FINAL

New & Renewable Energy Development Corporation of Andhra Pradesh Ltd.,

(A State Govt. Company)

(Formerly Non-Conventional Energy Development Corporation of Andhra Pradesh Ltd.,)

"Preparation of Feasibility Report and Detailed Project Report for Proposed Pumped Storage Hydro Electric Project at Gandikota in YSR (Kadapa) District, Andhra Pradesh"

FEASIBILITY REPORT

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Feasibility Report and Detailed Project Report for Proposed Pumped Storage Hydro Electric Project at Gandikota in YSR (Kadapa) District, Andhra Pradesh"

Prepared for	New & Renewable Energy Development Corporation of Andhra Pradesh Ltd.,
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CHAPTER-1: EXECUTIVE SUMMARY

CHAPTER-1

1. EXECUTIVE SUMMARY

1.1 Introduction

India is a fast-growing economy experiencing rapid industrialization, irrigation development, urbanization, improved village infrastructure etc. The demand for power which is one of the basic inputs for the economic growth of a country is therefore, on the rise in India. The chief sources of energy which are utilized for generation of electricity are: Fuel in all forms i.e. solid, liquid and gaseous, water energy and nuclear energy. The other sources of energy are sun (solar photo-voltaic etc.), wind and tides.

Hydro-power is a renewable, economical, non-polluting and environmentally benign source of energy. Hydropower stations have inherent ability for instantaneous starting and stopping, to help in improving reliability of power system and to meet the peak demand. Hydroelectric projects have long useful life and help in conserving scarce fossil fuels.

Pumped Storage Project is a type of hydroelectric generation plant that stores energy in the form of water, pumped from a lower elevation reservoir to upper elevation reservoir during off-peak period and generates electricity during peak period. This is currently one of the most effective means of storing large amount of electric energy. It helps in grid stability, reliable supply and providing quality power (in terms of voltage and frequency). In any typical PSP the water from Upper Reservoir passes through the waterways to the turbines installed at the power house to generate power during peak hours. The tail water is diverted through the tunnel to store water in the lower reservoir. The excess water from upper/lower reservoir (if any) gets discharged through spill way. During off peak hours the excess power from thermal stations and other sources will be fed back to pump the water from Lower Reservoir to Upper Reservoir through power house where generators and turbines then acts as motors and pumps respectively. The same cycle of operation gets repeated during peak and lean period.

As per review of forecast of all India and state wise electrical energy consumption (MU) and CAGR of Actual and Forecast, peak electricity demand in Southern Region will increase to 83652 MW in 2026-27 from 44782 MW in 2016-17. Accordingly, in Andhra Pradesh peak electricity demand in 2026-27 will be 16820 MW against 8245 MW in 2016-17. Increase of generation of NREDCAP is needed to cope up with the forecast of demand as stated above. Installation of Pumped Storage Project is suitable according to the present trend of world power scenario to meet up therefore peak demand as well as to avoid use of fossil fuel and to avail the opportunity of god gifted geological condition.

In the view of above, a proposal for installation of **1000 MW Gandikota Pumped Storage Project** is very much essential to fulfill peak power demand and justified in consideration with the requirement of excess 38870 MW peak electricity demand at Southern Zone in 2026-27 in comparison to 2016-17. Gandikota Pumped Storage Project is expected to generate 1000 MW of power for 5 hrs 23 minutes in a day considering 95% of plant availability in a year. Gandikota PSP can generate 1964.92 MU of energy in a year from the said project. Pumping time is required about 7 hours 03 minutes in a day.

In light of installation of the Gandikota PSP, work for preparation Detailed Project Report has been awarded to WAPCOS vide order no. NREDCA/WE/PSP/2020 Dt. 02.11.2020. The Feasibility Report has been prepared as a part of the assignment.

1.2 Project Background

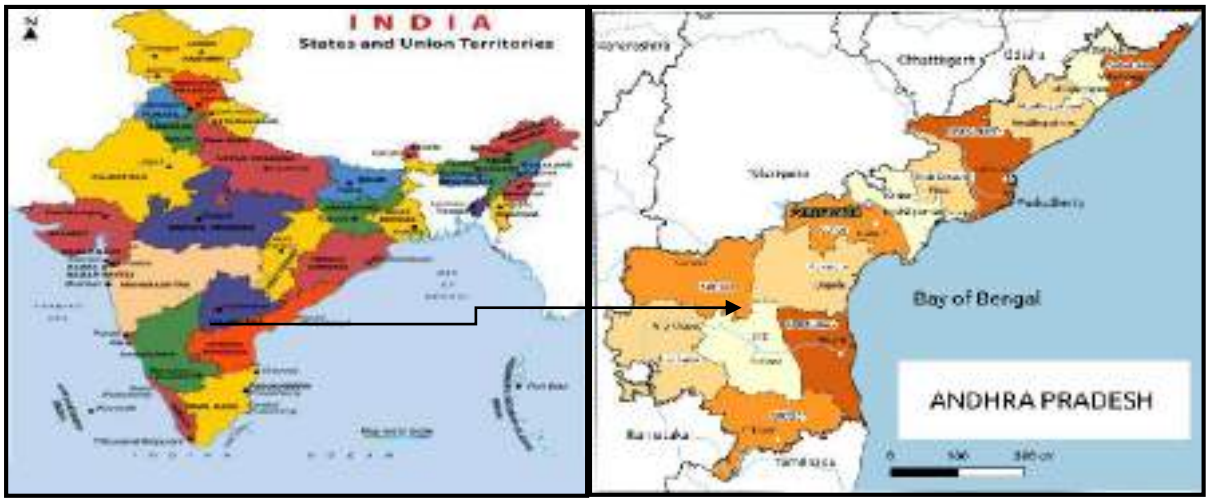
The proposed Gandikota Pumped Storage project envisages utilization of available head between newly constructed upper dam and existing Gandikota reservoir as lower pond. An Underground Power House (UGPH) will be located in between two reservoirs. Both the reservoirs are interconnected through water conductor and the generator and turbines installed at the power house in between the reservoirs.

Pre- feasibility report will help for preparation of Detailed project report of Gandikota Pumped Storage schemes in Andhra Pradesh to strengthen the power position and flexibility to control the frequency of the power grid and power requirement of the state

and utilisation of generated power during peak hours of power demand and utilisation of excess power during lean hours for pumping of water to upper reservoir.

Since the Upper and Lower Reservoirs have effective storage capacity for maximum hours of generation daily at full rated output, it is possible to operate the project on daily basis.

In Techno-Commercial Feasibility Report which was prepared in December 2019, the project was conceptualized as 600MW, however considering the latest Hydrological as well Topographical survey data the Project has merits to have higher Installed capacity than 600 MW. Present Feasibility Report is for 1000 MW PSP project.



Source: - Google Earth

Fig. - 1 : Location Map

1.3 Project Location

The proposed Gandikota Pumped Storage Project is located in Kondapuram village of Kadapa district of Andhra Pradesh, India **(Figure 1: Location Map)** and belongs to Rayalaseema region. The project falls in the Lat. N 14° 48' 38" and Long. E 78° 15' 30". It is located 80 KM towards west from District headquarters Kadapa. The Upper reservoir at present is not accessible but the Lower is accessible to nearest road network which is at about 5 km from NH-67. Upper dam falls in forest area and there is no habitation. Lower dam is utilized for Irrigation, Drinking water and fisheries purpose. The Index Map of the Project has been presented at **Annexure-1.1.**

1.4 Access to The Project

The Project is located in Kondeyor in Kadapa district in the state of Andhra Pradesh in India. The nearest rail head is Yerraguntala which is about 70 km from Yeddula Eswar Reddy (Gandikota) Reservoir and with loading & unloading facility. The nearest airport is Kadapa which is 100 km (approx.) from project site The nearest sea port is Krishnapatnam Port & is about 230 km from the project site.

1.5 Scope of Work

The project is envisaged to be Pumped Storage Scheme consisting of two reservoirs: one at lower elevation and other at upper elevation, to provide the effective "head" for power generation. The water conductor system will connect the two reservoirs through an underground power house.

The scope of work envisages preliminary studies for:

- Collection of hydrological/meteorological data and assessment of water availability for the project.
- Use of existing Gandikota reservoir of capacity **760.30 Mcm** created by an earthen dam across river Penna to serve as Lower reservoir which has a live storage capacity of **669.38** Mcm.
- Location of Upper dam to provide maximum live storage within Full Reservoir Level (FRL) and Minimum Draw down Level (MDDL).

- Selection of an underground power house with numbers of pump-turbines of different capacity each along with an auxiliary system. Working out the tentative orientation of the powerhouse on preliminary geotechnical, engineering and hydraulic aspects.
- An underground Transformer Cavern with number of Power Transformers for each machine.
- Secondary Gas Insulated or open Switchyard to be arranged in the Cavern or open yard for the Transformers. These Transformers will be connected by bus duct galleries to machine hall.
- Preliminary geological, geotechnical and engineering appraisal of Head Race Tunnel (Concrete Lined) cum pressure shaft (steel lined) and Tail Race Tunnel for conveyance of water.
- Power potential studies on the line of present power scenario and future demands.
- Tentative projection of cost and benefits of the project.

1.6 Topography & General Climate

The proposed Project is located near village Neknampeta in Kadapa district in the state of Andhra Pradesh in India and belongs to Rayalaseema region. The area has a tropical wet and dry climate characterized by year round high temperatures. It has a record of reaching more than 50 degree Celsius. Summers are especially uncomfortable with hot and humid climate. During this time temperatures range from a minimum of 34 °C and can rise up to a maximum of 40 °C. Humidity is around 75% during the summer months. Monsoon season brings substantial rain to the area. It gets rainfall from both the South west monsoon as well as the North East Monsoon. June to October is usually the monsoon. Winters are comparatively milder and the temperatures are lower after the onset of the monsoons. During this time the temperatures range from a maximum of 25 °C and can rise up to a maximum of 35 °C. Humidity is much lower during the winter season. The average annual rainfall of the district Kadapa is 710 mm, which ranges from nil rainfall in January to 137 mm in October.

