the areas where monitoring of wells can not be done or has not been done.

The committee has suggested 15-25% as the rainfall infiltration factor for unconsolidated alluvium. Taking the value of infiltration as 15%, the ground water recharge from rainfall for buffer zone has been estimated as **50.37** mcm.

$$316.82 \times 1{,}000 \times 1{,}000 \times 0.15 \times 1.060 = \mathbf{50.37\ mcm}$$

Buffer area x rainfall infiltration of alluvium x Av. Annual rainfall = Recharge

This value of ground water recharge calculated from rainfall infiltration matches with the value calculated on the basis actual increment in ground water storage by rainfall.

3.8.8 Return Flow of Irrigation

The norms prescribed by the Estimate Committee for return seepage from the irrigation fields for loamy soils has been suggested as 20% of the total water applied for the irrigation. There are a number of open wells and bore wells in the buffer zone being operated for irrigation tapping alluvium. In addition, 4800 hectares of land is being irrigated by canals, providing 86.40 mcm of water during the year 2013. Taking 20% as return flow to saturation zone, ground water recharge by seepage amounts to 19.53 mcm.

$$(86.40 + 11.23) \times 0.20 = 19.53 \text{ mcm}$$

(Surface water + Ground water) × return flow = recharge

The total ground water recharge therefore amounts to **69.14 mcm** after including recharge from return flow of irrigation water.

3.9 Ground Water Discharge

3.9.1 Ground Water Discharge in Core Zone (Plant Area)

At present, there is no operational dug well or bore well (with pump) in the plant area. So, the total ground water discharge from core zone is nil. There is also no proposal to draw any ground water for the plant as the water requirement of 8000 m^3/hr will be met from the dam on Nagavalli river.

3.9.2 Ground Water Discharge in Buffer Zone (10-km Radius Area)

The ground water discharge takes place mainly by evapo-transpiration and by withdrawal from bore wells and open dug wells operated mainly for irrigation.

There are 180 open wells with pumps in operation for irrigation tapping alluvium along with 330 bore wells. Average yield of open wells with pump tapping alluvium has been taken as 80 m^3/day, while bore wells yield 240 m^3/day. Taking these values, the discharge from alluvium is estimated as under.

180×80×120 = 1.73 mcm (Open wells with pumps tapping alluvium)
No. of wells × average yield/day × Rabi irrigation = Withdrawal

330×240×120 = 9.50 mcm (Bore wells with pumps tapping alluvium)
No. of B/w × average yield/day × Rabi irrigation = Withdrawal

In addition, the drinking and livestock water requirement of around 40 villages having a local population of about 1,67,322 is met by bore wells, open dug wells and hand pumps and is around 4.58 mcm considering 75/litre/capita/day consumption, i.e. therefore amounts to **15.81 mcm**.

3.10 Present Status of Ground Water Development

The present study reveals that against the total ground water recharge of 69.14 mcm, including recharge from return flow of irrigation water, the ground water discharge is 15.81 mcm indicating the status of ground water development of buffer zone as 22.87 %. The buffer zone therefore appears to be safe. Similarly, against nil ground water discharge, the core zone receives ground water recharge of 1.04 mcm indicating safe status of ground water development.

The Central Ground Water Board in association with state ground water organization carry out estimation of dynamic ground water reserves of every taluka/mandal of the state by monitoring the water levels in key wells during pre and post monsoon periods every year along with estimation of ground water draft. The report is published once in two years and last report has been released in November, 2011 for the dynamic ground water reserves as on 31.03.2009. This report places all the talukas/ mandals in different categories like safe, semi-critical, critical and over-exploited depending on the status of ground water development and long term water level trend. This report has indicated the status of ground water development of mandal Komarada of district Vizianagaram indicating present status of ground water development of 20 % only and thus is placed in safe category.

4.0 GEOTECHNICAL INVESTIGATIONS FOR ASH POND AREA

4.1 Introduction

It is proposed that coal for the power plant will be imported from Indonesia. The total coal requirement will be 7.61 MTPA. Taking the maximum ash generation of 16%, it is anticipated that fly ash of 0.976 MTPA and Bottom ash of 0.244 MTPA will be produced. Initially, it will be stored in ash pond area covering 300 acres in the south-western side of the plant area and on the western side of the hill till fly ash is collected by the nearby cement plant and only bottom ash remains in the pond. With a view to find out the necessity of either laying the natural clay or HDPE lining at the bottom of the ash pond area so that ground water does not get contaminated, it was considered necessary to conduct geotechnical investigations to find out the in-situ permeability of the soil below the ash pond area. Accordingly, geotechnical investigations were conducted in the ash pond area and details are discussed as under.

4.2 Findings of Permeability Tests carried out Inside the Proposed Ash Pond Area

There are various methods to determine in-situ permeability of soils and these are mainly:

- Constant and falling head tests; and
- Laboratory permeability test.

Constant and Falling Head Tests

This field test is usually carried out in boreholes to determine permeability of substrata and is most reliable. In the constant head method, the water level in the test hole is maintained constant and the permeability is computed from the data of steady state constant discharge whereas in the falling head method, the water level in the test hole is allowed to fall and the equivalent permeability is computed from the data of the rate of fall of water level. The falling head method was adopted for the field studies in the ash pond area.

Laboratory Permeability Test

Few thin walled samples are obtained from the site and laboratory permeability testing is carried out. This method gives specific values of the site from where the samples were collected and its application over a large area has its limitations. If the clay / sub soil is very dry and hard, attempting thin walled sampling often disturbs the sample either during sampling or sample extraction prior to testing. Therefore the method was not considered useful in this case.

4.3 In-situ Permeability Test

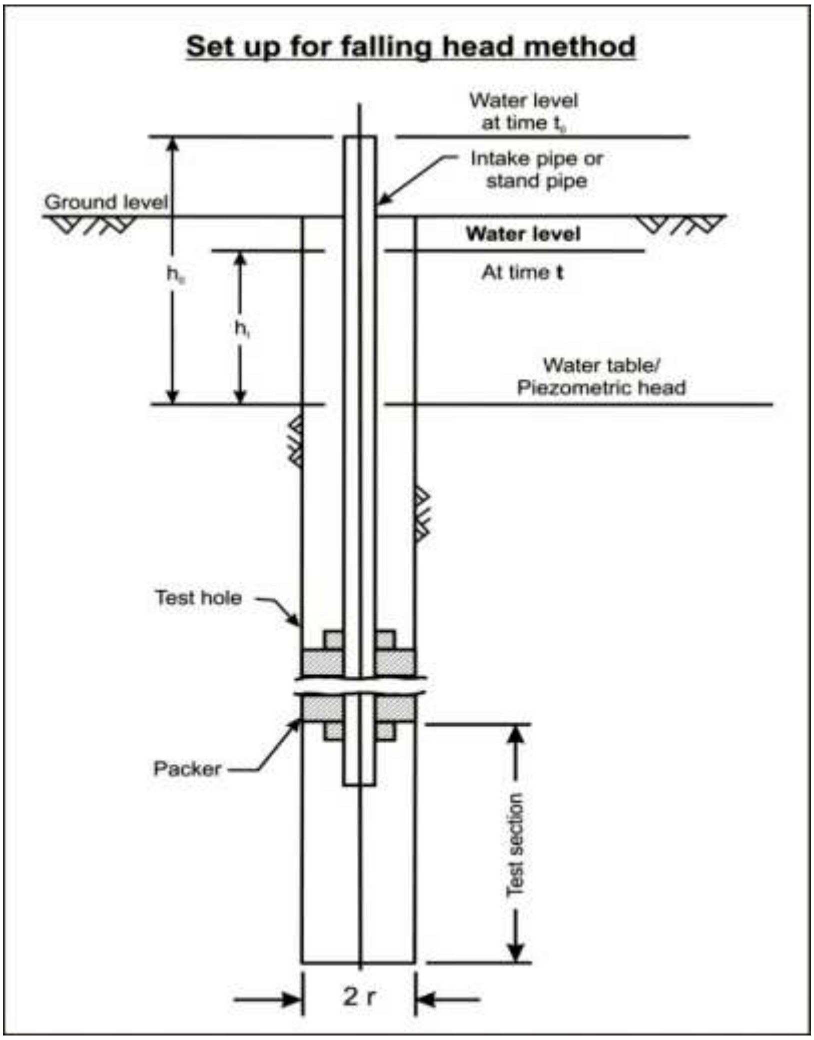
By Falling Head Method:

The coefficient of permeability is usually evaluated on the basis of Darcy’s law which states that the rate of flow through a porous medium is proportional to the hydraulic gradient. This relationship is applicable for steady and laminar flow through saturated soils.

Boreholes were augured to various depths depending on the refusal depth (rock) keeping a diameter of 100 mm. The hole was pre soaked 1 to 3 hours prior to testing. Tests were carried out at 12 locations in ash pond **(Figure-4.1 & Annexure-I).** The permeability by falling head method for different test horizons was computed by the following relation:

$K = d^2 /8L (\log_e L/R) (\log_e h_1 / h_2)/(t_1 - t_2)$

Where k= coefficient of permeability
d= diameter of intake pipe
L= length of test zone
h_1= head of water in pipe at time t_1
h_2= head of water in pipe at time t_2
R= radius of hole



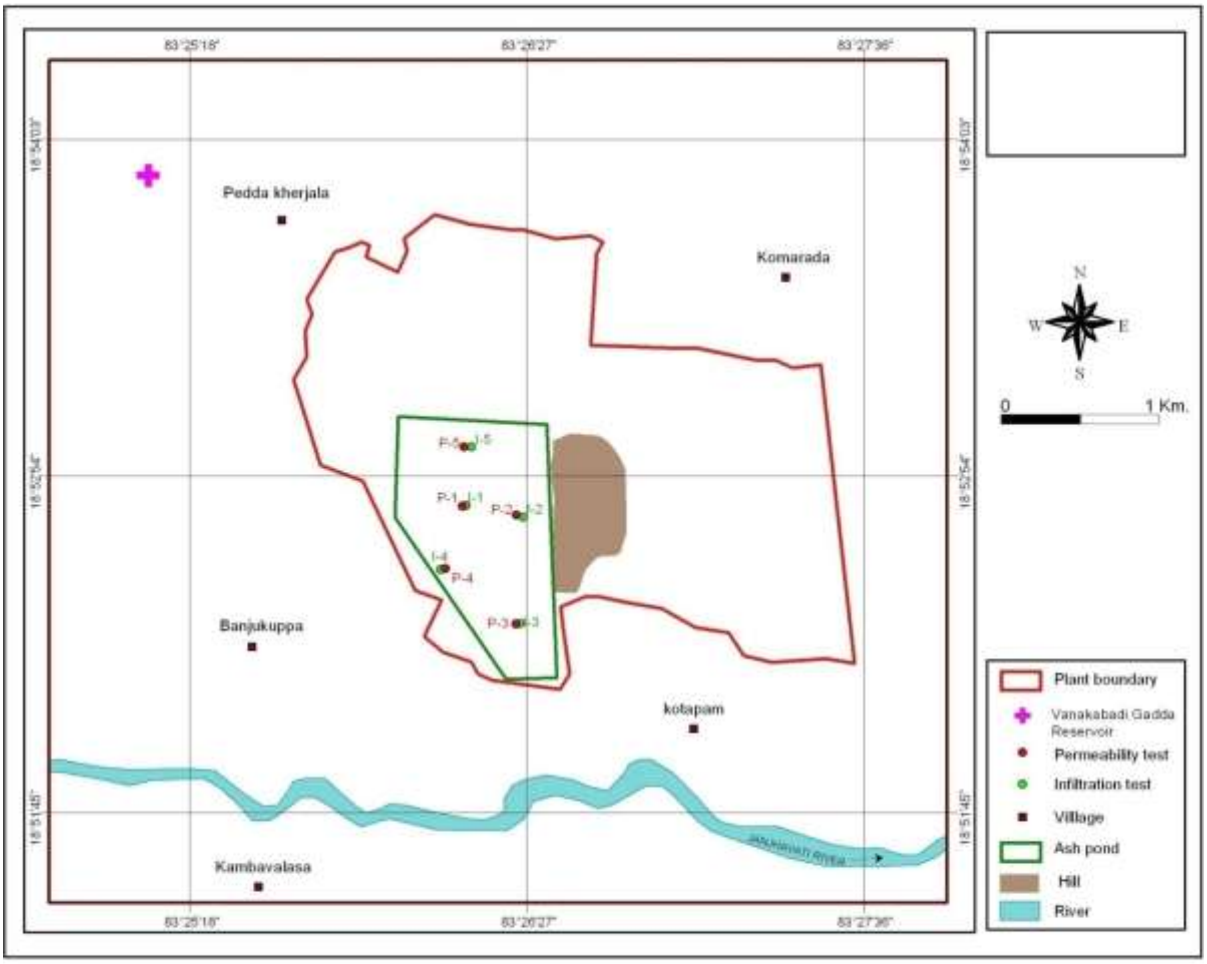


FIGURE-4.1
LOCATION OF PERMEABILITY & INFILTRATION TESTS

Results

In general, the permeability was calculated from the first 60 minutes drawdown.

TABLE-4.1
COEFFICIENT OF PERMEABILITY IN ASH POND AREA
(BASED ON FALLING HEAD METHOD)

Location	Depth tested below ground level (m)	K (cm/sec)
P-1	0-0.80	2.41048E-05
P-2	0-1.0	8.75E-06
P-3	0-1.20	9.32E-05
P-4	0-0.80	5.11E-06
P-5	0-1.0	9.47E-06

4.4 Infiltration Test

The infiltration tests were conducted using double ring infiltrometers. The double ring infiltrometer is a way of measuring saturated hydraulic conductivity of the surface layer, and consists of an inner and outer ring inserted into the ground. Each ring is supplied with a constant head of water manually. Hydraulic conductivity can be estimated for the soil when the water flow rate in the inner ring is at a steady state.

It works by directing water on to a known surface area due to the parameters of the inner ring. The rate of infiltration is determined by the amount of water that infiltrates into the soils per surface area, per unit of time. Infiltration can be measured by either a single or double ring infiltrometer, with preference usually lying with the double ring because the outer ring helps in reducing the error that may result from lateral flow in the soil.

TABLE-4.2
SOIL INFILTRATION RATES IN THE PROPOSED ASH POND AREAS

Location	Steady State Infiltration Rate (mm/hr)	Saturated Hydraulic Conductivity (Ksat in cm/sec)
I-1	78	0.003142
I-2	66	0.002658
I-3	90	0.003625
I-4	78	0.003142
I-5	72	0.0029

Analysis of Data

Data is gained by a drop in water height, giving an infiltration of water over time. These data points are plotted in a graph of infiltration versus time. Theoretically once the soil becomes saturated, a steady state infiltration rate will be reached, which is seen on a graph as a section of data points infiltrating showing linearality. Once this linear section is identified other outlying data points can be excluded from the analysis and a line of best fit can be fitted to the applicable data. The gradient of this fitted line gives the steady state infiltration rate for that particular soil. The steady state infiltration rate can then be multiplied 1.45, to obtain the hydraulic conductivity (K_{sat}), of that soil. This is a measure of how conductive a soil is at saturation, which is a measure of permeability. Accordingly soil infiltrations tests were conducted at 5 sites in ash pond area **(Figure-4.1)** and the soil infiltration rates were determined.

Interpretation of Base Line Data

Boreholes augured up to maximum of 1.20 m below the ground level in the area, reveal the thickness of sandy silt as 0.50 m followed by silty clay with some gravel and water table at a depth of 5.50 m below ground level. The in-situ permeability values range from 2.41×10^{-5} to 3.66×10^{-6} cm/sec for the silty clays, between depth from 0.0 to 1.20 m (Table-4.1).

The low-moderate infiltration rates of soil as 66 to 114 mm/hr (and hydraulic conductivity of 2.17×10^{-3} to 4.59×10^{-3} cm/sec) observed in the study area is due to the sandy and silty clays. The infiltration rates of soil will have still slower rate of flow after the ponds become operational due to turbid nature of water with higher density as compared to clean water and after compaction of the base.

4.5 Impact on Ground Water Resources

The ground water assessment studies carried out in ash pond areas indicate that the present status of ground water development is and will remain nil. The ash pond areas therefore lie in safe category. It is therefore concluded that there will not be any impact of the ponds on ground water regime. More over as there is silty clay alluvial horizon from surface to maximum depth of 1.50 m followed by weathered granite gneiss with very very low to low permeability (observed) which will normally isolate the ground water from the ash pond and may not allow seepage from ash pond to reach zone of saturation which is at the average depth of 1 to 1.5 m below ground level during post monsoon period. As the values of permeability have been found around 10^{-6} to 10^{-7} cm/day, it is proposed that to be on safe side, the ash pond area after compaction, may be provided with natural clay layer of 300 mm of permeability value of 10^{-7} to 10^{-9} cm/sec for making it a fool proof impervious barrier or by laying HDPE lining.

4.6 Impact of Ash Pond on Water Quality

With the laying of natural clay layer in addition to compacted alluvium horizon, the quality of surface and ground water is not likely be affected. However, it is proposed that piezometers for monitoring the water levels and water quality may be constructed around the ash ponds to study any variation in water quality and quantity. If during any heavy rainfall, any rain water which may seep out from the ash pond will be collected in the lower part of the ash pond and will be recycled after necessary treatment.

4.7 Contamination from Bottom Ash & Fly Ash

Ash generated by thermal power plant is either disposed in the form of a slurry in ash pond (wet disposal) or in dry condition (dry disposal) as ash mounds. The physical and chemical properties of ash have great influence on the impact on the environment. In coal fired thermal power plant, about 20% of the ash collected is in form of bottom ash and 80% is fly ash. The fly ash is mostly lifted by cement plants and only bottom ash is stored in ash ponds.

Looking to the potential pollution hazards of bottom ash, it becomes necessary to prevent the seepage from the ash ponds to ground water which is very shallow. If ash pond area does not have natural clay with permeability value of 10^{-9} cm/sec to 10^{-7}, cm/sec then it becomes necessary to lay either a clay liner or HDPE lining. However, in the present case, there is an impervious layer of silty clay up to average depth of 1.5 m having the permeability values of 10^{-6} to 10^{-7} cm/sec, it might not work as an effective impervious barrier after compaction. However, to make a complete 100 % impervious layer and taking no chances of any seepage to ground water which is hardly 1 to 1.5 m below the land surface, it is proposed that a 300 mm thick pure clay, having hydraulic conductivity in the range of 10^{-7} cm/sec to 10^{-9} cm/sec may be laid on the surface and fully compacted below ash pond area or HDPE lining may be done at the bottom of ash pond.

5.0 FLOOD HAZARD ZONATION MAPPING OF NAGAVALI & JANJHAVATI RIVERS

5.1 Flood Hazards

Floods are most common natural calamities that the country has to face almost every year in various parts in varying degrees. Floods are the major disasters causing substantial loss to human life and huge loss to cattle heads apart of damages to property, agriculture, natural resources and environment.

Andhra Pradesh is no exception to the floods, although not on that scale and not as frequent as in Assam, Bihar, U.P. and West Bengal etc. Floods and particularly flash floods, in hilly and hard rock terrain, are produced due to heavy intensity of rainfall in the catchment area of river leading to overflowing of the river over its banks, inundating a large area and causing a substantial loss in the flooded area.

5.2 Hydrological Modeling using HEC-RAS

HEC-RAS is a computer program for modeling water flowing through systems of open channels and computing water surface profiles. HEC-RAS finds particular commercial application in floodplain management and flood insurance studies to evaluate floodway encroachments. Some of the additional uses are: bridge and culvert design and analysis, levee studies, and channel modification studies. It can be used for dam breach analysis, though other modeling methods are presently more widely accepted for this purpose. The program was developed by the US Department of Defense, Army Corps of Engineers in order to manage the rivers, harbors, and other public works under their jurisdiction; it has found wide acceptance by many others since its public release in 1995.

Hydraulic Simulation: In this project HEC-RAS was used which is a numerical model that designed for hydraulic simulation. This model could be used to perform one-dimensional steady flow, unsteady flow calculations. The system is comprised of graphical user interface, separate hydraulic analysis components, data storage and management capabilities, graphical and reporting facilities. The steady-flow version of the model solves one-dimensional step-backwater calculations.

To use this version for a natural river, it is assumed that flow is comparatively steady along the whole reach because time-dependent variables are not included in the energy equation; flow varies gradually between cross-sections **(Figure-5.1)** due to the energy equation having a postulated hydrostatic pressure distribution at each cross-section; flow is one-dimensional and therefore the calculation is based on the premise that the total energy head is the same at every point in a cross section; the bed-slope of the channel is less than 10% because the pressure head is represented by water depth, which is measured vertically in the energy equation; and the energy slope is constant over the cross-section.

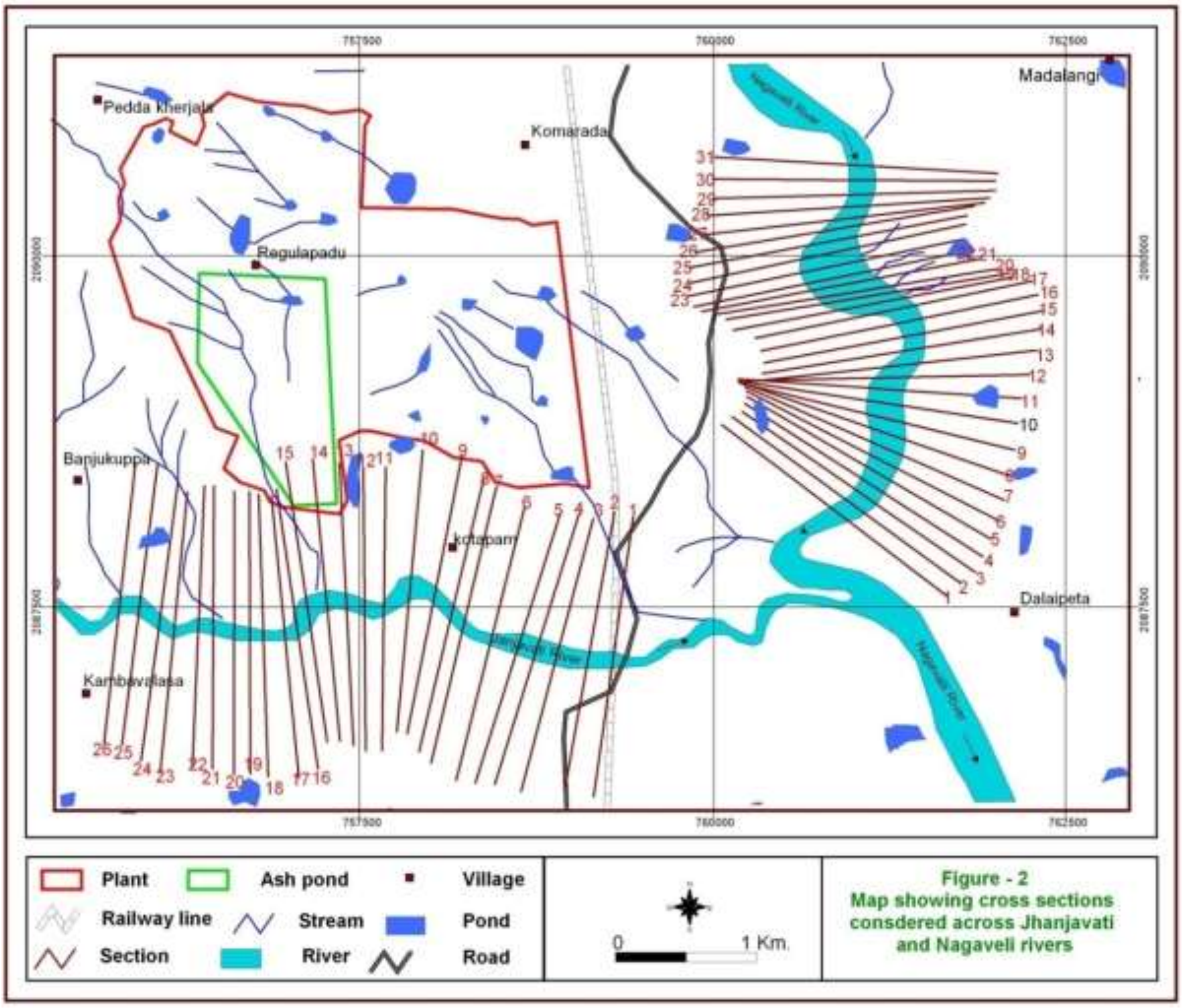


FIGURE 5.1
MAP SHOWING CROSS SECTIONS CONSIDERED ACROSS JANJHAVATI AND NAGAVALI RIVERS

Steady flow analysis is applied to calculate water surface profiles for steady gradually varied flow condition. Additionally the steady flow component is capable of modeling subcritical, supercritical and mixed flow regime water surface profiles. The basic computational procedure in HEC-RAS model is based on the solution of the one-dimensional energy equation. The energy equation is written as:

$$y_2 + z_2 + \frac{a_2 V_2^2}{2g} = y_1 + z_1 + \frac{a_1 V_1^2}{2g} + h_e$$

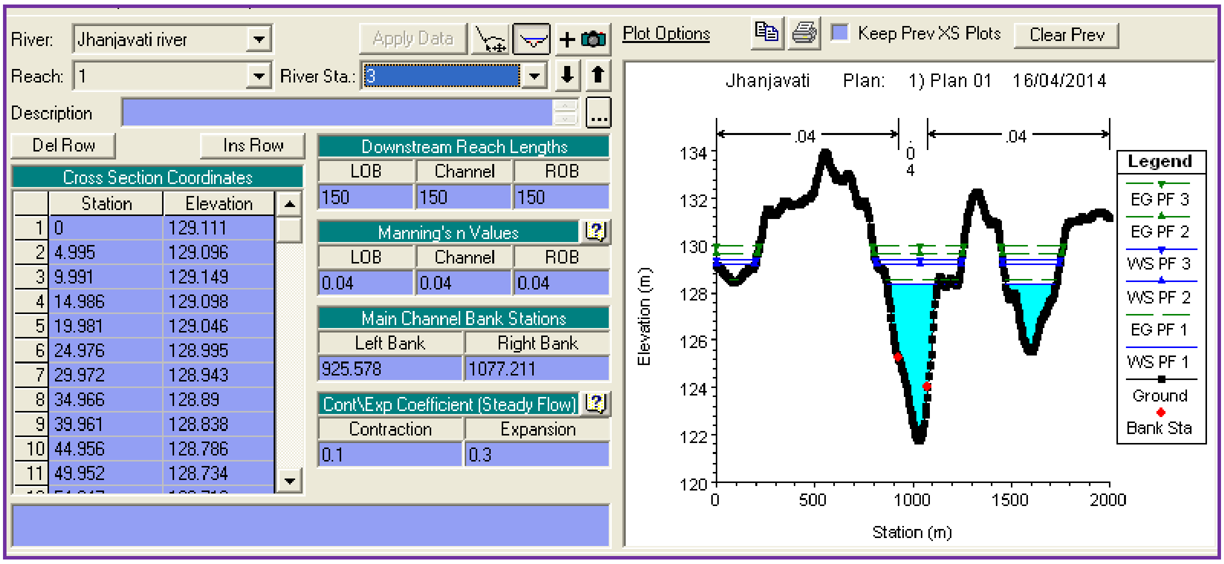
Where:

y_1, y_2 = Depth of water at cross sections
z_1, = Elevation of the main channel inverts

z_2
v_1, v_2 = Average velocities (total discharge/total flow area)
a_1, a_2 = Velocity weighting coefficients
g = Gravitational acceleration
h_e = Energy head loss

Energy losses are evaluated by friction (i.e., Manning`s equation) and contraction/expansion coefficient multiplied by the change in velocity head. The momentum equation is utilized in situations where the water surface profile is rapidly varied. These situations include mixed flow regime calculations, hydraulics of bridges and evaluating profiles at river confluences in stream junctions. Water surface profiles are computed from one cross section to the next by solving the energy equation with an interactive procedure called the standard step method.

The basic data requirements for simulation are included **(Figure-5.2)** the geometric data, study limit determination, river system schematic, cross section geometry, ineffective flow areas, reach lengths, energy loss coefficients, Manning`s n, Equivalent Roughness 'k`, contraction and expansion coefficients, steady flow data, boundary condition, flow regime. Selection of a suitable value for Manning`s n is very significant to the accuracy of the computed water surface profiles.



River: Jhanjavati river
Reach: 1
River Sta.: 3
Description

Cross Section Coordinates

	Station	Elevation
1	0	129.111
2	4.995	129.096
3	9.991	129.149
4	14.986	129.098
5	19.981	129.046
6	24.976	128.995
7	29.972	128.943
8	34.966	128.89
9	39.961	128.838
10	44.956	128.786
11	49.952	128.734

Downstream Reach Lengths

LOB	Channel	ROB
150	150	150

Manning's n Values

LOB	Channel	ROB
0.04	0.04	0.04

Main Channel Bank Stations

Left Bank	Right Bank
925.578	1077.211

Cont\Exp Coefficient (Steady Flow)

Contraction	Expansion
0.1	0.3

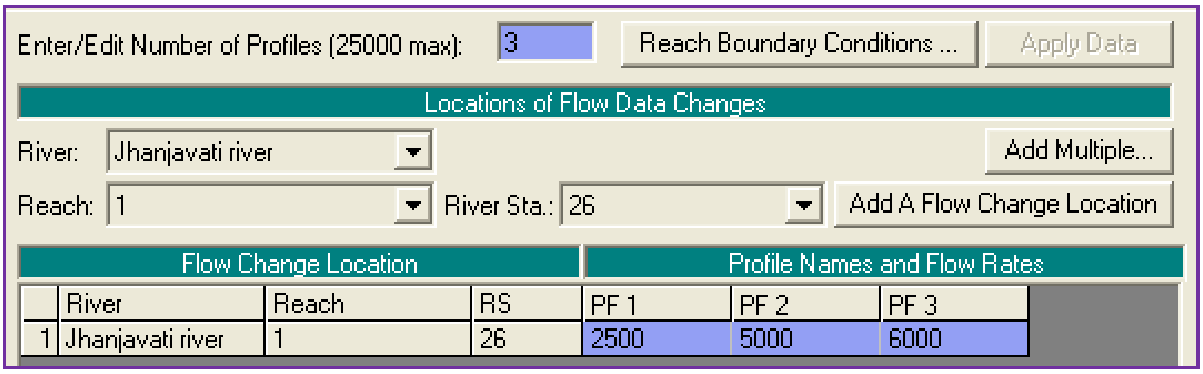
FIGURE-5.2
INPUT CROSS-SECTION DATA

Boundary conditions are another part of model that must be completed. Boundary conditions are necessary to establish the starting water surface at the ends of the river system. In a subcritical flow regime, boundary conditions are only required at the downstream ends of the river system. If a supercritical flow regime is going to be calculated, boundary conditions are only necessary at the upstream ends of the river system. If a mixed flow regime calculation is going to be made, then boundary conditions must be entered at all open ends of the river system. Ultimately after completing of all essential data, model could be run.

5.3 Flood Zonation Mapping for Janjhavati River

Peak flow data **(Figure-5.3)** is the most accurate input for the hydraulic simulation of the river reach. Peak flow (PF = 6000 cumec) was used as the steady flow data for simulation. Normal depth for upstream and critical depth for downstream was considered as boundary conditions for this analysis.

Other inputs such as Manning`s n value, river system schematic, contraction and expansion coefficients, flow regime entered to model and HEC-RAS model has run for steady flow and mixed flow regime.



Enter/Edit Number of Profiles (25000 max): 3

River: Jhanjavati river

Reach: 1

River Sta.: 26

	River	Reach	RS	PF 1	PF 2	PF 3
1	Jhanjavati river	1	26	2500	5000	6000

FIGURE-5.3
INPUT FLOW DATA

PF-1 = 2500 m^3/s (assume)
PF-2 = 5000 m^3/sec (assume)
PF-3= 6000 m^3/sec (Janjhavati dam's MFD)

Flood levels in two of the analyzed cross sections 14 and 1 can be shown in **Figure-5.4 to 5.9** for 2500 cumec, 5000 cumec and 6000 cumec peak flow, respectively.

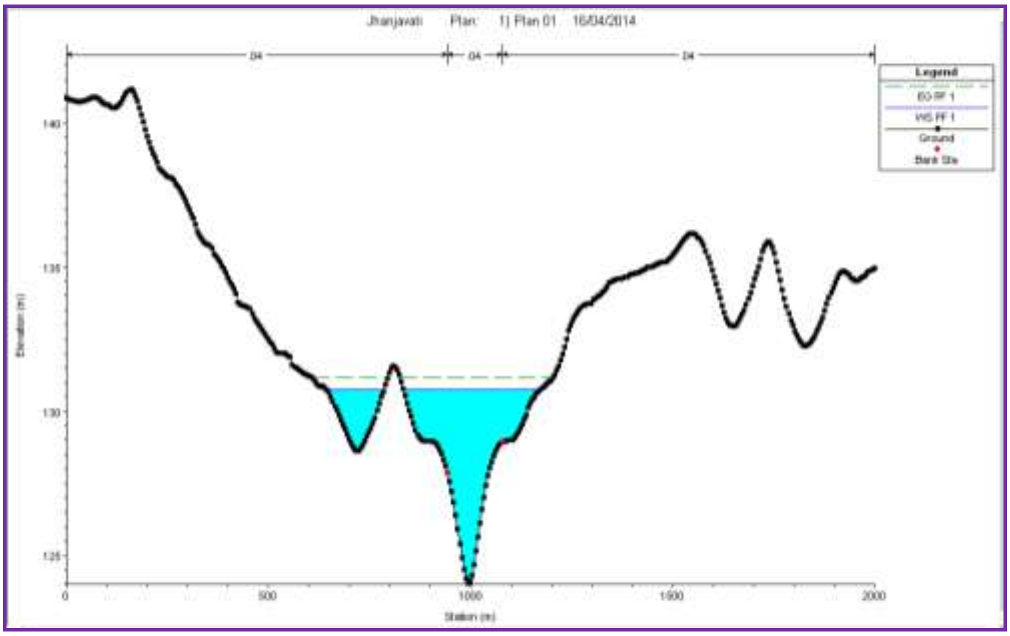


FIGURE-5.4
CROSS-SECTION-14 FOR PEAK FLOW OF 2500 CUMECS

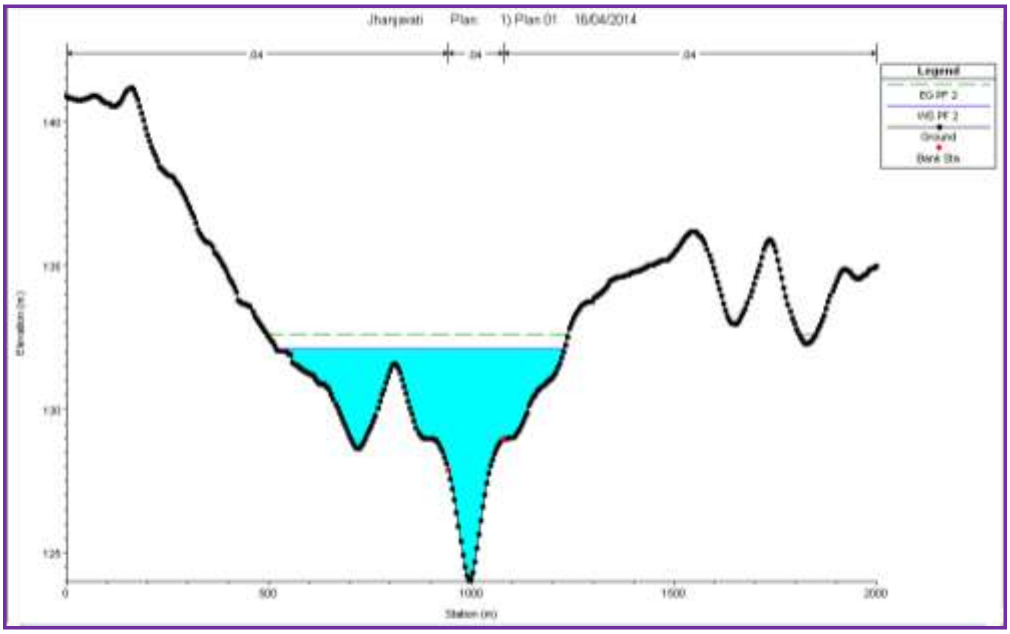


FIGURE 5.5
CROSS-SECTION-14 FOR PEAK FLOW OF 5000 CUMECS

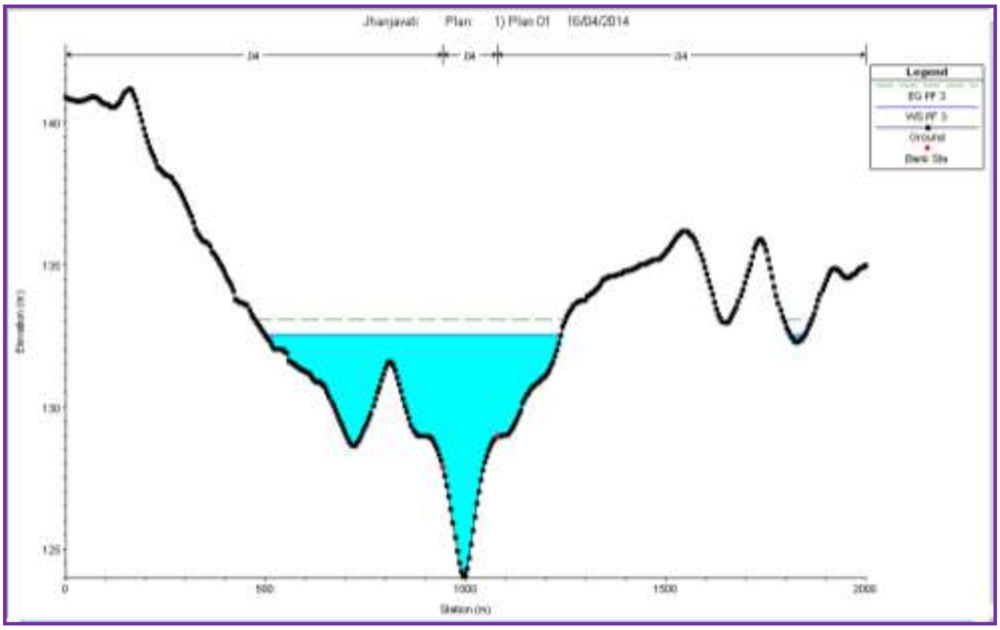


FIGURE-5.6
CROSS-SECTION-14 FOR PEAK FLOW OF 6000 CUMECS

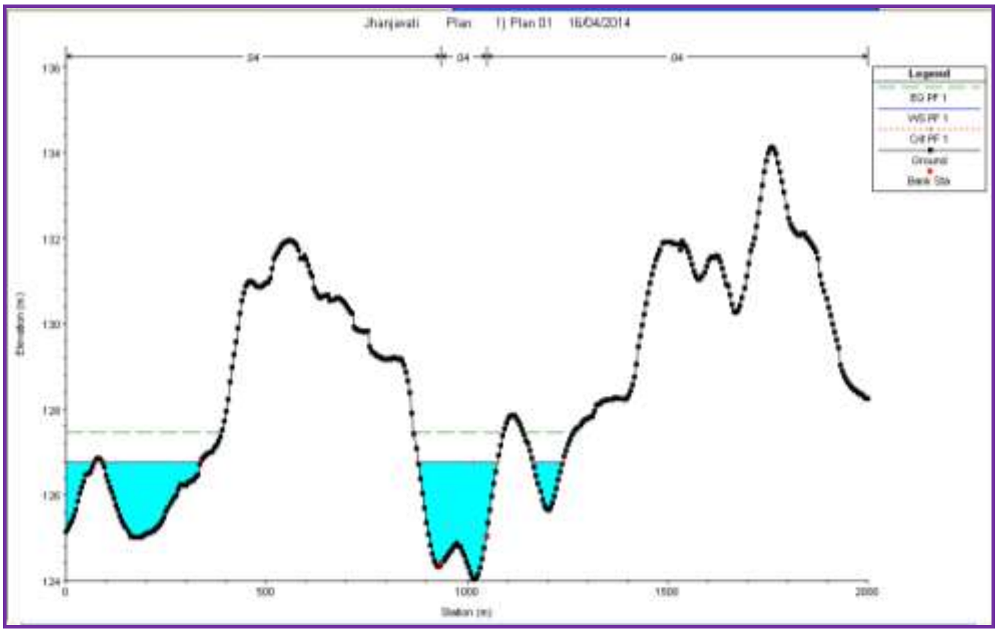


FIGURE-5.7
CROSS-SECTION-1 FOR PEAK FLOW OF 2500 CUMECS

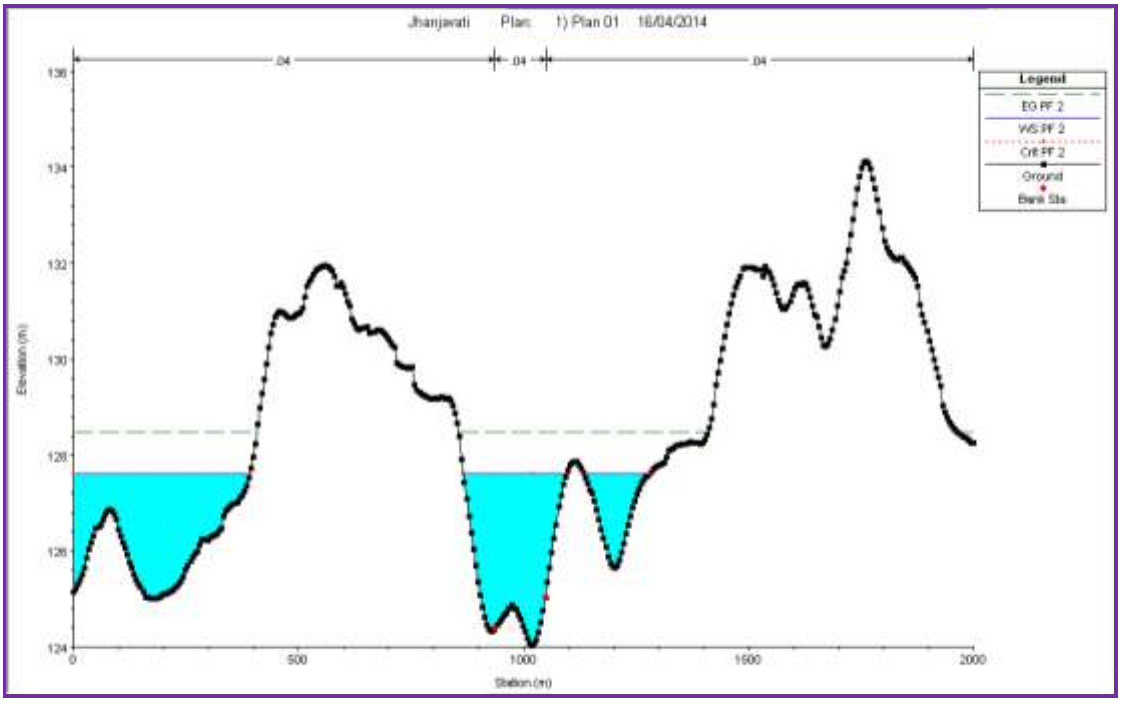


FIGURE-5.8
CROSS-SECTION-1 FOR PEAK FLOW OF 5000 CUMECS

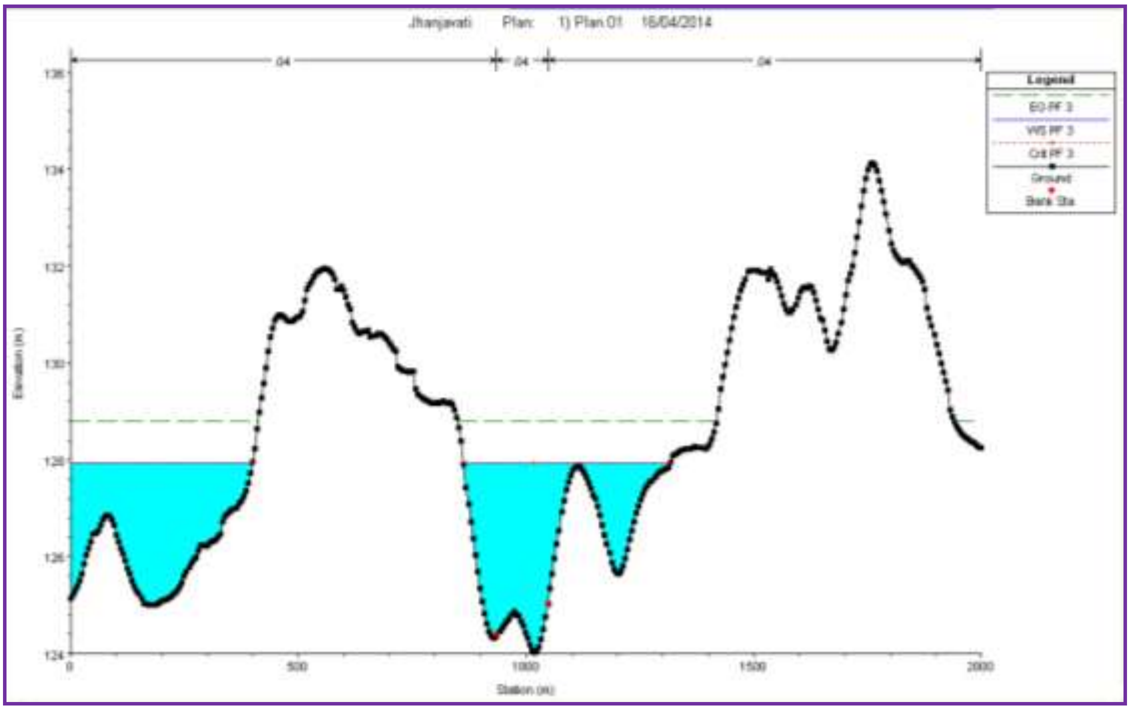


FIGURE-5.9
CROSS-SECTION-1 FOR PEAK FLOW OF 6000 CUMECS

There is 3.98 m, 4.46 m and 4.59 m water level differences in cross sections 14 and 1, respectively between flood levels in three mentioned peak flows (**Figure-5.4 to Figure-5.9 and Table-5.1).**