1.7 Geology

The district is mainly drained by the Penner River and its major tributaries like Cheyyeru and Kunderu and Sagileru. The southern granitic terrain is drained by Mandvi River, a tributary of Cheyyeru River. The drainage is parallel to sub-parallel in nature and controlled by structure. Numerous straight courses reflect that they are flowing along synclinal axis, litho-contact zones, faults/ major discontinuity zones etc.

The southern part is mainly comprises pediplain- pediment complex with residual hills of granite gneiss and structural ridges represented by dykes traversing ENE-WSW and NNW-SSE directions. There is an alternate sequence (Hogbacks) made up mostly by highly resistant quartzite and low lying structural valleys made by shale and dolomitic limestone. At places, quartzites occur as plateaus owing to high resistance to weathering and low dip.

In the eastern segment belongs to the Nallamlai hill ranges where steeply dipping structural ridges formed by quartzites with inter-ridge low area known as “structural valleys’ where less resistant Cumbum Shales and Phyllites are present.

The oldest rocks in the area belongs to mainly late Archaean or late Proterozoic age which are succeeded by rock of Dharwarian age and both are traversed by dolerite dykes as intrusive. The major part of the Cuddapah District is occupied by Cuddapah basin, which is a huge depression formed over the denuded surfaces of older rocks extending into neighbouring districts. The Archaean comprises the Peninsular Gneissic Complex represented by granite, granite gneiss, granodiorite and migmatite. The Cuddapah Supergroup of rocks comprising of Papaghni, Chitravati and Nallamalai groups occur to the east and north of the Archaeans and Dharwars and occupy the major portion of the district. Mainly meta-sedimentary rocks comprising of quartzite, conglomerate, shale, tuff, chert, limestone, slate with phyllite are the major types of rocks also found in the area.

A series of NW-SE, NE-SW & E-W trending lineaments (shear, fault) are also present in the area as reflected in the District Resource Map of GSI.

1.8 Seismicity of the Area

As per Seismic Zonation Map of India (IS 1893 – 1984) the district Kadapa falls in Zone II (least active seismic zone) and Zone III (moderate seismic zone). 91% of the total area and 95% of the total population of the district falls in Zone II; while 9% of the total area and 5% of the total population falls in Zone III.

The project area falls under seismic zone-II.

1.9 Installed Capacity and Power Generation

The factors that influence the installed capacity of pumped storage scheme at a site are the requirement of daily peaking hours of operation, operating head, live pondage in the reservoirs and their area capacity characteristics. Based on the study on above parameters the key details of the scheme are summarized below:

Installed Capacity (MW)	1000
No of units	4
Unit Size (MW)	250
Head (min) (m)	250.03
Net Rated Head (m)	258.41
Head (max) (m)	266.80
Hours of Peaking Operation	5 Hours 23 minutes (5.38 Hours)
Annual Energy Generation (GWh)	1964.92
Annual Pumping Energy (GWh)	2444.59
Cycle Efficiency	76.36 %

1.10 Land Requirement

The total land to be acquired for the project is approximately 190 Ha. Based on the site visit, most of the land required lies in forest area. The clearance and acquisition of land will be as per the land guidelines. Suitable site will be selected for much disposal at DPR stage. The various components of the land required is shown in Table below:

S. No.	Appurtenance	Area (Ha.)
1.	Project Component	130
2.	Roads	20
3.	Muck Disposal/ Quarry Site	30
4.	Contractor's facility	10
	Total	**190**

1.11 Power Evacuation Arrangement

The power generated from the project at different voltages will be stepped up to HV with the help of a Transformer in relation with HV substation where the generated power will be evacuated through transmission line. This power from the Transformer will be transmitted to the GIS / Switch yard and then will be evacuated from Pothead yard to the nearest substation of RTPP 400 kV Substation according to the technical and economical suitability.

1.12 Estimates of the Cost

The estimated project cost is ₹ 3698.02 Crores at January, 2021 price levels. The preliminary cost estimate of the project has been prepared as per guidelines of CEA / CWC. The Abstract Summary of the cost estimates is given below:

Item	Estimated Cost (₹ Crores) (January. 2021)
Civil Works	₹ 1878.02
Electro-mechanical Works	₹ 1820.00
Total	**₹ 3698.02**

1.13 Financial Aspects

The estimated cost of the project is ₹ 3698.02 Crores at January, 2021 price levels and annual energy generation of 1964.92 GWh per year is proposed to be completed in a period 5 years.

The tariff has been worked out considering a debt-equity ratio of 70:30, and interest rate of 10.0 % on the loan component for the financial analysis of the project.

Based upon the parameters given above, the first year and levellised tariff is indicated below. The off peak energy rate has been considered as **(**₹1.00, 2.00, 2.50, 3.00 **/kWh)**

Table 1:1

Sl. No.	Off Peak Energy Rate (₹/kWh)	First Tariff (₹/kWh)	40 Year Levelized Tariff (₹/kWh)	Conversion cost of the project (excluding pumping cost) (₹/kWh)
1	3.00	9.15	8.49	4.47
2	2.50	8.48	7.82	4.47
3	2.00	7.81	7.15	4.47
4	1.00	6.47	5.81	4.47

1.14 Conclusion & Recommendation

Present report is prepared based on the limited available data which was collected and subsequently analysis and studies were carried out by WAPCOS. This report indicates that this PSP scheme has merits from technical and financial considerations.

1.15 Salient Features

1. LOCATION	
Country	India
State	Andhra Pradesh

District	Kadapa
River	Pennar River
Upper Reservoir	Lat. N- 14° 49' 47.28" , Long. E- 78° 13' 53.23"
Gandikota Reservoir (Lower Reservoir)	Lat. N- 14° 48' 28.54" , Long. E- 78° 15' 5.41"
Access to the Project	
Road	26 Km from National Highway 67
Airport	Kadapa : 100 km
Railhead (with unloading facilities)	Yerraguntala : 70 km
Port	Krishnapatnam : 230 km
2. PROJECT	
Type	Pumped Storage Project
Installed Capacity	4 X 250 MW
Peak Operating duration	5.38 hours daily (5 hours 23 Minutes)
3. HYDROLOGY	
Catchment Area	
Upper Dam	0 sq. km (Not on any Nallah/ Stream)
Lower Dam	19197 sq. km (Gross) 6808 sq km (Net)
Average Annual Rainfall	710 mm
Maximum Design Flood (PMF)	
Lower Reservoir	8180 cumec
4.0 CIVIL STRUCTURE	
4.1 UPPER RESERVOIR (New) (Composite Pit & Bund type)	
FRL	EL 481 M
MDDL	EL 464 M
Reservoir surface area at FRL	54.50 Ha. (46.51 Ha. At MDDL)

Gross Storage capacity	9.514 MCM
Live storage	8.592 MCM (0.303 TMC)
Dead Storage at 464 m	0.922 MCM
4.2 LOWER RESERVOIR (Existing)	
FRL	EL 212 M
MDDL	EL 202.9 M
Reservoir surface area at FRL	10773.89 Ha. (2814.56 Ha. At MDDL)
Gross Storage capacity	760.30 MCM (26.850 TMC)
Live storage	669.38 MCM (23.639 TMC)
Dead Storage at 202.9 m	90.93 MCM (3.211 TMC)
4.3 UPPER DAM	
Type	**Composite Pit and Rockfill Bund**
Top of Dam	EL 482.00 M
River Bed Elevation	EL 462.0 M
Total Length of Dam at top	2930 m
Max. Height of Dam	20 m (from bed level)
Top width of dam	8 m
4.4 LOWER DAM	
Type	Concrete
Top of Dam	EL 215.00. M
River Bed Elevation	EL 192.0 M
Total Length of Dam at top.	320 m
Max. Height of Dam	25.2 m
Top width of dam	5 m
4.5 LOWER DAM SPILLWAY ARRANGEMENT	
Type	Overflow Ogee type Gateless free flow
Crest Elevation	EL 203.35 M
MWL	EL 212.00 M
Design Flood	8180 cumec
No. of Bays	14

4.6 Intake Structure	
Type	Horizontal Type with anti-vortex lubbers
Inlet Invert Level	EL 441.04
4.7 Headrace Tunnel (Concrete Lined)	
Diameter	8.90 m
Length	532 m
No. of Tunnel	2
4.8 Pressure Shaft	
Diameter	7.00 m
Length	383 m
No. of Tunnel	2
4.9 Penstock (Steel Lining)	
D x L x line	-
After Bifurcation	4.95m x 92m x 4lines
4.10 Tailrace Tunnel (Concrete Lined)	
After bifurcation tunnel from draft tube (D x L x line) (Steel Lined)	5.50m x 75m x 4 lines
Diameter	8.90 m
Length	755 m
No. of Tunnel	2
4.11 Outlet Structure	
Type	Horizontal Type with anti-vortex lubbers
Invert level	EL 179.94
4.12 Powerhouse	
Type	Underground Cavern
Size	160.00 m (L) x 24 m (W) x 55 m (H)
4.13 Transformer Room including Secondary GIS	
Type	Underground Cavern including Secondary GIS
L x W x H	137.00 m (L) x 18.00 m (W) x 22.50 m (H)