TABLE-5.1
WATER LEVEL DIFFERENCE IN TWO CROSS SECTIONS DUE TO PEAK FLOW

Peak Flow (cumes)	Water level (in msl) at cross-section-14	Water level (in msl) at cross-section-1	Water level difference (in m)
2500	130.75	126.77	3.98
5000	132.08	127.62	4.46
6000	132.52	127.93	4.59

One of the most important results of HEC-RAS simulation is preparing different water surface profiles of Janjhavati river at different peak flows **(Figure-5.10 to 5.12).**

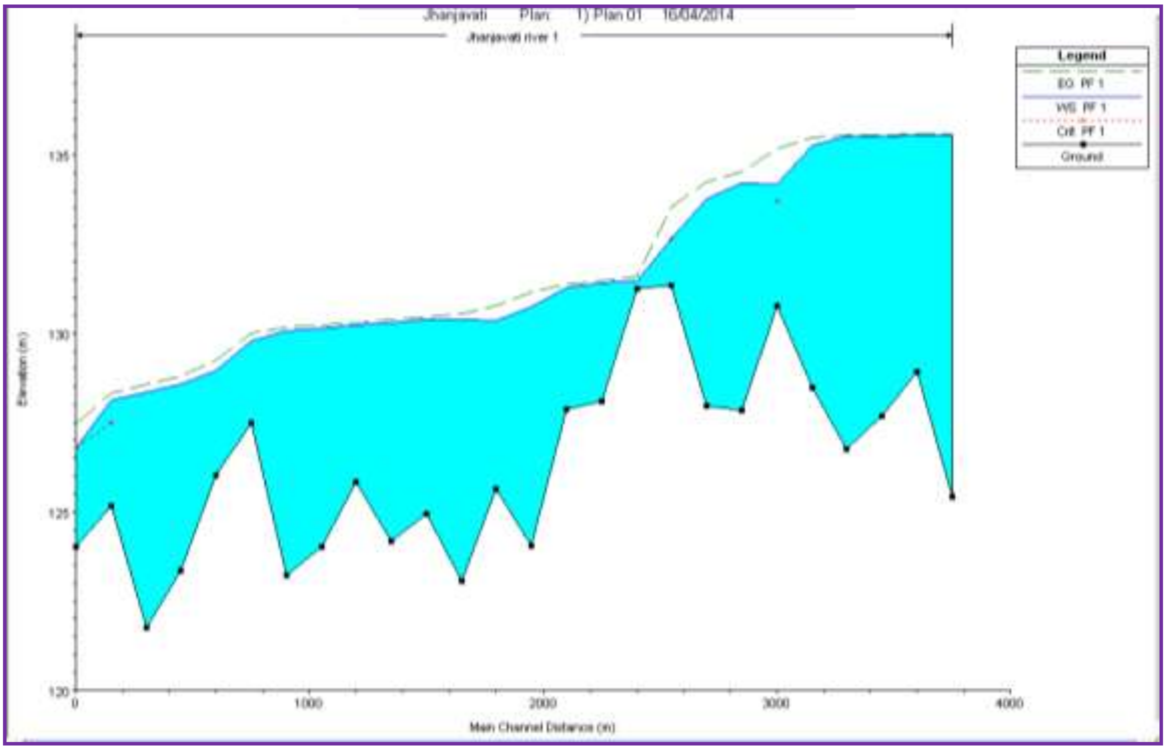


FIGURE-5.10
WATER SURFACE PROFILE OF JANJHAVATI RIVER AT 2500 CUMEC PEAK FLOW

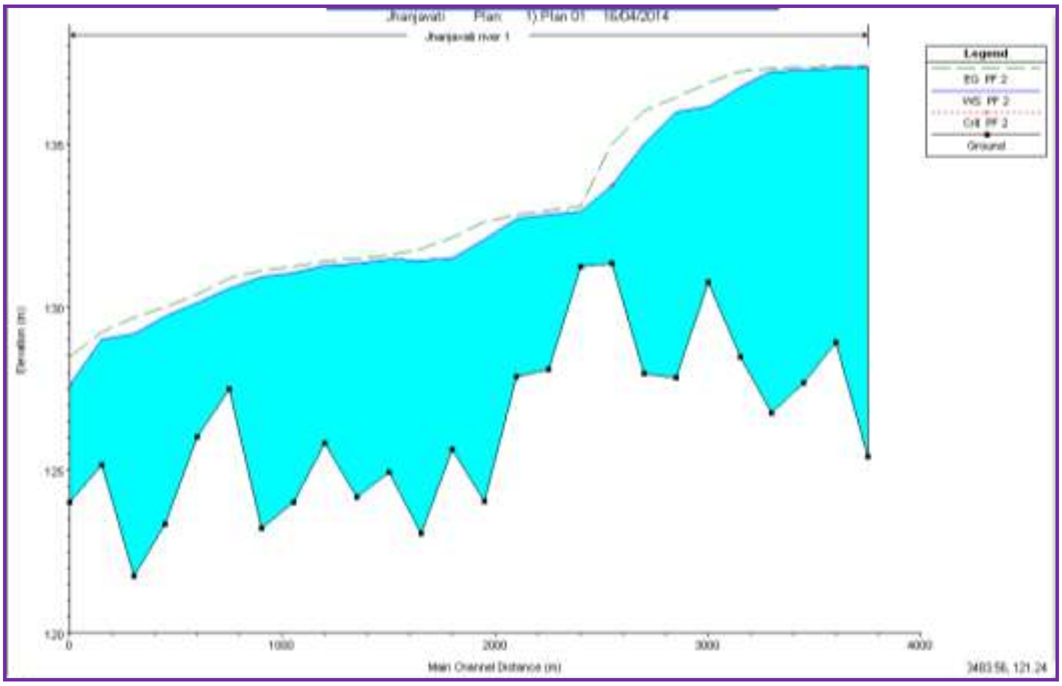


FIGURE-5.11
WATER SURFACE PROFILE OF JANJHAVATI RIVER AT 5000 CUMEC PEAK FLOW

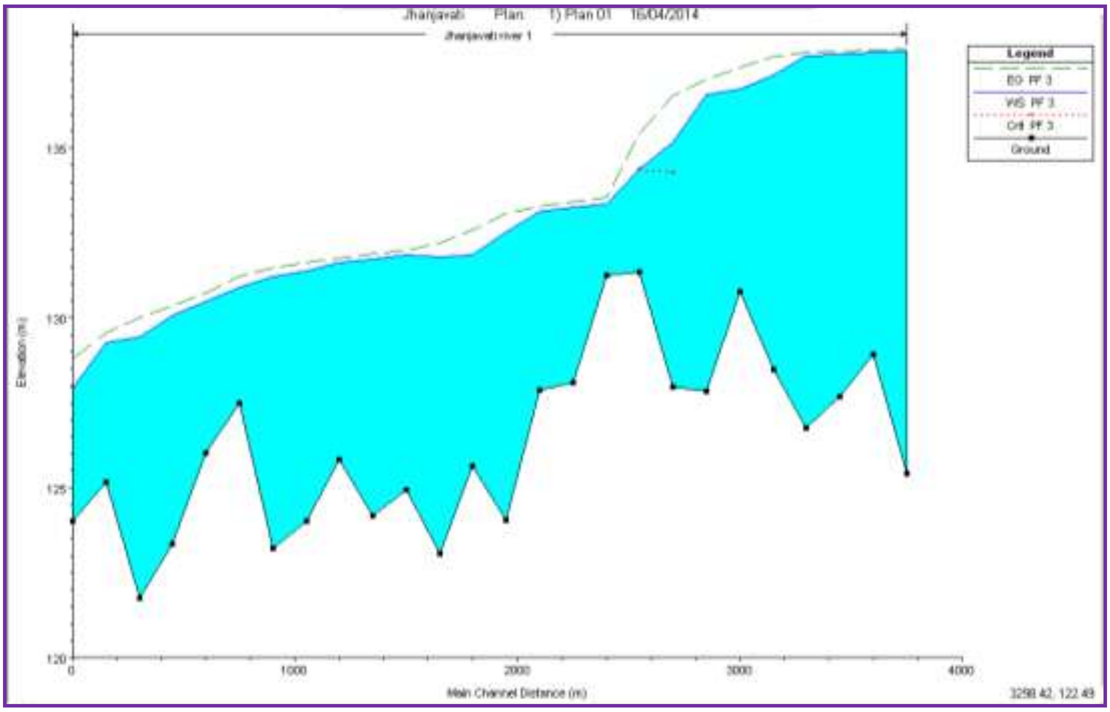


FIGURE-5.12
WATER SURFACE PROFILE OF JANJHAVATI RIVER AT 6000 CUMEC PEAK FLOW

In the next step, the results of hydraulic simulation within HEC-RAS model were exported to GIS for floodplain delineation and further analysis. Delineation of flood extents and depths within the floodplain of Janjhavati river was conducted in different peak flows based on the integration of hydraulic simulation results and GIS analysis using ArcView. Computed water surface elevations for flow of 2500 m^3/sec, 5000 m^3/sec and 6000 m^3/sec is mapped with the help of ARCVIEW GIS software. Critical flooding area along the Janjhavati river **(Figure-5.13)** and section **(Figure-5.14)** could be distinguished based on the grid layer of flood depths.

To prevent the flood hazard to the power plant, structural measures including flood walls and levees construction and also channel excavation and modification, should be considered for future flood mitigation plans.

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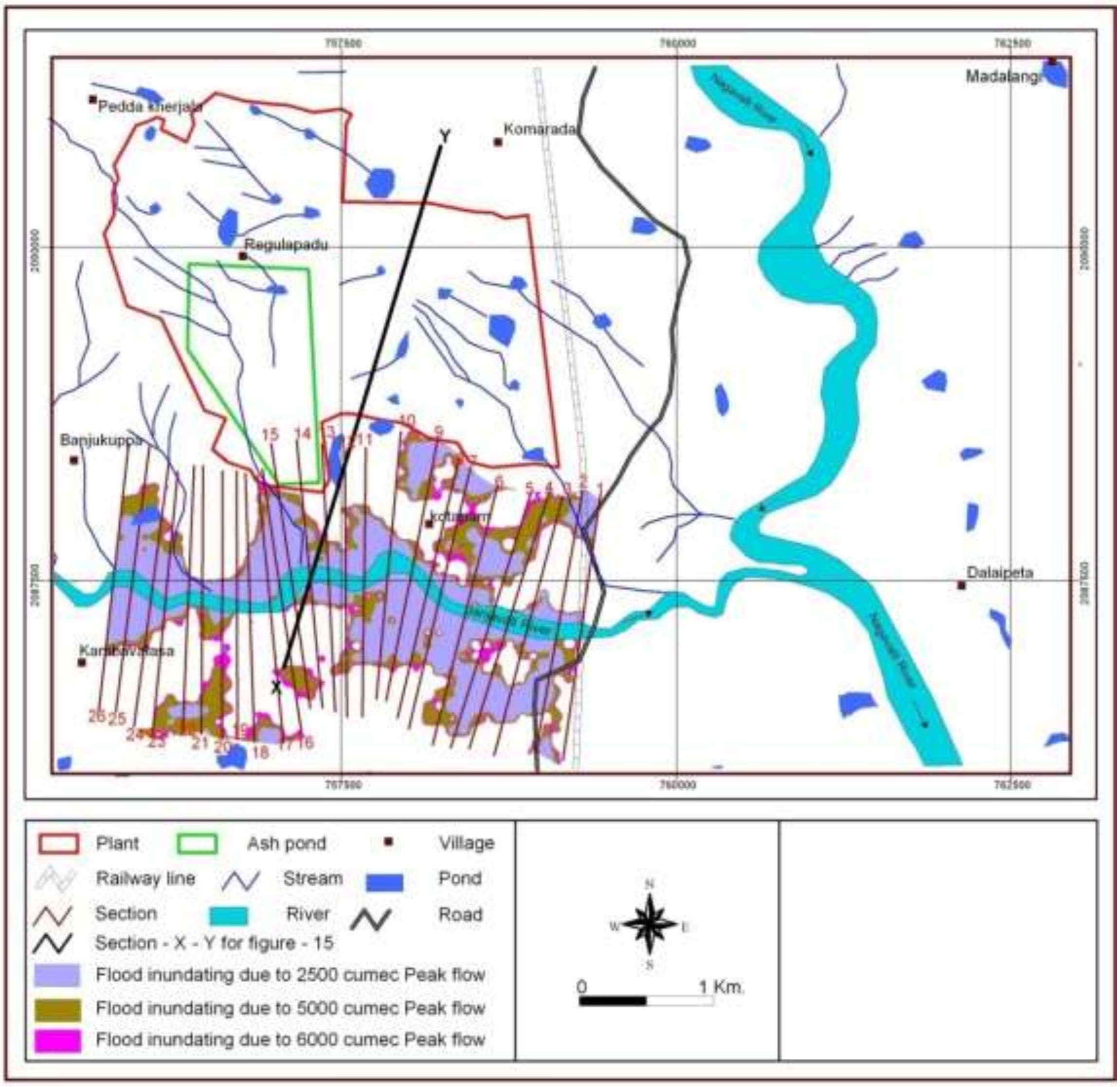


FIGURE-5.13
FLOOD AFFECTED AREA DUE TO JANJHAVATI RIVER

AT DIFFERENT PEAK FLOWS

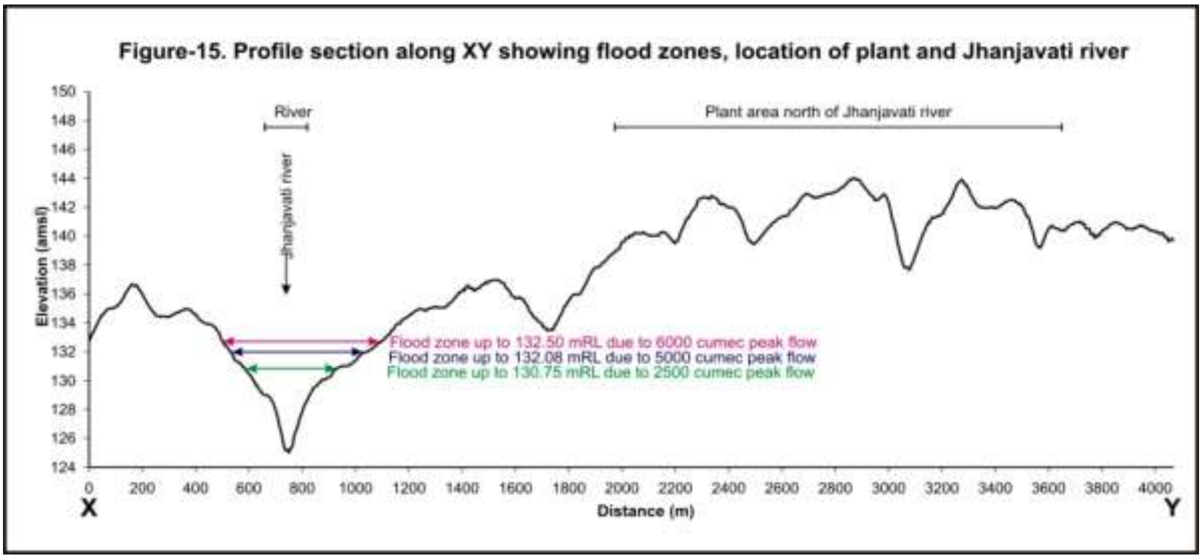
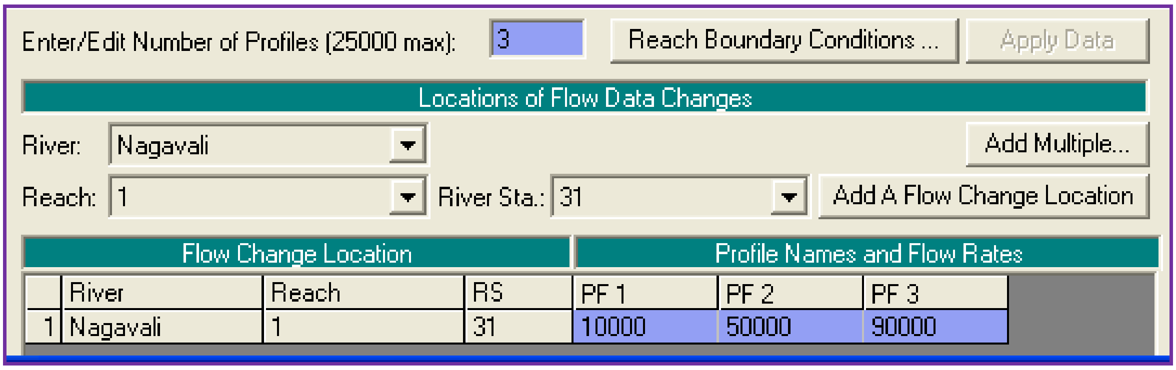


FIGURE-5.14. PROFILE SECTION ALONG XY SHOWING FLOOD ZONES, LOCATION OF PLANT & JANJHAVATI RIVER

5.4 Flood Zonation Mapping for Nagavali River

Peak flow data **(Figure-5.15)** is the most accurate input for the hydraulic simulation of the river reach. Peak flow (PF = 90000 cumec) was used as the steady flow data for simulation. Normal depth for upstream and critical depth for downstream was considered as boundary conditions for this analysis. Other inputs such as Manning`s n value, river system schematic, contraction and expansion coefficients, flow regime entered to model and HEC-RAS model has run for steady flow and mixed flow regime.

PF-1 = 10000 m^3/s (assume)
PF-2 = 50000 m^3/sec (assume)
PF-3= 90000 m^3/sec (Thotapalli Regulator MFD)



Enter/Edit Number of Profiles (25000 max): 3

River: Nagavali

Reach: 1 River Sta.: 31

	River	Reach	RS	PF 1	PF 2	PF 3
1	Nagavali	1	31	10000	50000	90000

FIGURE-5.15
INPUT FLOW DATA

Flood levels in two of the analyzed cross sections 18 and 4 can be shown in **Figure-5.16 to 5.21** for 10000 cumec, 50000 cumec and 90000 cumec peak flow, respectively.

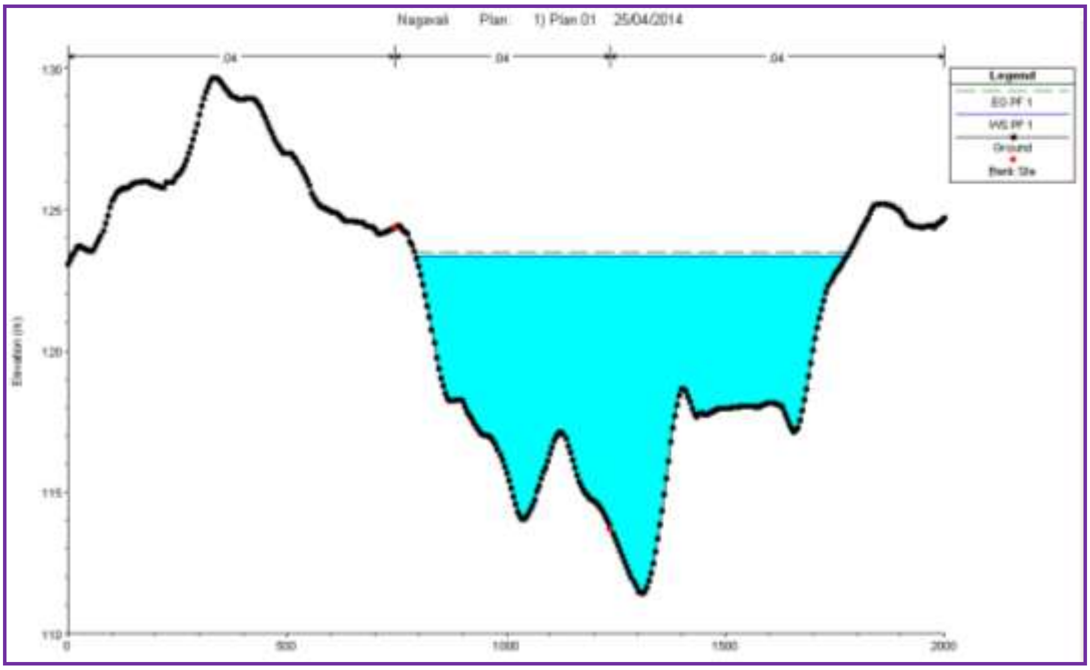


FIGURE-5.16
CROSS-SECTION-18 FOR PEAK FLOW OF 10000 CUMECS

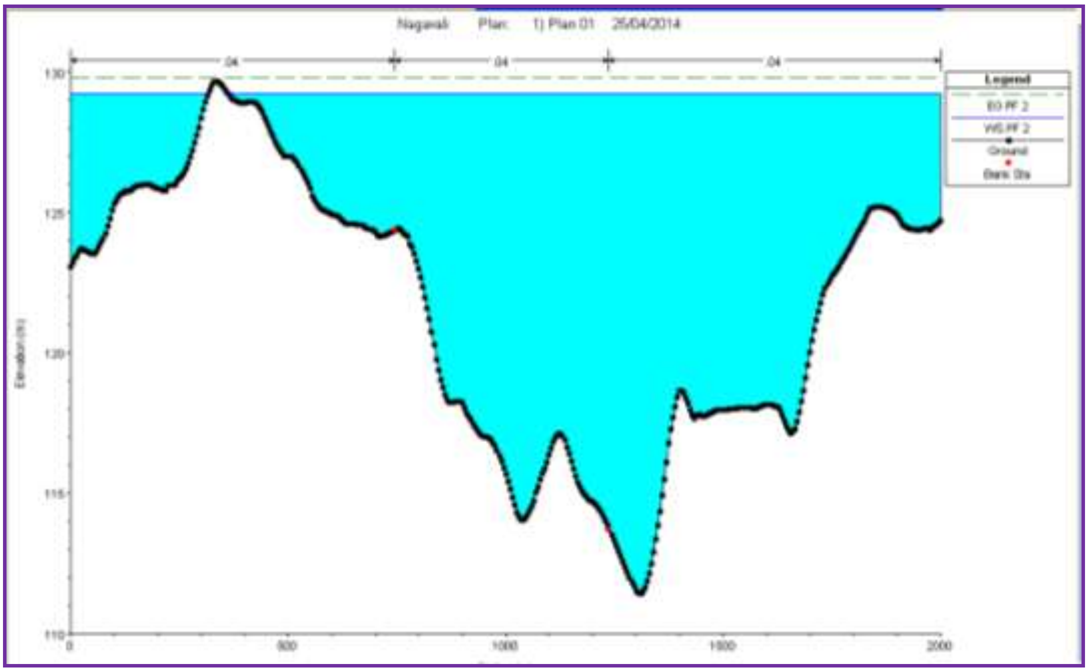


FIGURE-5.17
CROSS-SECTION-18 FOR PEAK FLOW OF 50000 CUMECS

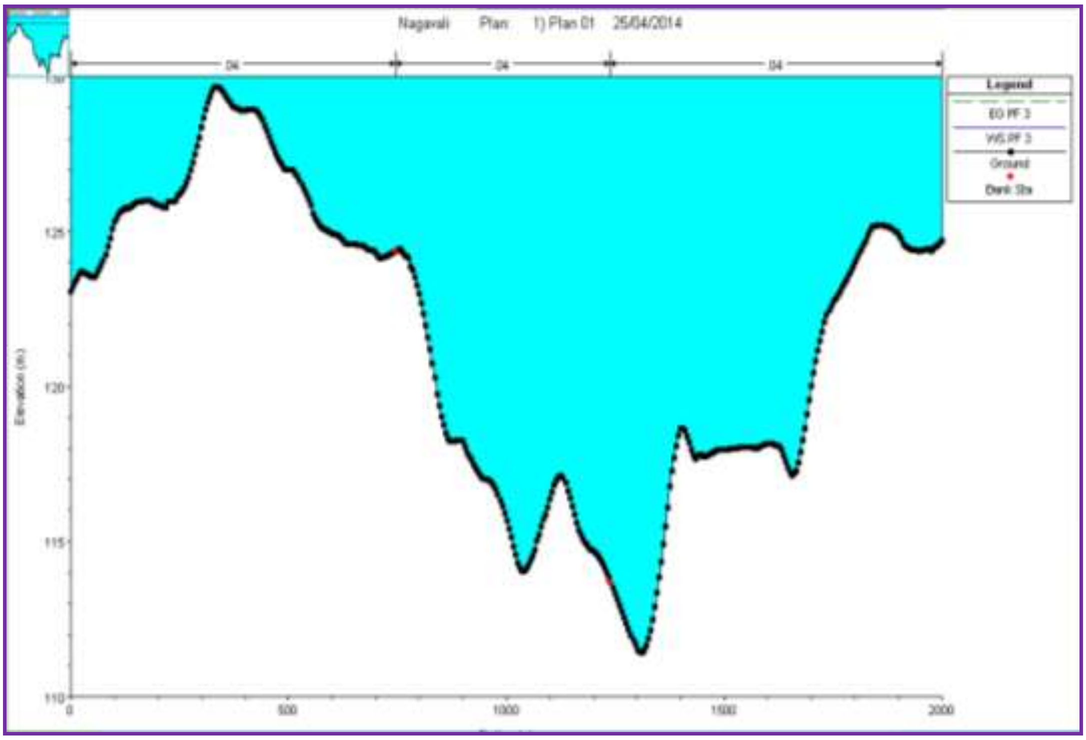


FIGURE-5.18
CROSS-SECTION-18 FOR PEAK FLOW OF 90000 CUMECS

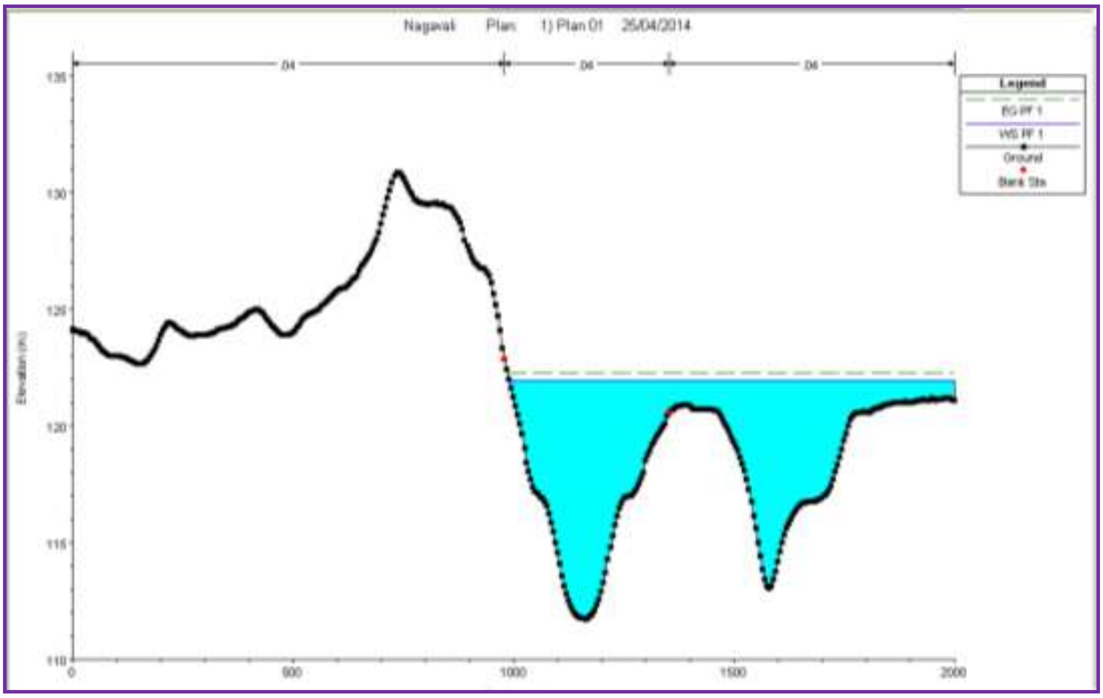


FIGURE-5.19
CROSS-SECTION-4 FOR PEAK FLOW OF 10000 CUMECS

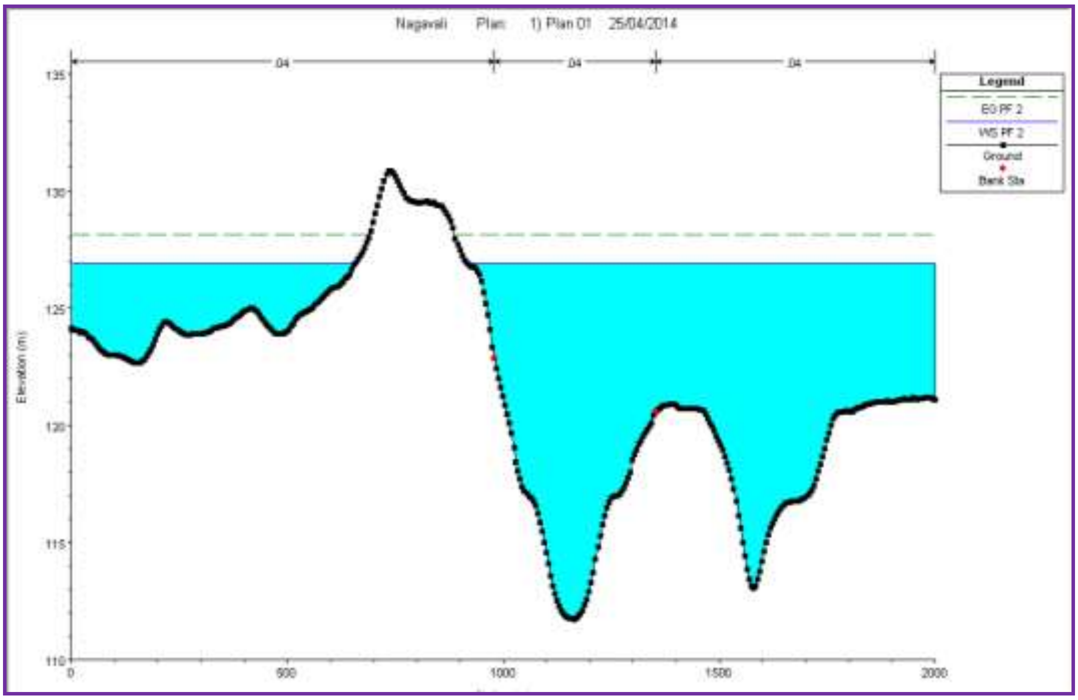


FIGURE-5.20

CROSS-SECTION-4 FOR PEAK FLOW OF 50000 CUMECS

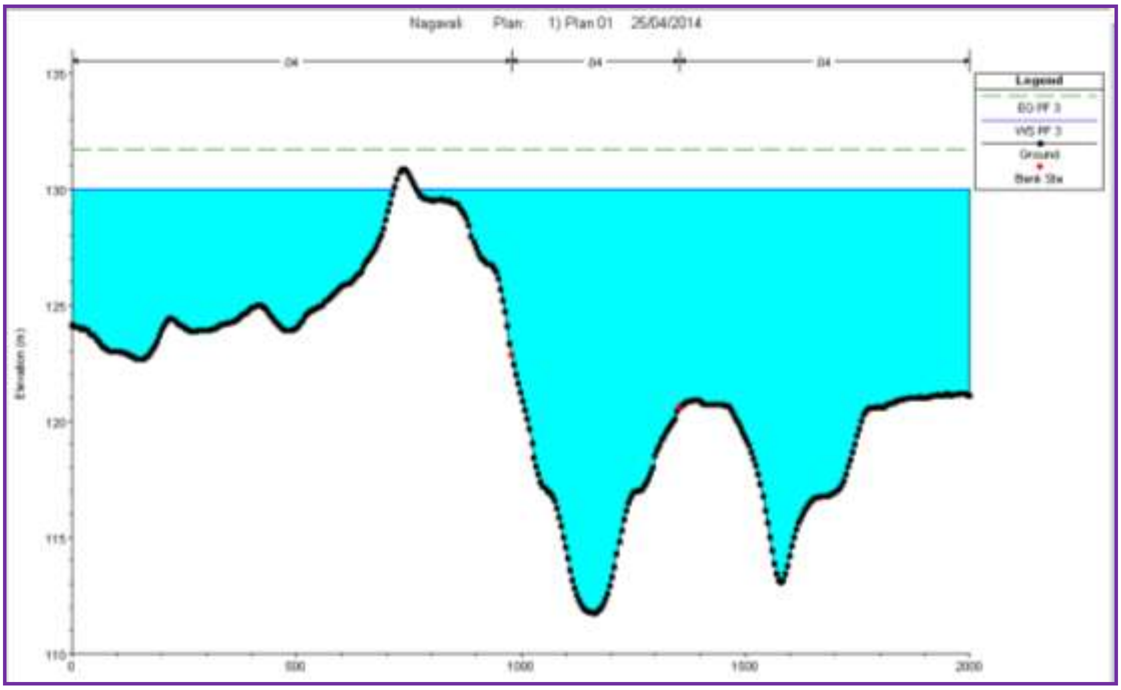


FIGURE-5.21

CROSS-SECTION-4 FOR PEAK FLOW OF 90000 CUMECS

There is 1.39 m, 2.30 m and 2.61 m water level differences in cross sections 18 and 4, respectively between flood levels in three mentioned peak flows **(Figure-5.22 to 5.24 and Table-5.2)**

TABLE-5.2
WATER LEVEL DIFFERENCE IN TWO CROSS SECTIONS DUE TO PEAK FLOW

Peak Flow (cumes)	Water level (in msl) at cross-section-14	Water level (in msl) at cross-section-1	Water level difference (in m)
10000	123.36	121.97	1.39
50000	129.23	126.93	2.30
90000	132.59	129.98	2.61

One of the most important results of HEC-RAS simulation is preparing different water surface profiles of Nagavali river at different peak flows **(Figures 5.22 to 5.25).**

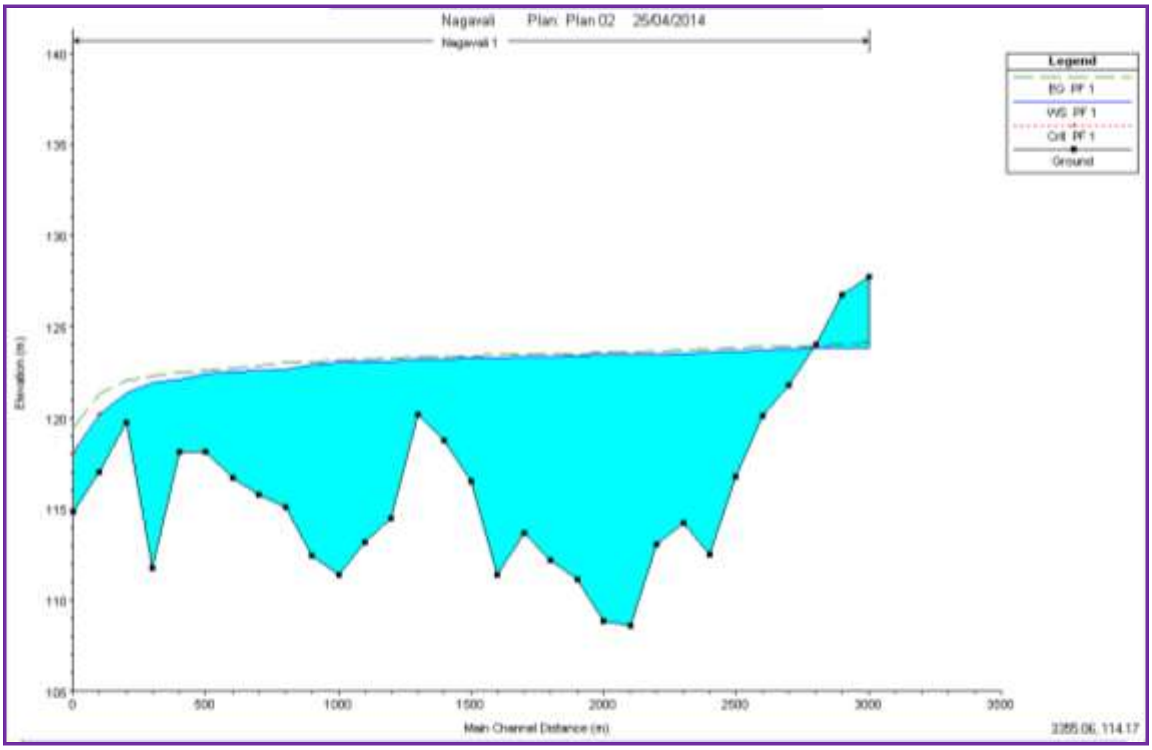


FIGURE-5.22
WATER SURFACE PROFILE
OF NAGAVALI RIVER AT 10000 CUMEC PEAK FLOW

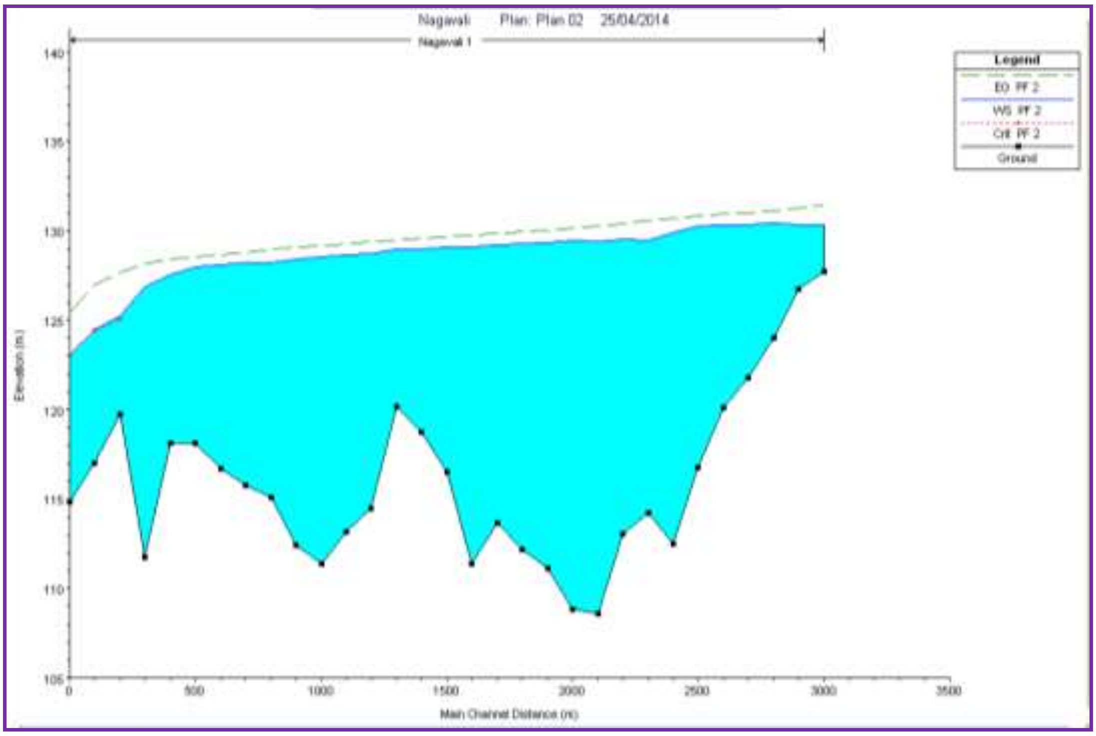


FIGURE-5.23. WATER SURFACE PROFILE OF NAGAVALI RIVER AT 50000 CUMEC PEAK FLOW

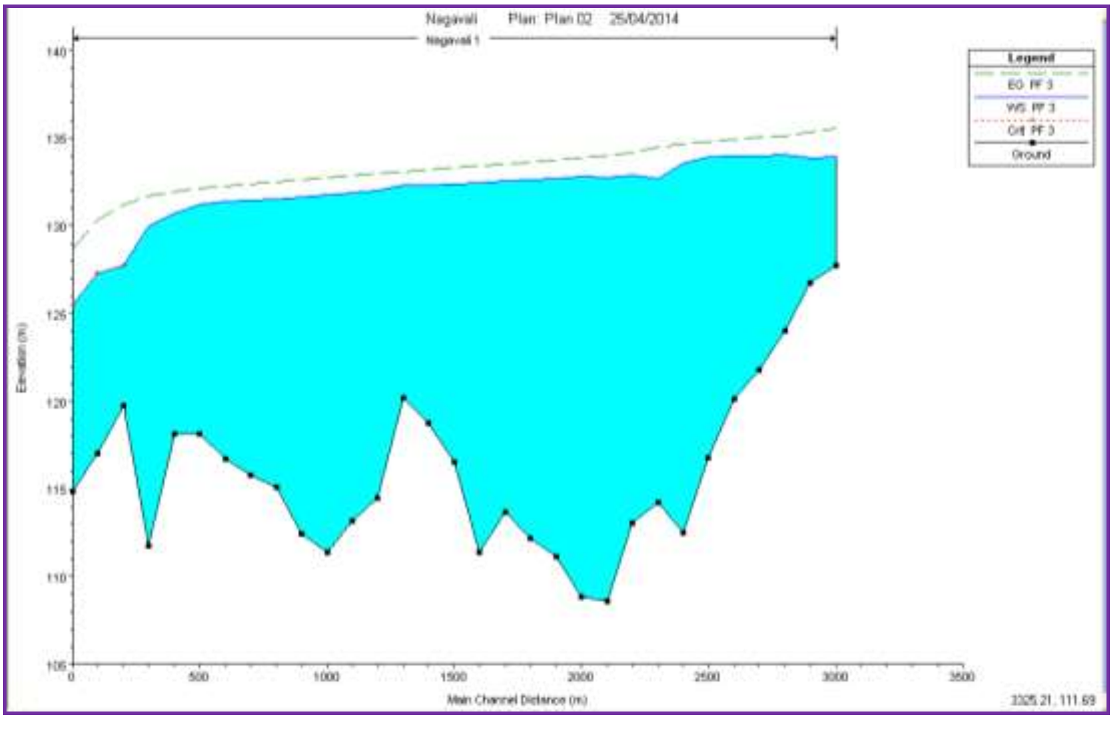


FIGURE-5.24. WATER SURFACE PROFILE OF NAGAVALI RIVER AT 90000 CUMEC PEAK FLOW

In the next step, the results of hydraulic simulation within HEC-RAS model were exported to GIS for floodplain delineation and further analysis. Delineation of flood extents and depths within the floodplain of Nagavali river was conducted in different peak flows based on the integration of hydraulic simulation results and GIS analysis using ArcView. Computed water surface elevations for flow of 10000 m^3/sec, 50000 m^3/sec and 90000 m^3/sec is mapped with the help of ARCVIEW GIS software. Critical flooding area along the Nagavali river **(Figure-5.25)** and section **(Figure-5.26)** could be distinguished based on the grid layer of flood depths. To prevent the flood hazard to the power plant, structural measures including flood walls and levees construction and also channel excavation and modification, should be considered for future flood mitigation plans.