4.14 Main Access Tunnel (MAT)	
Type W X H	D- shaped, Length – 746 m 8.00 m (W) x 8.00 m (H)
5.0 Electromechanical Equipment	
5.1 Pump Turbine	
Type	Vertical Shaft reversible Francis Turbine
Number of unit	4 (Four) Units
Turbine center Line	El. 160.50 m
Max. Head as Turbine	266.80 m
Rated Turbine Head	258.41 m
Min. Head as Turbine	250.03 m
Turbine Output at Rated Head	250.37 MW
Turbine Output at 10% overhead operation	275.41 MW
Max. Head as Pump	277.34 m
Rated Pump Head	268.80 m
Min. Head as Pump	260.26 m
Max. discharge of Turbine at rated Turbine head	110.75 Cumec
Pump input at Rated Head	285 MW
Min. discharge at Max. Pump head	98.45 Cumec
Max. discharge at Min. Pump head	104.94.00 Cumec
Max. discharge of Pump at rated head	101.59 Cumec
Synchronous Speed	250 rpm
5.2 Generator-Motor	
Type	3 phase AC Synchronous Generator – Motor, Semi Umbrella Type
Number of unit	4 Units
Rated Capacity	Generator : 250 MW Motor : 300 MVA
Rated Voltage	18.0 kV ±10%
Rated Frequency	50 cycles per second
Rated Speed	250 rpm

Over Load Capacity	306 MVA
5.3 Main Transformer	
Type	Indoor type, oil-immersed, single phase bank or special three phase, forced oil forced water (OFWF) cooled, with on-load tap-changer (OLTC).
Numbers	12 + 1 (Single phase Spare)
Rated Capacity	330 MVA
Rated Voltage	Primary; 18.0 kV Secondary; 400 kV adjustable range of the secondary voltage: - 5% to +5%
Connection	Primary: Delta Secondary: Star
Neutral Grounding System for Secondary Winding	Solidly Grounded
5.4 Generator-Motor Circuit Breaker	
Type	Indoor, Metal-enclosed, SF6 and single pressure type
Number of Unit	Four (4) units
Rated Voltage	18.0 kV
Rated Normal Current	12,000 A
Phase Reversal Equipment	Three Phase, 24kV, 12000 A
5.5 Gas Insulated Switchgear	
5.5.1 Circuit Breaker	
Type	400 kV Gas Insulated Switchgear (GIS)
Number of Feeder	Four (4) feeders
Rated Voltage	400 kV
Rated Normal Current	2,500 A
Rated Short Time (1sec) withstand Current	50 kA
5.6 400 kV XLPE Cable	
Type	Single Core 400 kV Cross linked polyethylene insulated (XLPE) type
Rated Voltage	400 kV
Number of Circuits	12 nos. + 1 spare single phase

5.7 Pump Starting Method	
Type	1 no. Static Frequency Converter Starting(SFC) & also Back to back starting (BTB)
Capacity of Starting Transformer	1 no.18.0/19.2 kV and 19.2/18.0 kV, 30.00 MVA
5.8 Diesel Engine Generator	
Number of Unit	Two (2) units
Rated Capacity	2 x 1000 kVA ,11 kV
5.9 EOT Crane	
Type	Indoor, Electric Overhead Traveling Crane
Number of Unit	Two (2) units
Rated Capacity	250 ton (Main hoist), 80 ton and 10 ton
Span	22.00 m
5.10 Transmission Line	
Type	Double Circuit Double Moose Conductor
Capacity Voltage Level	400 kV
Length	Nearest 400 kV Substations - (as per available bay and capacity of the substations.)
5.11 Land Details (Ha.)	
Project Component	130
Roads	20
Muck Disposal/ Quarry Site	30
Contractor's facility	10
Total	**190 Ha.**
5.11 Project Cost (Price Level January, 2021)	
Item	**Estimated Cost (₹. Crores)**
Civil Works	₹ 1878.02
Electro-mechanical Works	₹ 1820.00
IDC	₹ 760.09
Total	₹ 4458.12

5.12 Project Benefit's

Sl. No.	Off Peak Energy Rate (₹/kWh)	First Tariff (₹/kWh)	40 Year Levelized Tariff (₹/kWh)	Conversion cost of the project (excluding pumping cost) (₹/kWh)
1	3.00	9.15	8.49	4.47
2	2.50	8.48	7.82	4.47
3	2.00	7.81	7.15	4.47
4	1.00	6.47	5.81	4.47

Annexure-1.1

ANDHRA PRADESH
DISTRICT MAP

MAHARASHTRA
CHHATTISGARH
ODISHA
TELANGANA
KARNATAKA
SRIKAKULAM
VIZIANAGARAM
Srikakulam
Vizianagaram
VISAKHAPATNAM
Visakhapatnam
EAST GODAVARI
WEST GODAVARI
Kakinada
Eluru
Yanam (Puducherry)
Amaravati
KRISHNA
GUNTUR
Guntur
Machilipatnam
Kurnool
KURNOOL
PRAKASAM
Ongole
ANANTAPURAMU
Anantapur
Cuddapah
Y.S.R.
SRI POTTI SRIRAMULU NELLORE
Nellore
CHITTOOR
Chittoor
KARNATAKA
TAMIL NADU
Bay of Bengal
N
GANDIKOTA PUMPED STORAGE PROJECT (1000MW)

LEGEND
- State/UT Boundary
- District Boundary
- State Capital
- District Headquarter

Map not to Scale

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NEW & RENEWABLE ENERGY DEVELOPMENT CORPORATION OF ANDHRA PRADESH	
CONSULTANTS WAPCOS LIMITED (A GOVERNMENT OF INDIA UNDERTAKING) MINISTRY OF JAL SHAKTI	
GANDIKOTA PUMPED STORAGE PROJECT (1000 MW)	
INDEX PLAN	
	DRAWN R. K. CHAUHAN / CHKD. VINAY SHANKAR
	REV. NO. / APPRD. RAJEEV SINGH
DATE: JUNE-2021	DRG.NO.-WAP/D&RE/GANDIKOTA/PFR-1

CHAPTER-2:

ECONOMIC SCENE OF ANDHRA PRADESH

CHAPTER- 2

2. ECONOMIC SCENE OF ANDHRA PRADESH

2.1 Introduction

Andhra Pradesh has been one of the progressive States of India. It is located in the Southern peninsula of India. The state is bound by Chhattisgarh on the north, Odisha on the northeast, Telangana and Karnataka on the west, Tamil Nadu on the south, and the Bay of Bengal on the east. The erstwhile state of Andhra Pradesh has been bifurcated into two states, Telangana and residuary Andhra Pradesh (Seemandhra), by the Andhra Pradesh Reorganisation Act, 2014 also known as the Telangana Act. The state of Andhra Pradesh is made up of the two major regions of Rayalaseema, in the inland southwestern part of the state, and Coastal Andhra to the east and northeast, bordering the Bay of Bengal. The state comprises thirteen districts in total, nine of which are located in Coastal Andhra and four in Rayalaseema.

The Andhra Pradesh has been blessed with rich natural resources by the nature. Amongst all States, Andhra Pradesh tops in various socio-economic indicators. The state has well-developed social, physical and industrial infrastructure and virtual connectivity. It also has good power, airport, IT and port infrastructure. The economy of Andhra Pradesh is one of the fastest growing economies in India, with growth outstripping that of the wider Indian economy in the past few years.

The GSDP (Gross State Domestic Product) of Andhra Pradesh at constant (2011-12) Prices for the year 2018-19 (Advance Estimates) indicate a growth of 11.61% as against for 2015-16 (First Revised Estimates). Per Capita Income at current prices increased to ₹122,376 from ₹108,163 in 2015-16 registering a growth of 13.14%. The economy is primarily dependent on agriculture, which directly and indirectly employs 62% of the population.

With a geographical area of 1, 62,970 Sq Km, Andhra Pradesh ranks as the 8th largest State in the country. Situated in a tropical region, the state has the 2nd longest coastline in the country with a length of 974 Km. As per the forest records, the state ranks 9th in

India having forest cover area of 37707 Sq. Kms which amounts to 23.54% of the total geographical area. In terms of population, Andhra Pradesh is the tenth largest state in the Country accounting for 4.10% of the total population of the country, as per 2011 Census. The density of population for Andhra Pradesh is 304 persons per square kilometer, as against 382 persons per square kilometer at all India level in 2011. The literacy rate of the earstwhile state is 67.7 percent in 2011 as compared to 62.07 percent in 2001. The literacy rate of the State is lower than the all India literacy rate of 74.04 percent.

Most of the soils are made up of a combination of sand, silt, and clay. The formation of soil is primarily influenced by major factors such as climate, altitude and composition of bedrock etc. The land utilization classification reveals that 37.08% of the state geographical areas is under net area sown (60.43 lakh hectares), 22.63 % under forest (36.88 lakh hectares), 8.91% under current fallow lands (14.51 lakh hectares), 12.63% under land put non-agricultural uses (20.58 lakh hectares), 8.25 % under barren and uncultivable land (13.45 lakh hectares) and remaining 7.03% is under other fallow land.

Andhra Pradesh has huge oil & natural gas reserves. The state's Krishna-Godavari basin, spread over an area of nearly 52,000 sq km, has a total hydrocarbon resource base of 1,130 million metric tonnes.

2.2 Economic Parameters

2.2.1 GSDP/NSDP

Andhra Pradesh's Gross State Domestic Product (GSDP) for the year 2018-19 (Advance Estimates) at current prices has been estimated as Rs.933402 Crores as against Rs.809548 crores for 2017-18 (First Revised Estimates). The sectorial growth rates of GVA of Andhra Pradesh for 2018-19 at constant (2011-12) prices are Agriculture: 10.78%, Industry: 10.24% and Services sector: 11.09%. The Per Capita Income (NSDP) of Andhra Pradesh at current prices has registered a growth of 13.96 percent as it increased from Rs.1,43,935 in 2017-18 (FRE) to Rs.1,64,025 in 2018-19, as compared to the Per Capita Income of All India which has increased from Rs. 1,14,958 in 2017-18 to Rs. 1,26,699 (AE) in 2018-19.

2.2.2 Foreign Direct Investment (FDI) inflow & Investments

Andhra Pradesh has been one of the foremost states to have developed sector-specific policies. Forming industrial clusters and developing infrastructure, such as biotech parks, textile parks and hardware parks, has been the state's key strategy to attract investments in various industries. According to the Department for Promotion of Industry and Internal Trade (DPIIT), FDI inflows in Andhra Pradesh between April 2000 and March 2019 reached US$ 18.46 billion.