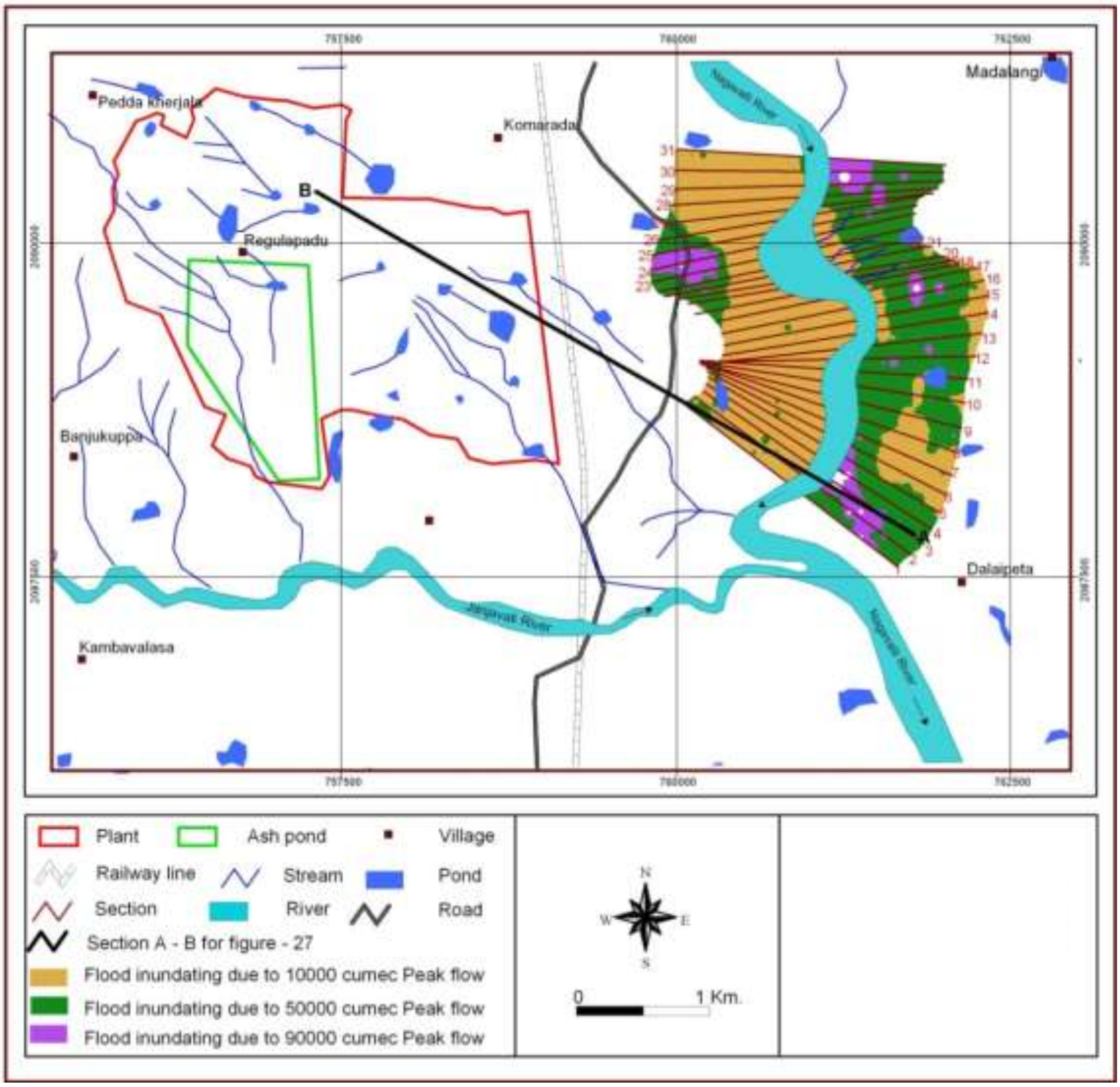


FIGURE-5.25
FLOOD AFFECTED AREA DUE TO NAGAVALI RIVER AT DIFFERENT PEAK FLOWS

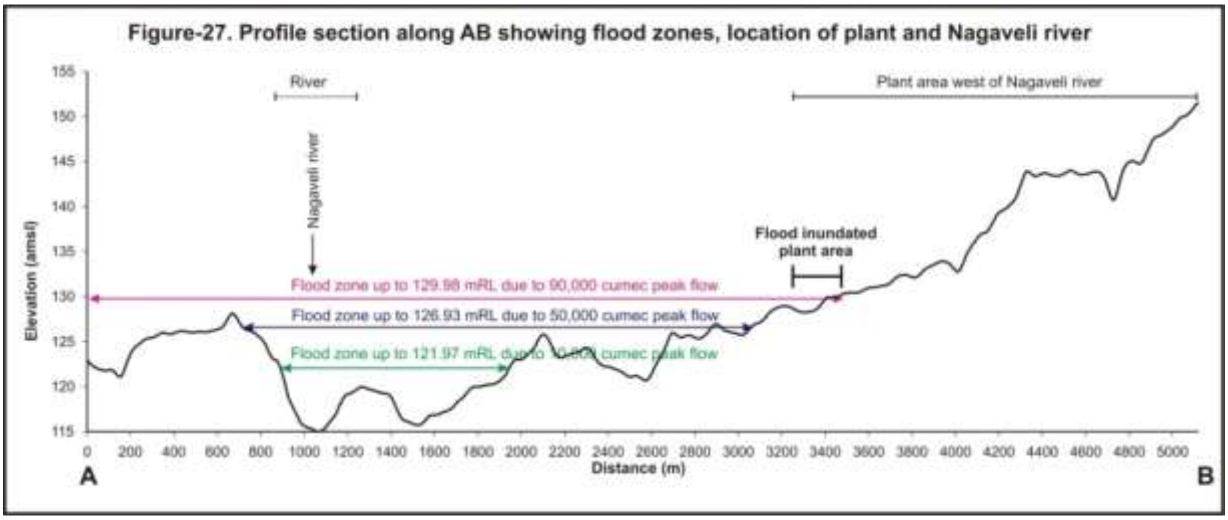


FIGURE-5.26. PROFILE SECTION ALONG AB SHOWING FLOOD ZONES, LOCATION OF PLANT & NAGAVALI RIVER

6.0 GROUNDWATER QUALITY AND PATHWAYS OF POLLUTANTS

With a view to find out the quality of groundwater in the surrounding area of the plant and to trace the movement of any pollutants in the ground water from ash pond or plant, 8 ground water samples were collected from the open shallow dug wells. The location of wells which were sampled for groundwater is shown in **Figure-6.1**. The water samples were analyzed for 42 constituents and parameters including biological constituents. The results of chemical analysis are shown in Table-6.1 including the common constituents present in groundwater, heavy and toxic elements to know the present ground water quality and likely pathways of important constituents in the direction of ground water flow. Pathways of pollutants have been determined by using a soft ware.

TABLE-6.1
LOCATION OF GROUND WATER SAMPLES

Location Code	Locations	Source	Distance (km)	Direction
GW1	Plant site	Open well	-	-
GW2	Komarada village	Open well	1.7	ENE
GW3	Matturu village	Open well	2.8	NE
GW4	Kotipam village	Open well	1.0	SE
GW5	Kancharapadu village	Hand pump	2.9	SW
GW6	Vanakabadi village	Open well	2.6	NW
GW7	Kummarigunta village	Hand pump	2.7	S
GW8	Gumuda village	Open well	1.7	E

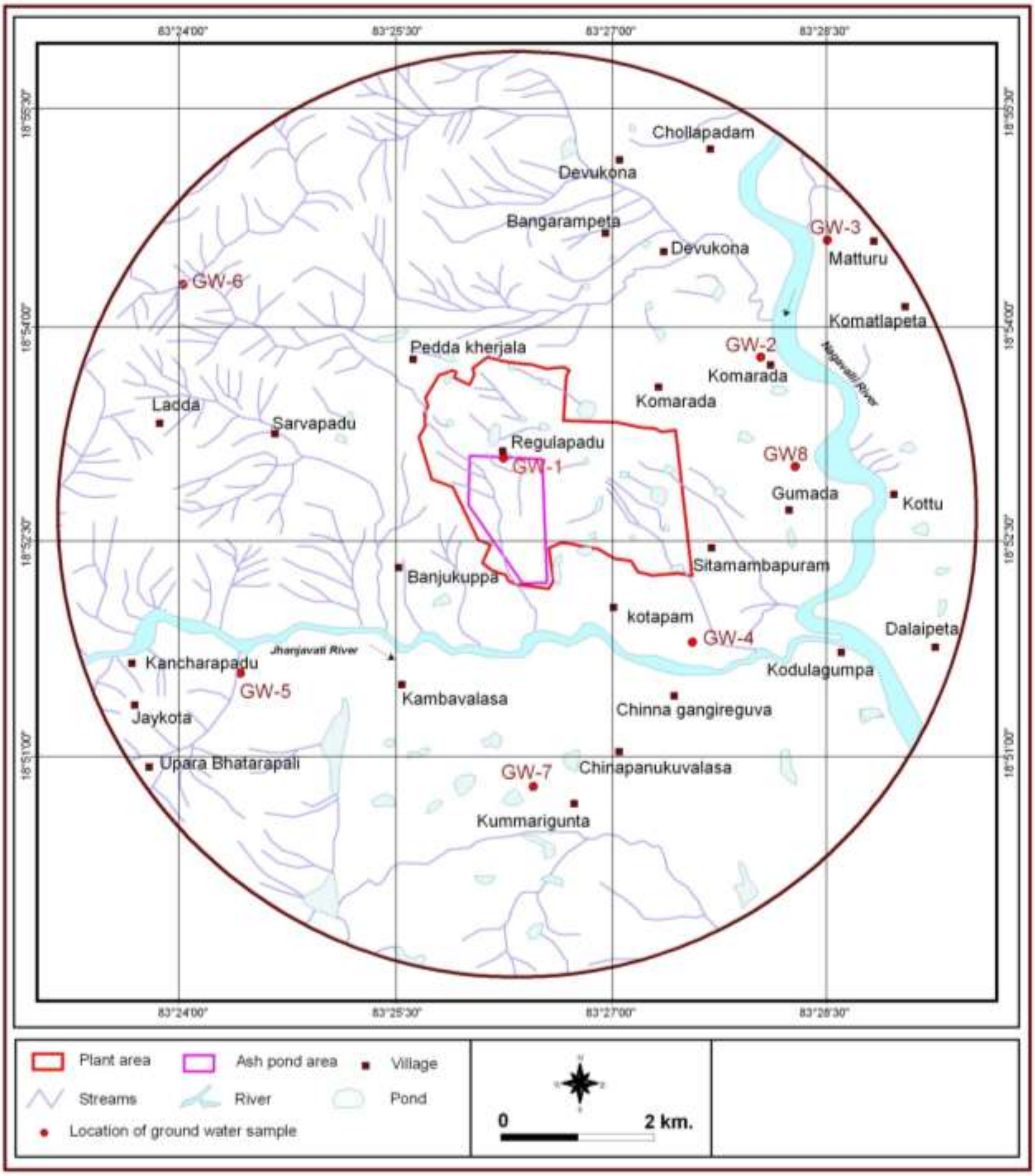


FIGURE-6.1
MAP SHOWING THE LOCATION OF GROUND WATER SAMPLES COLLECTED FROM THE SURROUNDING AREA OF THE PLANT

TABLE-6.2
RESULTS OF CHEMICAL ANALYSIS OF 8 GROUND WATER SAMPLES

Sr. No	Parameters	Unit	IS:10500 limits	GW1	GW2	GW3	GW4
1	pH	-	6.5-8.5 (NR)	7.1	6.8	6.9	7.1
2	Color	Hazen	5 (25)	1	2	2	2
3	Odour	-	UO	UO	UO	UO	UO
4	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Turbidity	(NTU)	5 (10)	2	2	3	2
6	Total Hardness	mg/l	300 (600)	68	65	60	140
7	Calcium Hardness as $CaCO_3$	mg/l	$	42	28	20	96
8	Magnesium Hardness as $CaCO_3$	mg/l	$	26	40	40	44
9	Conductivity	μδ/cm	$	100	90	83	233
10	Total Dissolved Solids	mg/l	500 (2000)	91	82	76	213
11	B.O.D (3days at 27^0c)	mg/l	$	<3	<3	<3	<3
12	COD	mg/l	$	<10	<10	<10	<10
13	Chlorides as Cl^-	mg/l	250 (1000)	11.3	12.4	8.9	16
14	Residual Free Chlorine	mg/l	0.2 Min. (-)	<0.2	<0.2	<0..2	<0.2
15	Fluoride as F	mg/l	1.0 (1.5)	0.1	0.1	0.3	0.7
16	Calcium as Ca	mg/l	75 (200)	16.8	11.2	8	38.4
17	Magnesium as Mg	mg/l	30 (100)	6.3	9.7	9.7	12.6
18	Sulphates as SO_4^-	mg/l	200 (400)	1.1	1.3	1.2	3.4
19	Nitrates as NO_3	mg/l	45 (NR)	6.4	3.2	4.6	8.6
20	Total Nitrogen	mg/l	$	1.5	3.5	0.8	9.1
21	Total Phosphorus	mg/l	$	0.31	0.29	0.42	0.7
22	Phenolics as C_6H_5OH	mg/l	0.001(0.002)	<0.001	<0.001	<0.001	<0.001
23	Cyanide as CN	mg/l	0.05 (NR)	<0.05	<0.05	<0.05	<0.05
24	Alkalinity as $CaCO_3$	mg/l	200 (600)	68	60	56	176
25	Boron	mg/l	1 (5)	<0.01	<0.01	<0.01	<0.01
26	Sodium as Na	mg/l	$	7.5	7.3	8.4	24.5
27	Potassium as K	mg/l	$	0.9	1.2	1.4	3.8
28	Iron as Fe	mg/l	0.3 (1.0)	0.8	0.6	0.7	0.8
29	Copper as Cu	mg/l	0.05 (1.5)	0.02	0.03	0.02	0.02
30	Manganese as Mn	mg/l	0.1 (0.3)	0.02	0.01	0.02	0.01
31	Aluminum as Al	mg/l	0.03 (0.2)	0.03	0.03	0.03	0.03
32	Chromium as Cr^{+6}	mg/l	0.05 (NR)	<0.05	<0.05	<0.05	<0.05
33	Cadmium as Cd	mg/l	0.01 (NR)	<0.01	<0.01	<0.01	<0.01
34	Selenum as Se	mg/l	0.01 (NR)	<0.01	<0.01	<0.01	<0.01
35	Arsenic as As	mg/l	0.01 (NR)	<0.01	<0.01	<0.01	<0.01
36	Lead as Pb	mg/l	0.05 (NR)	0.03	0.03	0.03	0.03
37	Zinc as Zn	mg/l	5 (15)	0.32	0.35	0.31	0.35
38	Mercury as Hg	mg/l	0.001 (NR)	<0.001	<0.001	<0.001	<0.001
39	Anionic Detergents as MBAS	mg/l	0.2 (1.0)	<0.1	<0.1	<0.1	<0.1
40	Poly Nuclear Aromatic Hydrocarbons (PAH)	mg/l	$	<0.01	<0.01	<0.01	<0.01
41	Mineral Oil	mg/l	0.01 (0.03)	<0.01	<0.01	<0.01	<0.01
42	Pesticides	mg/l	Absent(0.001)	<0.01	<0.01	<0.01	<0.01
43	E.Coli	-	Absent (-)	Absent	Absent	Absent	Absent
44	Total Coliforms	MPN/ 100 ml	10 (-)	--	--	--	--

Sr. No	Parameters	Unit	IS:10500 limits	GW5	GW6	GW7	GW8
1	pH	-	6.5-8.5 (NR)	6.9	7.2	7.1	7.1
2	Color	Hazen	5 (25)	2	1	2	1
3	Odour	-	UO	UO	UO	UO	UO
4	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Turbidity	(NTU)	5 (10)	3	2	3	3
6	Total Hardness	mg/l	300 (600)	96	148	120	172
7	Calcium Hardness as $CaCO_3$	mg/l	$	44	92	92	128
8	Magnesium Hardness as $CaCO_3$	mg/l	$	52	56	28	44
9	Conductivity	μδ/cm	$	142	230	186	257
10	Total Dissolved Solids	mg/l	500 (2000)	130	211	170	235
11	B.O.D (3days at 27^{0}c)	mg/l	$	<3	<3	<3	<3
12	COD	mg/l	$	<10	<10	<10	<10
13	Chlorides as Cl^-	mg/l	250 (1000)	12.4	14.2	28.4	7.1
14	Residual Free Chlorine	mg/l	0.2 Min. (-)	<0.2	<0.2	<0..2	<0.2
15	Fluoride as F	mg/l	1.0 (1.5)	0.4	1.1	1.1	0.8
16	Calcium as Ca	mg/l	75 (200)	17.6	36.8	36.8	51.2
17	Magnesium as Mg	mg/l	30 (100)	12.6	13.6	6.8	10.7
18	Sulphates as SO_4^-	mg/l	200 (400)	0.7	2.6	1.1	2.7
19	Nitrates as NO_3	mg/l	45 (NR)	2.5	19.2	3.3	20.2
20	Total Nitrogen	mg/l	$	0.6	4.2	1.5	5.1
21	Total Phosphorus	mg/l	$	0.6	0.45	0.5	0.1
22	Phenolics as C_6H_5OH	mg/l	0.001(0.002)	<0.001	<0.001	<0.001	<0.001
23	Cyanide as CN	mg/l	0.05 (NR)	<0.05	<0.05	<0.05	<0.05
24	Alkalinity as $CaCO_3$	mg/l	200 (600)	108	168	116	164
25	Boron	mg/l	1 (5)	<0.01	<0.01	<0.01	<0.01
26	Sodium as Na	mg/l	$	18.3	21.4	22.3	22.1
27	Potassium as K	mg/l	$	0.8	0.8	1	0.7
28	Iron as Fe	mg/l	0.3 (1.0)	0.3	0.3	0.3	0.3
29	Copper as Cu	mg/l	0.05 (1.5)	0.05	0.05	0.05	0.05
30	Manganese as Mn	mg/l	0.1 (0.3)	0.01	0.01	0.01	0.01
31	Aluminum as Al	mg/l	0.03 (0.2)	0.03	0.03	0.03	0.03
32	Chromium as Cr^{+6}	mg/l	0.05 (NR)	<0.05	<0.05	<0.05	<0.05
33	Cadmium as Cd	mg/l	0.01 (NR)	<0.01	<0.01	<0.01	<0.01
34	Selenum as Se	mg/l	0.01 (NR)	<0.01	<0.01	<0.01	<0.01
35	Arsenic as As	mg/l	0.01 (NR)	<0.01	<0.01	<0.01	<0.01
36	Lead as Pb	mg/l	0.05 (NR)	0.03	0.03	0.03	0.03
37	Zinc as Zn	mg/l	5 (15)	0.45	0.32	0.41	0.33
38	Mercury as Hg	mg/l	0.001 (NR)	<0.001	<0.001	<0.001	<0.001
39	Anionic Detergents as MBAS	mg/l	0.2 (1.0)	<0.1	<0.1	<0.1	<0.1
40	Poly Nuclear Aromatic Hydrocarbons (PAH)	mg/l	$	<0.01	<0.01	<0.01	<0.01
41	Mineral Oil	mg/l	0.01 (0.03)	<0.01	<0.01	<0.01	<0.01
42	Pesticides	mg/l	Absent(0.001)	<0.01	<0.01	<0.01	<0.01
43	E.Coli	-	Absent (-)	Absent	Absent	Absent	Absent
44	Total Coliforms	MPN/ 100 ml	10 (-)	--	--	--	--

A perusal of the results of the chemical analysis of water samples in relation to drinking water standards (IS 10500- 2012) reveals that groundwater, by and large is perfectly suitable for drinking use. pH is well within acceptable limit. Total dissolved salts in all the samples are within the acceptable limit of 500 mg/l and are ranging from 76 mg/l to 235 mg/l. Total hardness is also within the acceptable limits of 200 mg/l in all the 8 water samples ranging from 60 mg/l to 172 mg/l as Calcium Carbonate. Chloride is also within acceptable limit of 250 mg/l and is 7.1 mg/l to 28.4 mg/l. Fluoride in 6 samples is less than 1.00 mg/ll and within the acceptable limit while in two samples, it is 1.1 mg/l, within the permissible limit of 1.5 mg/l. Similarly, the nitrate in all the 8 water samples is also within the acceptable limit of 45 mg/l and is ranging from 2.5 mg/l to 20.2 mg/l.

All other common constituent, toxic and heavy metals like sulphate, boron, phenolic compounds, cyanides, anionic detergents, cadmium, arsenic, copper, lead, zinc, manganese, iron, chromium, aluminium, mercury, selenium, pesticies and microbiological contents are within acceptable limits of drinking water Indian Standards (IS-10500-2012). The e-coli and total coliform are also absent as these are usually absent in ground water.

6.1 Theory

Risk mapping of groundwater contamination is an important tool for groundwater protection, land use management and public health. This study presents a new approach for groundwater contamination risk mapping, based on hydrogeological setting, land use, contamination load, and groundwater modeling.

6.2 Theory of Contaminant Hydrology

Contaminants can migrate directly into groundwater from below-ground sources (e.g. storage tanks, pipelines) that lie within the saturated zone. Additionally contaminants can enter the ground-water system from the surface by vertical leakage through the seals around well casings, through wells abandoned without proper procedures, or as a result of contaminant disposal of improperly constructed wells.

Generally three processes can be distinguished which govern the transport of contaminants in groundwater: advection, dispersion and retardation. Dispersion and density/viscosity differences may accelerate contaminant movement, while retardation processes can slow the rate of movement. Some contamination problems involve two or more fluids. Examples include air, water and organic liquids in the unsaturated zone, or organic liquids and water in an aquifer.

Advection

The term advection refers to the movement caused by the flow of groundwater. Ground-water flow or advection is calculated based on Darcy's law. Particle tracking can be used to calculate advective transport paths. Particle tracking is a numerical method by placing a particle into the flow field and numerically integrating the flow path.

Dispersion

Dispersive spreading within and transverse to the main flow direction causes a gradual dilution of the contaminant plume **(Figure-6.2)**. The dispersive spreading of a contaminant plume is due to aquifer heterogeneities **(Figure-6.3)**. Dispersion on the macroscopic scale is caused by variations in hydraulic conductivity and porosity. Solute transport can be influenced by preferential flow-paths, arising from variations of hydraulic conductivity, at a decimeter scale.

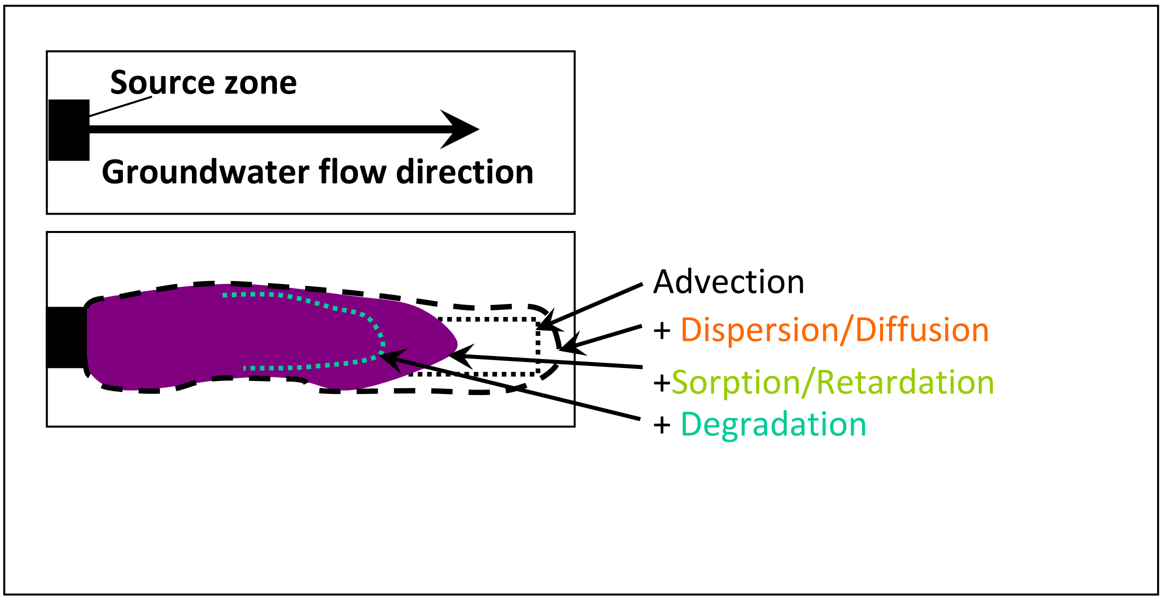


FIGURE-6.2
TRANSPORT PROCESSES OF CONTAMINANTS IN GROUNDWATER

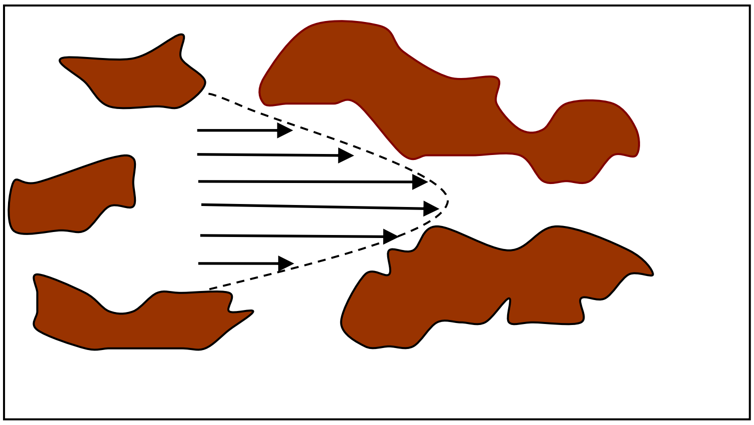


FIGURE-6.3
DIAGRAM ILLUSTRATING THE VELOCITY VARIATION WITHIN AN INDIVIDUAL PORE

Retardation

Two major mechanisms that retard contaminant movement are sorption and biodegradation.

If the sorptive process is rapid compared with the flow velocity, the solute will reach an equilibrium condition with the sorbed phase and the process can be described by an equilibrium sorption isotherm. The linear sorption isotherm can be described by the equation:

$C^* = K_d\, C$

where C^* = mass of solute sorbed per dry unit weight of solid (mg/kg)

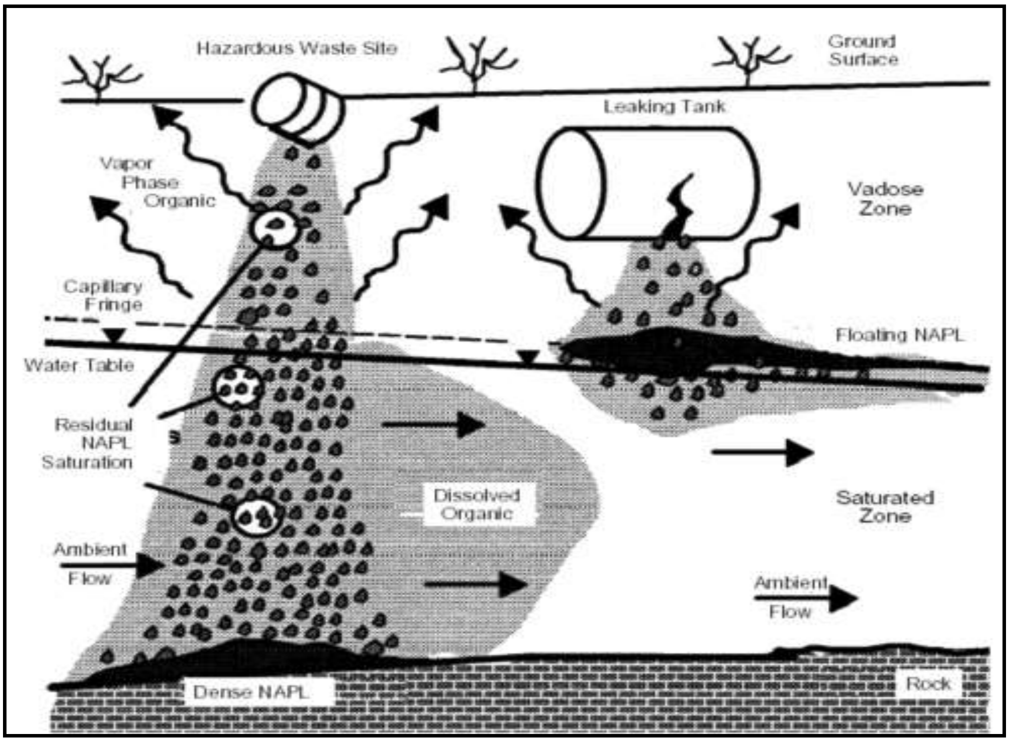
C = concentration of solute in solution in equilibrium with the mass of solute sorbed onto the solid (mg/l)

K_d = distribution coefficient (L/kg)

Non-Aqueaous Phase Liquids (NAPL)

Organic liquids that have densities greater than water are referred to as DNAPL (dense non aqueous phase liquids). Non-aqueous phase liquids that have densities less than water are called LNAPLs (light non-aqueous phase liquids). Contamination by LNAPL typically involve spills of fuels like gasoline or jet fuel **(Figure-6.4).**

<u>**FIGURE-6.4. MIGRATION PATTERNS FOR NAPL**</u>



6.3 Source of Pollutants in a Thermal Power Plant

To study the groundwater quality and assess any possible contamination by the thermal power plant, chemical analysis including heavy metal in the groundwater in the surrounding villages was carried out. 8 water samples collected from wells and boreholes were analyzed for their cadmium, arsenic, copper, lead, mercury, selenium, zinc, manganese, lead contents and their levels compared with Indian Standards specified maximum contaminant level.

The pathways for few common constituents which were found more than permissible limits of IS 10050-1991 like TDS (more than 2000 mg/l), Chloride (more than 1000 mg/l) and total hardness (more than 600 mg/l), sulphate (more than 400 mg/l). Although fluoride and nitrate are within desirable limits, its dispersion maps have also been prepared and are shown in **Figures-6.6 to 6.11.**

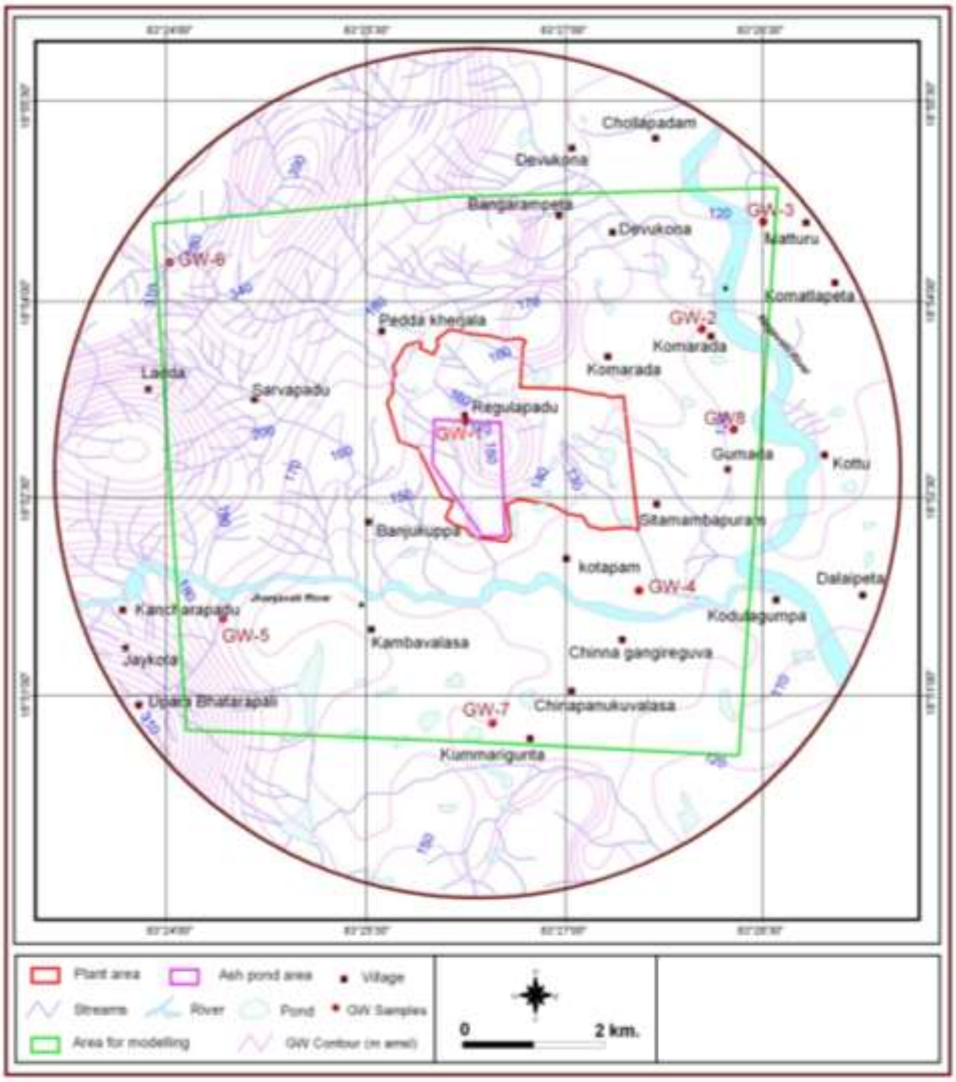


FIGURE-6.5
MAP SHOWING AREA FOR MODELING

The ground water flow of the area is towards the north and towards the river. As ground water moves from south to north, there should be slight increase in the salinity of ground water as southern part happens to be the area of recharge and river as area of discharge. A review of the distribution of total dissolved solids in the ground water of the buffer zone of the plant area, shows that by and large there is low salinity area in the south. However, there are few isolated and localized areas having high salinity. There is no possibility of any contamination from the plant as these do not fall in the ground water flow direction as water samples of GW-7. More over, no water sample collected on the downstream side of the plant shows any toxic or heavy metals, fluoride and nitrate more than desirable limits indicating that there is no contamination from the plant. This is due to local hydrogeological conditions having poor sub-surface drainage and not due to any pollution or contamination from a polluting source within the plant.

Similar situation is seen for total hardness, chloride, sulphate, fluoride and nitrate which can be attributed to the local conditions rather than pollution from the plant.