Natural resources, policy incentives and infrastructure in the state are favorably suited for investments in major sectors such as drugs and pharmaceuticals, biotechnology, IT and ITeS, mines and minerals, textiles, leather and tourism. Attracting investments in the IT sector is in focus.

A new industrial policy is geared at attracting foreign direct investments in India through manufacturing. It is hoped that the annual growth rate for the MSME sector attains a 12 to 15% sustainable growth. Foreign Direct investments in India topped US$1.74 billion by end of last year. A majority of this came from Andhra Pradesh and its vibrant economy. On the other hand, the services sector in Andhra Pradesh is estimated to have attracted Foreign Direct Investments in India of up to US$3.54 billion. The services sector in this region comprises of the financial and non-financial services. The telecommunications sector too, performs relatively well.

2.3 Agriculture

Andhra Pradesh is predominantly an Agricultural economy as agriculture is the most vital and sensitive sector of the state as agriculture is the main source of livelihood for nearly 60 percent of the population. Agriculture has been the chief source of income and main occupation for the state with 60% of population engaged in agriculture and related activities. Rice is the major food crop and staple food of the state. Other important crops are sugarcane, cotton, mango, tobacco, Maize, pulses etc. Four important rivers of India, the Godavari, Krishna, Penna, and Tungabhadra flow through the state, providing irrigation. Recently, crops used for vegetable oil production such as sunflower and peanuts have gained favour. Andhra Pradesh was among the very few

states in the country which went in for the Green Revolution in rice cultivation in the 1970s.

The area under food grains is estimated to be 40.26 lakh hectares in 2018-19 as against 42.06 lakh hectares in 2017-18, showing a decrease of 4.27%. The total production of food grains in 2018-19 is estimated at 151.12 lakh tonnes while it was 167.22 lakh tonnes in 2017-18 showing a decrease of 9.63%. The cropping intensity for the year 2018-19 has marginally declined to 1.24 from 1.26 of the last year. The number of holdings has been increasing - from 76.21 lakh holdings in 2010-11 to 85.24 lakh in 2015-16. This huge rise in the number of holdings coupled with a decline in the area operated has contributed to a fall in the average size of the holding from 1.06 hectares in 2010-11 to 0.94 hectares in 2015-16. The “YSR RythuBharosa” Scheme to be implemented in the state from October 15th, 2019 will help the farming community in a big way. In a landmark decision, the state government has decided to facilitate “Crop Insurance Premium payment by the government itself instead of farmers for the entire notified area”.

2.4 Horticulture

Andhra Pradesh has changed their cropping pattern at a rapid rate and the horticulture sector is growing at a faster pace than agriculture, making Andhra Pradesh a major horticulture hub. The returns from Horticulture per unit of land are higher as compared to Agriculture. Horticulture, as a climate resilient alternative involving less risk, assures higher income to farmers. In the context of global warming & climate change and increasing per capita income of middle class, this sector has more potential as food habits are changing and people are becoming more health conscious. The government is planning to expand the area under horticulture crops considerably. Incentives like extending 90% Subsidy on micro irrigation drip and sprinkle have dramatically improved the horticulture production significantly. In the state area under Horticulture crops is 17.62 Lakh Hectares with a production of 327.57 Lakh MTs. Andhra Pradesh stands at 1st position in productivity for Chillies, Cocoa, Lime, Oil Palm, Papaya and Tomato, 2nd in Cashew, Mango, Turmeric and Sweet Orange in India. An area of 1,25,317 Ha. was brought under perennial, non-perennial fruit and plantation crops. Micro-Irrigation

implemented in about 2 lakh ha. during 2018-19, showed an increase of 8% achieved over previous year. Andhra Pradesh is the Second largest producer of silk in India. The total area under Mulberry in the State stands at 1,04,790 acres.

2.5 Irrigation

Irrigation development plays an important role in the agricultural production as rainfall is inadequate, uncertain and uneven in the state of Andhra Pradesh. The cropping pattern and the agricultural productivity in the state are greatly guided by irrigation. Irrigation Development not only correlates to Agriculture but also to other Socio-Economic aspects like industry, navigation, hydropower, pisiculture, water supply etc. The State is broadly divided into two agro-climatic zones. The Rayalseema zone, which is semi-arid and drought prone receives about 700 mm rainfall. The net sown area is only 38 per cent in this zone and the irrigation infrastructure is poor. The Coastal zone has more than 1000 mm rainfall and the climate is sub-humid. The soil salinity and floods are the limiting factors. The State has many rivers and lakes and there are 40 major, medium and minor rivers in the state of which 15 are interstate rivers. The State has prioritized in creation of Irrigation Potential. So far, 105.36 lakh acres of irrigation potential has been created up to March 2019 under major anicuts on Krishna, Godavari and Pennar rivers through projects like Nagarjuna Sagar, Telugu Ganga, Somasila, SRBC, Vamsadhara, Medium Irrigation projects and Minor Irrigation schemes.

2.6 Forest Resources

Andhra Pradesh state with its diversified topography ranging from the hills of Eastern Ghats and Nallamallas to the shores of Bay of Bengal supports varied ecotypes, which in turn support a rich diversity of flora & fauna. As per the forest records, the state ranks 9th in India having forest cover area of 37707 Sq. Kms which amounts to 23.54% of this forest area, the Very Dense Forest is 1957 Sq. Kms the Moderate Dense Forest is 14051 Sq. Kms, Open Forest is 12139 Sq. Kms Scrub Forest is 9560 Sq. Kms. Forest cover has been recognized as critical for a living environment as it influences the quality and quantity of air and water. While the tangible benefits like Timber, Bamboo, Fuel wood, Fodder, Non-Timber Forest Products etc. are quantifiable but the intangible benefits like maintenance of ecological balance, conservation of soil and moisture,

regulating the water flow, sequestering carbon-dioxide from the atmosphere etc. are not quantified but are of great significance.

2.7 Fisheries

The State of Andhra Pradesh is endowed with highly diversified and potential water resources and offering immense scope for expansion of pisciculturer sector for socioeconomic growth of the State. It is one of the most promising sector and occupies a predominant place in the socio-economic development of the state as it contributes substantially to economic growth and income generation to lakhs of people. The sector utilizes the natural resources for generating rural employment, production of protein rich food, valuable contribution to GSDP and source of foreign exchange through sea food exports. The State ranks first in brackish water shrimp production, first in fresh water prawn production, second in fresh water fish production, second in total value of fresh water fish and fourth in marine fish production. The State contributes more than 65% of cultured shrimp produced in the country.

2.8 Industry

Industrial development is one of the major components of economic development of the State. Andhra Pradesh, the tenth largest State in India in terms of population, and seventh in terms of area, is endowed with rich natural resources & mineral wealth. The state has a population of 4.96 crore (as per Population Census 2011), accounting for 4 per cent of the country's population residing in 4.9 per cent of the country's geographical area. The State has accorded top priority to industrial and infrastructure growth, and intends to position the State as the most preferred destination for investors by providing favorable business climate, excellent infrastructure, good law and order, and cordial industrial relations. The Government has introduced various investor-friendly policies for different sectors to facilitate availability of resources, provide conducive industrial environment, develop state of-the art infrastructure, foster innovation and create employment opportunities. The State has already made an impact through its investor-friendly initiative by being ranked as the 2nd best state in the country on Ease of Doing Business as per a report by the World Bank.

Forming industrial clusters and developing infrastructure, such as biotech parks, textile parks and hardware parks, has been the State's key strategy to attract investments in various industries. Natural resources, policy incentives and infrastructure in the state are favourably suited for investments in major sectors such as drugs and pharmaceuticals, biotechnology, IT and ITeS, mines and minerals, textiles, leather and tourism. As of January 2019, the state had 19 operational SEZs across diversified sectors which include textiles and apparel, food processing, footwear and leather products, multi-product, pharma, IT SEZs etc. Seemandhra, comprising Rayalaseema and coastal Andhra, has most of the power projects of undivided Andhra Pradesh. Coal-based power plants are mostly located in the state due to proximity to the ports. As of February 2019, Andhra Pradesh had a total installed power generation capacity of 23,973.90 MW.

During 2018-19, 44 Large and Mega industrial projects have been established. Similarly, during this period, 10068 Micro, Small and Medium Enterprises were established. Visakhapatnam–Chennai Industrial Corridor (VCIC), is a key part of the East Coast Economic Corridor (ECEC), designed to complement the ongoing efforts of the Government of Andhra Pradesh (GoAP) to enhance industrial growth and create high quality jobs. Chennai-Bangalore Industrial Corridor (CBIC) is one of the mega infrastructure projects of Government of India which passes through the State with the main objective of increasing the share of manufacturing sector in the GDP of the country and to create smart sustainable cities which will have world-class infrastructure, convenient public transport power management and an efficient water and waste management system.

2.9 Information Technology

The State of Andhra Pradesh is poised towards creating a benchmark in Information & Communication Technology (ICT) endowed with a high quality state-of-the-art physical & communication infrastructure of international standards, harnessed human resources, and proactive business friendly policies of the Government. The IT sector is the backbone of the economy, and will continue to provide the thrust required to generate large investments and employment while also ensuring the delivery of citizen centric

"good governance". The Government is committed for making the state as a suitable destination for IT Services, Electronic Manufacturing /Assembling. The Government is helping the growth of IT in general.

2.10 Service Sector

Service Sector Mission is one of the seven missions constituted by the Government of Andhra Pradesh. The area under Service Sector mission is creating job opportunities by promoting tourism and information technology sectors thereby giving a thrust to tourism, hotel, real estate, banking, IT Services, transport and logistics. Service Sector mission departments and sub-departments interact with other departments within the state and also with various departments of Government of India, external agencies such as Banks, other departments of state governments, private agencies and institutions for discharging various functions and delivery services. It is imperative for the economic growth of the state since every additional job in this sector contributes 3.8 times to GVA as compared to agriculture. Services sector provides an opportunity for shifting excessive and less productive work force out of the primary sector. Services has a share of 46% in State GVA.

Air transport and storage are other important growth engines that have been identified for promoting the services sector of Andhra Pradesh. Kadapa Airport has been made operational under the Regional Connectivity Scheme, and international operations are planned for commencement from Vijayawada and Tirupati airports in addition to Vishakhapatnam. Construction of Multi Modal Logistics parks (MMLP), and Cargo Terminal at the selected airports is underway, which shall promote trade (domestic/exports) and also create demand for services. Inland waterway works shall commence shortly, which shall not only provide seamless cargo movement at cheaper cost, but also create immense employment opportunities.

2.11 Power

Power sector is a critical infrastructure element required for the smooth functioning of the state economy. An efficient, resilient and financially robust power sector is essential for growth and poverty reduction. The availability of reliable, quality and affordable

power helps in the rapid Agriculture and Industrial development and the overall economy of the state. It is one of the vital infrastructural inputs for the socioeconomic development of any nation, either in the form of finite resources such as coal, oil and gas or in renewable forms such as hydroelectric, wind, solar and biomass, or its converted form of electricity.

Andhra Pradesh is the fourth largest power generating state in the country and also has the largest hydro power generation capacity in India (Andhra Pradesh is on first position for installed hydro power generation capacity). The installed capacity in the Andhra Pradesh state is 24518 MW (up to 30/11/2019). During the year 2019-20, additional generation capacity of 1,600 MW of thermal power is expected to be commissioned.

Apart from the state sector, private players have considerable presence in Andhra Pradesh. Private power plants operating in the state use transmission lines of Andhra Pradesh Transmission Company (AP Transco) that looks after the trans-mission of electricity in the state. Due to its geographical location, the power generated by all power plants is being fed to the Southern Grid, which is accessible to all states which are a part of the southern grid.

The Power scenario of the State has been explained in the subsequent chapters.

CHAPTER-3: POWER SCENARIO

CHAPTER - 3

3. POWER SCENARIO

3.1 Introduction

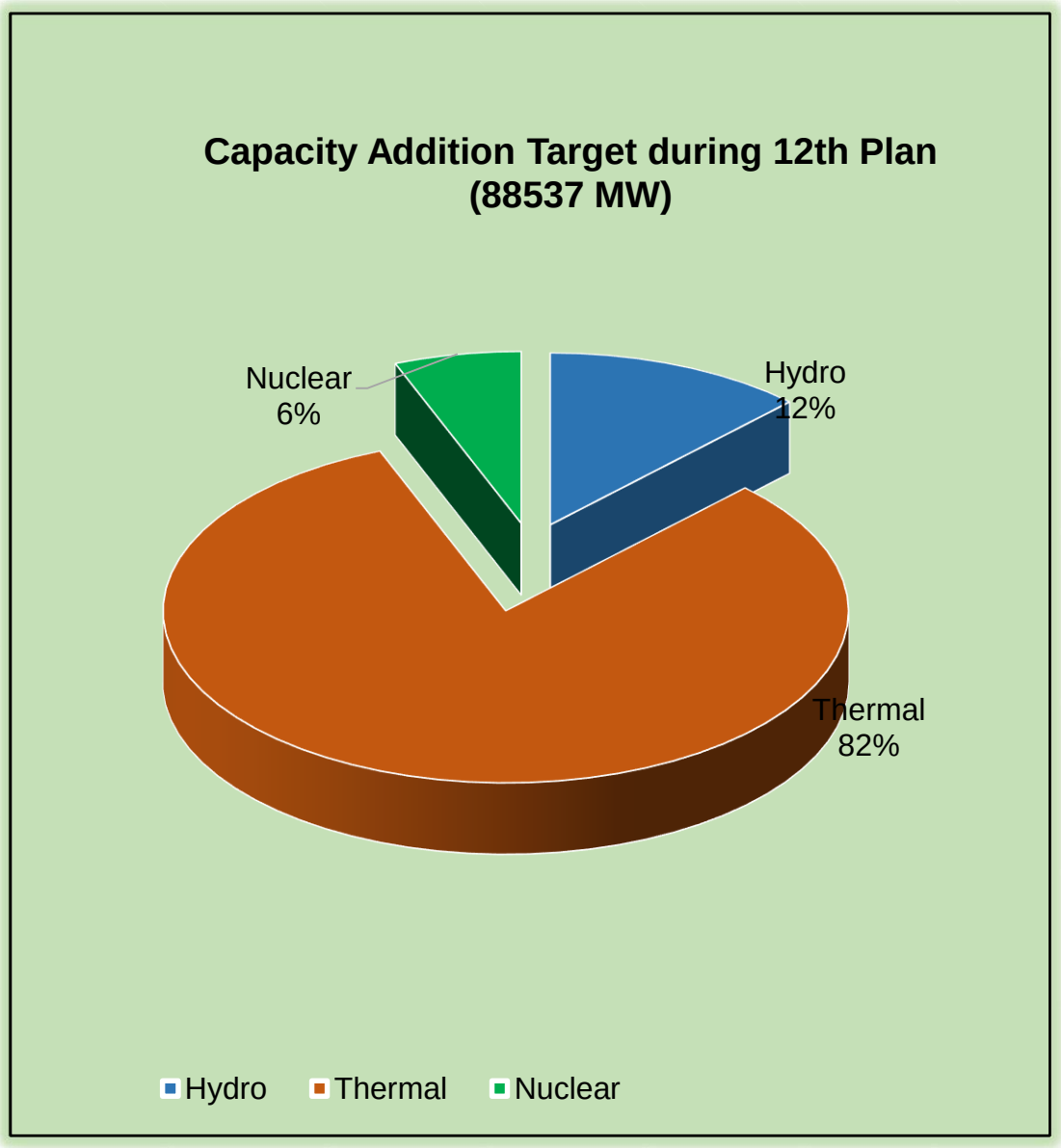
If India is to maintain high rate of growth and provide universal and sustainable access to electricity, the power sector needs to grow and reform faster in all the three constituent areas of generation, transmission and distribution. In the XI Plan there have been major slippages in capacity creation especially in the central sector. The primary impediments are uncertainty in fuel linkages, environmental clearances, land acquisition and shortage of equipment. Presently the electricity distribution network covers 98.75 per cent of the villages in India. Poor private sector participation, problems in obtaining clearances on the Right of Way and inadequate indigenous manufacturing capacities are the major bottlenecks in enhancing capacities. In the case of distribution, the large AT&C losses have discouraged private participation and prevented the state utilities from investing in the network.

8 percent GDP growth requires 6 percent growth in energy supply from all sources. Our fossil fuel sources are limited and our import dependence is already high and as such, we need to push for renewable energy i.e. Wind, Solar, and Storage hydro. As per review carried out by CEA, as on 31.03.2017 the actual capacity addition during 12th five year plan (2012-2017), from conventional sources is 99209.5 MW (Thermal – 91730.5 MW, Hydro - 5479 MW and Nuclear - 2000 MW) against target of 88537 MW. This is about 112% of the target, but 55% of total capacity addition during 12th Plan has come from private sector. There has been considerable slippage against the capacity addition target in respect of Hydro (5418 MW) and Nuclear (3300 MW) during 12th Plan period.

As on 28.02.2021 India achieved at total installed capacity 92970.48 MW from Renewable energy source. The country has revised its renewable energy capacity target to 175 GW by the year 2021-22.

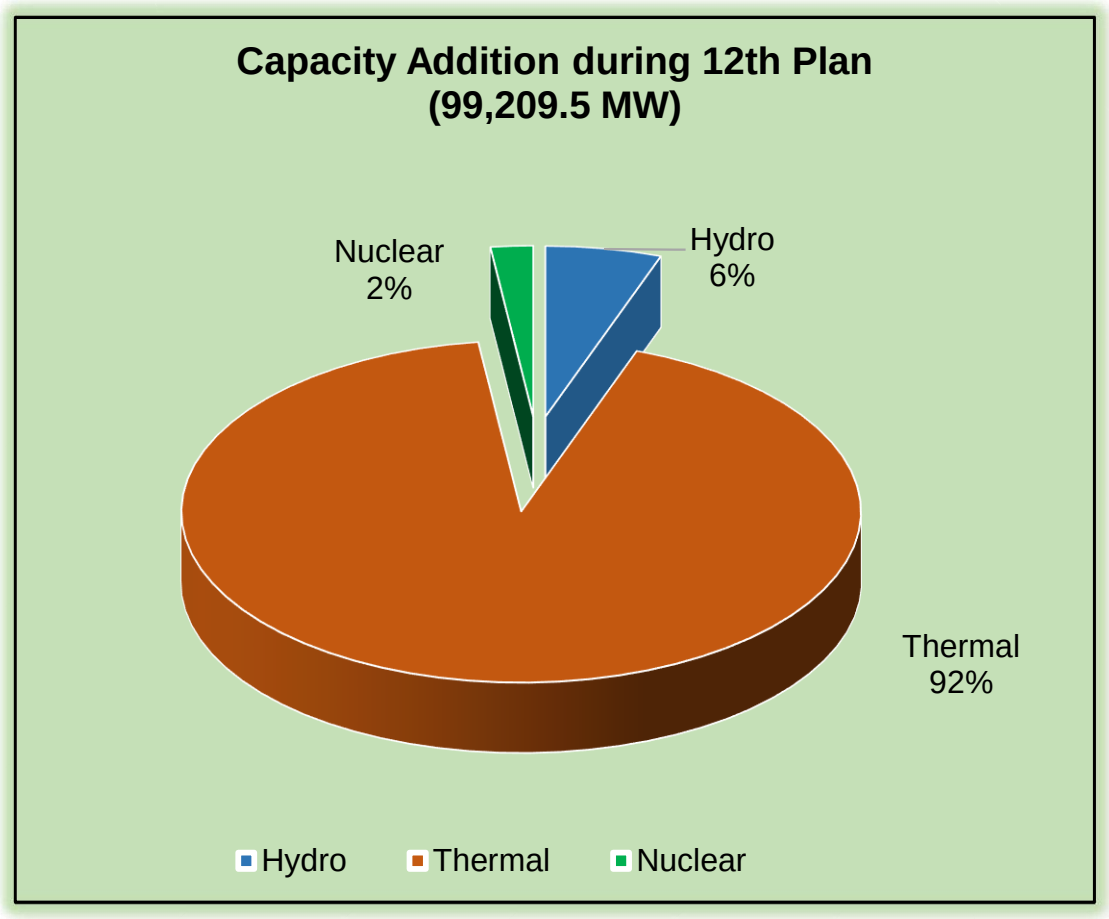
As per the 19th Electric Power Survey report, the projected peak demand is 226 GW and energy requirement is 1566 BU at the end of 2021-22 and peak demand is 299 and energy requirement is 2047 BU at the end of the year 2026-27.