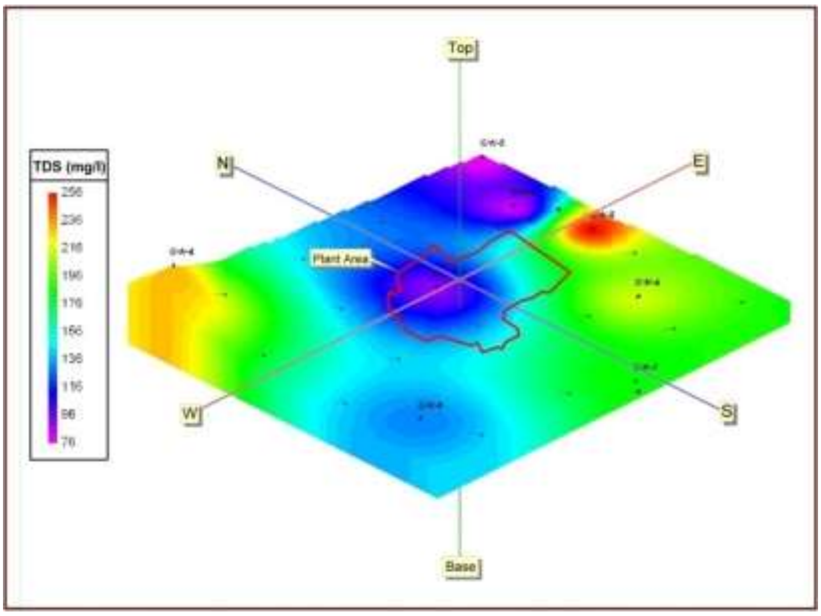


FIGURE-6.6
MODEL SHOWING THE PATHWAYS FOR TDS IN GROUND WATER SAMPLES OF PLANT AND ITS SURROUNDING AREA

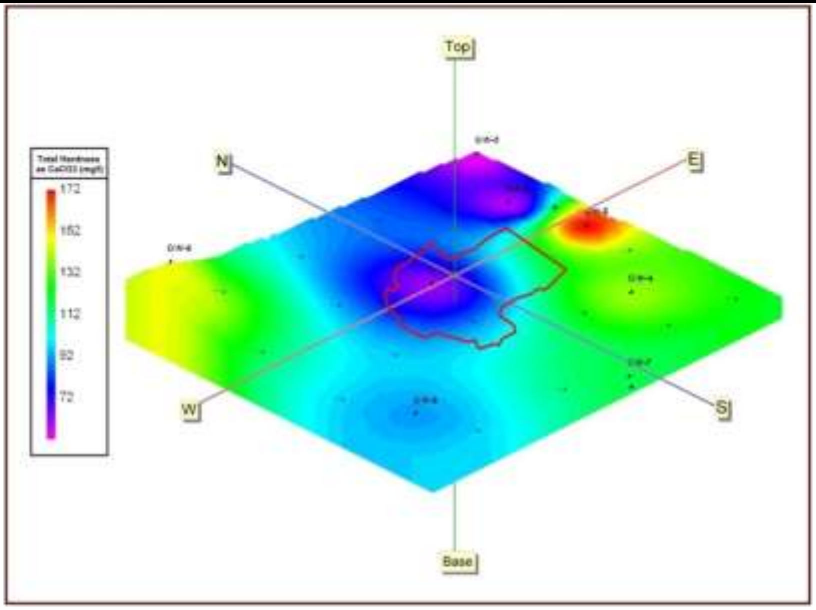


FIGURE-6.7
MODEL SHOWING THE PATHWAYS FOR TH IN GROUND WATER SAMPLES OF PLANT AND ITS SURROUNDING AREA

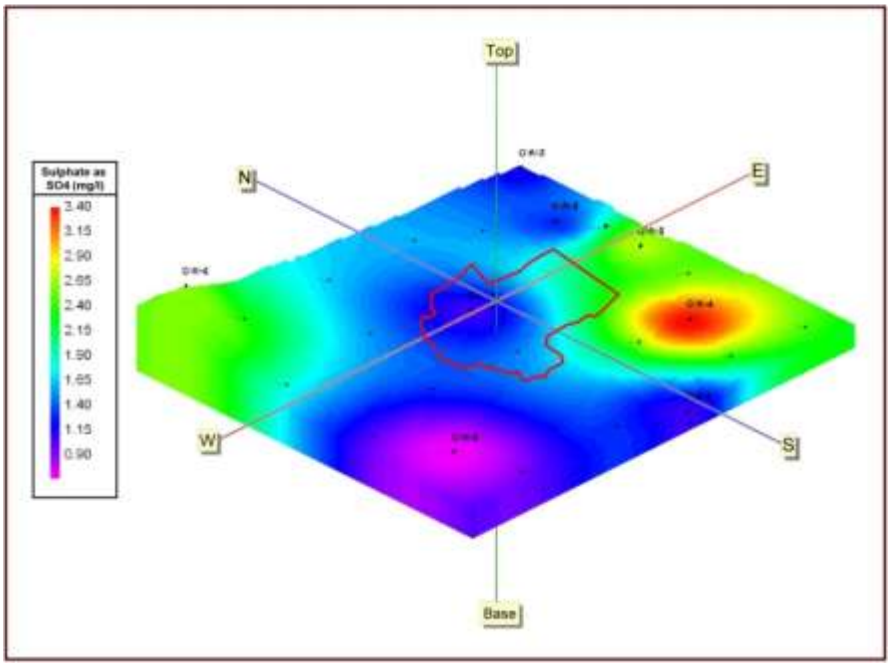


FIGURE-6.8
MODEL SHOWING THE PATHWAYS FOR SULPHATES IN GROUND WATER SAMPLES OF PLANT AND ITS SURROUNDING AREA

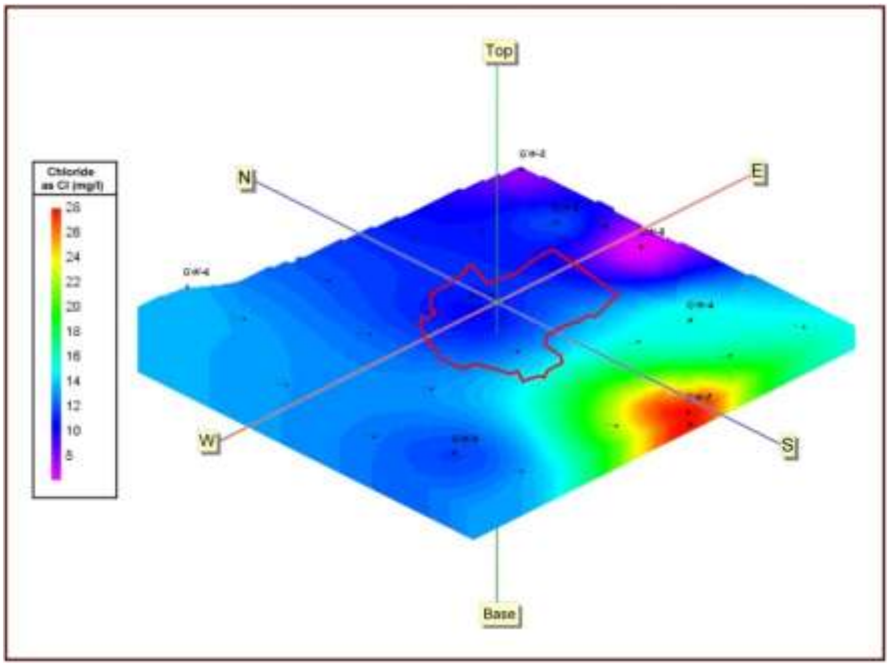


FIGURE-6.9
MODEL SHOWING THE PATHWAYS FOR CHLORIDES IN GROUND WATER SAMPLES OF PLANT AND ITS SURROUNDING AREA

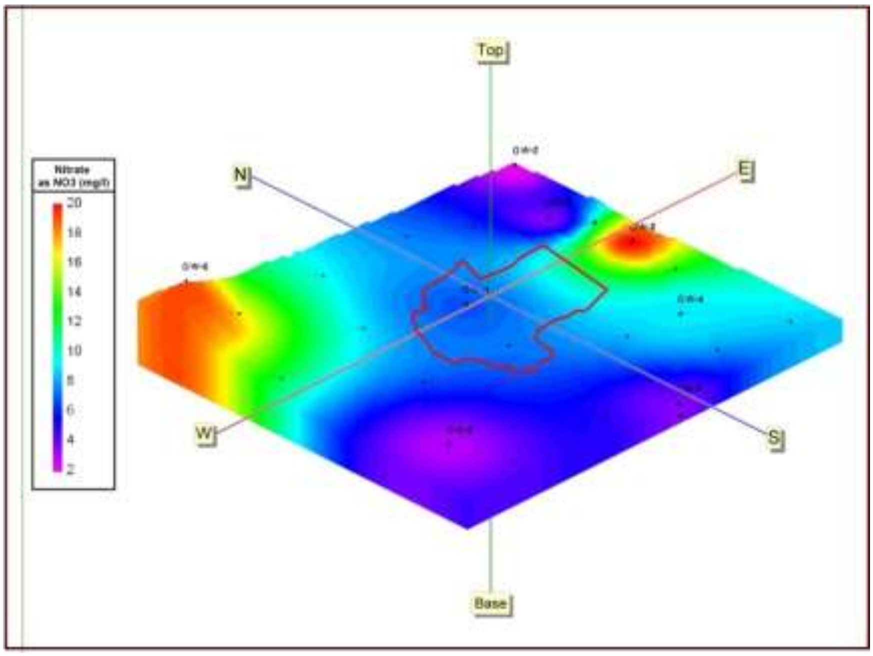


FIGURE-6.10
MODEL SHOWING THE PATHWAYS FOR NITRATES IN
GROUND WATER SAMPLES OF PLANT AND ITS SURROUNDING AREA

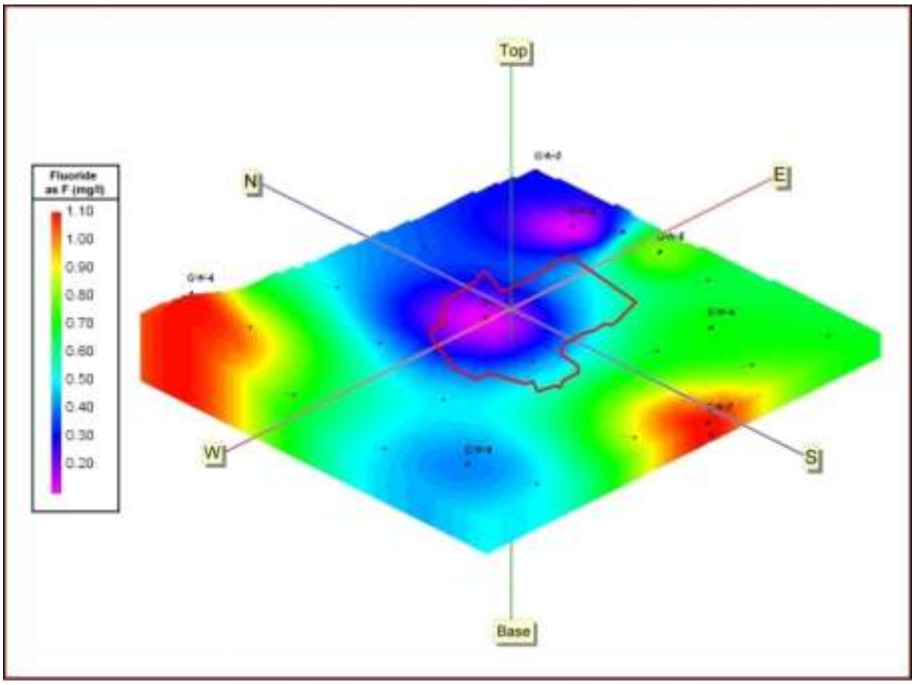


FIGURE-6.11
MODEL SHOWING THE PATHWAYS FOR FLUORIDES IN
GROUND WATER SAMPLES OF PLANT AND ITS SURROUNDING AREA

6.4 Conclusions from the Study and any Remedial Measures

It has been observed that pathways for the common constituents have been found as per the groundwater flow direction which is towards the north. As the hydraulic conductivity is very low in ground water in granite gneiss, the ground water movement is very slow. As there is no constituents present in the groundwater affecting human health like toxic or heavy metals, fluoride or nitrate beyond the desirable limits, no remedial measures are required and no measures are being suggested.

The study therefore reveals that there is no risk to the local population as no groundwater contamination from AIPL thermal plant has taken place or is likely to take place in future.

7.0 RAIN WATER HARVESTING PROGRAM

7.1 Need for Rain Water Harvesting for the Plant Area

After conducting the comprehensive hydrogeological assessment studies of the plant area and its 10 km radius area of buffer zone, it has been concluded that both zones have almost negligible ground water abstraction as compared to long term ground water recharge and therefore lie within safe zone. The CGWB in its last report released in November, 2011 for the dynamic ground water reserves as on 31.3.2009 has reported the status of ground water development of Vizianagram district as 19 % of the long term ground water recharge and therefore lies in safe category. Similarly, Vizianagram mandal has also been declared as safe zone. MoEF while issuing the EC has asked for rain water harvesting program in the plant area so that the existing ponds retain water as in the past, before the setting up the plant.

Although, AIPL does not propose to draw any ground water from the plant by bore wells and the area being safe, AIPL realizing its national obligation and as asked by MoEF is proposing to harvest all the harness able rain water in the plant area.

7.2 Basic Requirement for Artificial Ground Water Recharge Project

There are two basic requirements for taking up any artificial ground water recharge program and these are:

a) Availability of non-committed surplus monsoon runoff; and
b) Identification of suitable hydrogeological environment and sites for creating sub-surface reservoir through cost effective artificial recharge techniques.

While considering these two aspects in special reference to plant area, it is observed that there is a definite availability of surplus monsoon water as surface runoff within the plant area of 1675 acres and also from the roof tops of different buildings, paved and open area. But this cannot be recharged due to non-availability of unsaturated zone.

Another important aspect is to evaluate the storage potential of sub-surface reservoir having maximum unsaturated zone with maximum specific yield and hydraulic conductivity during the period when water is available for recharge. Artificial ground water recharge cannot be undertaken where water level is within 3 m below the land surface during the post-monsoon period. The water table in the plant area has been observed at an average depth of 1 to 2 m below the general ground level during post monsoon period thereby indicating that there is no unsaturated zone which could be recharged. Under such condition, only rain water can be harvested and collected in the existing main village tanks so that tanks retain water as in the past.

7.3 Rain Water Harvesting Program

While reviewing the plant lay out and the location of existing village tanks **(Figure-7.1)**, it is observed that out of 17 village ponds, 11 tanks will be covered by the plant, town ship, ash pond, raw water reservoir and crushed coal stack pile and only 6 tanks will be left in the vacant or green belt area and will continue to get water from its own micro-water shed.

Rain water harvesting program has been designed in such a way that roof top rain water from different buildings is harvested and is either taken to the diversion drain of Vanakabadi Gedda or to Komarada village tank located outside the plant area. So, there will not be any adverse impact on the surface hydrology of the area. The rain water which used to be collected in 11 village ponds (which hardly had any use except by the stray cattle) and would be closed now due to construction of plant and its roof top rain water will join the Vanakabadi diversion drain. While the six village tanks which are located in vacant land /green belt will survive and continue to get its water from its micro-water sheds.

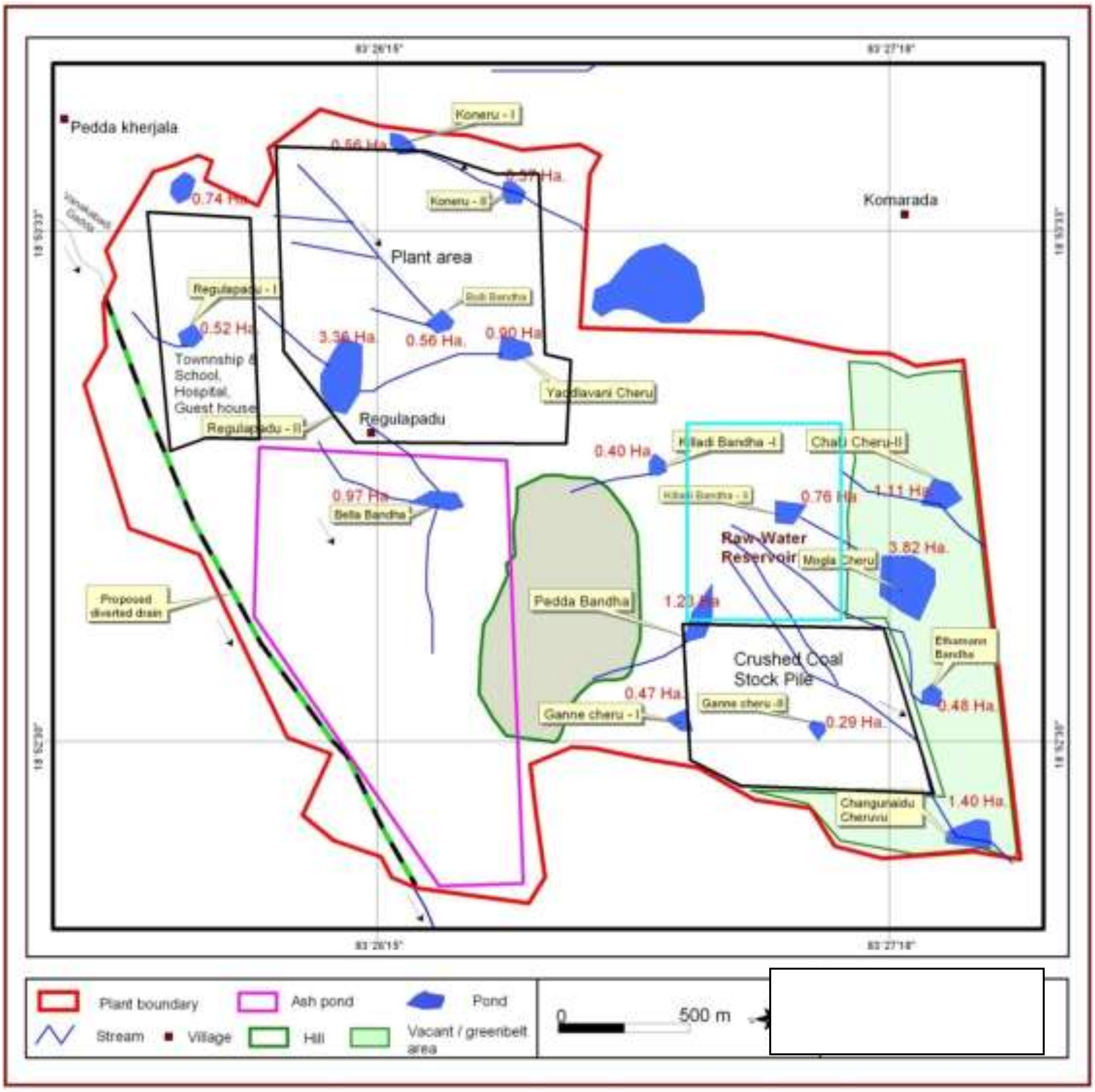


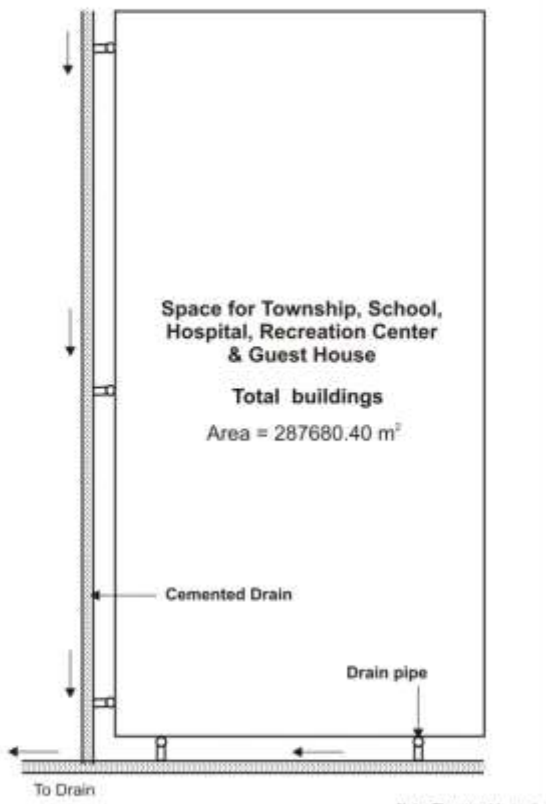
FIGURE-7.1
PLANT LAY OUT SHOWING LOCATION OF EXISTING TANKS

7.4 Roof Top Rain Water Harvesting

7.4.1 Township, School, Hospital, Recreation Centre & Guest House

It is proposed to construct a township, school, hospital, recreation centre & guest house building having total RCC flat roof top area of 2,87,680 m^2. All the roof top rain water will be collected through drain pipes and brought to cemented drain which will be constructed in front and back of the building as shown in **Figure-7.2.** All the drains will join and discharge the roof top rain water will meet diversion drain designed for Vanakabadi Gedda passing on the western part of the plant (Figure-2.12).

Figure-7.2. Recharge system for township, school, hospital, recreation centre & guest house



Note: Figure not to scale

The availability of roof top water and the peak runoff from the roof top of the township, school, hospital, recreation centre & guest house building having total roof top area of 2,87,680 m^2 has been estimated as under, taking annual average rainfall as 1060 mm, 0.85 as runoff coefficient for cemented roof and average rainfall intensity of 100 mm /day as peak rainfall for Vizianagram block.

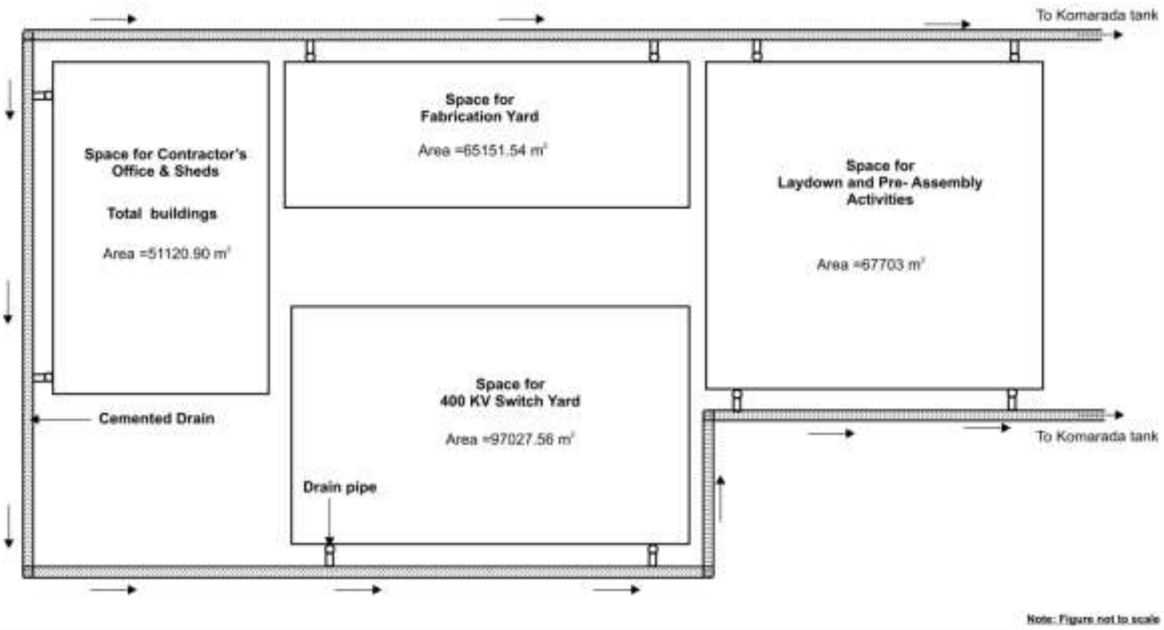
Availability of roof top rain water 2,87,680 x 0.85 x 1.060 = 2,59,200 m^3

Peak availability of water during 24 hours 2,87,680 x 0.85 x 0.10 = 24,453 m^3

7.4.2 Office, Laydown and Pre-assembly Activities Area, and 400 KV Switch Yard

It is proposed to construct an office, laydown and pre-assembly activities area, and 400 KV switch yard building having total RCC flat roof top area of 2,81,003 m^2 (51,120.90+ 65,151.54+67,703.00+97,027.56). All the roof top rain water will be collected through drain pipes and brought to cemented drain which will be constructed in front and back of the building as shown in **Figure-7.3.** All the drains will join and discharge the roof top rain water in the pond located just outside the plant in north-eastern direction.

Figure-7.3. Recharge system for office, laydown and pre-assembly activities area, and 400 KV switch yard



The availability of roof top water and the peak runoff from the roof top of the office, laydown and pre-assembly activities area, and 400 KV switch yard building having total roof top area of 281003 m^2 has been estimated as under, taking annual average rainfall as 1060 mm, 0.85 as runoff coefficient for cemented roof and average rainfall intensity of 100 mm /day as peak rainfall for Viziangaram block.

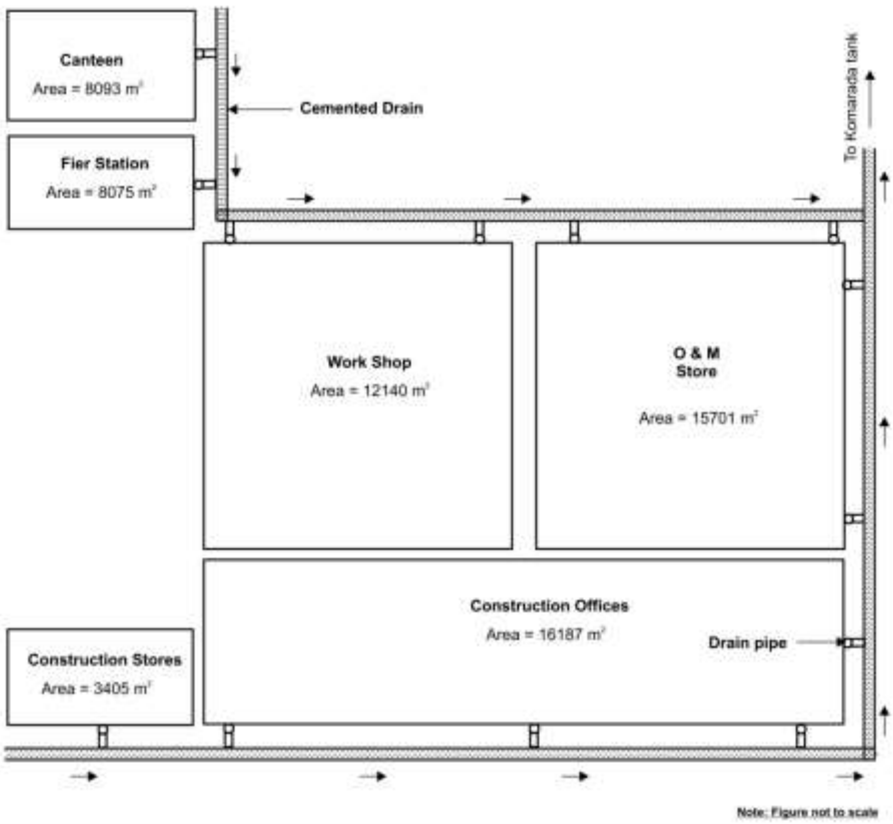
Availability of roof top rain water   2,81,003 x 0.85 x 1.060 = 2,53,184 m^3

Peak availability of water during 24 hours   2,81,003 x 0.85 x 0.10 = 23,885 m^3

7.4.3 Canteen, Fire Station, O & M Store, Workshop, Construction Store & Construction Offices

It is proposed to construct a canteen, fire station, O & M store and workshop, construction store & construction office building having total RCC flat roof top area of 63601 m^2 (8093+ 8075+12140+15701+3405+16187). All the roof top rain water will be collected through drain pipes and brought to cemented drain which will be constructed in front and back of the building as shown in **Figure-7.4.** All the drains will join and discharge the roof top rain water in Komarada village tank located near north-east boundary of the plant.

Figure-7.4. Recharge system for canteen, fire station, O & M store, workshop, construction stores & construction offices



Note: Figure not to scale

The availability of roof top water and the peak runoff from the roof top of the canteen, fire station, O & M store and workshop, construction store & construction office building having total roof top area of 63601 m^2 has been estimated as under, taking annual average rainfall as 1060 mm, 0.85 as runoff coefficient for cemented roof and average rainfall intensity of 100 mm /day as peak rainfall for Vizianagaram block.

Availability of roof top rain water	63,601 x 0.85 x 1.060 = 57,305 m^3
Peak availability of water during 24 hours	63,601 x 0.85 x 0.10 = 5,406 m^3

7.5 Surface Runoff of the North Eastern Part of the Plant

After the construction of the plant, town ship, ash pond, raw water reservoir and crushed coal stack pile, there will be vacant land or land to be provided for green belt (30 % of the total plant area) which will generate surface runoff depending on its catchment area of micro-water shed which will join the 6 village tanks.

These tanks will retain water, as in the past and will not be affected by the plant. Although, these village tanks can not be used by stray cattle, as in the past, due to the fencing of the plant, they will retain its original aesthetic environment.

7.6 Total Rain Water Harvested in the Plant Area

The rain water harvesting program of the plant has been designed with a view that maximum harnessable rain water may be collected and taken to nearest water development source. The roof top rain water from all the buildings, located in the western part of the plant will be led to Vanakabadi Gedda diversion drain and of the buildings on the eastern side to be led to Komarada village tank. The surface runoff of the vacant land or green belt will continue to fill the six village tanks as in the past as it will not be disturbed by the plant.

TABLE-7.1. TOTAL RAIN WATER HARVESTED IN THE PLANT

Sr. No.	Buildings	Water Availability (m^3)
1	Roof top rain water from township, school, hospital, recreation centre & guest house to be led to Vanakabadi Gedda diversion drain	25,9200
2	Roof top rain water from office, laydown and pre-assembly activities area, and 400 KV switch yard. to be led to Komarada village tank, just out side plant area	25,3184
3	Roof top rain water from canteen, fire station, O & M store, workshop, construction store & construction offices to be led to Komarada village tank, just out side plant area	57,305
	Total	**5,69,689 m^3**

8.0 HYDROLOGICAL NET WORK SYSTEM

8.1 Introduction

The MoEF, while conveying the environmental clearance for setting up 4 x 660 MW coal based power plant near village Komarada vide letter J-13012/13/ 2009-IA .II (T) dated 15.03.2010 has laid down a condition (xxiv) that AIPL will establish a hydrological net work system by sinking new piezometres around the ash pond to measure the water levels quarterly and its water particularly for heavy metals to study the impact of the ash pond on water regime. The data so obtained should be compared with base line data so as to ensure that ground water quality is not adversely affected due the plant. Although no ground water abstraction is proposed from the plant area, the fluctuation of quarterly water level may indicate ground water recharge from rain fall and different existing tanks. Annual report indicating the impact on the water regime of the plant area may be submitted to the Regional Office of the MoEF and CGWB.

Accordingly, a hydrological net work system has been designed for selecting the sites and design of piezometers to be drilled and monitored in the plant area and particularly around the ash pond.

HCPL initiated the field studies in February, 2014 and identified the locations where new piezometers are to be constructed where the impact of ash pond on water quality, particularly Cr, As and Pb along with fluctuation of water levels may be monitored.

8.2 Hydrological Net Work System

To view to find out the impact of ash pond on the ground water regime, it is necessary to monitor the water levels quarterly and water quality. Any adverse impact due to ash pond on ground water regime will be observed if there is any seepage from the ash pond storing the bottom ash along with fluctuation of quarterly water levels.

For establishing a hydrological net work system, the sites for new piezometers surrounding the ash pond and the plant area have been selected in relation of drainage, ground water flow direction and existing village tanks. A piezometer, essentially is small dia bore hole, deep enough to retain water level over next 20-30 years during pre-monsoon period.

8.2.1 Criteria for Selection of Piezometers

While selecting the sites for piezometers under the hydrological net work system, the following points were considered.

1. Location of piezometers should not be in the area of influence of any working bore well or an open well or raw water reservoir otherwise the static regional water table will not be available. The piezometers are therefore located away from these locations but in the surrounding area of the ash pond.

2. Location of piezometers has to be within the plant area where project proponent has the surface rights of the land as no private cultivator will allow the construction of piezometers in his land and safety of such piezometers will not be assured.

3. Depth of piezometers may be decided in such a way that piezometers are deep enough to have the water level during summer months and also for next 20 to 30 years.

Keeping these criteria in consideration, location of piezometers has been decided and are discussed as under.

8.2.2 Selection of Piezometer

The plant covering an area of 1675 acres (677.86 hectares) has no bore wells or open wells except few main water bodies as tanks and a prominent hill. The plant map where the piezometers are to be constructed along with the location of the ash pond which covers an area of 300 acres (121.408 ha) is shown as **Figure-8.1.** The coordinates of the piezometers included in the hydrological network system are shown in **Table-8.1.**

TABLE-8.1
CO-ORDINATES OF PIEZOMETERS

Sr. No.	Piezometer No.	Longitude (E)	Latitude (N)
1	P-1	83° 26' 33.7"	18° 52' 11.7"
2	P-2	83° 26' 07.8"	18° 52' 21.7"
3	P-3	83° 25' 57.2"	18° 52' 51.4"
4	P-4	83° 25' 45.2"	18° 53' 25.8"
5	P-5	83° 26' 19.4"	18° 53' 08.4"
6	P-6	83° 26' 33.2"	18° 52' 29.5"
7	P-7	83° 27' 30.3"	18° 52' 19.5"
8	P-8	83° 27' 24.5"	18° 53' 14.1"

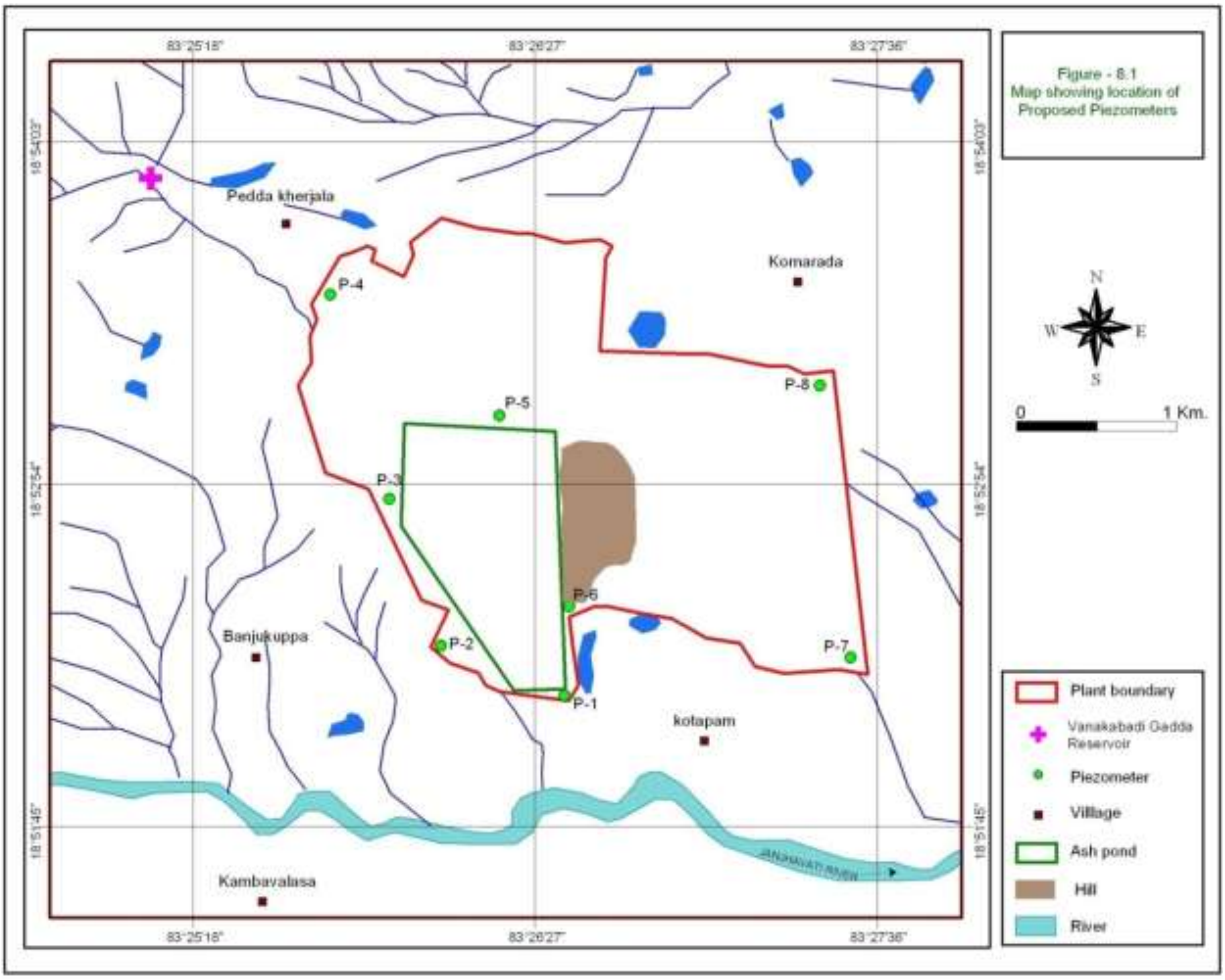


FIGURE-8.2
MAP SHOWING LOCATION OF PROPOSED PIEZOMETER

8.2.3 Design of Piezometer

Piezometer is essentially a small diameter borehole (100 mm) deep enough to have the zone of saturation permanently which is exclusively to be used for measuring ground water level. This should not be in the area of influence of any working bore well or dug well or water body/water reservoir and should only indicate static water level or top of the zone of saturation at any given time. The location of piezometers in any area should be spaced in such a way that fluctuation of water level may indicate the changes caused due to impact of plant and ash pond.

The piezometers are proposed to be painted blue and a wire fencing provided around it so that people may not damage it. The security staff posted in the plant will see to it that piezometers are not damaged.

It is proposed that AIPL will start construction of new 8 piezometers as suggested in this report by engaging a local drilling contractor. The piezometer will be drilled by deploying a DTH drilling used for construction of hand pumps in Vizianagram district. Depth of the piezometers will be 40 m with 0.6 m pipe above the land surface. Each piezometer will be provided with casing pipe either of mild steel or PVC of 100 m in dia up to depth of 3 to 6 m depending on the thickness of alluvium and weathered granite gneiss. The bore well will remain naked till 40 m depth as it will not collapse being in hard rock. The piezometers may be provided with a threaded cap at the top of the pipe which will be opened by pipe wrench for measuring the water levels. Each piezometer will be provided with cemented platform (1.00 m x 1.00 m) and pipe of 0.6 m above the land surface as shown in **Figure-8.2.** Each piezometer may be provided with sign board indicating the No. of the piezometer.

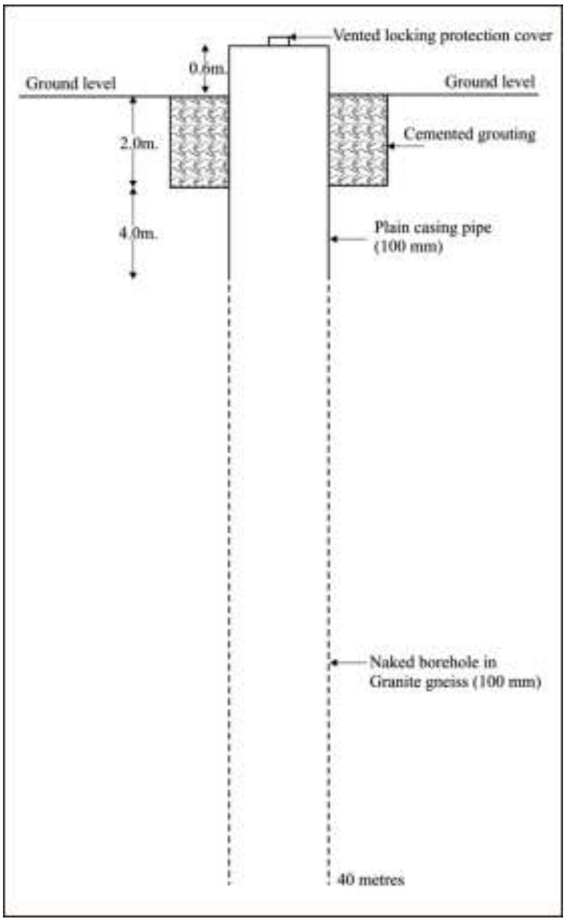


FIGURE-8.2
DESIGN OF PIEZOMETRES

8.2.4 Monitoring Program

As suggested by the MoEF, all the piezometers are to be monitored four times in a year, pre-monsoon (April/May), mid-monsoon (August), post–monsoon (November) and winter (January) seasons every year. The water levels will be measured by using electrical water level indicator having a graduated measuring tape where a sonde, after touching water level in a piezometer lights an electric bulb and makes an alarming sound.

Water level is measured from top of casing and its height from land surface is noted. As piezometers have been constructed, these are to be monitored every quarter.

8.2.5 Monitoring the Water Quality

As it has been indicated that water quality is also to be monitored quarterly, water samples may be collected from each piezometer by installing an ordinary hand pump. The hand pump may be operated for half an hour so that fresh water may come from the aquifer and then water sample be collected for chemical analysis. The water levels may be collected either one day before or after the collection of water sample so that the piezometer shows static water level.

With the proposed hydrological net work system and its regular monitoring and interpretation of ground water level data on annual basis, along with water quality, it will be possible to study the impact of ash pond and the plant on water regime. This will also help in knowing the net annual change in ground water storage due to ground water recharge and discharge during the year. Any depleting trend in water levels, if observed, can be set right by taking up suitable rain water harvesting measures. Any deterioration in water quality particularly the heavy metals, may be controlled by taking suitable mitigation measures.

Without such hydrological net work system in operation and study, any impact or conclusion relating to water regime can not be known. Such monitoring program is therefore going to be highly useful to find out any impact on ground water quality and in ground water storage due to ash pond/plant and the mitigations measures can be proposed to reverse the declining trend of water levels or deterioration in water quality if any.

Appendix-I. Hydrological data of key wells of buffer zone of Komarda thermal power plant monitored during pre and post monsoon 2013

S.N.	VILLAGE	LATITUDE	LONGITUDE	DEPTH OF WELL (M)	POST MONSOON WATER LEVEL (M)	PRE MONSOON WATER LEVEL (M)	AQUIFER	YIELD m^3/hour	PUMP CAPACITY (HP)	PURPOSE
1	Regalapadu	18°53'04.8"	83°26'04.1"	9.45	2.50	4.05	Alluvium	-	Manual	Drinking
2	Lnvalsa	18°52'41.3"	83°26'09.7"	9.50	4.45	6.10	Alluvium	-	Manual	Drinking
3	Sitamambapuram	18°53'00.5"	83°27'47.3"	6.88	2.45	4.15	Alluvium	-	Manual	Drinking
4	Gumpa	18°51'38.0"	83°28'31.2"	10.50	6.80	8.20	Alluvium	-	Manual	Drinking
5	Lingumdhora	18°52'35.5"	83°26'17.9"	5.10	0.50	2.62	Alluvium	-	Manual	Drinking
6	Gandhinagar	18°56'00.1"	83°27'14.7"	9.88	1.75	3.90	Alluvium	-	Manual	Drinking
7	Kondakunera RF	18°58'04.8"	83°25'45.5"	45.40	7.20	9.10	Alluvium	14.00	3 HP/EM	Water Supply
8	Saruguda	18°57'19.4"	83°25'56.0"	7.40	5.50	7.30	Alluvium	-	Manual	Drinking
9	Old Ulipori	18°56'20.9"	83°26'26.3"	8.70	4.10	5.70	Alluvium	-	Manual	Drinking
10	Vikrampuram	18°48'43.2"	83°26'41.8"	8.70	2.30	3.80	Alluvium	-	Manual	Drinking
11	Sivuni	18°48'11.5"	83°26'05.7"	6.75	2.10	3.65	Alluvium	-	Manual	Drinking
12	Parvathipuram	18°46'59.1"	83°26'08.7"	9.45	3.60	5.70	Alluvium	-	Manual	Drinking
13	Gavarapeta	18°49'54.0"	83°31'11.8"	7.45	0.75	1.90	Alluvium	-	Manual	Drinking
14	Kichhada	18°51'16.8"	83°31'19.0"	10.20	3.30	5.90	Alluvium	-	Manual	Drinking
15	Kurupam	18°51'53.0"	83°33'06.2"	12.10	2.60	4.10	Alluvium	-	Manual	Drinking
16	Palem	18°54'02.1"	83°30'54.6"	6.50	2.10	4.25	Alluvium	-	Manual	Drinking
17	Chekkavalasa	18°53'29.7"	83°30'47.4"	10.50	2.25	4.65	Alluvium	-	Manual	Drinking
18	Puligummi	18°52'16.3"	83°30'21.8"	11.00	2.36	5.75	Alluvium	-	Manual	Drinking
19	Dalaipeta	18°51'41.3"	83°29'18.2"	10.40	2.45	5.00	Alluvium	-	Manual	Drinking
20	Nimmalpadu	18°50'18.1"	83°29'45.0"	10.40	2.60	5.10	Alluvium	-	Manual	Drinking
21	Krishnapalli	18°47'10.1"	83°25'06.1"	9.20	2.15	4.82	Alluvium	-	Manual	Drinking
22	Krishnapalli	18°47'31.7"	83°24'31.9"	9.20	2.40	4.36	Alluvium	-	Manual	Drinking
23	Srirangrajapuram	18°48'22.1"	83°23'27.7"	10.30	2.25	4.55	Alluvium	-	Manual	Drinking
24	Chandalingi	18°49'45.4"	83°22'09.7"	8.40	2.36	4.94	Alluvium	-	Manual	Drinking
25	Kummarigunta	18°50'46.6"	83°26'34.2"	7.50	2.45	4.93	Alluvium	-	Manual	Drinking
26	Kambavalasa	18°51'31.0"	83°25'40.9"	7.20	3.60	5.40	Alluvium	-	Manual	Drinking
27	Kancharapadu	18°51'32.8"	83°23'25.3"	8.20	3.25	5.26	Alluvium	-	Manual	Drinking
28	Digubhadrapali	18°52'03.4"	83°22'51.1"	9.40	3.40	6.00	Alluvium	-	Manual	Drinking
29	Pipalbhadra	18°52'29.2"	83°21'00.7"	9.20	1.75	4.40	Alluvium	-	Manual	Drinking
30	Kabbalara	18°52'11.8"	83°20'38.5"	7.20	2.25	5.00	Alluvium	-	Manual	Drinking

Appendix-II

LOCATION OF INFILTRATION & PERMEABILITY TESTS

Infiltration No.	Co-ordinates						
I-1	83°	26'	14.48"		18°	52'	47.98"
I-2	83°	26'	26.12"		18°	52'	45.57"
I-3	83°	26'	25.49"		18°	52'	23.88"
I-4	83°	26'	09.23"		18°	52'	34.85"
I-5	83°	26'	15.49"		18°	53'	0.02"

Permeability No.	Co-ordinates						
P-1	83°	26'	13.65"		18°	52'	47.89"
P-2	83°	26'	24.67"		18°	52'	46.05"
P-3	83°	26'	24.59"		18°	52'	23.68"
P-4	83°	26'	10.25"		18°	52'	35.06"
P-5	83°	26'	13.98"		18°	53'	0.02"

1.0 Introduction

The National Green Tribunal (NGT) has suggested Andhra Pradesh Pollution Control Board (APPCB) to satisfy itself in terms of design, projected efficiency levels of various treatment units and the quality characteristics with regard to the discharge of treated wastewater into downstream of confluence point of river Janjavathi and river Nagawali prior to the issuance of consent to operate.