Total Energy savings due to implementation of various energy saving measures during the years 2021-22 and 2026-27 are estimated to be 249 BU and 337 BU respectively.



Source: Central Electricity Authority (CEA)

Fig.3.1 - Capacity Addition target during 12th Plan (Type wise)



Source: CEA

Fig.3.2 - Capacity Addition during 12th Plan (Type wise)

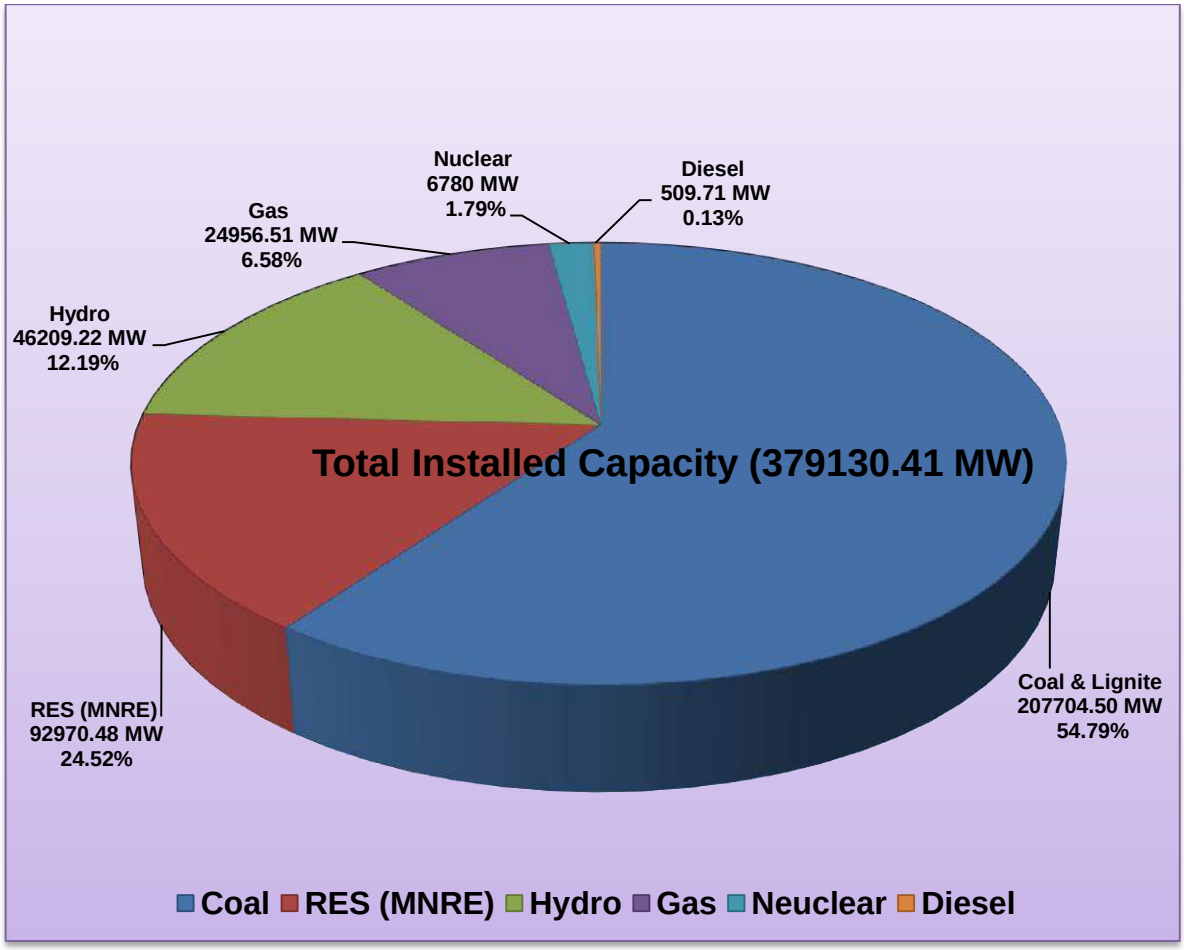
Considering the capacity addition (19th EPS. CAGR 6.18%) from Gas 406 MW, Hydro 6823 MW, Nuclear 3300 MW, RES 117756 MW and likely retirement of 22716 MW (5927 MW-old and inefficient units + 16789 MW completing 25 years by 2022 and without FGD space) of coal based capacity during 2017-22, the study result reveals that coal based capacity addition of 6445 MW is required during the period 2017-22. However, a total capacity of 47855 MW coal based power projects are currently under different stages of Construction and are likely to yield benefits during the period 2017-22. Thereby, the total capacity addition during 2017-22 is likely to be 176140 MW.

Considering the demand projections for the year 2026-27, as per the 19th EPS, coal based capacity addition of 47855 MW already under construction for benefits during 2017-22, committed capacity addition of Nuclear 6800 MW, Hydro 12000 MW, RES

100000 MW and likely retirement of 25572 MW of coal based capacity (which will be completing more than 25 years of age by 2027) during 2022-27, the study results reveal that capacity addition of 46420 MW is required during the period 2022-27. This capacity addition required during 2022-27, as shown in the results is, in fact, the peaking capacity requirement to be met in the grid. This capacity requirement can be met from any conventional source of energy but preferably from peaking power plants like Hydro, Gas or Energy Storage Devices.

3.2 Installed Generating Capacity in India

The mode wise total installed capacity in the country as on 28th February, 2021 (as per CEA) is 379130.41 MW and given below:



Source: CEA

Fig.3.3 - Total Installed Generating Capacity as on 31st November, 2019

The state-wise distribution of the total installed capacity in southern region is given in the **Table 3.1:**

Table 3:1 Region Wise All India Installed Capacity (in MW) as on 28th February, 2021

Region	Thermal					Nuclear	Hydro	RES (MNRE)	Grand Total
	Coal	Lignite	Gas	Diesel	Total				
Northern	54097.79	1580.00	5781.26	0.00	61459.05	1620.00	20288.77	18259.23	101627.05
Western	74295.12	1400.00	10806.49	0.00	86501.61	1840.00	7562.50	28630.62	124534.73
Southern	44634.52	3640.00	6491.00	433.66	55199.99	3320.00	11774.83	44094.34	114389.16
Eastern	27287.05	0.00	100.00	0.00	27387.05	0.00	4639.12	1581.90	33608.07
North Eastern	770.02	0.00	1776.96	36.00	2582.98	0.00	1944.00	369.17	4896.14
Islands	0.00	0.00	0.00	40.05	40.05	0.00	0.00	35.22	75.27
All India	**201084.50**	**6620.00**	**24956.51**	**509.71**	**233170.72**	**6780.00**	**46209.22**	**92970.48**	**379130.41**

Source: CEA

The Southern The Southern Region has an installed capacity of 114389.16 MW as on 28th February, 2021 consisting of 55199.99 MW thermal, 11774.83 MW hydro and 44094.34 MW from renewable energy sources. The hydro installation of 11774.83 MW in overall installation of 114389.16 MW in Southern Region is only 10.29% which is much below the optimum hydro thermal mix of 40:60. Thus there is an urgent need to take up more storage based hydro projects with an aim to achieve optimum hydro thermal mix in the region.

The total energy requirement in the country during 2018-19 was 1274595 Million Units (MUs) as against 1213326 MUs during the previous year, registering an increase of 5%. The total energy supplied in the country during 2018-19 was 1267526 MUs as against 1204697 MUs during the previous year, registering an increase of 5.20%.

The energy not supplied during the year 2018-19 was 7070 MUs (0.6%) against 8629 MUs (0.7%) during the previous year. The peak demand during the year 2018-19 was 177022 Mega Watt (MW) as against 164066 MW during the previous year, registering

an increase of 7.9%. The peak demand met during 2018-19 was 175528 MW as against 160752 MW during the previous year, registering an increase of 9.2%. The demand not met during the year 2018-19, decreased from 3314 MW (2.0%) to 1494 MW (0.8%) as compared to previous year. The power supply position in the Country and in the Southern Region are given in the **Table 3.2** and **Table 3.3**

Table 3:2 Power Supply Position (Energy & Peak) in the Country

Energy				
Year	Energy Requirement (MU)	Energy Supplied (MU)	Energy not Supplied	
			(MU)	(%)
2014-15	1068923	1030785	38138	3.6
2015-16	1114408	1090850	23558	2.1
2016-17	1142928	1135332	7596	0.7
2017-18	1213326	1204697	8629	0.7
2018-19	1274595	1267526	7070	0.6
Peak				
Year	Peak Demand (MW)	Peak Met (MW)	Demand not Met	
			(MW)	(%)
2014-15	148166	141160	7006	4.7
2015-16	153366	148463	4903	3.2
2016-17	159542	156934	2608	1.6
2017-18	164066	160752	3314	2.0
2018-19	177022	175528	1494	0.8

Source: Executive Summary on Power Sector October'2019, CEA

Table 3:3 Power Supply Position Report (Energy & Peak) in the Southern Region from April, 2020- February, 2021

Energy					Peak			
State/ Region	Energy Requirement (MU)	Energy Supplied (MU)	Energy not Supplied		Peak Demand (MW)	Peak Met (MW)	Demand not Met	
			(MU)	(%)			(MW)	(%)
Andhra Pradesh	55499	55496	4	0.0	10463	10457	6	0.1
Telangana	58717	58713	4	0.0	13452	13452	0	0.0
Karnataka	60922	60918	4	0.0	13432	13432	0	0.0
Kerala	22578	22561	16	0.1	4062	3914	147	3.6
Tamil Nadu	90885	90880	5	0.0	15174	15064	110	0.7
Puducherry	2387	2387	0	0.0	422	422	0	0.0
Lakshadweep	51	51	0	0.0	11	11	0	0.0
Southern Region	**290987**	**290954**	**33**	**0.1**	**54270**	**54215**	**55**	**0.1**

Source: Executive Summary on Power Sector February ’2021, CEA

3.2.1 Capacity Addition Targets and Achievements in the 12th Plan, 2017-18, 2018-19 and 2019-20

Regarding the renewable generation capacity by 2012-22, it was brought out that the RES (only wind & solar) capacity would increase from 26 GW to 160 GW (solar 100 GW and wind 60 GW) during the same period.