The details of water requirement, wastewater generation, water balance and the treatment proposed are described briefly. It will be ensured that the units proposed for the treatment of effluent will be verified by APPCB before issuing consent to operate. The detailed design will be prepared and implemented at the time of detailed engineering.

1.1 Water System and Requirement

The raw water is used for condenser cooling, the cycle make-up and other consumptive water requirements after appropriate treatment. The total water requirement of entire project will be 70 MCM (8000 m^3/hr) which will be drawn from Nagavali river. The raw water will be brought to the plant by pipeline.

Estimated total consumptive water requirement for the plant is about 8000 m^3/hr for 2640 MW, considering re-circulating closed cooling water system with cooling tower. The above quantity of water includes makeup water for the cooling towers (to compensate for water lost on account of evaporation, drift and blow down) and other consumptive requirement. In-principle allocation of 8000 m^3/hr water from Nagavali river has been accorded by Irrigation & CAD of Govt. of Andhra Pradesh for this project.

1.1.1 Plant Water System

It is proposed to install a closed recirculating cooling water system using induced draft cooling towers, with 10°C temperature rise across the condenser. It is envisaged to design the system for 5 cycles of concentration (COC). Estimated cooling water circulation requirement is about 70000 m^3/hr for each unit and auxiliary cooling water requirement is 5600 m^3/hr approximately. Considering evaporation, drift loss and blow down and selected COC, the make-up water requirement will be about 7300 m^3/hr for 4 units. Accordingly, estimated make-up water requirement for the cooling water system and other consumptive needs is 8000 m^3/hr.

1.1.2 Intake System

The plant water requirement will be met by three (3) numbers makeup pumps. The intake water makeup pumps will be located at one side of river. The above pumps will supply raw water to the plant.

Make-up water will be brought to the plant area through pipes. To supply the make-up water, three (3) nos. 4000 m^3/hr capacity makeup water pumps (2 working and 1 standby) will be installed in the makeup water pump house, the makeup water system is designed for continuous operation. The makeup water pumps will supply water to the reservoir in the plant.

1.1.3 Circulating and Auxiliary Cooling Water System

The plant CW system will include the CW and auxiliary CW pumping system, induced draft cooling tower. It is proposed to provide one common circulating water pumping station for a set of 2 units in the plant. Each such pumping station will have four (4) numbers of circulating water pumps, two (2) for each unit. For carrying circulating water from CW pump house to TG area and from TG area to cooling tower, steel pipe will be provided. For interconnecting CW duct with CW pump, condenser and cooling towers, steel pipes would be used.

For each unit 2x100% auxiliary cooling water pumps will be provided for supply of auxiliary cooling water to 3x50% heat exchangers, which will be used for cooling the closed cycle cooling water. The auxiliary cooling water pumps will be located within the TG building. These pumps will take suction from the CW pump discharge entering the condenser and return back to the CW outlet line from the condenser.

The cold water after cooling tower will be led to the CW pump house through the cold-water channel by gravity. CW system blow-down would be drawn from the discharge of the CW pumps and discharged to ash water sumps / CMB. Since no blow down water is envisaged to be disposed outside – it is preferred to tap off the CW blow down from the outlet of the condenser. This will reduce the CW pump size and the auxiliary power consumption.

For each condenser cooling, 2 numbers of CW pumps supply water at rate of about 35000 - 37500 m^3/h to the cooling water system. CW pump house is common for two units having four CW pumps; no standby pump has been envisaged. One complete set of spare pump with motor will be provided for ease of maintenance.

1.1.4 Water Treatment System

The water treatment system comprises of water pre-treatment plant, DM plant, chlorination plant, condensate polishing plant, CW treatment plant as described below. Clarified water requirement of the plant will be met by 4 clarifiers each of capacity 2500 m^3/hr.

- **DM Plant**

A DM plant of total 160 m^3/hr capacity is envisaged to ensure make-up requirement of heat cycle at the rate of approx. 1.5 % of the BMCR steam flow, make up to closed circuit auxiliary system, hydrogen generation plant (if applicable) and stator water-cooling system. The DM plant will consist of ACF, SBC, DG, SBA and MB to produce DM water. Configuration of the DM Plant will be such that at least one standby stream is available.

DM water will be stored in 4x600 m^3 of DM water storage tank. DM water storage tank capacity is adequate to meet 20 hrs make-up requirement for all units. The two nos. (2x100%) DM water Transfer pumps each of capacity 50 m^3/hr will be provided to transfer the DM water from the DM plant storage tank to four reserve feed water (condensate) tanks each of capacity 70 m^3 for further heat cycle make up system.

The DM water cycle make-up system will consist of 2x100% cycle make up pumps for feeding to condensate hot well as well as reserve feed water storage (condensate) tank. Besides, there will be 2 x 100% SG fill pumps for direct filling of SG with demineralised water. These pumps will be located near DM water tanks.

1.1.5 Service Water & Potable Water System

Drinking water requirement for the plant will be met from the output of filters after treatment. There will be 2x100% drinking water pumps, which will supply drinking water to various facility area overhead tanks.

Plant service water requirement will be met from the Overhead Service water tank and 2x100% service water pumps, which will supply service water to various facility areas.

1.2 Wastewater Generation and Proposed Treatment

Effluents will be generated from cooling tower blow down, wash water and wastewater from sanitary facilities. Sanitary effluent will be treated in sewage treatment plant. The cooling water blow down will be treated and reused in ash conduction and disposal system and dust suppression system. Blow down from cooling towers will be the main sources of the wastewater. Besides this, DM plant waste, domestic waste from canteen and toilets will be the other wastes generated. The cooling tower blowdown will be reused in dust suppression, ash/coal handling, fly ash conditioning, ash disposal and service water. The treated wastewater from sewage & effluent treatment plant will be used in greenbelt development. Various types of wastewater to be generated in the proposed project with their quantity is given in **Table-1** and the water balance is shown in **Figure-1.**

TABLE-1
WASTEWATER GENERATION FROM THE PROPOSED POWER PLANT

All Values are given in m^3/hr

Sr. No.	Units	Water Requirement	Loses/Uses	Wastewater Generated	Remarks
1	Cooling tower make up	7300	5840	1460	Reused for AHP, CHP and green belt
2	Potable Water	19	14	5	Sent to CMB
3	Service water	170	170	0	-
4	Sludge Treatment	160	0	160	125 - Offsite disposal of sludge cake, 35 – treated and re-used
5	Filtration & DM plant	174	160	14	Sent to Neutralising pit and then to CMB
6	Fire water make-up	5	5	0	-
7	Plant drain after oil separation	-	-	8	Sent to CMB
8	Total Evaporation and Seepage Losses	172	172	0	-

Sr. No.	Units	Water Requirement	Loses/Uses	Wastewater Generated	Remarks
	Total	**8000**	**6361**	**1647**	763 – AHP, 300-CHP, 100-Green Belt and Plant washing 324-Guard Pond

About 324 m^3/hr of wastewater will be treated and discharged into downstream of confluence point of river Janjavathi and river Nagawali after the water quality matches the APPCB/CPCB discharge standards. Continuous monitoring of effluent discharge will be undertaken and it will be ensured that when discharge enters the natural drain the ambient temperature will be maintained.

1.2.1 Proposed Treatment

Wastewater will be generated from cooling towers, boilers in the power plant. Besides, domestic wastewater from canteen and employees wash area, township will also be generated. The wastewater from various units of the plant shall be appropriately treated and disposed. The proposed wastewater treatment is given in **Table-2.**

TABLE-2
THE PROPOSED WASTE WATER TREATMENT

Type of Wastewater	Treatment Proposed
Cooling tower blow down	Sent to Central Monitoring Basin (CMB)
Boiler blow down	Sent to CMB, If any
DM plant regeneration waste	Neutralization pit and sent to CMB
Service water	Treated in ETP (flocculator, settling tank) and sent to CMB
Effluents from fuel storage areas, floor washings, runoff from Oil handling area	Passed through Oil water separator and sent to CMB
Sewage from township and plant	Treated in STP

1.2.1.1 Effluent Treatment Plant

The plant is designed to treat all effluent except for the cooling tower blow down. The effluent generated from cooling tower blow down will be used for ash handling system to the extent possible. The following are the different type of effluent to be treated before reuse.

a. The Cooling Tower (CT) blow down will be used for ash handling system to the extent possible;

b. Effluent from clarifiers and filters will be fed to ash handling plant;

c. All chemical area drains and demineralization waste are directed to the neutralization basin. Once the pH of the wastewater has been adjusted to acceptable limit, the neutralization basin effluent will be transferred to CMB;

d. Effluent from boiler, turbine and other areas, which may contain oil traces, will be sent to oil/water separator. The oil will be pumped out periodically and trucked out for offsite disposal. Then the water will be directed to CMB;

e. The wastewater in transformer area may contain oil. Disposal of wastewater from transformer yard will be directed to oil/water separator; and

f. Effluent generation is dependent, to some extent, on the operating practices in the plant. Any residual effluent will be used for dust suppression (for coal handling plant and open areas) and green belt.

Flow scheme for wastewater flow scheme and the proposed STP are given in **Figure-2** and **Figure-3** respectively**.**

1.2.1.2 Ash Water

Most of the cooling tower blow down will be used for ash handling plant. Ash slurry will be directed to ash pond from where clear water after clarification will return to AHP system.

1.2.1.3 Rain Water

i) Rainfall runoff from the coal pile will contain mainly suspended solids. This runoff will be routed to the settling basin for retention and settling of suspended solids, and the clear water from there may be used for dust suppression system; and

ii) The rain water will be collected in the rain water harvesting pits from the storm water drain running all around the project. Rain water harvesting pits are connected at regular interval to the storm water drain. Thus the rain water will recharge the ground water.

Excess rain water will flow to common collection pit from where water can be pumped for use in the ash handling system.

1.3 Expected Quality of Wastewater

The expected quality of raw and treated wastewater from the power plant including sewage water and discharge limits as specified by environment protection rules is given in **Table-3**. The treated wastewater will be discharged into downstream of confluence point of river Janjavathi and river Nagawali as per specified discharge standards of APPCB/CPCB.

TABLE-3
EXPECTED QUALITY OF WASTEWATER

Sr. No.	Parameter	Unit	Raw wastewater	Treated Wastewater	Permissible Limits as per GSR 422 (E) for On-land Discharge (Irrigation)
1	pH	-	5.5 to 9.0	6.0 to 8.5	5.5 to 9.0
2	Suspended Solids	mg/l	100 to 500	<100	200
3	Oil & Grease	mg/l	10 to 200	<5	10

Sr. No.	Parameter	Unit	Raw wastewater	Treated Wastewater	Permissible Limits as per GSR 422 (E) for On-land Discharge (Irrigation)
4	Total Dissolved Solids	mg/l	500 to 10000	<1000	--
5	BOD	mg/l	250 to 350	<30	100
6	COD	mg/l	450 to 600	<100	-

1.4 Water Pollution Management

The recommended measures to minimise the impacts and conservation of fresh water are:

- Recycling of wastewater generated in cooling tower into process and ash disposal, coal handling and service water requirements;
- The plant raw water requirement shall be optimised. The COC in cooling system shall be maximised (such as COC=5);
- The effluent carrying oil spillage in the plant area shall be sent to oil-water separator for removal of oil;
- Coal stock piles and ash ponds shall be provided with garland drains and water shall be treated for suspended / floating solids;
- Adequate treatment of wastewater prior to recycling/reuse to maximum extent;
- Provision of sewage treatment plant to treat domestic sewage generated from plant and township;
- Utilization of treated domestic wastewater in toilet flushing, greenbelt development and dust suppression;
- Lining of effluent pond suitably to prevent any seepage into ground to avoid any groundwater contamination;
- Provision of separate storm water system to collect and store run-off water during rainy season and utilization of the same in the process to reduce the fresh water requirement;
- Final disposal shall be through open channel with natural cascade aeration arrangement to improve DO in treated effluent;
- Treated effluents from all streams should be stored in CMB / Guard Pond having 5 to 6 days detention time and the aquaculture may be practiced with bioassay tests on regular basis;
- The treated wastewater before disposal shall be checked for conformity of Environment Protection rules; and
- Suitable rainwater harvesting structures to be constructed.

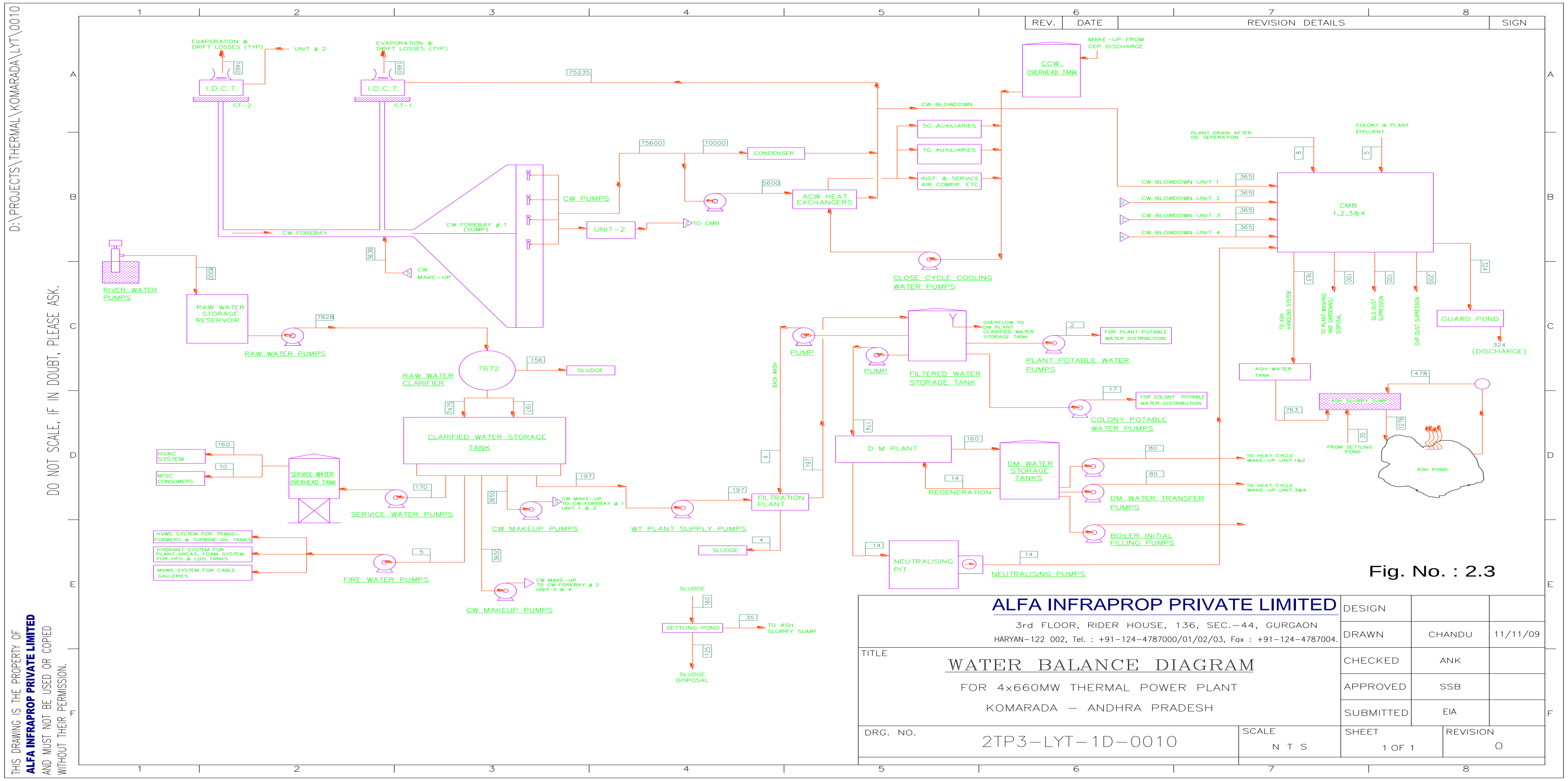


FIGURE-1
WATER BALANCE DIAGRAM

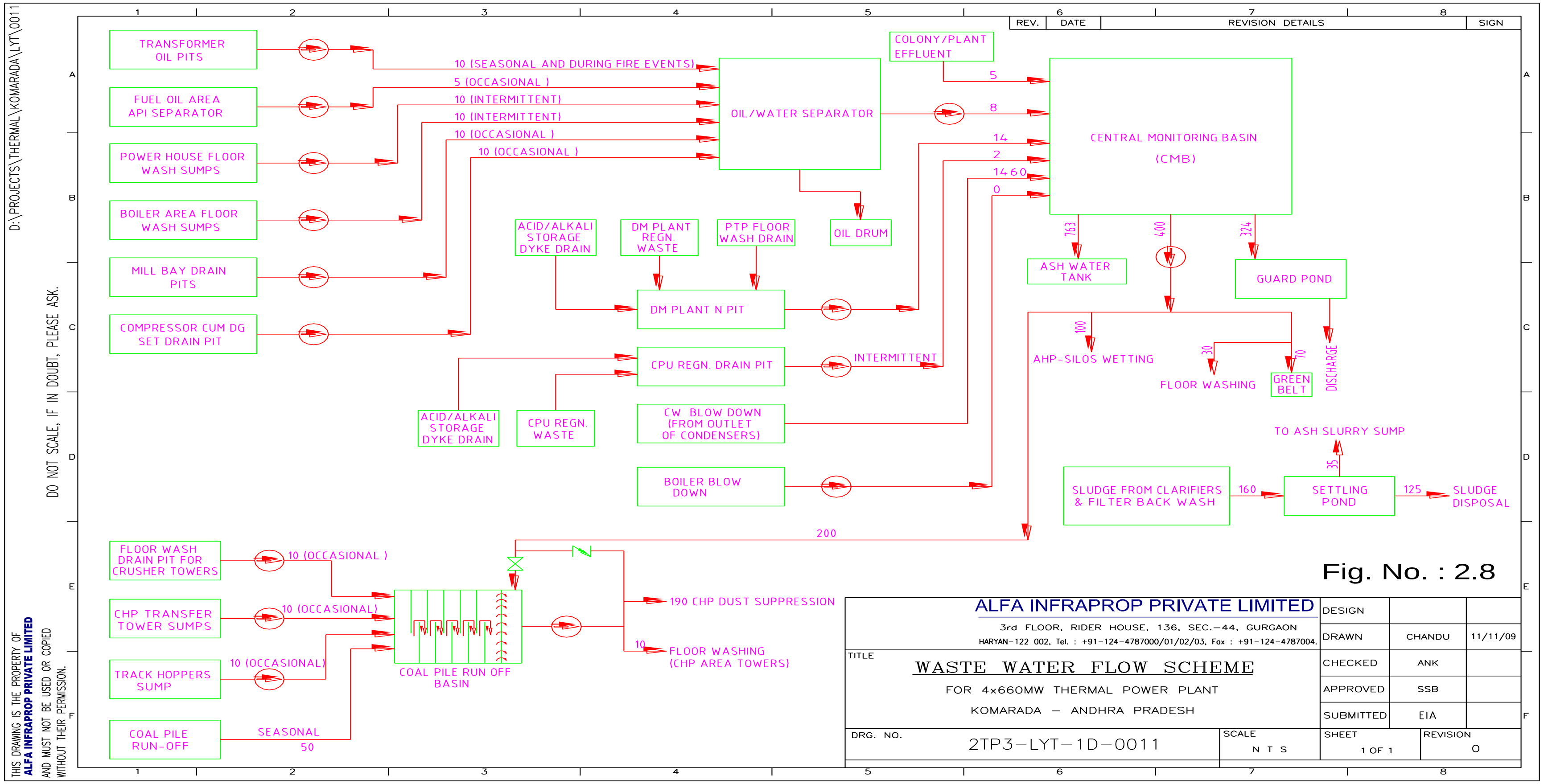


FIGURE-2

FLOWCHART SHOWING EFFLUENT TREATMENT SCHEME

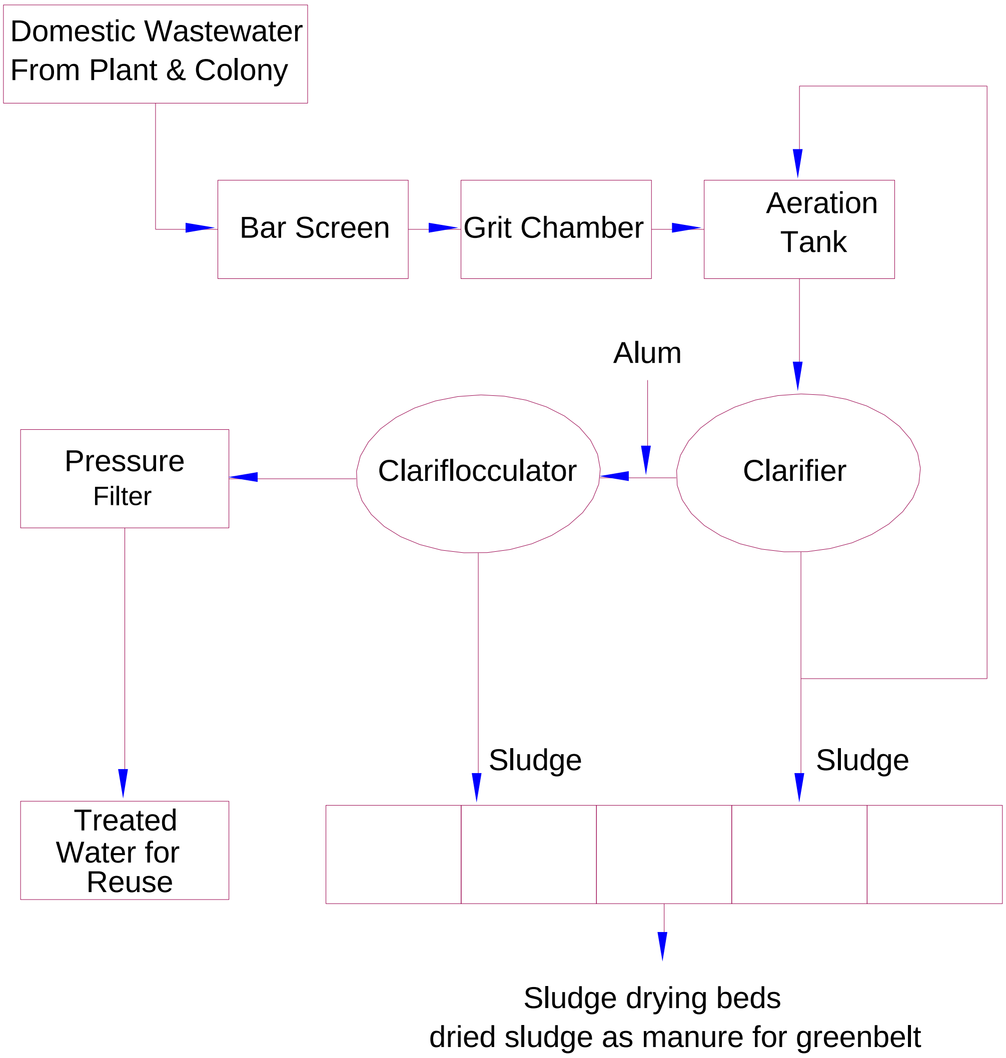


FIGURE-3
FLOWCHART SHOWING PROPOSED STP

1.0 Preamble

M/s. Alfa Infraprop Pvt. Limited proposes to set up a 4X660 MW coal based power plant near Komarada village & mandal, Vizianagaram district, Andhra Pradesh. Ministry of Environment and Forests (MoEF) granted Environmental Clearance (EC) for the above said project vide letter no. J-13012/13.2009-IA.II(T) dated 15.3.2010.

The EC was challenged in the National Green Tribunal (NGT) by two appellants. NGT, vide its judgment, had directed EAC to discuss five issues again in detail, even if these have already been taken into consideration and add specific mandatory conditions as appropriate. As part of it, the EAC is directed to review its appraisal process with regard to issues raised in the public hearing and give attention to points missed by it, if any, during the earlier process of appraisal and stipulate additional conditions, if so warranted.

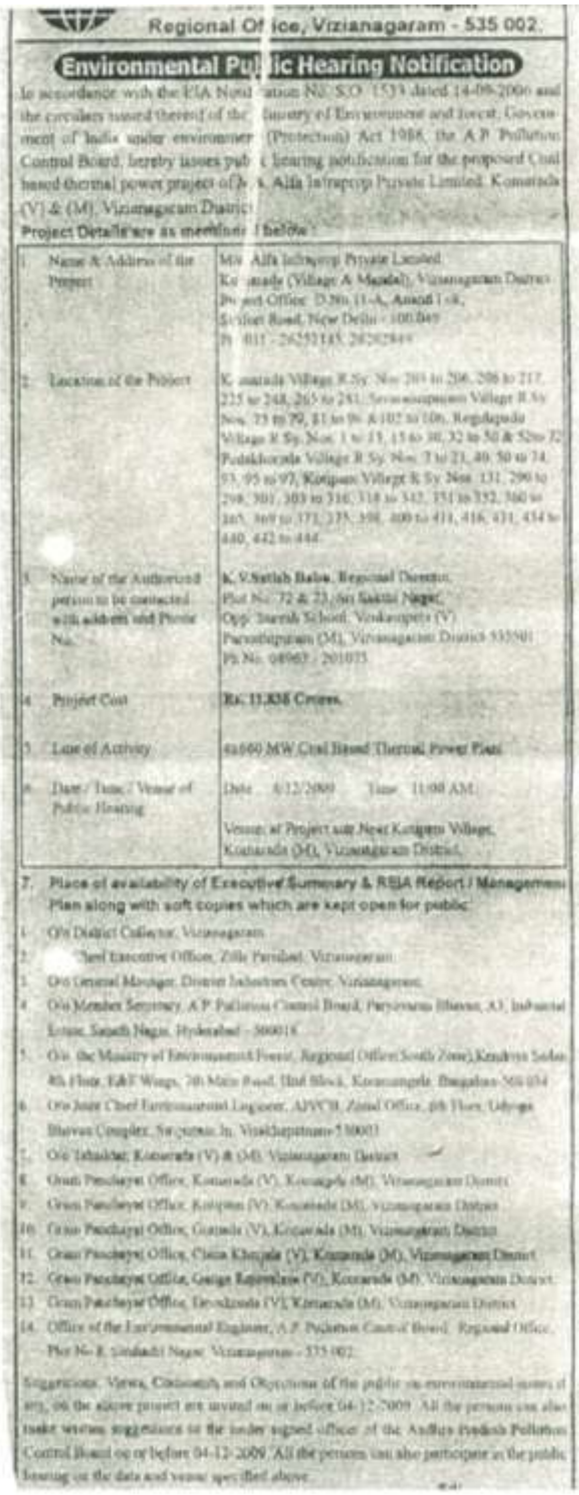
1.1 Public Hearing

The public hearing for the proposed 4X660 MW coal based thermal power plant near Komarada village and mandal, Vizianagaram district, Andhra Pradesh was conducted on 4th December 2009 at project site near Kotipam village, Komarada mandal, Vizianagaram district as per Environment Impact Assessment Notification dated 14th September 2006.

The press notification indicating date and venue of the public hearing was issued by Regional officer, APPCB, on 4th November 2009 with project details and Corrigendum on 18th November 2009 in two (2) prominent news papers viz. The Hindu (English Daily) and Eenadu (Telugu Daily) with project details, inviting suggestions, views and objections from the public regarding proposed power plant of M/s. Alfa Infraprop Pvt Limited.

Public hearing meeting was convened by Shri. K. Ramesh, Environmental Engineer, APPCB, Regional Office Vizianagaram and chaired by Shri G. Ramanarayana Reddy, District Collector and Magistrate, Vizianagaram. The minutes of the public hearing is enclosed as **Annexure-I**.

Details of specific photos of public hearing and paper notification are shown in **Figure-1** and the action plan for the issues raised in public hearing are shown in **Table-1**.



Regional Office, Vizianagaram - 535 002.

Environmental Public Hearing Notification

In accordance with the EIA Notification No. S.O. 1533 dated 14-09-2006 and the circulars issued thereof of the Ministry of Environment and forest, Government of India under environment (Protection) Act 1986, the A.P. Pollution Control Board, hereby issues public hearing notification for the proposed Coal based thermal power project of M/s. Alfa Infraprop Private Limited, Komarada (V) & (M), Vizianagaram District.

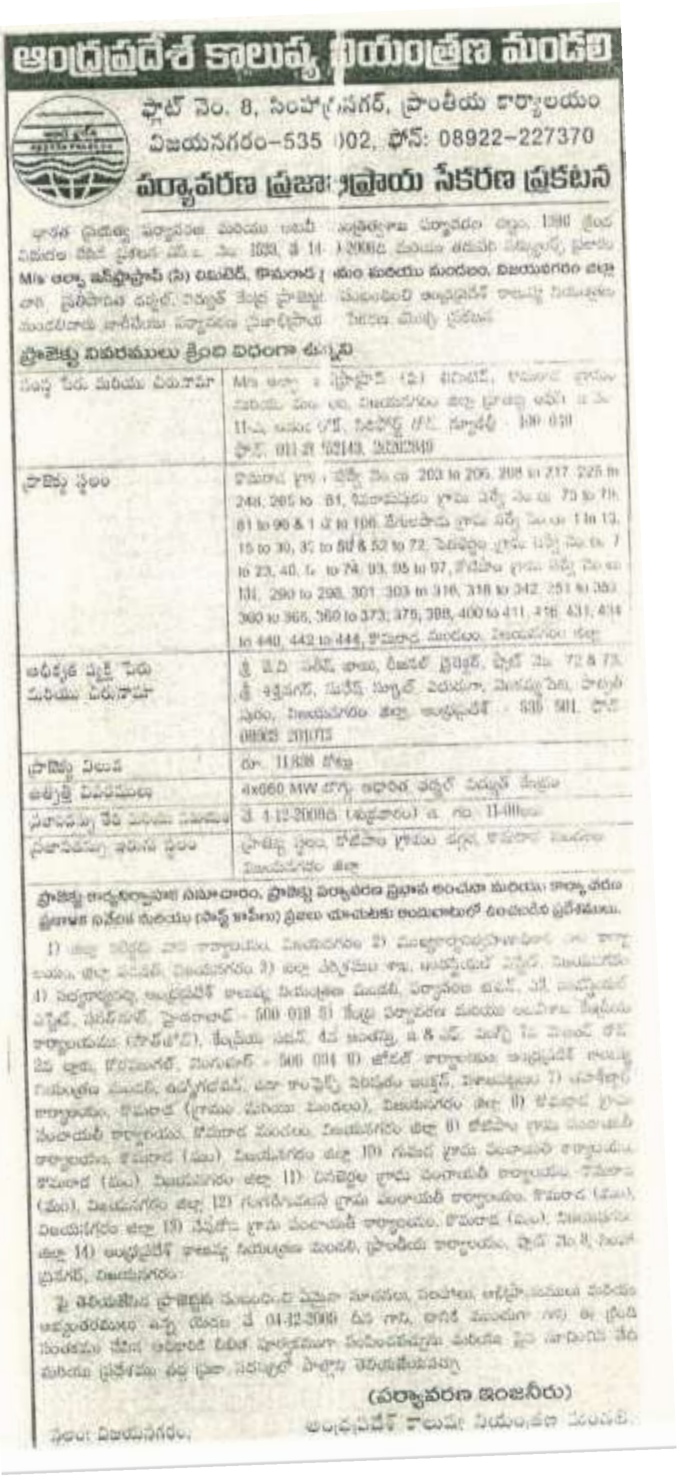
Project Details are as mentioned below :

1.	Name & Address of the Project	M/s Alfa Infraprop Private Limited Komarada (Village & Mandal), Vizianagaram District Project Office: D.No. 11-A, Anand Lok, Siri Fort Road, New Delhi - 110 049 Ph: 011 - 26252145, 26262849
2.	Location of the Project	Komarada Village R.Sy. Nos. 203 to 206, 208 to 217, 225 to 248, 265 to 281, Sivaramapuram Village R.Sy. Nos. 73 to 79, 81 to 96 & 102 to 106, Regidapeda Village R.Sy. Nos. 1 to 13, 15 to 30, 32 to 50 & 52 to 72, Pedakherada Village R.Sy. Nos. 7 to 23, 40, 50 to 74, 93, 95 to 97, Kotipam Village R.Sy. Nos. 131, 290 to 298, 301, 303 to 316, 318 to 342, 351 to 352, 360 to 365, 369 to 373, 375, 398, 400 to 411, 416, 431, 434 to 440, 442 to 444.
3.	Name of the Authorised person to be contacted with address and Phone No.	**K.V.Satish Babu**, Regional Director, Plot No. 72 & 73, Sri Sakthi Nagar, Opp. Suresh School, Venkampeta (V) Parvathipuram (M), Vizianagaram District 535501 Ph.No. 08963 - 201075
4.	Project Cost	**Rs. 11,838 Crores.**
5.	Line of Activity	4x660 MW Coal Based Thermal Power Plant
6.	Date / Time / Venue of Public Hearing	Date: 4/12/2009 Time: 11:00 AM Venue: at Project site Near Kotipam Village, Komarada (M), Vizianagaram District.

7. Place of availability of Executive Summary & REIA Report / Management Plan along with soft copies which are kept open for public:

1. O/o District Collector, Vizianagaram
2. O/o Chief Executive Officer, Zilla Parishad, Vizianagaram
3. O/o General Manager, District Industries Centre, Vizianagaram
4. O/o Member Secretary, A.P. Pollution Control Board, Paryavarana Bhavan, A3, Industrial Estate, Sanath Nagar, Hyderabad - 500018
5. O/o the Ministry of Environment & Forest, Regional Office (South Zone), Kendriya Sadan, 4th Floor, E&F Wings, 7th Main Road, IInd Block, Koramangala, Bangalore-560 034
6. O/o Joint Chief Environmental Engineer, APPCB, Zonal Office, 6th Floor, Udyog Bhavan Complex, Siripuram Jn, Visakhapatnam-530003
7. O/o Tahsildar, Komarada (V) & (M), Vizianagaram District
8. Gram Panchayat Office, Komarada (V), Komarada (M), Vizianagaram District
9. Gram Panchayat Office, Kotipam (V), Komarada (M), Vizianagaram District
10. Gram Panchayat Office, Gumada (V), Komarada (M), Vizianagaram District
11. Gram Panchayat Office, Chinna Khergala (V), Komarada (M), Vizianagaram District
12. Gram Panchayat Office, Ganga Rajupuram (V), Komarada (M), Vizianagaram District
13. Gram Panchayat Office, Devukonda (V), Komarada (M), Vizianagaram District
14. Office of the Environmental Engineer, A.P. Pollution Control Board, Regional Office, Plot No. 8, Simhadri Nagar, Vizianagaram - 535 002

Suggestions, Views, Comments and Objections of the public on environmental aspects if any, on the above project are invited on or before 04-12-2009. All the persons can also make written suggestions to the under signed officer of the Andhra Pradesh Pollution Control Board on or before 04-12-2009. All the persons can also participate in the public hearing on the date and venue specified above.



ఆంధ్రప్రదేశ కాలుష్య నియంత్రణ మండలి

ఫ్లాట్ నెం. 8, సింహా నగర్, ప్రాంతీయ కార్యాలయం
విజయనగరం-535 002, ఫోన్: 08922-227370

పర్యావరణ ప్రజాభిప్రాయ సేకరణ ప్రకటన

ప్రాజెక్టు వివరములు క్రింది విధంగా ఉన్నవి

[illegible]	Ms [illegible] 11-[illegible] 110 049 011 2[illegible] 52143, 26262849
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ఉత్పత్తి వివరములు	4x660 MW [illegible]
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(పర్యావరణ ఇంజనీరు)

స్థలం: విజయనగరం. [illegible]

FIGURE-1(A)
PAPER NOTIFICATION

FIGURE-1(B)
PUBLIC HEARING PHOTOGRAPHS

TABLE-1
ISSUES RAISED DURING PUBLIC HEARING

Sr. No.	Name of the Person	Opinion / Query's/Complaint's/ Suggestion's/ Apprehension's	Proponent Response at the Time of PH	Action Plan/ Further Clarification	Budget
1	Sri Dantuluri Varma, District Secretary, Rythu Coolie Sangaam, Vizianagaram District	Land identified for the project is cultivable land and is not a barren land.	The major portion (above 75%) of 1675 acres is barren, non-cultivable land.	As per the land revenue records, out of 1675 acres, about 1331.76 acres (79.5 %) of land is barren and non-cultivable land and about 291.05 acres (17.3%) is single crop agricultural land. the remaining 52.19 acres is covered under minor ponds. The certificate issued by Tehsildar to this effect is enclosed as **Annexure-I.**	---
		Because of proposed Venakabadi reservoir, there is a chance for two crops.	Out of 1675 acres, only 250 acres of land is falling in proposed Vanakabadi project ayacut. Irrigation department has already identified alternate land against 250 acres of proposed Vanakabadi reservoir ayacut land under project.	Out of 1675 acres, about 282.2 acres is falling under proposed ayacut. However, irrigation department has revised the ayacut under vanakabadi gedda reservoir by inletting the water into pedda tank of Komarada village which can irrigate an ayacut of 257.79 acres. Letter from irrigation department is enclosed as **Annexure-II.**	---
		The reservoirs of Totapalli and Jhanjavati would be polluted due to discharge of effluents from the proposed plant.	All precautionary measures will be taken as per the state and central pollution control board measures.	<u>Measures to Control Water Pollution</u> Recycling of wastewater generated in cooling tower into process and ash disposal, coal handling and	Rs. 40 Crores for ETP and STP and about 50 Lakhs for their annual

Sr. No.	Name of the Person	Opinion / Query's/Complaint's/ Suggestion's/ Apprehension's	Proponent Response at the Time of PH	Action Plan/ Further Clarification	Budget
				service water requirements; The effluent carrying oil spillage in the plant area will be sent to oil-water separator for removal of oil; Coal stock piles and ash ponds will be provided with garland drains and water will be treated for suspended / floating solids; Adequate treatment of wastewater prior to recycling/reuse to maximum extent; Provision of sewage treatment plant to treat domestic sewage generated from plant and township; Provision of separate storm water system to collect and store run-off water during rainy season and utilization of the same in the process to reduce the fresh water requirement; Final disposal shall be through open channel with natural cascade aeration arrangement to improve DO in treated effluent;	maintenance.

Sr. No.	Name of the Person	Opinion / Query's/Complaint's/ Suggestion's/ Apprehension's	Proponent Response at the Time of PH	Action Plan/ Further Clarification	Budget
				Suitable rainwater harvesting structures to be constructed; and The waste water will be treated as per CPCB/APPCB norms before being discharged. The treated wastewater of about 324 m^3/hr will be discharged in the downstream of the confluence point of Nagawali and Janjavathi river.	
		There is a chance of 10^0 C rise than normal temperatures in the surrounding environment.	The exhaust gases are left into atmosphere at 275 m height from project land and will have no or little impact on the surrounding temperature.	There is no chance for increase in the ambient temperature in nearby area of the project due to power plant. Moreover company shall adopt latest technology i.e. super critical technology and tree plantation will be taken up in an area of about 438 acres which will help to mitigate the impact on ambient temperature in and around the project area.	About Rs. 20 crores has been allocated for green belt development. Rs. 2 Lakh per month for the maintenance including horticulturist salary.
		Acid rains would be expected due to emissions of power plant.	The emissions are as per the norms of CPCB/SPCB, we don't anticipate any acid rain due to the proposed power plant	Stack of 275 m height for wider dispersion of gaseous emissions will be provided. Hence acid rain in not anticipated. Also, as the project is located in semi arid climate, acid rains are not anticipated in the region. Further, online stack monitoring will be installed to check the emissions.	Rs. 150 crores for stack

Sr. No.	Name of the Person	Opinion / Query's/Complaint's/ Suggestion's/ Apprehension's	Proponent Response at the Time of PH	Action Plan/ Further Clarification	Budget
		If 1675 acres land allocated to the project proponent, Linganna Dora Valasa & Komara Kotha Valasa would be completely evacuated.	Neither single house nor village is part of the proposed project land.	The proposed project site doesn't involve any hutments and hence no resettlement compensation will be needed. However, as part of the corporate social responsibility, various developmental activities are planned in the study area as described in Section-1.2 of this reply.	---
		There would be shortage of water for 25,000 acres agriculture lands, if 2.5 TMC water would be allocated to the proposed plant from Thotapalli Reservoir.	The Government of Andhra Pradesh allocated flood water from Nagavali river. The proposed project is not drawing water allocated for irrigation.	Proposed project have no proposal to withdraw any water allocated for irrigation, only the flood water was allocated by the Govt of AP. The water allocation letter by irrigation department is enclosed as **Annexure-III**. Further, flow meters will be installed to keep record of water withdrawal quantity.	
2	Sri Reddy Sri Ramamurthy, General Secretary, CPI (M), Parvathipuram,	The proponent who has taken lands from local people on 99 years lease basis would be dealt with.	The company has been purchasing Private lands on mutual consent basis. The company has applied for alienation of Government lands through channel following the process from MRO – RDO – DC – CCLA.	About Rs. 4.46 crores compensation has been paid to Govt. land and about 16.2 crores has been paid for private land.	Rs. 20.66 Crores
		No one is bothering about the pollution coming out from NCS sugar factory near Lachayya peta.	Not under the purview of proposed project.	NCS sugar factory is located at a distance of about 110 km from the proposed power project. Hence, NCS sugar factory is not expected to have any adverse impact in the region.	---

Sr. No.	Name of the Person	Opinion / Query's/Complaint's/ Suggestion's/ Apprehension's	Proponent Response at the Time of PH	Action Plan/ Further Clarification	Budget
		Even 1 TMC of Nagavali water should not be used. Only underground water should be used.	The proposed project is not drawing any water allocated for irrigation	The Government of Andhra Pradesh has allocated flood water from Nagavali river.	---
		There would be shortage of water for 30,000 acres cultivation lands, if 2.5 TMC of water is allocated from Nagavali to the proposed project.	Only waters of Totapalli reservoir on river Nagavali are being used. Hence, there won't be any shortage of water for irrigation.	The Government of Andhra Pradesh has allocated flood water from Nagavali river.	---
		Rs 10 Lakhs would be paid as compensation for each acre land and provide shelter for displacement people.	The compensation for the government lands will be done as per the Policy of AP state Government. Private lands are being purchased on mutual consent.	About Rs. 16.2 Crores compensation has been paid to the private land	Rs. 16.2 Crores
		The project construction should be continued only after clearing all the doubts of people	Noted	The project will be implemented only after clearing all the concerns of the people.	---
3	Sri Pola Eswararao, All India Rythu Coolie Sangaam,	The land losers of Totapalli reservoir project has not yet got any employment and growth opportunities.	Not under the purview of proposed project	Though the point is not in our purview, it will be ensured that the PAPs of Totapalli reservoir will be given employment in our proposed power plant depending on their skills.	---
		Allocation of 2.5 TMC water from 12 TMC Thotapalli reservoir would affect the thousands of Ayacut lands under reservoir.	Only waters of Totapalli reservoir on river Nagavali are being used hence there won't be any shortage of water already allocated for irrigation through Totapalli reservoir	The Government of Andhra Pradesh has allocated only flood water from Nagavali river.	---
		If this large scale industry like this will come into existence, all the surrounding villages' underground water gets polluted	All precautionary measures will be taken as per the state and central Pollution control board measures.	No ground water will be tapped for the proposed project. On the contrary the proposed rain water harvesting will improve	About Rs. 300 Crores has been allocated for ash pond

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				quality and quantity of underground water. The ash pond will be provided with HDPE/LDPE lining Hence no impact on ground water polluition is anticipated.	dyke.
		Lakhs of tons of Ash released from the project would pollute the ground water.	The ash pond will be lined to ensure that water will not percolate to earth.	Majority of the fly ash will be used for cement manufacturing. Penna Cements, ACC and India Cements have agreed to take the fly ash from the proposed power plant. Surplus ash will be stored in the ash pond and in line with MoEF Notification, 100% ash utilization will be achieved from 4th year onward. The ash pond will be lined with HDPE/LDPE to ensure that water will not percolate to earth. Ground water monitoring in various directions surrounding ash pond will be carried out.	About Rs. 300 Crores has been allocated for ash pond dyke.
		United Nations Organization is encouraging to construct only Solar, Wind Based Industries but not the thermal power plants which are responsible for Climate Change.	Noted	Generation of power to the tune of 2640 MW using the renewable technologies which are characterized by various uncertainties such as availability of renewable energy source, low PLF, technological risks etc doesn't	---

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				make technical or economic proposition. Also, the proposed project is based on super critical technology which would reduce the requirement of coal combustion and thus reduce emissions of CO_2 and other air pollutants such as SOx, NOx and fly ash as compared to project based upon sub-critical technology.	
4	Sri Patiwada Markandeyulu, Farmer, Gumada (V),	Welcomed the proposed project and informed that the local formers are unable to utilize these waste lands and in these difficult times, they are very happy to hear this proposed project is here. He requested the management of the company to take necessary care for environment protection, provide necessary health, free education, employment, water provision to irrigation land.	We thank you for your support. We have budgeted Rs 1180 Crores towards the environment pollution control equipment to be installed to control pollution within the specified norms. Facilities will be provided for health care, education, employment as per CSR policy.	<u>Measures to control air pollution</u> • Installation of higher efficiency ESP to limit the PM concentrations below 50 mg/Nm^3; • Provision of two bi-flue stacks of 275 m height for wider dispersion of gaseous emissions; • Provision of water sprinkling system at raw material storage yard; • Asphalting of the roads within the plant area; • Provision of dust extraction systems at dust generating source; • Greenbelt will be developed around the plant; • Asphalting of the roads within	Rs. 600 Crores has been allocated for air pollution control measures.

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				the plant area. Measures to Control Water Pollution • Recycling of wastewater generated in cooling tower into process and ash disposal, coal handling and service water requirements; • The effluent carrying oil spillage in the plant area will be sent to oil-water separator for removal of oil; • Coal stock piles and ash ponds will be provided with garland drains and water will be treated for suspended / floating solids; • Adequate treatment of wastewater prior to recycling/reuse to maximum extent; • Provision of sewage treatment plant to treat domestic sewage	For wastewater treatment, Rs. 40 Crores has been allocated.

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				generated from plant and township; • Provision of separate storm water system to collect and store run-off water during rainy season and utilization of the same in the process to reduce the fresh water requirement; • Final disposal shall be through open channel with natural cascade aeration arrangement to improve DO in treated effluent; • Suitable rainwater harvesting structures to be constructed; and • The waste water will be treated as per CPCB/APPCB norms before being discharged. <u>Measures to control Noise pollution</u> • Equipment will be designed to conform to noise levels prescribed by regulatory authorities;	For noise abatement, Rs. 100 crores has been

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				• Provision of acoustic barriers or shelters in noisy workplaces; • Provision of hoods to noise generating equipment like pumps; • Provision of thick greenbelt to attenuate the noise levels; and • Provision of Personal Protective Equipments (PPE) such as earplugs, earmuffs to the workers working in high noise level area. Solid Waste Management • In general ash will be given to potential ash users; • The excess ash will be disposed off using high concentrated slurry disposal system to impervious lined ash pond; • The generated waste oil shall be explored to be used in boiler furnace with HFO or shall be given to authorized recyclers; and • The organic portion of solid waste generated in the Sewage Treatment Plant (STP) will be used as manure in greenbelt development.	allocated. About Rs. 300 Crores has been allocated for ash pond dyke. Cost Towards Environmental Measures Rs. 1180 Crores will be spent towards environmental control equipment

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					and Rs. 30 crore per annum towards maintenance of the same.
5	Sri Buridi Nageswararao, Sarpanch, Kotipam (V)	Welcomed the proposed project as the project utilizes the barren (uncultivated) lands and the project helps in socio economic development of this area and expressed his concerns over objections raised by the non-local people on the proposed project.	We thank you for your support.	We thank you for the support. Various developmental activities are planned as part of the corporate social responsibility which will help in uplifting the socio economic conditions.	---
6	Sri B.S. Chalam, Kotipam (V)	Welcomed the proposed project as there is lot of unemployment in this area. The management of the proposed project has made clear statements that free health care, education, roads and improvement in irrigation water schemes would be provided for the local areas. He requested the company management to stand on their commitments. He also informed that if the people would die if they are living adjacent to the industries, then there would have been lot of people died / dyeing in cities like Hyderabad, Mumbai, Delhi who are living in almost industrial areas.	We thank you for your support. We stand by the CSR policy proposed to create health care, employment, education, road schemes etc to local area and people.	The following CSR activities will be taken in the nearby villages: Infrastructure development; Education; Medical facilities; Sanitation; Community development; Awareness programme; and Vocational training.	Capital expenditure: Rs 50 Crores Recurring Ex: Rs. 5 Crores

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7	Sri Dwarapu Reddy Jagadish, District President, TDP, Parvatipuram	Welcomed the proposed project by stating that there should be clarity on the below points: Basic Infrastructure facilities	We thank you for your support. Basic infrastructure facilities like health care, primary education, drinking water etc will be provided as per CSR policy.	Project affected villages would have compulsory education right for children upto graduation. Provision of 30 bedded hospital with all the facilities, free medicines and ambulance. Development of primary health centers, A mobile medical van to conduct health campaigns, Conducting vaccination / immunization programs, eye camps etc. Safe drinking facilities, suitable approach roads and bus shelters, improve the village sanitation system etc. Sponsoring meritorious scholarship for students of College / ITI /Polytechnic etc. Provide necessary assistance and facilities for vocational training.	Capital budget: Rs 50 Crores Recurring Expenditure on CSR- Rs. 5 Crores
		Water and air pollution control measures	Rs. 1180 Crores being spent towards environmental control equipment and Rs. 30 crore per annum towards maintenance of the same.	Covered in Point no.4	Rs. 600 Crores for air pollution control measures and Rs. 40 Crores for water pollution

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					control measures.
		Impacts on flora and fauna and mitigation measures	Impact of flora and fauna has been done and the same is part of EIA. As such there are no implications	Emissions and particulate matter in high concentrations may have negative impact by restricting the growth of trees by obstructing photosynthesis, reduce regeneration and elimination of sensitive species. However, as per the modelling studies carried out during EIA, resultant incremental concentrations are within the prescribed standards. Hence this aspect is of low sensitivity.	Rs. 20 Crores for green belt development.
		He requested project proponent to take necessary actions on the above and create awareness, confidence on project and confidence in people about project and then they won't have any objection to go ahead with the project if management would fulfill all the commitments made during the public hearing.	Noted, All the commitments made in the public hearing would be fulfilled by the company.	All the commitments made during the public hearing will be fulfilled.	---
8	Sri P. Narayana Rao, Kotipam (V)	Welcomed the project proposal and stated that the most of the lands in this area are barren lands and even for some fertile lands, water is not adequate for cultivation and he was struggling with his income which is very low to cater the basic needs of his entire family. In these	We thank you for your support Management stands by the commitments made in CSR policy.	The following CSR activities will be taken in the nearby villages: Infrastructure development; Education; Medical facilities; Sanitation; Community development;	Capex of Rs. 50 Crores has been allocated for CSR activities and recurring cost of Rs. 5 Crores has

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		circumstances, the project proposal in this area would definitely improve the socio and economic status of the local people by providing employment opportunities to them. He requested the management to stand on the commitments made in the public hearing.		Awareness proogramme; and Vocational training.	been allocated for the same.
9	Sri Puvvula Pedanarayana, Farmer, Komarada Kothavalasa (V)	Opposed the proposed project and informed that earlier revenue officials gave us one acre land for each family for farming and they are now expecting two crops due to proposed Vanakabadi reservoir.	Noted	There is no proposal to draw water allocated for irrigation. The Government of Andhra Pradesh has allocated only flood water from Nagavali river.	---
10	Sri Marisharla Simhachalam Naidu, Chairman, DCCB, Parvathipuram	Welcomed the proposed projects and highlighted the following points: Vizianagarm is a backward district and didn't had any growth opportunities.	We thank you for your support. Noted	The overall socio-economic status of the study area is low in terms of literacy, work participation rate, access to facilities, etc. More attention and care would be taken so that the needs and demand of these marginalized classes of the host and Project Influence Area population can get more exposure to modern facilities of education and development.	This as part will be covered in CSR allocated budget.
		Every project has its own merits and de-merits.	Noted	The proposed CSR activities will have a positive impact due to the proposed project.	---
		Project proponent has to take necessary precautions for a right environment management.	Rs 1180 Crores allocated for pollution control equipment to be installed to take adequate measures	Covered in Point no.4	Rs. 1180 crores has been allocated

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			to contain pollution within the specified norms.		for environment protection measures
		Project proponent has to provide necessary health and education facilities and employment for the locals.	Will be provided as per CSR policy declared.	Health • Development of primary health centers; • Provision of 30 bed hospital with all the facilities and free medicines; • Ambulance to take patients to hospitals in emergency situations; • A mobile medical van to conduct health campaigns which will lead to better conditions of the people • Conduction of vaccination / immunization programmes; • Eye camps; and • Provision of homeopathic doctor for free homeopathic consultation and free medicine. Education • Development of play ground for children; • Midday meals; • Sponsoring meritorious	Capex of Rs. 50 Crores has been allocated for CSR activities and recurring cost of Rs. 5 Crores has been allocated for the same.

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				scholarship for students of College / ITI / Polytechnic etc.; • Stipend to females would continue even after marriage if education continued; • Organize computer training for the children / youth of weaker section; • Up-gradation / renovation of existing schools; and • Providing water supply, furniture, computers, library, books, school bags, sports kits etc.	
11	Ms. Ramani, Member, Pragathisala Mahila Sangham	Opposed the proposed project and stressed that Government should help poor and not to capitalists. In the name of growth one can't make local people run away from here. Now in this area Local people are suffering with diseases like Dengue, Malaria etc., Instead of looking in to these things government is encouraging coal plant to pollute the local area and encouraging the capitalist to earn crores in the name of development.	Noted	Under CSR, 30 bedded hospital with all the facilities, free medicines and ambulance will be provided. Development of primary health centers, A mobile medical van to conduct health campaigns, Conducting vaccination / immunization programs, eye camps etc. Mitigation measures are covered in Point No.4	
12	Sri Yattu Gumpa Swami, Ex-Sarpanch, Kotipam (V)	Opposed the propose project and stated that long pending proposed Vanakabadi reservoir is going to be	The proposed project is not drawing any water from the proposed Vanakabadi reservoir.	The Government of Andhra Pradesh has allocated only flood water from Nagavali river.	---

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		completed. Because of the proposed project, there are chances that the proposed vanakabadi reservoir water may disappear. He further stated that they need water for irrigation land and not plants which generates pollution.	The proposed project is not drawing any water allocated for irrigation.		
13	Sri Nimmaka Jairaj, Ex. MLA, Kurupam	Expressed that how many people would be benefited and how it would be helpful for development of this area. This project being bigger than Simhadri, Ramagundam thermal plants and might have pollution impact with in 10 km. environment. Necessary pollution controls measures should be explained.	During the construction phase about 3000 people on average per day will be employed for a period of about four years. The manpower of power plant during operational period is estimated to be about 700 persons. Rs 1180 Crore is allocated towards pollution control equipment to be installed for adequate measures to control pollution within the specified norms. Rs 30 Cr per year is expected to be spent towards maintenance of these equipment.	During the construction phase about 3000 people on average per day will be employed for a period of about four years. The manpower of power plant during operational period is estimated to be about 700 persons. Environment Protection measures are covered in Point no. 4	Rs. 1180 Crores towards pollution control equipment. Rs. 30 Crores per year towards maintenance.
		Allocation of 1 TMC water from the proposed Thotapalli reservoir would affect the Aycut land under reservoir.	The proposed project is not drawing any water allocated for irrigation through Thotapalli reservoir.	Proposed project have no proposal to withdraw any water allocated for irrigation, only the flood water was allocated by the Govt of AP. Further, flow meters will be installed to keep record of water withdrawal	---

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				quantity.	
		He concluded by saying that, if above said point and people doubts are clarified then they welcome for setting up the proposed project.	Noted	The project will be implemented only after clearing all the concerns of the people and after obtaining EC from MoEF.	---
14	Sri Gangireddy Appalaswami Naidu, Ex-MPP, Rajalakshmipuram	Requested management of project to provide required education, health facilities and employment for locals.	The primary and secondary school will be provided. Project affected villages would have compulsory education right for children up to graduation. 30 bed hospital with health care facilities is proposed Priority and preferences would be given for the employment to the people from nearby villages as informed in the beginning of this meeting.	The following CSR activities will be taken in the nearby villages: Infrastructure development; Education; Medical facilities; Sanitation; Community development; Awareness programme; and Vocational training.	It is included in the CSR budget.
15	Sri Buradi Kalidasu, Unemployed youth, Kotipam (V)	Opposed the proposed project as the present company is following dual policy and they are planning to convert locals as daily wage labors. He also said that already this project has received all approvals. He said the project proponents would not stand by their commitments. And questioned why this project is coming near by the reservoir and further added that there are chances of vacating nearby villages due to pollution.	Priority and preferences would be given for the employment to the people from nearby villages as informed during PH and as detailed in CSR policy. The latest state of art pollution control equipment would be installed. Adequate measures will be taken to control pollution within the specified norms and there is no need to vacate any nearby villages. The project will not impact the nearby reservoir.	During the construction phase about 3000 people on average per day will be employed for a period of about four years. The manpower of power plant during operational period is estimated to be about 700 persons. Adequate measures will be taken to control pollution within the specified norms and there are no hutments within the project site, hence no resettlement is involved.	Budget for pollution control: Rs 1180 Crores Budget for CSR: Rs. 50 Crores

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16	Sri M. Simhachalam, Statewide Secretary, Adivasi Forum	Informed that the proposed project would create loss to local people and land should not be acquired through long lease. Project proponents should provide homes for homestead oustees, provide R & R package. They expressed the project should take off after the above points are taken care.	Private lands have been purchased on mutual consent. And the remaining Government lands alienation is being done as per AP State policy. We assure you that we fully comply with the stipulations of the R & R Policy as notified by the Government of AP.	About Rs. 16.2 Crores compensation has been paid to the private land and Rs. 4.46 crores compensation has been paid to Govt. land.	Total compensation paid = Rs. 20.67 Crores
17	Munjeti Nityanandam, Jiyyammavalasa (V),	Welcomed proposed project, and informed that these type of projects should be required for human resource development, and area development and he urged all others to encourage and support such projects.	We thank you for your support.	The proposed CSR activities will have a positive impact due to the proposed project.	CSR budget: Rs. 50 Crores
18	Smt. Thandra Aruna, Human Rights Forum	Opposed the proposed project and informed that the EIA report has to be made available in Telugu. The management of the project may not be stand on commitments made in the public hearing regarding employment like what happened in IDA, Pydibhimavaram area.	Reports have been provided as per MoEF guidelines. We stand by the commitments made during Public hearing towards the employment opportunities to locals.	We stand by the commitments made during public hearing towards the employment opportunities to locals.	---
19	Sri V.S. Krishna (Human Rights Forum, Visakhapatnam)	Objected to conduct public hearing as company acquired only 575 acres out of 1675 acres of total project land.	Public hearing is being conducted as per MoEF guidelines.	During the public hearing period, about 575 acres of land was acquired. Presently, about 1258 acres of land is in the name of M/s Alfa infra pvt Ltd. However, the public hearing was conducted as per the prevailing EIA Notification.	---

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		15.8 TMC out of 16 TMC Andhra share of Thotapalli reservoir is already allocated to irrigation, then how government could allocate 2.5TMC water to the proposed project.	The proposed project is not drawing any water already allocated for irrigation.	The Government of Andhra Pradesh has allocated only flood water from Nagavali river. The proposed project will not take any water allocated for irrigation.	---
		Where would the waste water @ 200,000 liters / hr disposed off and also how project would disposes off fly ash generated.	The waste water will be treated as per CPCB/APPCB norms before being discharged. Majority of the fly ash will be used for cement manufacturing and Penna Cements, ACC; India Cements have agreed to take the fly ash from the proposed power plant.	About 1647 m^3/hr of wastewater will be generated, in that 763 m^3/hr will be used for ash handling plant, 300 m^3/hr used in coal handling system, 100 m^3/hr used in ash silo wetting, 125 m^3/hr sludge for offsite disposal and 100 m^3/hr will be used for floor washing and green belt development. The remaining 324 m^3/hr will be sent out through guard pond after treating as per APPCB /CPCB standards. The treated wastewater will be discharged d/s of confluence point of Janjavati river. Solid Waste Management • In general ash will be given to potential ash users; • The excess ash will be disposed off using high concentrated slurry disposal system to impervious lined ash pond;	Rs. 40 Crores has been allocated for water pollution control measures and Rs. 300 crores has been allocated for ash pond dyke.

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				• The generated waste oil shall be explored to be used in boiler furnace with HFO or shall be given to authorized recyclers; and • The organic portion of solid waste generated in the Sewage Treatment Plant (STP) will be used as manure in greenbelt development.	
		He said that EIA report is having false information hence total public hearing is not valid.	The EIA report is unbiased, represents the facts and is made by renown consultant approved by MOEF	EIA report contains the primary data and secondary data collected from Govt agencies.	---
20	Sri C. Bhaskara Rao, Retired Professor	Opposed the proposed project and informed that thermal power plants are major responsible for "Climate Changes" by releasing CO_2 and further stated that say no to coal based power plants and encourage solar & wind based power plants and In December, 2009, all countries would meet in Copenhagen on international climate change to discuss various aspects relating to environment especially focusing on thermal power plants.	The project follows CPCB / SPCB norms on CO_2 release. On Copenhagen : point Noted,	There is no chance for majorincrease in the ambient temperature in nearby area of the project due to power plant. Moreover company shall adopt latest technology i.e. super critical technology and tree plantation will be taken up in an area of about 438 acres which will help to mitigate the impact on ambient temperature in and around the project area.	Budget for green belt: Rs. 20 Crores
21	Sri Pandranki Kurmi Naidu, Kotipam (V),	Welcomed the proposed project as it uses barren land and is not much useful for the farming. It is a happy situation to have a project in such a	We thank you for your support	Thank you for the support, further the CSR activities proposed will uplift the socio economic status of the nearby villages.	CSR budget: Rs. 50 Crores

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		place. Their villagers would have employment facility because of this project.			
22	Sri Chatrucharla Chandrasekhar Raju, Ex. MLA	For development of any country or any region, it is essential to establish industries. Taking into consideration of different opinions of people, He visited Krishnapatnam plant under construction near Nellore and Kothagudem power plants to know the facts of the Environmental Impacts due to proposed thermal plant. After having thoroughly discussed with concerned authorities about environmental pollution control measures, he said that, he realized that there is not much of damage due to emissions from power plants.	We thank you for your support. Noted	Thank you for the support. We hereby confirm that adequate measures will be taken to control pollution within the specified norms.	---
		He had requested the project proponent to take preventive measures on air pollution, water pollution etc. as prescribed by the Govt.	The latest state of art pollution control equipment would be installed and adequate measures will be taken to control pollution within the specified norms.	Covered in Point No. 4	Rs. 1180 crores for environment protection measures
		Taking into consideration of the industries established in developed cities like Hyderabad, Delhi, Mumbai, Noida, Gurgaon, he said, every one has to welcome the above thermal power plant as a great development in our area. He further requested the	Noted	Thank you for the support, further the CSR activities proposed will uplift the socio economic status of the nearby villages.	---

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		local people to cooperate with the proposed project.			
23	Sri Buridi Venugopal Naidu, Kotipam (V)	Opposed the proposed project and raised the following points: How can company provide employment for all people reside in nearby villages	During the construction phase about 3000 people on average per day will be employed for a period of about four years. The manpower of power plant during operational period is estimated to be about 700 persons. Preference will be given to educated, unemployed local persons.	During the construction phase about 3000 people on average per day will be employed for a period of about four years. Local people from the nearby villages will be given preference. The manpower of power plant during operational period is estimated to be about 700 persons.	---
		Because of this project, around 14km of nearby area gets polluted	All the mitigation measures are planned and Rs 1180 Crores is allocated towards pollution control equipment. For the control of pollution Greenbelt will be developed with in and around the plant boundary.	Covered in Point no. 4	Rs. 1180 crores for environment protection measures including Rs. 20 Crores for green belt.
		He said that they don't want project in their area but they don't have any objection if plant is proposed in any other area	No comments	About 1258 acres of land has already been acquired and necessary approvals for the construction of the proposed project is in process.	---
24	Sri Gollapalli Sudharsan Rao, Zilla Parished Vice Chairman, Vizianagaram	The issue today is not about whether project to be established or not, its about impact on environment related to the project.	Noted	The proposed project is based on super critical technology which would reduce the requirement of coal combustion and thus reduce emissions of CO_2 and other air pollutants such as SOx, NOx and fly ash as compared to project	---

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				based upon sub-critical technology.	
		Also urged that the local voice should be given preference over outside people.	Noted	Employment preference will be given for local people.	---
		Project Proponents has to confirm to the pollution control measures suggested in the report.	We confirm that the pollution control measures will be taken up to control the pollution	Covered in Point No. 4	Rs. 1180 crores for environment protection measures
		To what extent the employment will be provided.	During the construction phase about 3000 people on average per day will be employed for a period of about four years. The manpower of power plant during operational period is estimated to be about 700 persons.	During the construction phase about 3000 people on average per day will be employed for a period of about four years. Local people from the nearby villages will be given preference. The manpower of power plant during operational period is estimated to be about 700 persons.	---
		Because of this project people living in local four villages will get affected and what kind of packages are being offered to them. He requested the project proponent to clear all the apprehension raised by the local people and would give firm commitments regarding employment for the local people and welcomed the proposed project.	Free health care facility, drinking water, employment Preference will be given to educated, unemployed local persons. Provision of 30 bed hospital with all the facilities, free medicines and ambulance. Development of primary health centers, A mobile medical van to conduct health campaigns, Conducting vaccination / immunization programs, eye camps	The following CSR activities will be taken in the nearby villages: Infrastructure development; Education; Medical facilities; Sanitation; Community development; Awareness programme; and Vocational training.	Capex of Rs. 50 crores has been allocated for CSR activities and recurring cost of Rs. 5 crores has been allocated for the same.

<table>
<tr><th>Sr. No.</th><th>Name of the Person</th><th>Opinion / Query's/Complaint's/ Suggestion's/ Apprehension's</th><th>Proponent Response at the Time of PH</th><th>Action Plan/ Further Clarification</th><th>Budget</th></tr>
<tr><td></td><td></td><td></td><td>Safe drinking facilities, suitable approach roads and bus shelters, Improve the village sanitation system.
Sponsoring meritorious scholarship for students of College / ITI /Polytechnic etc.

Provide necessary assistance and facilities for vocational training.</td><td></td><td></td></tr>
<tr><td>25</td><td>Sri Thatraju Janardhan, Hon'ble MLA, Kuruppam raised the following points</td><td>Project proponent allocated Rs 1180 crores towards pollution control equipment and wanted to know how this money would be spent</td><td>Rs. 1180 Cr is allocated towards pollution control equipment to be installed for adequate measures to control pollution within the specified norms. Rs 30 Cr per year is expected to be spent towards maintenance of these equipment</td><td>Cost provision for Environmental measures are given as follows:
<table>
<tr><th>Description of Item</th><th>Cost (Rs in Crores)</th></tr>
<tr><td>Electrostatic Precipitators</td><td>450</td></tr>
<tr><td>Stacks</td><td>150</td></tr>
<tr><td>Ash pond dyke</td><td>300</td></tr>
<tr><td>Effluent Treatment Plant (ETP) & Sewage Collection, Treatment and Disposal (STP)</td><td>40</td></tr>
<tr><td>Dust Suppression system</td><td>20</td></tr>
<tr><td>Control of Fire & Explosion Hazards</td><td>80</td></tr>
<tr><td>Noise abatement</td><td>100</td></tr>
</table></td><td>Rs. 1180 Crores</td></tr>
</table>

Sr. No.	Name of the Person	Opinion / Query's/Complaint's/ Suggestion's/ Apprehension's	Proponent Response at the Time of PH	Action Plan/ Further Clarification	Budget
				Environmental Lab equipment and on line Monitoring equipments 20 Greenbelt 20 **Total 1180**	
		Pointed that around Rs 30 crores were allocated towards the maintenance of pollution control equipment	Noted	We confirm that the amount allocated will be utilized for the maintenance of pollution control equipment.	---
		The above commitments shouldn't change in case of changes in the management	Noted	We hereby commit that commitments made during the PH will be strictly implemented/followed.	---
		A pollution committee might be formed with the local representatives to oversee the implementation of pollution control measures	Noted	An environmental management cell will be formed to see the implementation of pollution control measures	---

1.2 Proposed CSR Activities

1.2.1 CSR Activities

M/s Alfa Infraprop Pvt. Ltd. proposes to undertake various CSR activities in the areas like infrastructure development, education, medical facilities, sanitation, community development and awareness programmes, vocational training in and around the project site. The budget estimated under CSR activities as one time capital expenditure will be of Rs.50 Crores and as recurring expenditure per annum will be of Rs. 5 Crores. The capital expenditure on CSR activities will be spent in about 5 years period from the zero date.

1.2.2 Education

The one (1) primary school and secondary school in the project affected villages with a moto as compulsory education right for children. In addition to this, the following facilities will be provided:

- Development of play ground for children's;
- Midday meals;
- Sponsoring meritorious scholarship for students of college/ITI/ polytechnic etc.;
- Stipend to females would continue even after marriage if education continued;
- Organize computer training for the children / youth of weaker section;
- Up-gradation/renovation of existing schools; and
- Providing water supply, furniture, computers, library, books, school bags, sports kits etc.

1.2.3 Health

- Development of primary health centers;
- Provision of 30 bed hospital with all the facilities and free medicines;
- Ambulance to take patients to hospitals in emergency situations;
- A mobile medical van to conduct health campaigns which will lead to better conditions of the people;
- Conduction of vaccination / immunization programmes;
- Eye camps; and
- Provision of homeopathic doctor for free homeopathic consultation and free medicine.

1.2.4 Drinking Water Facility

- Pure and safe drinking water through hand pumps and bore wells to meet daily water requirement.

1.2.5 Sanitation

Proper sewerage system will be created and will start Suvidha Public Toilet (SPT) at project site.

1.2.6 Vocational Training

- Bakery, papad and agarbathi making;
- Computer training;
- Candle making;
- Fashion technology courses;
- Food preservation;
- Handicraft;
- Mushroom cultivation;
- Organize skill development and vocational training for enabling people to form self help group;
- Printing press, spiral binding and screen printing;
- Spices grinding and packing;
- Tailoring embroidery classes to surrounding villagers;
- Training for girls and ladies of weaker section of society;
- Type writers and shorthand training; and
- Welders.

1.2.7 Self Employment

People who want to generate self employment like some shop, small business (poultry) can be given financial assistance up to Rs.50, 000/-.

- Self help groups;
- Income generation schemes; and
- Setting up of fly ash brick plants will generate employment and income

1.2.8 Employment

- During the construction and operation period, project would have significant requirement for masons, plumbers, electricians, carpenters, fitters, welders, security personnel, other miscellaneous services in canteen, plantation, drivers, housekeeping etc.;
- During construction phase, project would employ about 3000 skilled, semi-skilled and unskilled laborers;
- During operational phase, power plant would employ more than 700 personnel;
- In addition about 1300 people would be required in the form of various services required during operation of the power plant; and
- Preference will be given to the people from villages Kotipam, Banjukuppa, Lingamdora valasa, Regulapadu, kherjala, kotha Valasa, Gumada, Komarada for employment.

1.2.9 Roads & Bus Shelters

Construction of suitable approach roads and bus shelters, wherever required and repair, diversion of the existing roads and drains which will help in free and easy movement of people and material and also help boost the economic activity around the plant.

1.2.10 Community Welfare / Panchayat Halls

- Renovation and modernization of existing community / panchayat halls;
- Construction of new community / panchayat halls;
- Assistance to anganwadi centres; and
- Provision of solar energy to community / panchayat buildings

1.2.11 Communication

- Provision of public telephone booths in each village; and
- Provision of internet facility in the schools, community/panchayat halls.

1.2.12 Religious Places

- Keeping in view the religious values of villagers worship buildings as desired will be constructed; and
- Provision of solar energy in worship buildings.

1.2.13 Old Age Pension

Eligible senior citizens will be paid a monthly pension of Rs.1000 to ensure a comfortable life in old age.

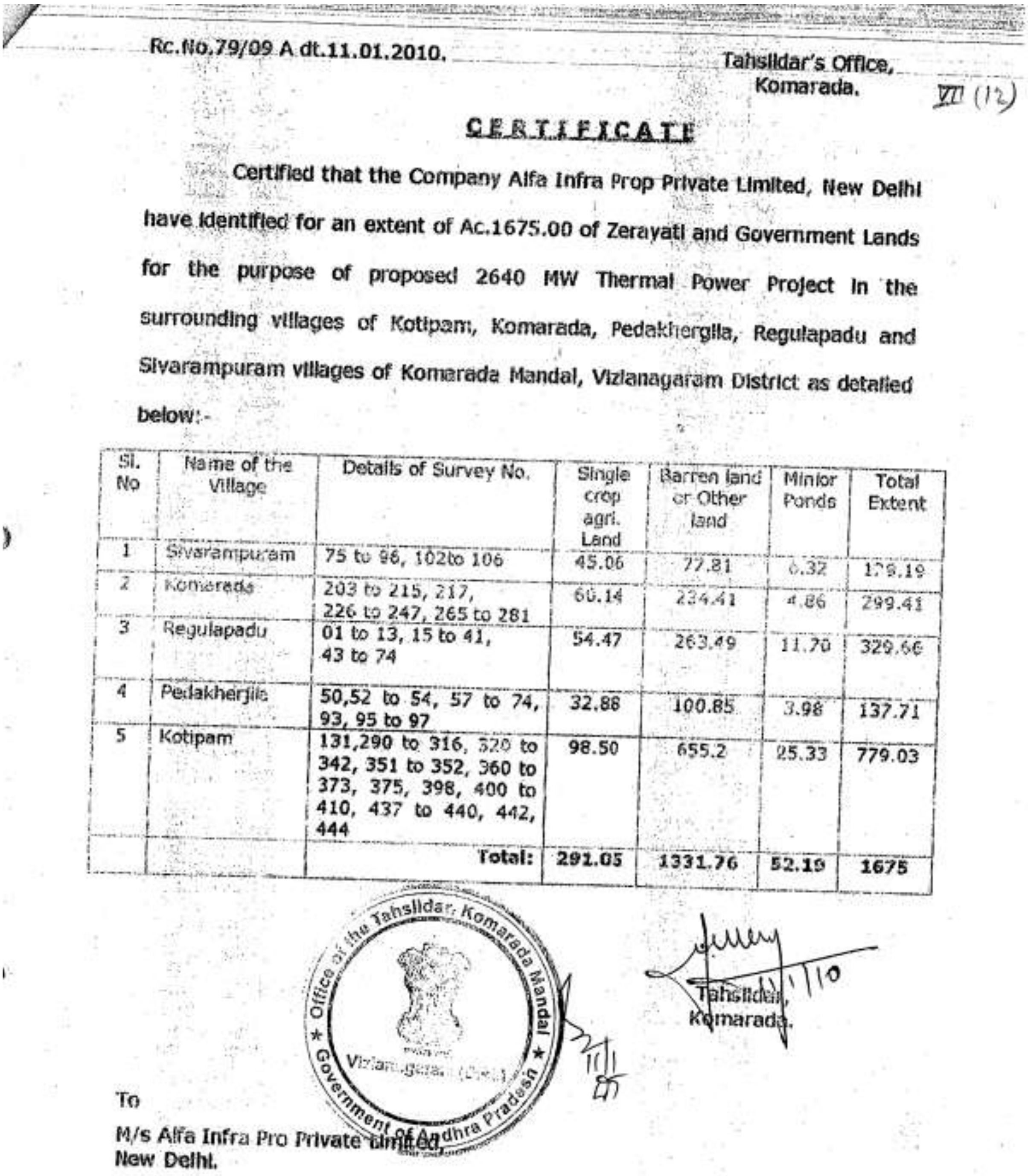
1.2.14 Physically Challenged

Physically challenged persons would be shown avenues of employment by facilitating requisite financial assistance.

1.2.15 Electricity

- Strengthening of street lighting system.

ANNEXURE-I
LETTER FROM TEHSILDAR



Rc.No.79/09 A dt.11.01.2010.

Tahsildar's Office,
Komarada.

VII (12)

CERTIFICATE

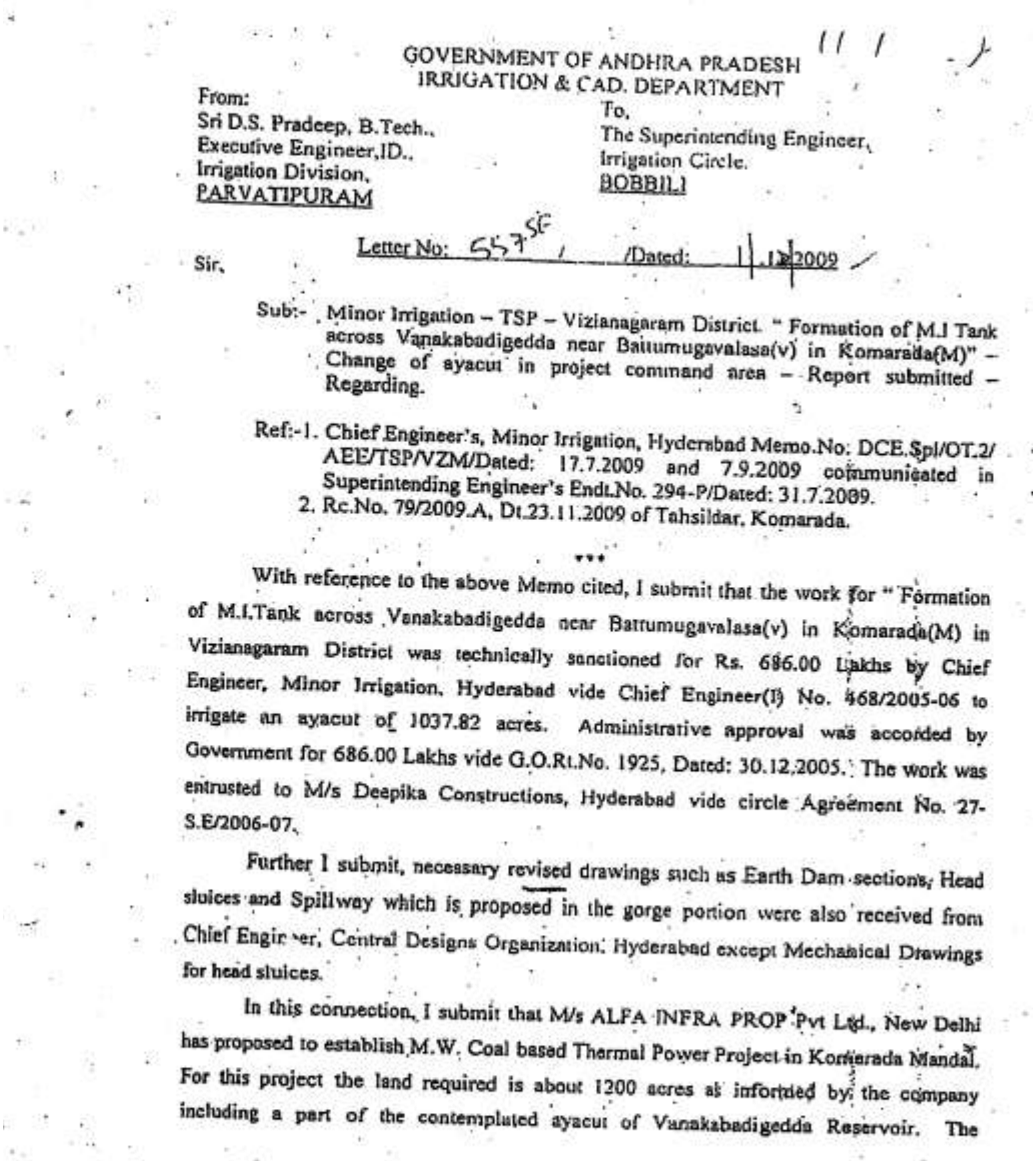
Certified that the Company Alfa Infra Prop Private Limited, New Delhi have identified for an extent of Ac.1675.00 of Zerayati and Government Lands for the purpose of proposed 2640 MW Thermal Power Project in the surrounding villages of Kotipam, Komarada, Pedakhergila, Regulapadu and Sivarampuram villages of Komarada Mandal, Vizianagaram District as detailed below:-

Sl. No	Name of the Village	Details of Survey No.	Single crop agri. Land	Barren land or Other land	Minor Ponds	Total Extent
1	Sivarampuram	75 to 96, 102to 106	45.06	77.81	6.32	129.19
2	Komarada	203 to 215, 217, 226 to 247, 265 to 281	60.14	234.41	4.86	299.41
3	Regulapadu	01 to 13, 15 to 41, 43 to 74	54.47	263.49	11.70	329.66
4	Pedakherjila	50,52 to 54, 57 to 74, 93, 95 to 97	32.88	100.85	3.98	137.71
5	Kotipam	131,290 to 316, 320 to 342, 351 to 352, 360 to 373, 375, 398, 400 to 410, 437 to 440, 442, 444	98.50	655.2	25.33	779.03
		Total:	291.05	1331.76	52.19	1675

11/1/10
Tahsildar,
Komarada.

To
M/s Alfa Infra Pro Private Limited,
New Delhi.

ANNEXURE-II
LETTER FROM IRRIGATION DEPARTMENT



GOVERNMENT OF ANDHRA PRADESH
IRRIGATION & CAD. DEPARTMENT

From:
Sri D.S. Pradeep, B.Tech.,
Executive Engineer,ID.,
Irrigation Division,
PARVATIPURAM

To,
The Superintending Engineer,
Irrigation Circle,
BOBBILI

Letter No: 557 SE / /Dated: 11.12.2009

Sir,

Sub:- Minor Irrigation – TSP – Vizianagaram District. " Formation of M.I Tank across Vanakabadigedda near Battumugavalasa(v) in Komarada(M)" – Change of ayacut in project command area – Report submitted – Regarding.