Table 3:4: Capacity Addition Target and Achievement for 12th Plan

Sector	Thermal	Hydro	Nuclear	Total

	Target	Ach.	Target	Ach.	Target	Ach.	Target	Ach.
Central	14878	15869	6004	2584	5300	2000	26182	20453
State	13922	22201	1608	2276	0	0	15530	24477
Private	43540	53661	3285	619	0	0	46825	54280
All India	**72340**	**91730**	**10897**	**5479**	**5300**	**2000**	**88537**	**99209**

(Figures in MW) Source: Executive Summary Report February'2021, CEA

Table 3:5: Capacity Addition Target and Achievement for 2017-18

Sector	**Thermal**		**Hydro**		**Nuclear**		**Total**	
	Target	**Ach.**	**Target**	**Ach.**	**Target**	**Ach.**	**Target**	**Ach.**
Central	4880	3170	800	390	500	0	6180	3560
State	3546	1760	300	200	0	0	3846	1960
Private	2940	3780	205	205	0	0	3145	3985
All India	**11366**	**8710**	**1305**	**795**	**500**	**0**	**13171**	**9505**

(Figures in MW) Source: Executive Summary Report February'2021, CEA

Table 3:6: Capacity Addition Target and Achievement for 2018-19

Sector	**Thermal**		**Hydro**		**Nuclear**		**Total**	
	Target	**Ach.**	**Target**	**Ach.**	**Target**	**Ach.**	**Target**	**Ach.**
Central	2760	1960	710	110	0	0	3470	2070
State	4506	2850	130	30	0	0	4636	2880
Private	0	972	0	0	0	0	0	972
All India	**7266**	**5782**	**840**	**140**	**0**	**0**	**8106**	**5922**

(Figures in MW) Source: Executive Summary Report February'2021, CEA

Table 3:7: Capacity Addition Target and Achievement for 2019-20

Sector	**Thermal**	**Hydro**	**Nuclear**	**Total**

	Target	Ach.	Target	Ach.	Target	Ach.	Target	Ach.
Central	6040	3940	600	300	700	0	7340	4240
State	4256.15	2780	210.99	0	0	0	4467.14	2780
Private	0	45	379	0	0	0	379	45
All India	**10296.15**	**6765**	**1189.99**	**300**	**700**	**0**	**12186.14**	**7065**

(Figures in MW) Source: Executive Summary Report February'2021, CEA

3.2.2 All India Electrical Energy Requirement, Peak Electricity Demand & Electrical Energy Consumption Projections for 2016-17 to 2026-27

According to 19th EPS, Energy Requirement & Peak Load in future in all India, Regions and States (in Southern Region) are as shown in Table 3.8 (A & B) & 3.9 (A & B).

Table 3:8: All India State/UT Wise Electrical Energy Requirement at Power Station Bus Bars (Utilities)

(2016-2022)

State/UT/Region	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Andhra Pradesh	54673	58846	63290	68034	73090	78540
Telangana	52695	61102	67680	75164	80700	84603
Karnataka	66146	69808	73636	77532	81622	85932
Kerala	24622	25875	27184	28535	29924	31371
Tamil Nadu	105923	111583	117505	123724	130189	136643
Puddducherry	2990	3121	3254	3387	3521	3664
Southern Region	**307047**	**330336**	**352549**	**376376**	**399047**	**420753**
Northern Region	**356521**	**376550**	**397530**	**420047**	**443704**	**468196**
Western Region	**352304**	**377343**	**403010**	**429217**	**455250**	**481501**
Eastern Region	**128300**	**138862**	**145674**	**153363**	**162669**	**171228**
North Eastern Region	**15876**	**17261**	**18758**	**20437**	**22083**	**23809**

Andaman & Nicobar Islands	329	356	358	414	446	475
Lakshadweep	52	54	55	57	59	62
All India	**1160429**	**1240760**	**1317962**	**1399913**	**1483257**	**1566023**

In Million Units Source: 19th Electric Power Survey of India (EPS), CEA

(2022-23 to 2026-27)

State/UT/Region	2022-23	2023-24	2024-25	2025-26	2026-27
Andhra Pradesh	84429	90794	97181	104072	111485
Telangana	881301	91836	95776	99945	104345
Karnataka	90381	95042	99916	105017	110368
Kerala	32861	34393	35964	37582	39357
Tamil Nadu	144145	152357	161349	170822	180989
Pudducherry	3809	3959	4114	4279	4448
Southern Region	**443754**	**468380**	**494301**	**521717**	**550992**
Northern Region	**493162**	**519399**	**549833**	**582182**	**616345**
Western Region	**508032**	**535810**	**564915**	**595591**	**627624**
Eastern Region	**179480**	**187906**	**196698**	**207085**	**217468**
North Eastern Region	**25598**	**27523**	**29619**	**31869**	**34301**
Andaman & Nicobar Islands	504	535	566	598	632
Lakshadweep	64	66	68	70	73
All India	**1650594**	**1739618**	**1836001**	**1939111**	**2047434**

In Million Units Source: 19th EPS, CEA

Table 3:9: All India State/UT Wise Peak Electricity Demand at Power Station Bus Bars (Utilities)

(2016-17 to 2021-22)

State/UT/Region	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Andhra Pradesh	8245	8874	9544	10259	11021	11843
Telangana	8300	10011	11262	12712	13757	14499
Karnataka	10895	11517	12169	12834	13534	14271
Kerala	4131	4341	4561	4788	5021	5263
Tamil Nadu	15412	16299	17230	18213	19240	20273
Pudducherry	476	497	518	539	561	583
Southern Region	**44782**	**48635**	**52171**	**56007**	**59581**	**62975**
Northern Region	**55596**	**58899**	**62279**	**65919**	**69766**	**73770**
Western Region	**50141**	**54673**	**58654**	**62728**	**66847**	**71020**
Eastern Region	**20883**	**22849**	**23868**	**25130**	**26633**	**28046**
North Eastern Region	**2810**	**3252**	**3537**	**3856**	**4170**	**4499**
Andaman & Nicobar Islands	67	73	78	84	91	97
Lakshadweep	10	10	10	11	11	11
All India	**161834**	**176897**	**188360**	**200696**	**213244**	**225751**

In Mega Watts Source: 19th EPS, CEA

(2022-23 to 2026-27)

State/UT/Region	2022-23	2023-24	2024-25	2025-26	2026-27
Andhra Pradesh	12731	13690	14656	15698	16820
Telangana	15338	16086	16885	17738	18653
Karnataka	15033	15834	16674	17554	18481

Kerala	5513	5770	6034	6305	6603
Tamil Nadu	21471	22784	24225	25750	27392
Pudducherry	606	630	655	681	708
Southern Region	**66710**	**70579**	**74666**	**79002**	**83652**
Northern Region	**77929**	**82017**	**86776**	**91835**	**97182**
Western Region	**75275**	**79748**	**84502**	**89528**	**94825**
Eastern Region	**29500**	**30895**	**32319**	**34031**	**35674**
North Eastern Region	**4891**	**5319**	**5790**	**6235**	**6710**
Andaman & Nicobar Islands	103	109	115	122	129
Lakshadweep	12	12	13	13	13
All India	**238899**	**252288**	**266844**	**282418**	**298774**

In Mega Watts Source: 19th EPS, CEA

3.3 Power Sector in Andhra Pradesh

3.3.1 Introduction

Power sector of Andhra Pradesh is divided into 4 categories namely Regulation, Generation, Transmission and Distribution. Andhra Pradesh Electricity Regulatory Commission (APERC) is the regulatory body. APGENCO deals with the electricity production and also maintenance, proposes new projects and upgrades existing ones as well. The APGENCO also set up a Special Purpose Vehicle (SPV), named as Andhra Pradesh Power Development Company Limited (APPDCL), a joint venture company of APGENCO (with 50% equity) and IL&FS (50% equity) to set up Krishnapatanam thermal power project (2x800 MW).

APTRANSCO is set up for transmission of power. Power distribution in the state is divided into two divisions, namely Eastern Power Distribution Corporation Limited (EPDCL) and Southern Power Distribution Corporation Limited (SPDCL), which distributes the power to the households and the industries. APGENCO, APPDCL,

NTPC and other private firms contribute to the generation of power in the state of Andhra Pradesh.

3.3.2 Existing Power Scenario of Andhra Pradesh

Generation of Electrical Energy

The total installed capacity of the Andhra Pradesh state as on 28th February, 2021 is 25277.42 MW comprising of 14714.46 MW Thermal power, 127.27 MW Nuclear power, 1673.60 MW Hydro power and 8762.09 MW Renewable energy sources which includes central and private sector also.