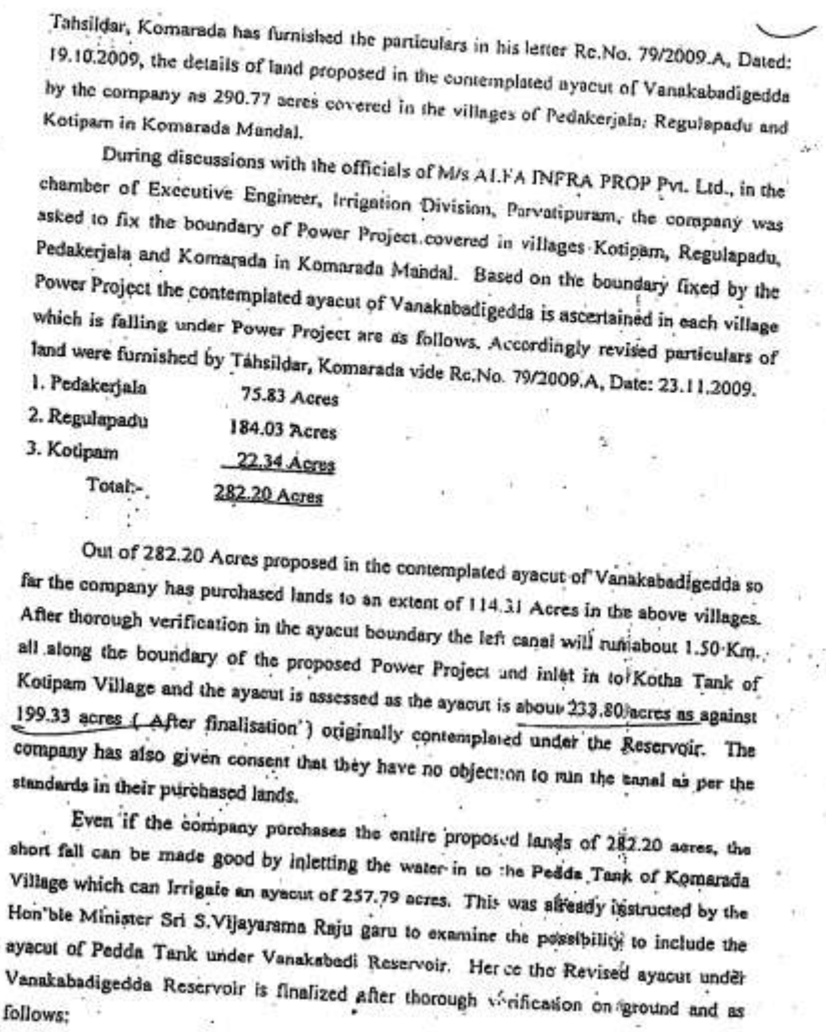
Ref:-1. Chief Engineer's, Minor Irrigation, Hyderabad Memo.No: DCE.Spl/OT.2/AEE/TSP/VZM/Dated: 17.7.2009 and 7.9.2009 communicated in Superintending Engineer's Endt.No. 294-P/Dated: 31.7.2009.
2. Rc.No. 79/2009.A, Dt.23.11.2009 of Tahsildar, Komarada.

***

With reference to the above Memo cited, I submit that the work for " Formation of M.I.Tank across Vanakabadigedda near Battumugavalasa(v) in Komarada(M) in Vizianagaram District was technically sanctioned for Rs. 686.00 Lakhs by Chief Engineer, Minor Irrigation, Hyderabad vide Chief Engineer(I) No. 468/2005-06 to irrigate an ayacut of 1037.82 acres. Administrative approval was accorded by Government for 686.00 Lakhs vide G.O.Rt.No. 1925, Dated: 30.12.2005. The work was entrusted to M/s Deepika Constructions, Hyderabad vide circle Agreement No. 27-S.E/2006-07.

Further I submit, necessary revised drawings such as Earth Dam sections, Head sluices and Spillway which is proposed in the gorge portion were also received from Chief Engineer, Central Designs Organization, Hyderabad except Mechanical Drawings for head sluices.

In this connection, I submit that M/s ALFA INFRA PROP Pvt Ltd., New Delhi has proposed to establish M.W. Coal based Thermal Power Project in Komarada Mandal. For this project the land required is about 1200 acres as informed by the company including a part of the contemplated ayacut of Vanakabadigedda Reservoir. The



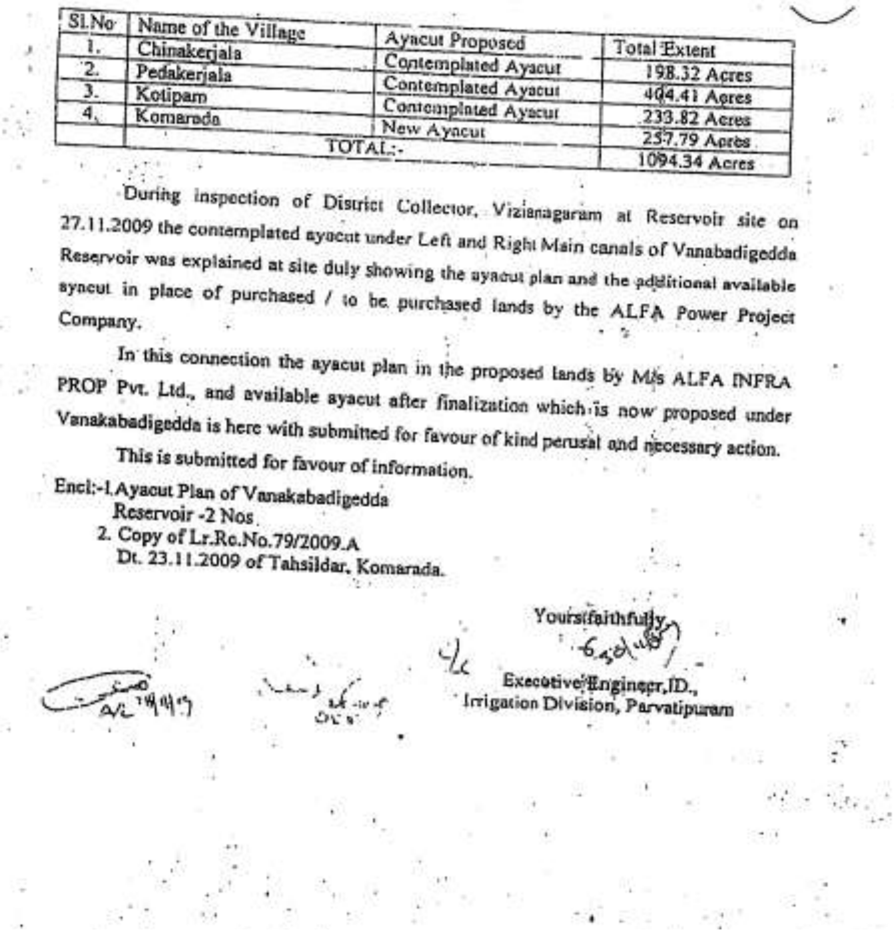
Tahsildar, Komarada has furnished the particulars in his letter Rc.No. 79/2009.A, Dated: 19.10.2009, the details of land proposed in the contemplated ayacut of Vanakabadigedda by the company as 290.77 acres covered in the villages of Pedakerjala; Regulapadu and Kotipam in Komarada Mandal.

During discussions with the officials of M/s ALFA INFRA PROP Pvt. Ltd., in the chamber of Executive Engineer, Irrigation Division, Parvatipuram, the company was asked to fix the boundary of Power Project covered in villages Kotipam, Regulapadu, Pedakerjala and Komarada in Komarada Mandal. Based on the boundary fixed by the Power Project the contemplated ayacut of Vanakabadigedda is ascertained in each village which is falling under Power Project are as follows. Accordingly revised particulars of land were furnished by Tahsildar, Komarada vide Rc.No. 79/2009.A, Date: 23.11.2009.

1. Pedakerjala	75.83 Acres
2. Regulapadu	184.03 Acres
3. Kotipam	22.34 Acres
Total:-	282.20 Acres

Out of 282.20 Acres proposed in the contemplated ayacut of Vanakabadigedda so far the company has purchased lands to an extent of 114.31 Acres in the above villages. After thorough verification in the ayacut boundary the left canal will run about 1.50 Km. all along the boundary of the proposed Power Project and inlet in to Kotha Tank of Kotipam Village and the ayacut is assessed as the ayacut is about 233.80 acres as against 199.33 acres (After finalisation) originally contemplated under the Reservoir. The company has also given consent that they have no objection to run the canal as per the standards in their purchased lands.

Even if the company purchases the entire proposed lands of 282.20 acres, the short fall can be made good by inletting the water in to the Pedda Tank of Komarada Village which can Irrigate an ayacut of 257.79 acres. This was already instructed by the Hon'ble Minister Sri S.Vijayarama Raju garu to examine the possibility to include the ayacut of Pedda Tank under Vanakabadi Reservoir. Hence the Revised ayacut under Vanakabadigedda Reservoir is finalized after thorough verification on ground and as follows:



Sl.No	Name of the Village	Ayacut Proposed	Total Extent
1.	Chinakerjala	Contemplated Ayacut	198.32 Acres
2.	Pedakerjala	Contemplated Ayacut	404.41 Acres
3.	Kotipam	Contemplated Ayacut	233.82 Acres
4.	Komarada	New Ayacut	257.79 Acres
	TOTAL:-		1094.34 Acres

During inspection of District Collector, Vizianagaram at Reservoir site on 27.11.2009 the contemplated ayacut under Left and Right Main canals of Vanabadigedda Reservoir was explained at site duly showing the ayacut plan and the additional available ayacut in place of purchased / to be purchased lands by the ALFA Power Project Company.

In this connection the ayacut plan in the proposed lands by M/s ALFA INFRA PROP Pvt. Ltd., and available ayacut after finalization which is now proposed under Vanakabadigedda is here with submitted for favour of kind perusal and necessary action.

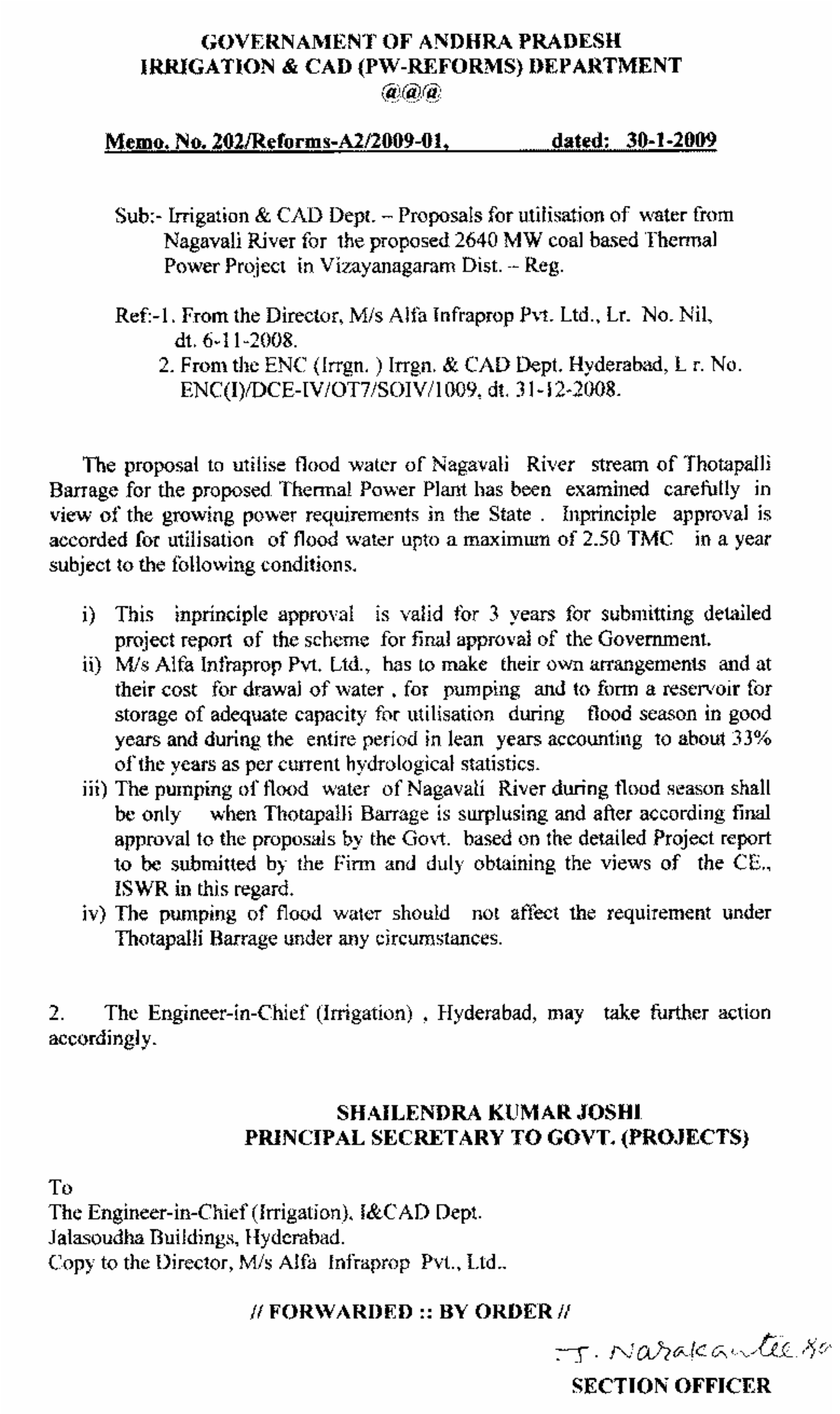
This is submitted for favour of information.

Encl:-1. Ayacut Plan of Vanakabadigedda
Reservoir -2 Nos
2. Copy of Lr.Rc.No.79/2009.A
Dt. 23.11.2009 of Tahsildar, Komarada.

Yours faithfully,

Executive Engineer, ID.,
Irrigation Division, Parvatipuram

ANNEXURE-III
WATER ALLOCATION LETTER



GOVERNAMENT OF ANDHRA PRADESH
IRRIGATION & CAD (PW-REFORMS) DEPARTMENT
@@@

Memo. No. 202/Reforms-A2/2009-01, dated: 30-1-2009

Sub:- Irrigation & CAD Dept. – Proposals for utilisation of water from Nagavali River for the proposed 2640 MW coal based Thermal Power Project in Vizayanagaram Dist. – Reg.

Ref:-1. From the Director, M/s Alfa Infraprop Pvt. Ltd., Lr. No. Nil, dt. 6-11-2008.
2. From the ENC (Irrgn.) Irrgn. & CAD Dept. Hyderabad, L r. No. ENC(I)/DCE-IV/OT7/SOIV/1009, dt. 31-12-2008.

The proposal to utilise flood water of Nagavali River stream of Thotapalli Barrage for the proposed Thermal Power Plant has been examined carefully in view of the growing power requirements in the State . Inprinciple approval is accorded for utilisation of flood water upto a maximum of 2.50 TMC in a year subject to the following conditions.

i) This inprinciple approval is valid for 3 years for submitting detailed project report of the scheme for final approval of the Government.
ii) M/s Alfa Infraprop Pvt. Ltd., has to make their own arrangements and at their cost for drawal of water , for pumping and to form a reservoir for storage of adequate capacity for utilisation during flood season in good years and during the entire period in lean years accounting to about 33% of the years as per current hydrological statistics.
iii) The pumping of flood water of Nagavali River during flood season shall be only when Thotapalli Barrage is surplusing and after according final approval to the proposals by the Govt. based on the detailed Project report to be submitted by the Firm and duly obtaining the views of the CE., ISWR in this regard.
iv) The pumping of flood water should not affect the requirement under Thotapalli Barrage under any circumstances.

2. The Engineer-in-Chief (Irrigation) , Hyderabad, may take further action accordingly.

SHAILENDRA KUMAR JOSHI
PRINCIPAL SECRETARY TO GOVT. (PROJECTS)

To
The Engineer-in-Chief (Irrigation), I&CAD Dept.
Jalasoudha Buildings, Hyderabad.
Copy to the Director, M/s Alfa Infraprop Pvt., Ltd..

// FORWARDED :: BY ORDER //

T. Narakantee. SO
SECTION OFFICER

ECOLOGICAL STUDIES

FOR

ALFA INFRAPROP PVT LIMITED, KOMARADA VILLAGE, VIZIANAGARAM DISTRICT, ANDHRA PRADESH

Sponsored by:

Alfa Infraprop Private Limited

Report Prepared by:

Vimta
Driven by Quality. Inspired by Science.

VIMTA Labs Ltd., 142, IDA, Phase-II
Cherlapally, Hyderabad – 500 051, India
www.vimta.com

June, 2014

PREFACE

ALFA INFRAPROP PVT LIMITED

KOMARADA VILLAGE, VIZIANAGARAM DISTRICT, A.P

ECOLOGICAL STUDIES
FOR
ALFA INFRAPROP PVT LIMITED, KOMARADA VILLAGE, VIZIANAGARAM DISTRICT, A.P

For and on behalf of VIMTA Labs Limited

Approved by : **M. Janardhan**

Signed :

Position : **Head & Vice President (Env)**

Date : 12th June, 2014

This report has been prepared by **Vimta Labs Limited** with all reasonable skill, care and diligence within the terms of the contract with the client, incorporating our General Terms and Conditions of Business and taking account of the resources devoted to it by agreement with the client.

Driven by Quality. Inspired by Science.

Vimta Labs Limited
Registered Office
142, IDA Phase II, Cherlapally
Hyderabad-500 051, India
T : +91 40 2726 4141
F : +91 40 2726 3657

DECLARATION

I hereby declare that the present report titled ***"Ecological Studies For Alfa Infraprop Pvt Limited, Komarada Village, Vizianagaram District, Andhra Pradesh."*** has been prepared by the undersigned, **Dr Mandar Nanajkar**.

It is further to be noted that I am a **catagory**-**A QCI-NABET** accredited expert for **Ecology & Biodiversity** and am working with **Vimta Labs Ltd, Hyderabad** which is also a **QCI-NABET** accredited organisation.

Dr Mandar Nanajkar

(Category-A accredited 'Ecology and Biodiversity' Expert)

June, 2014

1.0 BACKGROUND

M/s. Alfa Infraprop Pvt. Limited (AIPL) is proposed to set up a 4X660 MW coal based power plant near Komarada village & Mandal, Vizianagaram district, Andhra Pradesh **(Figure-1 & Figure-2)**. This project is in line with the central government's massive power capacity addition plan, which sets a target of adding 78,700 MW of power generation capacity in the country in the 11th Plan (2007-2012) out of which more than 15000 MW are expected to be met by the private sector. This proposed project at Vizianagaram district by M/s Alfa Infraprop Pvt. Limited would assist in meeting the increased demand of power in southern grid.

It is envisaged that coal for the power plant would be linked from Mahanadi Coalfields Limited (MCL), Orissa and/or imported coal. It is proposed to draw through rail line for transferring coal to plant site from coal field/sea port.

The proposed project would require 1675-acre (≈678-ha) of land including the ash pond and colony after optimisation of the land requirement as per the suggestion of EAC during ToR meeting held on April 16, 2009. In the proposed power plant four (4) boilers with super critical technology will be installed which will be fired on coal. The total coal requirement for the project at 80% Plant Load Factor (PLF) will be 13.6 MTPA from Mahanadi Coalfields Limited (MCL) or 7.61 MTPA from imported coal sourced from Indonesia. Depending on the linkages there is a possibility of blending the MCL coal and imported coal (i.e.70% MCL coal and 30% Imported coal). The water requirement will be about 70 Million Cubic Meters (8000 m^3/hr), which will be drawn from Nagavali river which runs about 1.8 km from the site. Two twin-flue stacks of 275 m with ESP of more than 99.9% efficiency will be provided to control particulate matter to below 50 mg/Nm^3. The cost of the total project is about Rs.11,838 Crores, which includes Rs 1180 Crores for environmental protection measures.

2.0 Purpose of the Study

Based on the recommendations of the EAC, the project was granted Environmental Clearance (EC) vide letter dated 15.3.2010 by the Ministry of Environment and Forests. This EC was challenged in the National Green Tribunal (NGT). The National Green Tribunal states, after seeking clarifications and explanations from all the concerned parties, that ***"The EAC is directed to discuss the ecological aspects of the flood plain of the riverine systems in the vicinity of the proposed project and impose conditions, if required, to be followed by the Project Proponent"***. Further based on the above comment, the present study was carried out considering the objectives given below:

3.0 Objectives of the Study

- To study the present status of terrestrial ecology of the study area;
- To study the aquatic ecology of the important water bodies in the study area;
- Assessment of the ecological sensitivities in the flood plains of the study area; and
- Prediction of potential impacts on the terrestrial and aquatic ecosystems in the study area.

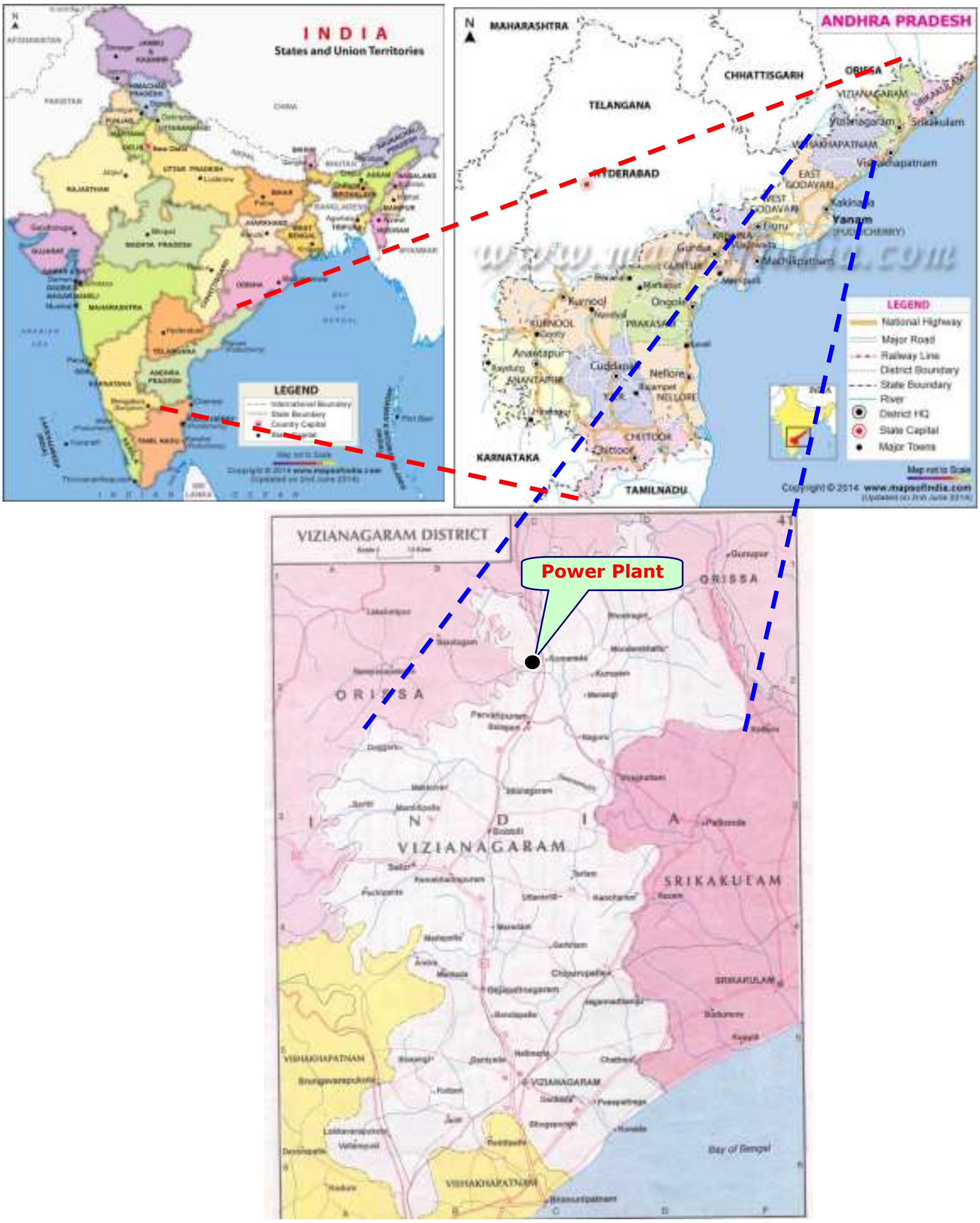


FIGURE-1

LOCATION MAP OF THE PROPOSED POWER PLANT

FIGURE-2
STUDY AREA MAP (10 KM RADIUS)

4.0 Methodology

To achieve the above objectives, a detailed study of the area was undertaken during the 2nd week of March 2014 and the different methods adopted were as follows:

- Generation of primary data by undertaking systematic ecological studies in the study area;
- Primary data collection for flora through random quadrant sampling method for trees, shrubs and herbs from the selected locations to know the vegetation cover;
- Faunal studies by taking transect in the study area to spot the fauna and also to know the fauna through indicators such as pugmarks, scats, fecal pallets, calls and other signs;
- Aquatic sample collection for phytoplankton and zooplankton; and
- Sourcing secondary data with respect to the study area from published literature and concerned government agencies.

The locations for terrestrial and aquatic ecological studies are shown in **Figure-3** and the details are given in **Table-1.**

TABLE-1
TERRESTRIAL AND AQUATIC SAMPLING LOCATIONS

Station	Location	Distance from the Site (Km)	Direction
Terrestrial			
TE1	RF near Ulipiri	5.1	N
TE2	Kuneru RF	8.0	N
TE3	Pujariguda PF	6.6	NE
TE4	Konavalasa RF	6.5	SW
Aquatic			
AE1	Nagavali near Komrada	3.3	NE
AE2	Jhanjavathi River	1.5	SE
AE3	After Confluence Point	2.6	ESE
AE4	Thotapalli Reservoir	9.9	SE

5.0 Terrestrial Biodiversity

The study area represents the adjoining forests of the Eastern Ghats region. According to Champion and Seth, the study area represents the forest type- II-5B-I categorized as Northern Tropical Mixed Dry Deciduous Forests. These forest are mostly degraded and are mostly dry scrublands due to heavy anthropogenic pressure.

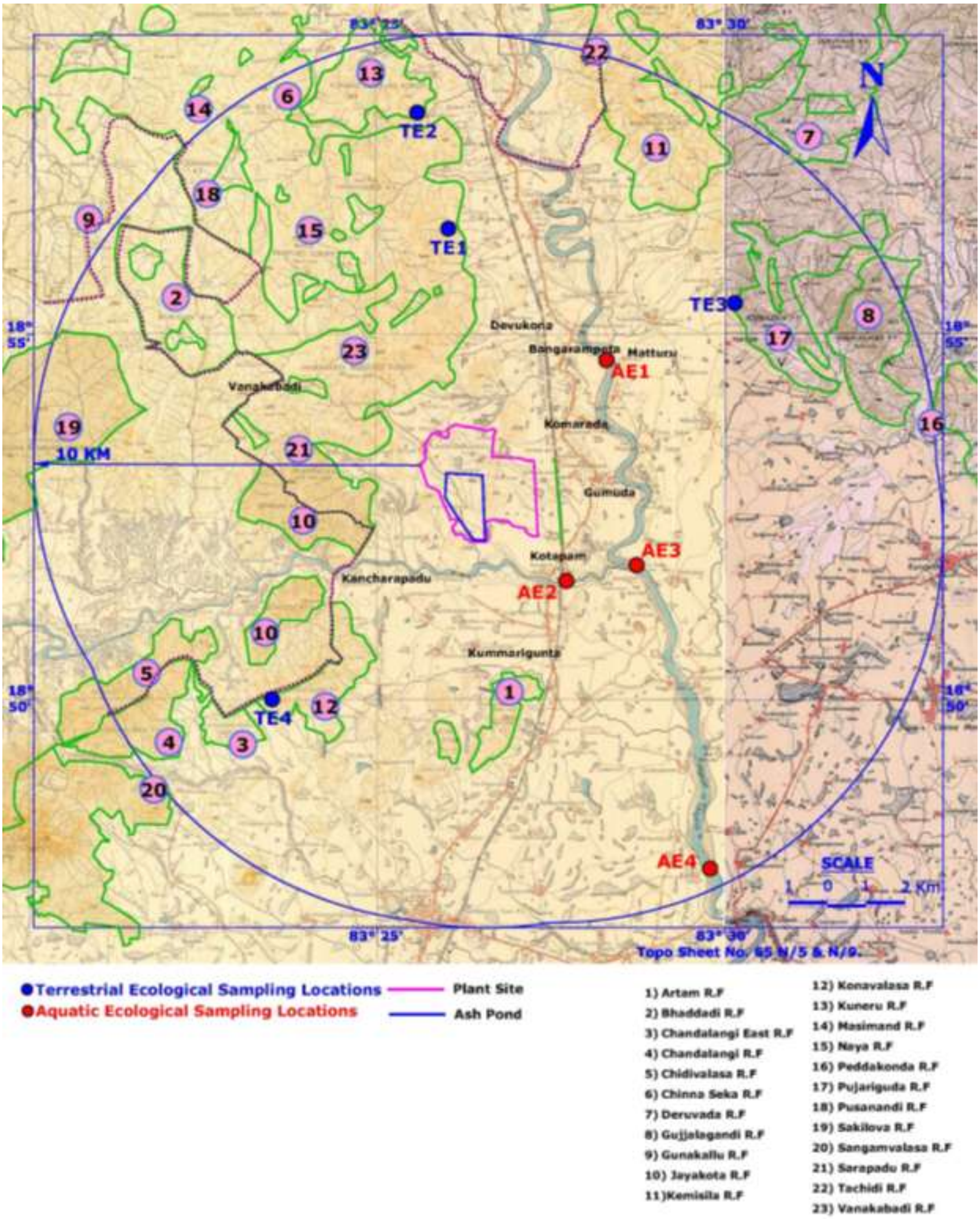


FIGURE-3

SAMPLING LOCATIONS IN THE STUDY AREA MAP

5.1 Flora and the Reserve Forests

The region harbors reserve forest that are mostly in the northern half of the study area. These forest areas were previously not represented by teak but in the recent past the forestry practices have made it a teak dominated forest in few areas. Most of the forest areas are secondary grown forest and represents medium sized teak mixed with other Terminalia species and bamboo thickets. In the pre-monsoon season, most of the forest floor was covered by thick leaf litter of teak. Due to this deciduous nature of species, the fallen litter does not allow the growth of herbaceous flora and grasses on the forest floor. The reserve forests which are in the Odisha state are dominated by *Shorea robusta* and used by the local people for extraction of gum **(Figure-4)** to sell in the local markets.

The list of reserve and protected forests falling inside the study area are given in **Table-2** below and their locations are shown in **Figure-3**:

TABLE-2
DETAILS OF FOREST BLOCKS IN STUDY AREA

Sr. No.	Name of the Forest Block	Distance from Project Site (km)	Direction from Project Site
1	Sarapadu RF	0.5	W
2	Vanakabadi RF	0.5	NNW
3	Jayakota RF	1.5	WSW
4	Konavalasa RF	3.2	SW
5	Artam RF	3.5	S
6	Naya RF	3.8	NW
7	Bhaddadi RF	4.8	WNW
8	Pusanandi RF	5.7	NW
9	Pujariguda PF	6.2	ENE
10	Kemisila RF	6.2	NNE
11	Chidivalasa RF	6.6	SW
12	Chinna Seka RF	6.7	NNW
13	Sakilova RF	6.8	W
14	Chandalangi East RF	6.9	SW
15	Chandalangi RF	7.4	SW
16	Kuneru RF	7.3	NNW
17	Gujjalagandi PF	8.1	ENE
18	Gunakallu RF	8.6	WNW
19	Masimand RF	9.5	NNW
20	Sangamvalasa RF	9.7	SW
21	Tachidi RF	9.7	NNE
22	Peddakonda RF	9.9	E
23	Deruvada RF	10.0	NE

The forest fringe communities were also represented by old grown large canopy forming *Mangifera indica, Tamarindus indica* and *Shorea robusta*. At all the sampling locations the most dominant tree was *Tectona grandis*. The average girth of *Tectona grandis* was 93 cm with an average height of 19 m. The sub dominant species was *Shorea robusta* with an average girth of 108 cm and an average height of 12 m. The other species was *Mangifera indica* with an average girth of 197 cm and an average height of 23 m and species occurring in the forest areas with low abundance were viz; *Chloroxylon swietenia, Tamarindus indica, Semecarpus anacardium, Terminalia* sp.*, Ailanthus excelsa, Buchanania lanzan, Sterculia* sp.*, Maduca indica* and *Pterocarpus indicus.*

Shorea robusta with gum on bark

Sampling quadrants in the Reserve Forest

Teak Forest

FIGURE-4
VEGETATION IN THE STUDY AREA (Contd…)

Sampling in the Reserve Forest

FIGURE-4
VEGETATION IN THE STUDY AREA (Contd…)

Bamboo thickets on the forest fringe

Bauhinia vehlii

FIGURE-4

VEGETATION IN THE STUDY AREA

Bamboo thickets were also noted in the hill slopes of the reserve forests and some areas had bamboo clumps on the forest fringes (**Figure-4**).

The middle and the under storey was mainly dominated by *Lantana camara, Bauhinia wahlaii, Euphorbia* sp., *Dodonea* sp., *Wrightia* sp., *Agave* sp. and *Buchanania lanzan.* While the under storey was represented by *Cyperus rotundus, Spermacoce hispida, Mimosa pudica, Euphorbia hirta* (weed) and other grasses. There was no understory in the areas where there was mono-cultural teak growing due to the leaf litter forming a thick blanket on the forest floor.

5.2 Plantations

Many people in the region practice plot plantation of economically important species that produce timber. This can be observed in the study area wherein the plantation of plots have been done with high density for species of *Eucaliptus* sp and *Casurina* sp. It was also noted that some areas were planted with *Tectona grandis* (Teak).

5.3 Fauna

The commonly observed fauna was common mongoose, hare, wild boar and very rarely spotted deer. The area harbours good population of birds mostly associated with marshes and grassland. While the forest areas harbour typical species of dry deciduous tropical eco-tone. Indian robin, red-vented bulbul, hoopoe, yellow-wattled lapwing, egrets, cormorant, red-wattled lapwing (**Figure-5**), scaly breasted munia, cattle egret, common myna, rosy pastor, black shouldered kite, black drongo, small green bee eater, bay-backed shrike, rose ring parakeet, common pariah kite, indian moorhen, cuckoo, great heron, doves, pied kingfisher and pale harrier were spotted during the survey.

Common garden lizard (*Calotes versicolor*) and common skinks (*Mabuya* spp.) were observed on the forest floor, near villages and agricultural lands. The other species occurring in the region include reptiles like vipers, indian cobra and common krait. Amphibians such as the indian bull frog (*Hoplobatrachus tigerinus)* and indian skipper frog (*Euphlyctis cyanophlyctis)* were observed in the water bodies.

Butterflies such as plain tiger, glassy tigers, common crow, common rose, common sailor, blue pansy, chocolate pansy, cabbage white and danaid eggfly were observed. The common crow was the most dominant butterfly observed in reserve forests, forest fringes, grass and weed covered areas near the agricultural fields and plantations.

It can be concluded from the survey that there are no Wildlife Sanctuaries, National Parks and Biosphere Reserves or Migratory corridors of any important species within the study area. There are no Schedule-I species protected under the Wildlife (Protection) Act, 1972 within the study area.

5.4 Discussion with the Forest Department

As per the discussion with Assistant DFO at Parvathipuram, there are no sensitivities in the study area and there are no sanctuaries, national parks, biosphere reserves and no corridors of any migratory animals in the study area. There are no schedule-I species within the study area. The forests are mostly dominated by teak and sal because of plantation activities. The forest areas are mostly devoid of large faunal organisms wherein only spotted deer occurs that too rarely. As per the discussions, there are no sites of migratory birds in the region.

Egret & Cormorant

Red-wattled Lapwing

FIGURE-5
REPRESENTATIVE AVIFAUNA FROM THE STUDY AREA

Extraction of NTFPs is common in the area as the tribals collect gum, fruits, seeds, flowers (*Madhuca indica*) and broom making species to sell in local market. There is no much grazing pressure in the forest areas. The regeneration of sal has been very high in this region in the recent past. Sal germination is protected under a special program – Aided Natural Regeneration. Under this program, the sal saplings are selectively culled for better regeneration and healthy growth. In the other activities carried out, the Forest Department displayed medicinal plants in the recently held tribal festival in the region. The list of flora and fauna from the study area is given as **Annexure-I**.

5.5 Floodplains in the Study Area

A floodplain or flood plain is an area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge (Goudie, 2004*). It includes the floodway, which consists of the stream channel and adjacent areas that actively carry flood flows downstream, and the flood fringe, which are areas inundated by the flood, but which do not experience a strong current. In other words, a floodplain is an area near a river or a stream which floods when the water level reaches flood stage.

A floodplain is the natural unit of landscape, combining the link between terrestrial and aquatic ecosystems and it encompasses the entire area of land drained by various tributaries to the main river. The drainage area bordering the stream is called the riparian zone and is of critical importance to the function, as well as the protection and management of a river. Riparian zone has dynamic environment characterised by strong energy regimes, substantial habitat heterogeneity, a diversity of ecological processes and multidimensional gradients.

This zone is an area of trees, usually accompanied by shrubs and other vegetation along a river, stream or shoreline that is managed to maintain the integrity of the waterway to reduce pollution and to provide food, habitat and thermal protection for fish and wild life. The unique ecological functions of riparian zones are linked to dynamic biophysical processes and interactions across multiple spatial and temporal scales. Riparian buffer zones help in controlling soil or sediment erosion, maintaining water quality, provide habitats for different aquatic organisms, flooding & temperature control and construct a stable river bank. The floodplain is often desirable for farming and livestock production.

*: *Goudie, A. S., 2004, Encyclopedia of Geomorphology, vol. 1. Routledge, New York*

Among the 10 flood prone areas in India, the state of Andhra Pradesh has 1.39 million ha. of land catagorised under this zone and the parts of the study area are also influenced by floods in the recent past. The peak discharge of Nagavali river in the past is given in **Table-3**. The floodplains are a part of central India and Deccan river basin*. Nagavali river forms a basin within this system and the floodplains of this river provide a fertile landscape. The Nagavali floodplains that come within the impact zone of the project stretches about 9.1km (from the confluence point to the periphery of the southern boundary of the study area). This area also overlays with the floodplains of its tributaries such as Jhanjavathi and other small streams. The floodplains of the down-flow area of the project are mostly covered with agricultural lands, ponds, open scrubland and seasonal grasslands. The floodplain agricultural land is provided with a canal system and is mainly fed with monsoonal rains for its crops.

TABLE-3
PEAK DISCHARGE OF NAGAVALI RIVER

Sr. No.	Event	Peak Discharge at CWC Gauge at Srikakulam (m^3/sec)	Districts Affected
1	September 1990	1009	Srikakulam, Vizianagaram
2	July 1991	1671	Srikakulam, Vizianagaram
3	September 1991	845	Srikakulam, Vizianagaram
4	July 1992	1835	Srikakulam, Vizianagaram
5	September 1994	1616	Srikakulam, Vizianagaram
6	July 1996	992	Srikakulam, Vizianagaram

Source: Revenue (Disaster Management) Department, GoAP

Due to the availability of water resource and fertile soil, the area becomes conducive for development of agriculture, industries and urbanization. Despite all the suitable conditions, the area still remains undeveloped. The major developments in the Nagavali river basin are given below:

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*:-*http://www.mapsofindia.com/top-ten/geography/india-flood.html dated: 07.04.2014.*

- **Urban Centres:** The important towns in the basin are Amadalavalasa, Rayagada, Parvatipuram, Palkonda, Veeragattam and Bobbili.
- **Industries:** The basin has no large scale industry. The existing small scale industries are mostly oriented to forest and agricultural produce and are located in the Srikakulam.
- **Minerals:** Manganese, quartz, mica, graphite, limestone, bauxite and construction materials are found in abundance in the Basin.
- **Hydrological Sites:** Gauge discharge, sediment and water quality observations are made at Srikakulum observation station.

5.6 Agro-Ecosystems

In the study area (buffer zone) most of the area under cultivation is a single crop agriculture land wherein paddy is taken as kharif crop and the harvesting is completed by around January- February. The five major crops in this region of Andhra Pradesh are rice, sugarcane, groundnut, sesamum and millet. These are mostly found in well irrigated areas. Overall it was observed that the water for irrigation is mostly obtained from ground water and canal fed irrigation systems.

However in the study area the majority of the agricultural land was dominated by paddy cultivation and the harvesting of the paddy was already completed. The major crops in the study area also included mustard, cotton (**Figure-6**), corn, tomato, gourds and cabbage. Apart from these the other major tree crops include banana, palm, cashew (**Figure-6**) and mango. These tree species were seen planted and covered a sizable area of cultivable land in the study area. These tree species provide long lasting and constant income with low risk and efforts once well established. These trees have high water requirement thus can only be cultivated in areas with ample of water throughout the year.

5.7 Vegetation and Trees

The species observed in large numbers in the roadside plantations and village areas were *Mangifera indica, Tamarindus indica* (**Figure-7**) and *Terminalia* sp. The other trees in and around the villages and roadside include *Moringa oleifera* (Drumstick), *Ficus religiosa, F. bengalensis* and *Anona reticulate* (Ramfal). The villages also had other flowering plants and fruit bearing plants such as Guava, Palm etc.

The species occurring on the forest fringes, non-cultivated lands, village and farm land boundaries were *Anogeissus latifolia, Terminalia alata, Chloroxylon swietenia, Dalbergia paniculata, Lannea coramandelica, Shorea robusta, Madhuca indica, Buchanania lanzan, Albizzia labback, Boswellia serrate* and *Butea superba.*

Cotton

Mustard

FIGURE-6

AGRO-ECOSYSTEM IN THE STUDY AREA (Condt…)

Cashew plantation

Cashew plant with fruit

FIGURE-6

AGRO-ECOSYSTEM IN THE STUDY AREA (Contd...)

Banana Plantation

Palm Plantation

FIGURE-6

AGRO-ECOSYSTEM IN THE STUDY AREA

Mangifera indica

Tamarindus indica

FIGURE-7

ROADSIDE AND VILLAGE TREES IN THE STUDY AREA

5.8 Weeds

The total number of weeds occurring in Andhra Pradesh are 715 species including ten mostly deleterious weed species considered globally which cause heavy economic losses. Out of these, the study area shows the prevalence of *Cyperus rotundus, Echinochloa crusgalli* and *Imperata cylindrica* in the agricultural fields.

The most commonly occurring weeds in the agro-ecosystems are *Echinochloa crussgalli, Dentella repens, Bacopa monnieri, Fimbristylis miliacea, Panicum repens* and *Polygonum barbatum. Marsilea quadrifolia* is the only pteridophyte commonly infesting rice fields. Other weeds such as *Ludwigia octovalvis, Portulaca quadrifolia, Basilicum polystachyaon, Lindernia ciliata* and *Monochoria vaginalis* represent the irrigated fields*. Ludwigia adscendens, Hydrolea zeylanica, Lindernia parviflora,* and *Fimbristylis bisumbellata* were rare.

Many roadside areas and agricultural fields were also intruded by *Parthenium histerophorus, Celosia argentea* and *Lantana camara* while the aquatic and marshy areas were occupied by *Ipomea carnea.* Some of the large water bodies were also infested with *Eichhornia crassipes* **(Figure-8)** *Limnophylla indica, Ottelia alismoides* and *Pistia stratiotes*. These floating hydrophytes were also observed in the backwaters of Thotapalli reservoir wherein the marshy lands and the fringes of the reservoir were dominated by *I. carnea* and in continuity by *E. crassipes* in the water logged areas. This vegetation suggests that the water bodies are eutropicated and have a high organic load. These species pose a great threat in long term as they have the capability to make the reservoir shallower over the years and convert it into a marshy bog land.

One of the important invasive species observed in the study area was the Giant African Land Snail (*Achatina fulica*; **Figure-8**). It was not observed in the agricultural fields but was mostly seen on the walls and tree trunks. It has prolific growth rate and can spread high population in a short time. It has the potential to damage fruit crops and may incur economic losses in the future if not taken care off.

5.9 Cattle and Grazing

As per the discussion with the forest department, there is no much grazing pressure in the forest areas. However, the other areas which are open scrublands, non-cultivated barren lands, grasslands are used for grazing. These open lands grow ample of grass due to the soil type and moisture. The riverside plains also have good productivity in terms of grasses and fodder species which are often utilized for grazing and grass cutting for stall feeding.

Growth of *Ipomea carnea* in the floodplains of Jhanjavathi

Ipomea carnea

FIGURE-8

WEEDS AND INVASIVE SPECIES IN THE STUDY AREA (Contd…)

Eichhornia crassipes

Celosia argentea

FIGURE-8
WEEDS AND INVASIVE SPECIES IN THE STUDY AREA (Contd…)

Argemone mexicana

Achatina fulica

FIGURE-8

WEEDS AND INVASIVE SPECIES IN THE STUDY AREA

6.0 Water-Bodies

The study area consists of one major river i.e. Nagavali, one small river – Jhanjavathi that joins Nagavali in the study area and small streams that feed these two rivers. Due to undulating and hill terrain in the region there are many ephemeral ponds fed by the rivers during monsoon. There are two manmade dams/reservoirs in the study area viz; Rubber dam on Jhanjavathi river and Thotapalli reservior on Nagavali river which also have a canal system. Jhanjavathi river is joined by one of the tributaries- Wankabadi Gadda which is a perennial stream. This stream is adjacent to the western boundary of the proposed project site. The study area also comprises of many ponds and small puddles which are fed by the streams during monsoon. Most of the ponds are seasonal with few of them connected with the perennial streams and some are linked by canal.

6.1 Nagavali River

Nagavali river rises in the eastern slopes of the Eastern Ghats near Lakhbahal in the Kalahandi district of Odisha at an elevation of about 1,300 m. Another name of the river Nagavali is *Langulya*. The geographic co-ordinates of the river are $18^0$10" to $19^0$44" N and 82^0 53" to 84^0 05" E.

The total length of the river is about 256 km, of which 161 km is in Odisha and the rest in Andhra Pradesh. The catchment area of the basin is 9,510 square km. Nagavali is an interstate river with 4462 km^2 and 5048 km^2 river basin area located in Odisha and Andhra Pradesh respectively. The river basin receives 1000 mm average rain fall annually. The uplands of the river basin are hilly areas with predominantly tribal populated. It drains parts of the Kalahandi, Rayagada and Koraput districts of Odisha and Srikakulam, Vizianagaram and Visakhapatnam districts of Andhra Pradesh. The view of Nagavali river before, at and after the confluence point is shown in **Figure-9.**

The main tributaries of the river Nagavali are Jhanjavati, Barha, Baldiya, Satnala, Sitagurha, Srikona, Gumudugedda, Vottigedda, Suvarnamukhi, Vonigedda, Relligedda and Vegavati.

6.2 Thotapalli Reservoir

The backwaters of the Thotapalli reservoir **(Figure-10 & Figure-11)** fall inside the study area at 18^0 47′ 30" N and 83^0 25′ 24" E while the actual dam is outside the study area in the southern direction. This reservoir was first built in 1908 but over the years it was damaged and was not efficient. The new proposed repair and reconstruction work was initiated in 2005 and still the construction is continued.

The total available yield from the catchment area is 44.0 TMC and the yield allocated to be utilized by Andhra Pradesh is 16.0 TMC while the utilization by this barrage is 15.895 TMC. The storage capacity of the barrage at FRL/MWL (+105.0

m) is 2.509 TMC (71.05 M.Cum). The CCA under this project is 184000 acres while the existing Ayacut (Kharif Paddy) is 64000 acres. The barrage has an ogee spillway with a total length of 117 m and 8 nos of radial gates. The size of the vent is 12X7m and the design discharge of 3234 Cumecs. The project has earthen dam with two sluice gates, the dam has 8.2 km length on both sides with a width of 6 m and a maximum height of 20.2 m.

The everyday flow from the reservoir when all the gates are closed is 126 Cusecs. When the water reaches high levels in the reservoir, the gates are opened to release the excess stored water. At 3.4 m height about 42503 Cusec was released in October 2013 and during the floods of 2006 all the gates were opened to release 167000 Cusec of water. This was necessary as the construction was still underway and there was risk of damage. If the consumption is required or there is loss due to evaporation during the lean season, one gate is opened to increase the flow by 700 Cusec.

Nagavali river north of Komrada village

Nagavali river before confluence point

FIGURE-9

NAGAVALI RIVER IN THE STUDY AREA (Contd...)

Nagavali river at the confluence point

Nagavali river after confluence point

FIGURE-9

NAGAVALI RIVER IN THE STUDY AREA (Contd…)

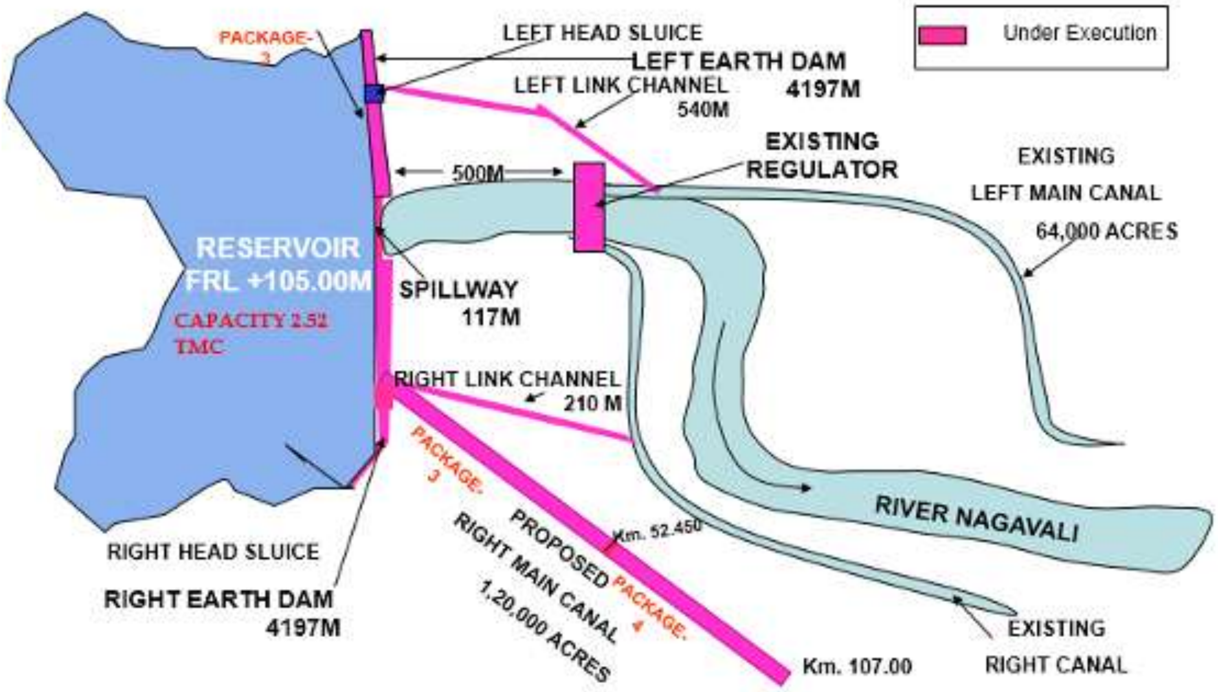

FIGURE-10
SCHEMATIC OF THOTAPALLI RESERVIOUR

FIGURE-11
THOTAPALLI RESERVIOUR

6.3 Jhanjavathi River

This is the tributary that joins the Nagavali river at $18^0$86”48’17 N and $83^0$47”07’04 E from the west. This is a perennial river which is fed by small streams and rivulets flowing from the reminiscent of the slopes of eastern ghats.

6.4 Rubber Dam

The two canals are 15 km long and irrigate land of 24000 acres. Out of the total 15 km length of the canals, about 8 km of both canals come under the study area covering the southern part of low lying areas with respect to Jhanjavathi river. Thus, the approximate areas covered by rubber dam system is about 13000 acres which entirely covers the down-flow floodplain region in the study area west of the Nagavali river.

There are two ponds in the down-flow direction of these canals viz; Gangasagaram and Valaragudam are about 30 and 40 acres each respectively. Both these ponds are fed by the canal water. The mechanism of operation is activated based on the need of water for agriculture land under the catchment of these canals. Farmers inform the executive engineer and accordingly the water is released from the dam in to the canals. The rubber dam and the flow downwards of the Jhanjavathi river and the canal is shown in **Figure-12.**

The water quality of the water is given in **Annexure-II**. The results reveal that all the parameters at all the locations are within the prescribed CPCB/APPCB limits.

6.5 Wankabadi Stream

This was a small perennial stream adjacent to the western boundary of the proposed project site. The flow of the stream originates from the north-western hill slopes which comprise of reserve forests. The streams join the Jhanjavathi river at the south-west corner of the proposed project boundary. It is envisaged that the project will not draw any water from this stream and also shall not discharge any treated or untreated waste from the project activities. The stream shall be left solely for the benefit of the farmlands and dependent agricultural activities.

FIGURE-12
THE RUBBER DAM AND THE FLOW DOWNWARDS OF THE JHANJAVATHI RIVER AND THE CANAL (Contd…)

FIGURE-12

THE RUBBER DAM AND THE FLOW DOWNWARDS OF THE JHANJAVATHI RIVER AND THE CANAL

6.6 Ponds in the Study Area

The study area consists of rivers, streams and ponds which reach their highest limits during monsoon season and are flooded during the heavy rain years which makes them overflow. This monsoonal flooding creates many small pools, ditches and ponds of varying sizes, wherein most of these ephemeral water bodies retain water for a very short duration while some of the larger ponds retain water up to the onset of summer or mid-summer. Most of the ponds are natural depressions with some manmade modifications to content the water while others have been prepared with embankment. Considering the topography of the study area and the surface drainage pattern of the region, it can be concluded that most of the seasonal ponds are fed by the streams flowing from the hilly areas. The list of major ponds in and around the project site area are given in **Table-4**.

Almost all the ponds are ephemeral and mostly used for fish cultivation, other activities and ponds near villages are used sometimes for domestic purpose. The agriculture in the region is not dependent on the streams and ponds water but the farmers in the study area are more dependent on rain water and canal water for irrigation (Annon 2008)*.

TABLE-4
LIST OF PONDS IN THE PROJECT SITE

Sr. No.	Pond Name	Longitude	Latitude	Pond Area (ha.)
1.	Bulli Bandha	83°26'22.3"	18°53'21.7"	0.56
2.	Yaddlavani Cheru	83°26'21.5"	18°53'18.6"	0.91
3.	Regulapadu- I	83°25'51.6"	18°53'20.1"	0.53
4.	Regulapadu -II	83°26'10.7"	18°53'15.2"	3.37
5.	Pedda Bandha	83°26'54.8"	18°52'45.2"	1.24
6.	Bella Bandha	83°26'22.8"	18°53'00.1"	0.98
7.	Killadi Bandha- I	83°26'49.3"	18°53'03.8"	0.40
8.	Killadi Bandha-II	83°27'05.7"	18°52'58.4"	0.76
9.	Chaki Cheru-I	83°27'23.8"	18°53'00.7"	1.12
10.	Mogla Cheru	83°27'20.2"	18°52'49.6"	3.83
11.	Ganne Cheru-I	83°26'52.0"	18°52'32.9"	0.48
12.	Ganne Cheru-II	83°27'09.5"	18°52'31.7"	0.30
13.	Ethamann Bandha	83°27'22.7"	18°52'35.9"	0.48
14.	Changunaidu Cheruvu	83°27'28.8"	18°52'19.2"	1.41
15.	Koneru-I	83°26'17.0"	18°53'43.2"	0.56
16.	Koneru-II	83°26'31.4"	18°53'37.6"	0.57
17.	Mogili Bandha	83°25'51.3"	18°53'38.9"	0.75
Total				**18.25 ha**

** :- Annon (2008) Annual Report- Central Ground Water Board Ministry of Water Resources Govt. of India Faridabad.*

7.0 Aquatic Biodiversity

The rivers and water bodies from the study area are catagorised in the 'Northern Deccan Plateau' under the aquatic eco-regions as described by Subramanium and Jaiswal (2012)*. The major components of the aquatic ecosystems are the phytoplankton, zooplankton, fishes and other benthic organisms.

The major biotic aspects of these aquatic ecosystem is the planktonic diversity, fishes, benthic invertebrates and macro-phytes. The nutrient flux is the major factor defining the biodiversity of any given aquatic water body. The size, shape, flow and seasonality are the important physical parameters that decide the biotic factors. If the water body is a small stream or a seasonal pond, the diversity and abundance of plankton, fishes and invertebrates shall generally remain low to the contrary when the water body is large such as a river or a lake, the diversity is high with good abundance of each species. Depending on these factors, the important water bodies from the study area were considered for aquatic diversity, viz; Nagavali river, Jhanjavathi river and Thotapalli reservoir. As many of the seasonal ponds in the study area were dry or about to dry, hence were not considered for the study.

7.1 Plankton

Phytoplankton form the basis of food chain in any aquatic water body. The diversity and abundance of phytoplankton mainly depends on the region, type of water body, either lentic or lotic, the nutrient flux in the system and the sunlight available for photosynthesis. These factors together form the dynamics of phytoplankton productivity over the seasons. The phytoplankton of a given water body determines the zooplankton populations and the fish productivity of the ecosystem.

Some of the important phytoplankton recorded were *Spirulina* sp., *Oscillatoria* sp. *Euglina* sp., *Nitzchia* sp., *Nevicula* sp. and *Spirogyra* sp. The list of phytoplankton species is given in **Table-5**. Out of all the phytoplankton species, Bacillariophyceae were observed to be comparatively dominant with 36% composition having an average density of 1753 nos/l followed by Chlorophyceae having 35% composition with average density of 1692 nos/l and Cyanophyceae with 29% having average density of 1450 nos/l. This composition suggests that there is no dominance of single group of algae and the conditions do not show polluted water. The percent composition of each phytoplankton group is given in **Table-6.**

**:- Subramanium KA and Deepa Jaiswal, 2012, Fauna of ecosystems of India-Freshwater, 1-22, (Published by Director, ZSI, Kolkata-India)*

TABLE-5
PHYTOPLANKTON FROM THE STUDY AREA

Sr. No.	Group	Species
1	**Cyanophyceae**	*Spirulina* sp.
		Oscillatoria sp.
		Anabaena sp
		Phormidium sp.
		Lyngbya sp.
2	**Chlorophyceae**	*Spirogyra* sp.
		Netrium sp.
		Euglena sp.
		Oedogonium sp.
		Rhizoclonium sp.
		Mougeotia sp.
		Gonatozygon sp.
3	**Bacillariophyceae**	*Nitzschia.* sp.
		Melosira sp.
		Cyclotella. sp.
		Fragillaria. sp.
		Synedra sp.
		Navicula. sp.
		Pinnularia sp.
		Pleurosigma sp.
		Cymbella. sp.
		Gomphonema. sp.

TABLE-6
PHYTOPLANKTON COMPOSITION FROM THE STUDY AREA

Group	Composition (nos/l)					% Composition
	AE1	AE2	AE3	AE4	Avg.	
Cyanophyceae	1078	1323	1568	1831	1450	29
Chlorophyceae	1651	1584	1807	1727	1692	35
Bacillariophyceae	1698	1468	1860	1987	1753	36

The zooplankton of the aquatic water body are the primary consumers and also in cases secondary producers which play an important role for the fisheries of the system. The diversity and abundance of zooplankton also depends on whether the water body is eutrophic or oligotrophic. They also are good representatives of the ecosystem health indicators. Species of copepod will usually dominate in the tropical region while more eutrophicated waters with high nutrient or organic loads will harbour high number of crustaceans and arthropods showing low diversity. The less polluted waters will have more of cladocerans and rotifers with overall high diversity.

The commonly occurring zooplankton were represented by species of *Keratella* sp., *Branchionus* sp., *Rotararia* sp., *Daphnia* sp., *Bosmina* sp., *Cyclops* sp., *Neodiaptomus* sp., *Diaptomus* sp. and others (represented by various insect larvae, nimphs, naids and ostracods). The zooplankton species list is given in **Table-7.**

The percent composition was dominated by rotifers showing 43% composition with an average density of 248 nos/l. The sub dominant groups were of copepods showing 38% composition with an average density of 217 nos/l while cladocerans and others contributed to less than 20% of the total zooplankton composition. The zooplankton composition is given in **Table-8.**

TABLE-7
ZOOPLANKTON FROM THE STUDY AREA

Sr. No.	Group	Species
1	**Rotifera**	*Keratella tropica*
		Keratella sp.
		Brachionus falcatus
		B. calciflorus
		B. rubens
		B. forficula
		B. angularis
		Monostyla sp.
		Dicranophorus sp.
		Rotararia sp.
		Ascomorpha sp.
		Notholca sp.
2	**Cladocera**	*Diaphnasoma* sp.
		D. exisum
		Macrotrix laticornis
		Daphnia pulex
		D. carinata
		Bosmina sp.
		Ceriodaphnia sp.
3	**Copepoda**	*Mesocylops* sp.
		Cyclops sp.
		Heliodiaptomus sp.
		Neodiaptomus sp.
		Diaptomus sp.
		Nauplii
4	**Others**	Ostracods
		Larvae
		Nymphs and Naids
		Other arthropods

TABLE-8
ZOOPLANKTON COMPOSITION FROM THE STUDY AREA

Groups	Composition (nos/l)					% Composition
	AE1	AE2	AE3	AE4	Avg.	
Rotifera	310	215	194	273	248	43
Cladocera	108	96	37	78	80	14
Copepoda	293	168	193	215	217	38
Others	23	14	32	36	26	5

7.2 Benthic Invertebrates and Macro-phytes

Some of the common benthic organisms inhabiting the river beds were *Parreysia corrugata* and *Cirithium* sp. (**Figure-13**) apart from submerged hydrophytes such as *Hydrilla* sp. on which many of the species forage and use them as protective habitat. The dominant bivalve *Parreysia corrugata* observed at location AE4 is a filter feeder and helps to maintain a good water quality while the gastropods are mostly grazers on submerged hydrophytes thus constantly maintaining the growth.

Some of the large water bodies were covered with *Eichhornia crassipes, Limnophylla indica, Ottelia alismoides* and *Pistia stratiotes*.

7.3 Fisheries

The rivers in the study area harbor fish species that include the three major carps, grass carp, common carp and a catfish which are commercially exploited by the locals for consumption and sell in local market. As this region is prone to flooding, mostly the rivers are full during the monsoon and they also flood the associated natural and manmade water-bodies in the region. This allows the fish communities to occupy the ephemeral ponds and small lakes in the region. During the monsoon these seasonal ponds are seeded with fish eggs and non-intensive aquaculture is practiced. The species harvested from the ponds are given in **Table-9**. In the post monsoon season, the ponds start shrinking due to the lean season and evaporation. The harvesting is carried out during this time before the pond dries up, which may vary according to the size of the pond and the water availability.

Parreysia corrugata

Cirithium sp.

FIGURE-13
SPECIES OBSERVED ON THE RIVER BED

TABLE-9
FISHES FROM THE STUDY AREA

Species	Common Name
Cyprinus carpio	Common Carp
Catla catla	Catla
Labeo rohita	Rohu
Cirrhinus mrigala	Mrigal
Channa striatus	Murral
Ctenopharyngodon idella	Grass Carp

7.4 Discussion with the Fisheries Department- Parvathipuram

As the information given by the Fisheries Development Officer (FDO)-Parvathipuram, there are fishery societies formed that fall under the downstream area of the flood plains. There are about 15-17 ephemeral ponds south of the confluence point wherein the size of the ponds is about 5 acres. The Fishery Department and the ITDA provides fish seeds for the interested people with 50% subsidy. Mostly the seeding takes place during July to September and the harvesting season is from January to March. These 15-17 ponds yield about 25-30 tonnes and the cost of fish can be about Rs. 50 per kg. But most of the fish cultivation is done for local consumption. There are two Girijan societies in the Komarada mandal while four fishery societies in Parvathipuram. There are other welfare schemes carried out through these societies which carry out activities such as capacity building and incident coverage. The approximate quantities of fish catch per hectare in this region as given by FDO are given in **Table-10** below:

TABLE-10
APPROXIMATE FISH CATCH FROM THE STUDY AREA

Common Name	Catch in kg /ha/month
Common Carp	2-3
Catla	4-5
Rohu	12-15
Mrigal	2
Murral	1
Grass Carp	2-3

8.0 Impact Prediction

8.1 Construction Phase

The construction phase of the proposed project will involve considerable civil work, building and construction work. These activities involve large scale mobilization of large equipment, heavy vehicles and temporary population influx for the construction activities. These aspects will have direct impacts on the local ecology if the activities are not regulated.

The direct impacts of the construction phase shall involve removal of vegetation. The excavation and civil work activity may result in, soil erosion, surface water hydrological changes. The construction activities may pollute the surface soil and water bodies due to unabated waste dumping, oil and grease contamination, toxin leaching into soil and water bodies.

Other indirect impacts may result during the construction phase due to temporary settlement of labour camps, heavy vehicular traffic and the direct construction and excavation work. These impacts are noise pollution and vibration due to operating machinery, air pollutants and dust emission from both the construction work as well as vehicular movement. Degradation of vegetation due to human presence and may result in poaching, fuel-wood burning and forest fire etc. The temporary human settlements may also be responsible for increase in domestic waste if proper waste management and treatment facilities are not maintained during the construction phase.

The project activities should be managed properly following strict regulation for construction related activities and labour camps shall be managed in accordance with the laid laws. Overall the construction phase activities are of short duration as well as localized and the project impacts shall also remain within the confinement of the proposed project area thus the overall impacts shall be of low magnitude.

As the proposed project site does not have any ecologically sensitive aspects other than lotic water bodies and if all the mitigation and management measures are followed as per the regulatory guidelines, the direct and the indirect impacts during the construction phase shall remain at the minimum.

8.2 Operational Phase

8.2.1 Terrestrial Ecosystems

The ecologically important aspects pertaining to the proposed project site are the reserve forests in the adjoining areas. The core area of the proposed project mostly comprises of open scrub land, fallow/ waste land, hillocks, slopes and shallow ephemeral ponds. The proposed project area does not harbour any schedule I species and the surrounding area has no protected area within 10 km radius.

Impact on Geographical Range of Species: All the species occurring in the project area have large species range and there is no occurrence of endemic species. Furthermore, the core project area and the adjoining areas share similar habitat and thus clearing of ground will not eliminate habitat of any species permanently. Overall, there are no threats for increasing the rarity of any species under this criterion.

Introduced Species/Weeds: There is likeliness of introducing exotic species due to proposed project activity. Influx of humans and regular human movement from the project area and the adjoining areas may result in introduction of obnoxious species. The vehicular movement and road traffic also sometimes results in introduction of unwanted species but the site already has existing traffic network and population interaction so the probability of increase in such species is less.

Forest Fire Frequencies: Often human movement and casual approach in the forest areas may lead to forest fires in the adjoining areas. Industrial accidents may also propagate to the adjoining areas causing forest fires but this is essentially a rare event hence is of low importance. The proposed project may pose a threat to the adjoining reserve forests and protected forests if the activities are not regulated. Since it is an accidental factor due to increased human activity and considering the implementation of best practices in health and safety it may be considered of low risk.

Habitat Fragmentation and Degradation: The proposed activity may result in vegetation clearing of large surface areas of land. These changes result in habitat fragmentation and shrinking of habitat for land animals and birds. As this site does not overlap with the migratory routes of any species and there are no other sensitivities hence this aspect can be catagorised as of low sensitivity. Furthermore the project involves massive plantation and greenbelt development which may increase the habitat for many species.

Pollutants from the Proposed Project: Emissions of gases such as CO, NO_x, SO_2 and particulate matter may have impacts on the nearby forest areas as these gases in high concentrations may have negative impact by restricting the growth of trees by obstructing photosynthesis, reduce regeneration and elimination of sensitive species (flora and fauna).

The predominant wind direction is from south-west and north-west direction, therefore the pollutants from the stack will be dispersed towards north-east and south-east respectively. As per the modelling studies carried out during the EIA stage, based on the type of coal used and the emissions accordingly, it can be concluded that the ground level concentrations do not reach the forest areas with high levels and are within the prescribed national air quality standards. Hence, the air emissions from the proposed project shall have insignificant impacts on the nearby forest areas hence this aspect is of low sensitivity.

Ecosystem Resilience: Ecosystem resilience is the overall diversity of the habitat, which helps to resist the adverse conditions and or calamities that may seriously damage that particular habitat. It is the capacity of an ecosystem to respond to a perturbation or disturbance by resisting damage and recovering quickly. Such perturbations and disturbances can include stochastic events such as fires, flooding, windstorms, insect population explosions and human activities such as deforestation and the introduction of exotic plant or animal species.

The proposed project may impose negative ecological attributes and might result in overall reduction in ecosystem resilience of the habitat if the activities are not confined to the project site and if not managed properly following the norms of statutory Governmental agencies. Further the project involves greenbelt development of diverse native species which may help to improve the ecosystem resilience of the region in the future.

Cumulative Impacts: It is important to take into account a holistic view for better representation of the predicted impacts of the proposed project. This requires the consideration of cumulative impacts of existing and past developmental activities in the vicinity of the project. As the project buffer zone does not have any earlier developmental activities except some small stone crushing units, the overall cumulative impact shall remain low.

The historic disturbance by the human settlement has considerable impacts on the ecology and biodiversity of the area especially the traditional tribal practices in this region for livelihood. From the field studies, it was evident that the project area showed signs of human pressure in the form of tree cutting, lopping, and extraction of NTFPs, cattle grazing as well as the absence of large mature trees in the forest areas.

Employment by the project and other income generating activities including alternative source of livelihood shall have positive impact on the biodiversity and restrict degradation of surrounding forest areas.

8.2.2 Floodplains and Riparian Ecosystems

There are about 17 ponds that fall within and around the project site boundary. The streams flowing from the north-west direction towards the proposed project site from the hilly forest areas feed these ponds. The excessive flow during the monsoon connects these small streams to the Jhanjavathi and Nagavali river. It is envisaged that these ponds shall not be disturbed by the project activity and shall be maintained as they are. The proposed project also does not involve water utilization from these ponds and streams nor does it involve any discharge of wastes in these water bodies.

The down flow areas of the project representing the floodplains comprise of streams, ponds, agricultural land and riparian habitats. These areas shall not have any impacts due to the proposed project as the project shall be drawing the required water from the confluence point. The floodplains that occur in the south of the Jhanjavathi river and east of Nagavali river are mostly replenished during the monsoon and for some times by the uphill streams flowing from the forest areas during the post monsoon. The water intake of the project will be located near the confluence point in the Nagavali river and thus there are no anticipated changes in the surface hydrology of the streams and ponds due to the project as these streams feed the two major rivers and not the other way round. The agricultural lands in the flood plains are monsoon dependent as well hence, it is envisaged that there will be no impacts.

The riparian ecosystems along the lotic water bodies and the agricultural field in the floodplain areas may incur impacts due to particulate matter settlement and deterioration of air quality which reduces the plant productivity. But as the project proposes to follow the best practices in the industry by installing Electro-Static Precipitator to reduce the release of particulate matter in the surrounding and strictly following the prescribed air quality standards which shall reduce the impacts considerably.

8.2.3 Aquatic Ecosystems

Water Usage and Discharge: The total water requirement of entire project will be 70 MCM (8000 m^3/hr). This required water will be met from confluence point of Nagavalli and Janjavati rivers situated 2 km from the site. The exact location of intake and outfall is 500 m south from the confluence point.

The raw water will be used for condenser cooling, the cycle make-up and other consumptive water requirements after appropriate treatment. The raw water will be brought to the plant by pipeline. Estimated total consumptive water requirement for the plant is about 8000 m^3/hr for 2640 MW, considering re-circulating closed cooling water system with cooling tower. The above quantity of water includes makeup water for the cooling towers (to compensate for water lost on account of evaporation, drift and blow down) and other consumptive requirement.

The most of the cooling tower blow down will be used for ash handling plant. Ash slurry will be directed to ash pond from where clear water after clarification will return to AHP system. About 324 m^3/hr of wastewater will be treated and discharged near the confluence point from the proposed plant site after the water quality matches the APPCB/CPCB discharge standards.

The quality of surface and ground water is not likely to be affected due to the disposal of ash as the ash pond will be lined with HDPE lining. During heavy rains any excess rainwater which overflows out of the ash pond will be collected in the lower part of the ash pond and will be reused after necessary treatment.

Eutrophication: This process is the ecosystem response to the addition of artificial or natural substances, such as nitrates and phosphates, through sewage to an aquatic system. The negative impacts include planktonic blooms, hypoxia, alteration in diversity, fish kill, growth of undesirable species and foul water bodies. As the proposed project shall be taking mitigation and management measures to ensure that water quality discharge standards are followed it is less likely that the water bodies will become eutrophicated. The present status suggest that some of the water bodies are already eutrophicated like Thotapalli Reservoir with low diversity and presence of species like *Eichhornia crassipes.*

Fisheries and Water Quality: The water bodies harbour freshwater fish species which are locally used as food source. These species may face threat in the future due to water usage by the increased population in the project area and sewage discharge in the rivers and streams. As a regular practice in the region, the ponds are seeded with species of carps at the onset of monsoon and harvested just before the drying of ponds during summer. The region does not harbour any endemic fish species and regular extensive aquaculture practices have already structured the communities of aquatic water-bodies. Basically, the aquaculture of the study area is monsoon dependent, non-intensive and is not done on large commercial scale. Based on the water intake and outfall location of the proposed project it can be inferred that the streams and the associated ponds in the downstream areas which are replenished by the streams will not be disturbed. Hence, the threat to the local fishery practices is very low from the project activities and furthermore as per the CPCB guidelines the discharged water shall be treated and released. Accordingly, the discharged water shall have low impacts on the aquatic ecosystem.

9.0 Summary and Conclusions

- There are no Schedule-I species as per the Wildlife (Protection) Act, 1972 and there are no National Parks, Wildlife Sanctuaries, Biosphere Reserves or migratory corridors of any species in the study area.
- It is re-confirmed that there are 23 Reserve Forests in the study area and there is no forest land involved in the project. The dominant species in the Reserve Forests are *Shorea robusta* and *Tectona grandis* with understory represented by *Bauhinia vahalii, Euphorbia hirta* and *Lantana camara*.
- The floodplain region is mostly occupied by agricultural land which are irrigated through canal system and groundwater during the non-monsoon. Paddy is the major crop taken in the entire region and some blocks have plantations of cashew, mango, palm and banana.
- The vegetation in the floodplains is represented by *Mangifera indica, Ficus relegiosa*, *Tamarindus indica, Anogeissus latifolia, Terminalia alata, Dalbergia paniculata, Lannea coramandelica, Shorea robusta* which are prevalent sporadically and mostly present on farm boundaries, villages, road-side and river banks.
- The water bodies in the study area were represented by Nagavali and Jhanjavathi River, about 17 ponds, streams, canal system fed by rubber dam and Thotapalli reservoir.
- The ponds in the study area are used for non-intensive fish cultivation of major carps. Most of the water bodies (ponds and reservoirs) are eutrophicated with the presence of high organic matter and covered with *Eichhornia crassipes.*

- It is envisaged from the field studies and the anticipated impacts of project on aspects such as geographical range of species, introduced & exotic species, forest fire frequencies, habitat fragmentation, ecosystem resilience, pollutants from the proposed project and cumulative impacts shall remain of low intensity.
- The anticipated impacts on the floodplain areas and the riparian ecosystems are considered negligible as there are no sensitive ecosystems or species in this area and the proposed project shall strictly follow all the national and regional regulatory guidelines for the release of pollutants and use best practices in the industry such as installation of ESP, water treatment plants along with development of green belt.
- The agricultural land in the floodplains is mostly monsoon dependent and in the lean season the fields are irrigated through the existing canal system hence the impact of water drawl and treated discharge shall not change the agricultural irrigation in the downstream floodplains of the study area. There will be no negative impacts on the streams and ponds in the study area and apparently on their water quality and fisheries.

ANNEXURE-I
MAJOR FLORA OF THE STUDY AREA

Sr. No.	Common Name
1	*Anogeissus latifolia*
2	*Terminalia atata*
3	*Chloroxylon swietenia*
4	*Lagerstroemia parviflora*
5	*Dalbergia paniculata*
6	*Lannea coramandelica*
7	*Boswellia serrata*
8	*Shorea robusta*
9	*Madhuca indica*
10	*Buchanania lanzan*
11	*Albizzia* sp
12	*Xylia xylocarpus*
13	*Acacia chundra*
14	*Butea monosperma*
15	*Schleichera oleosa*
16	*Wrightia* sp.
17	*Dendrocalamus strictus*
18	*Randia dumetrum*
19	*Gymnosporia Montana*
20	*Dodonaea viscose*
21	*Butea superba*
22	*Bauhinia vahlii*

Source: Divisional Forest Office, Parvathipuram

FAUNA OF THE STUDY AREA

Sr. No.	Common Name	Scientific Name	Status as per WLPA, 1972
A	**Mammals**		
1	Jungle cat	*Felis chaus*	Schedule-II
2	Hyena	*Hyaena hayena*	Schedule-III
3	Jackal	*Canis aureus*	Schedule-III
4	Common Mongoose	*Herpestes edwardsi*	Schedule-II
5	Porcupine	*Hystrix indica*	Schedule-IV
6	Hare	*Lepus nigircollis*	Schedule-IV
7	Common Squirrel	*Fanumbulus penunanti*	Schedule-IV
8	Malabar squirrel	*Ratufa indica*	Schedule-II
9	Spotted deer	*Axis axis*	Schedule-III
10	Sambar	*Cervus unicolor*	Schedule-III
11	Palm Civet	*Paradoxurus hermanphroditus*	Schedule-II
12	Rhesus Monkey	*Macaca mulatta*	Schedule-III
13	Wild Boar	*Sus scrofa*	Schedule-II
14	Common Langur	*Presbytis entellus*	Schedule-II
15	Common Otter	*Lutra lutra*	Schedule-II
16	Fruit Bat	*Cynopterus sphinx*	Schedule-V
B	**Birds**		
1	Dabchick	*Podiceps ruficollis*	Schedule-IV
2	Grey pelican	*Pelecanus philippensis*	Schedule-IV
3	Darter	*Anhinga rufa*	Schedule-IV
4	Cormorant	*Phalacrocorax niger*	Schedule-IV
5	Small egret	*Egretta garzetta*	Schedule-IV
6	Cattle egret	*Bubulcus ibis*	Schedule-IV
7	Paddy bird	*Andeola grayli*	Schedule-IV
8	Painted Stork	*Ibisleucocephalus*	Schedule-IV
9	Open-billed Stork	*Anastomus oscitans*	Schedule-IV
10	Cotton Teal	*Nettapous coromandelianus*	Schedule-IV
11	Pariah Kite	*Milvus migrans*	Schedule-IV
12	Brahminy Kite	*Haliastur Indus*	Schedule-IV
13	Grey Partridge	*Francolinus pondicerianus*	Schedule-IV
14	Bush Quail	*Perdicula asiatica*	Schedule-IV
15	Purple Moorhen	*Porphyrio porphyrio*	Schedule-IV
16	Red-Wattled Lapwing	*Vanellus indicus*	Schedule-IV
17	Sandpiper	*Tringa hypoleucos*	Schedule-IV
18	Brown Headed Gull	*Larus brunnicephalus*	Schedule-IV
19	Whiskered Tern	*Childonias hyfrida*	Schedule-IV
20	Green Pigeon	*Treron phonenicoptera*	Schedule-IV
21	Blue rock Pigeon	*Columba livia*	Schedule-IV
22	Spotted Dove	*Streptopelia chinensis*	Schedule-IV
23	Rose Ringed Parakeet	*Psittacula krameri*	Schedule-IV
24	Koel	*Eudynamys scolopacea*	Schedule-IV
25	Crow Pheasant	*Centropus sinensis*	Schedule-IV
26	Spotted Owlet	*Athena brama*	Schedule-IV
27	Indian Nightjar	*Caprimulgus asiaticus*	Schedule-IV
28	Swift	*Apus affinis*	Schedule-IV
29	Pied kingfisher	*Ceryle rudis*	Schedule-IV
30	Bee-Eater	*Merops orientalis*	Schedule-IV
31	Blue jay	*Coracias bengualensis*	Schedule-IV
32	Golden Oriole	*Oriolus oriolus*	Schedule-IV

Sr. No.	Common Name	Scientific Name	Status as per WLPA, 1972
33	Black Drongo	*Dicrurus adsimillis*	Schedule-IV
34	Common Myna	*Acrodptjeres tristis*	Schedule-IV
35	Common Crow	*Corvus splendens*	Schedule-V
36	Treepie	*Dendrocitta vangabunda*	Schedule-IV
37	Red-Vented Bulbul	*Pycnotus cafer*	Schedule-IV
38	Jungle babbler	*Turdoides striatus*	Schedule-IV
39	Common Babbler	*Turdoides striatus*	Schedule-IV
40	Tailor Bird	*Orthotomus sutorius*	Schedule-IV
41	Magpie Robin	*Copsychus salvaris*	Schedule-IV
42	Indian Robin	*Saxicoloides fulicata*	Schedule-IV
43	Purple Sunbird	*Nectarinia asiatica*	Schedule-IV
44	Spotted Munia	*Lonchura punctulata*	Schedule-IV
C	***Reptiles***		
1	Krait	*Bungarus faciatus*	Schedule-IV
2	Cobra	*Naja naja*	Schedule-II
2	Russel's viper	*Vipera ruselli*	Schedule-II
3	Rat snake	*Ptyas mucosus*	Schedule-II
4	Common wall lizard	*Henidactylus spp.*	-
5	Garden lizard	*Calotes versicolour*	-
6	Chameleon	*Chameleon zeylanicus*	Schedule-II

Source: Divisional Forest Office, Parvathipuram

ANNEXURE-II
SURFACE WATER QUALITY ANALYSIS RESULTS FROM THE STUDY AREA

Sr. No	Parameters	Units	Permissible Limits as per IS:10500	AE1	AE2	AE3	AE4
1	pH	-	6.5 to 8	7.5	7.5	7.5.	7.5
2	Colour	Hazen	5	3	3	3	3
3	Conductivity	us/cm	$	288	301	310	295
4	DO		mg/l	5.7	5.8	5.6	5.5
5	BOD		mg/l	<3	<3	<3	<3
6	COD		mg/l	<5	<5	<5	<5
7	Total hardness as $CaCO_3$	mg/l	300	75.0	82.0	93.0	89.0
8	Total Dissolved Solids	mg/l	500	190	180	206	168
9	Chlorides as Cl	mg/l	250	42.3	46.0	47.0	44.0
10	Residual free Chlorine	mg/l	0.2 Min	<0.2	<0.2	<0.2	<0.2
11	Fluoride as F	mg/l	1.0	0.3	0.3	0.3	0.4
12	Calcium as Ca	mg/l	75	20.0	22.0	24.0	27.0
13	Magnesium as Mg	mg/l	30	6.5	7.3	8.1	8.2
14	Phosphates as PO4	mg/l	$	0.1	0.1	0.1	0.1
15	Sulphates as SO4	mg/l	200	6.5	7.3	12.7	20.5
16	Nitrates as NO3	mg/l	45	5.4	6.0	8.0	7.7
17	Phenolics as C_6H_5OH	mg/l	0.001	<0.001	<0.001	<0.001	<0.001
18	Cyanide as CN	mg/l	0.05	<0.02	<0.02	<0.02	<0.02
19	Alkalinity as $CaCO_3$	mg/l	200	76.0	78.0	83.0	87.0
20	Boron	mg/l	1	0.02	0.02	0.02	0.02
21	Sodium as Na	mg/l	$	28.0	29.0	24.0	27.0
22	Potassium as K	mg/l	$	10.0	10.5	9.5	9.5
23	Iron as Fe	mg/l	0.3	0.04	0.05	0.03	0.04
24	Copper as Cu	mg/l	0.05	<0.01	<0.01	<0.01	<0.01
25	Aluminium as Al	mg/l	0.03	0.01	0.01	0.01	0.01
26	Chromium as Cr^{+6}	mg/l	0.05	<0.05	<0.05	<0.05	<0.05
27	Cadmium as Cd	mg/l	0.01	<0.01	<0.01	<0.01	<0.01
28	Selenium as Se	mg/l	0.01	<0.01	<0.01	<0.01	<0.01
29	Arsenic as As	mg/l	0.01	<0.01	<0.01	<0.01	<0.01
30	Lead as Pb	mg/l	0.05	<0.01	<0.01	<0.01	<0.01
31	Zinc as Zn	mg/l	5	<0.01	<0.01	<0.01	<0.01
32	Mercury as Hg	mg/l	0.001	<0.001	<0.001	<0.001	<0.001
33	SAR	-	$	1.41	1.40	1.42	1.41
34	Anionic detergents as MBAS	mg/l	0.2	Absent	Absent	Absent	Absent
35	Oil & Grease	mg/l	0.01	<0.01	<0.01	<0.01	<0.01
36	Insecticides	mg/l	Absent	Absent	Absent	Absent	Absent
37	Total Coliforms	MPN/ 100	10	<2	<2	<2	<2

Note: -$- No Standards available