Demand and Supply Scenario

The energy requirement of Andhra Pradesh during FY 2016-17 was 54673 MU and in the FY 2020-21 it would be 78540 MU as per projection made in the 19th EPS of India due to rapid increase in power demand for all types of present and future customers (Domestic, Commercial, Irrigation, Industries, Railway traction and others).

Table 3:10: Installed Capacity of APGENCO

Sl. No.	Name of Power Stations	No. of Units	Installed Capacity (MW)
A.	**Thermal Power:**		
1.	Dr Narla Tata Rao (Vijayawada) TPS Stage-I,II,III	6 x 210 MW	1260.0 MW
2.	Dr Narla Tata Rao (Vijayawada) TPS Stage-IV	1 x 500 MW	500.0 MW
3.	Rayalaseema TPP Stage-I,II,III & IV	5 x 210 MW + 1 x 600 MW	1650.0 MW
	Total Thermal		**3410.0 MW**
B.	**Hydro Power:**		
1.	Machkund PH (APGENCO share: 70%)	3 x 17 MW + 3 x 23MW = 120 MW (AP Share - 84.0)	84.0 MW
2.	Tunga Bhadra Dam PH	4 x9 MW = 36 MW (AP Share - 28.8)	28.8 MW
3.	Hampi PH	4 x 9 MW = 36 MW (AP Share - 28.8)	28.8 MW

4.	Upper Sileru PH	4 x 60 MW	240.0 MW
5.	Donkarayi Canal PH	1 x 25 MW	25.0 MW
6.	Lower Sileru PH	4 x 115 MW	460.0 MW
7.	Srisailam Right Bank PH	7 x 110 MW	770.0 MW
8.	Nagarjunasagar Right Canal PH	3 x 30 MW	90.0 MW
9.	Penna Ahobilam HES	2 x 10 MW	20.0 MW
10.	Chettipeta Mini Hydel	2 x 0.5 MW	1.0 MW
11.	Nagarjuna Sagar Tail Pond Power House	2 x 25MW	50.0 MW
	Total Hydro		**1797.6 MW**
C.	**Non-Conventional Power:**		
1.	400 MWp Solar PV Plant (TalariCheruvu, Anantapur Dist.)	1 x 100 MW	400.0 MW
1.	5.426 MWp Solar PV Plant	1 x 5.426 MW	5.426 MW
	Total Non-Conventional		**405.426 MW**
	Grand Total		**5613.026 MW**

Source: Andhra Pradesh Power Generation Corporation Limited (APGENCO)

Table 3:11: Southern Region & Andhra Pradesh Electrical Energy Requirement (MU) at power station bus bars (Utilities)

State/Region	2016-17	2021-22	2026-27	2031-32	2036-37
Andhra Pradesh	54673	78540	111485	145148	180190
Southern Region	307047	420753	550992	680149	824657

Source: 19th EPS, CEA

Table 3:12: Southern Region & Andhra Pradesh Peak Electricity Demand (MW) at power station bus bars (Utilities)

State/Region	2016-17	2021-22	2026-27	2031-32	2036-37

Andhra Pradesh	8245	11843	16820	23223	29661
Southern Region	44782	62975	83652	104900	128655

Source: 19th EPS, CEA

3.4 Importance of Hydro in Present Scenario

The current development profile and trends in generation capacity addition in India have resulted in the following aspects:

- **Skewed development pattern between different generation technologies:** The current portfolio of installed capacity of 365980.54 MW as on 30.11.2019 is dominated by thermal power with around 56% share. Hydro, with an installed capacity of 45399.22 MW has a share of around 13%. Adequate diversity in generation asset base has not been maintained with growth in hydro assets not being concomitant with growth in the thermal asset base. This also impacts the long-term least cost development pattern with over reliance on 25-year thermal plants vis-à-vis more than 40 year hydro assets

  .

- **Inadequate peaking and quick response capability:** While regional grids have been integrated and frequency regimes have been streamlined, the country faces lack of assets capable of meeting peaking deficits and with quick response characteristics. For meeting peak requirement and to mitigate the variability due to renewable energy sources of the order of 175 GW by 2022 and with the shortage of gas, the peak and the balancing requirement is to be primarily met by Hydro Electric Projects.

- **Sustainable low carbon development:** While India is considering a low carbon strategy and actively considering focusing on Energy Efficient Renovation & Modernization to utilize existing assets, the low carbon strategy can be fostered further with a higher thrust on green capacity additions via hydropower development. These factors necessitate renewed emphasis on 'responsible hydropower development' to promote economic growth. Hydro's

critical role in sustainable development and energy security for the country is based on the elements of sustainability, availability and affordability.

(Ref: - National Electricity Plan January 2018, CEA)

3.5 Pumped Storage Plants - Best Friend of Electricity Grid

PSPs improve overall economy of power system operation, increase capacity utilization of thermal stations and reduce operational problems of thermal station during light load period. The other advantages of pumped storage development are availability of spinning reserve at almost no cost to the system and regulating frequency to meet sudden load changes in the network. PSPs have the ability to provide ancillary benefits such as flexible capacity, voltage support and Black-start facility etc. Pumped storage technology has advanced significantly since its original introduction and now includes adjustable speed pumped turbines which can pump water at different speed with different load. PSPs has the technology, which can quickly shift from motor, to generator, to synchronous condenser modes, for easier and more flexible operation of the Grid.

Since the energy gained from Pumped Storage Plants (PSP) is less than the energy input, it is necessary that Off-Peak power to be used as input may be available at reasonable tariff for making the Pumped Storage Plants commercially viable.

3.5.1 Advantages of Pumped Storage Hydro Projects

- Provides Large Grid Storage and Long Discharge time
- High Ramp rate
- Balancing the Grid for Demand -Driven variations
- Balancing Generation -Driven Variations
- Voltage Support
- Grid Stability
- Black start facility
- Improves overall economy of power system operation and increases capacity utilization of thermal, solar and wind stations.

(Ref: - CERC)

3.5.2 Issues and Way Forward for Pumped Storage Hydro Projects

- Since Pumped storage schemes use energy for pumping operation, commercial justification of peak energy produced from these plants pose problem. It is therefore desirable that separate regulation for peak energy may be envisaged.
- Regulatory treatment to Pump Storage schemes and market design is very critical for commercial viability of these plants as pricing rules should fully capture benefits of PSP and reward such assets for the full range of services provided by them to the Power system.
- The Pumped storage schemes should be considered as Grid Element instead of Energy Generation Source and may be funded from Power System Development Fund (PSDF) or National Clean Energy and Environment Fund (NCEEF).
- Water and Water Power is state subject. State Governments should be encouraged to allocate the identified pumped storage schemes to prospective developers for implementation.
- Some of the identified schemes, may be located in areas which have been declared as Wild Life Sanctuaries. The State/Central Governments are required to take necessary action to de-notify the areas required for development of pumped storage schemes involving Wild Life Sanctuaries.
- In case, it is possible to locate a pumped storage scheme where upper/lower reservoir is already existing/under construction, it would be more cost effective and easily implementable.

(Ref: - CERC)

3.5.3 Regulatory Issues and Challenges

- Grid Stabilization and security - Large Capacity addition Renewable Generation and dealing with its variability
- Technical Mechanism - Backing down of renewable and need for flexible operation of conventional generation
- Difficult sites and Long gestation period

- High Capital cost of storage based Pumped Storage Plants and resultant high tariffs
- Poor Financial health of State Discoms
- Lack of Market Mechanism
- Lack of Ancillary Services
- Competition from other conventional sources

(Ref: - CERC)

3.5.4 Variability & Uncertainty of RES

- Renewable Energy Sources (RES) such as wind and solar power are variable and uncertain in nature.
- They are not able to generate electricity on demand and their power output fluctuate with weather conditions (such as wind speed, wind direction, temperature, rain, cloud cover and humidity.

3.6 Necessity and Justification

It is observed that expansion of estimated power requirement during the period of 13th five year plan (1st April 2017 to 31st March 2022) and estimated power requirement in 2030, NREDCAP can take part in this integration of power generation of the country.

As per forecast of 12th and 13th (National 5 Year Plan), the Electrical Energy Requirement of Southern Zone for the period 2016-17 is estimated to be 307047 MU and for the period 2026-27 is estimated to be 550992 MU. Requirement of Peak Electricity Demand at power station Bus bars has been estimated as 44782 MW for the period 2016-17 and 83652 MW and for the period 2026-27.

As per review of forecast of all India and state wise electrical energy consumption (MU) and CAGR of Actual and Forecast, peak electricity demand in Southern Region will increase to 83652 MW in 2026-27 from 44782 MW in 2016-17. Accordingly, in Andhra Pradesh peak electricity demand in 2026-27 will be 16820 MW against 8245 MW in 2016-17. Increase of generation of NREDCAP is needed to cope up with the forecast of demand as stated above. Installation of Pumped Storage Project is suitable

according to the present trend of world power scenario to meet up therefore peak demand as well as to avoid use of fossil fuel and to avail the opportunity of god gifted geological condition.

To maintain Indian standard frequency 50 cycles/sec and Grid balancing by generation of power or drawl is very much effective with Pump Storage Project Projects. There is a big scope to keep up this ratio with the installation of a Pump Storage Project as well as to add generation according to need of the grid which will ensure the active participation in expansion of power generation of the country in coming years.

Pump Storage project helps the grid (frequency balance) by adding power by generation in peak demand and draw power during off peak for pumping. It helps the thermal power stations to generate more power in off peak by drawl of power for pumping of pumped storage project which helps to relieve the back down of thermal power stations, reduce costly oil support, minimize the breakdown, and ultimately improve the PLF of Thermal Power Stations.

If a big Solar project is connected with grid, frequency of the grid may change due to its sudden variation of generation due to its natural variation like, cloud, rain, storm etc. It is a hard task for Thermal power station to cope up the grid balance due to sudden change in solar generation, but costlier variable speed machine instead of fixed speed machine in the pumped storage project has the scope to cope up this variation within millisecond.

Proposal for installation of **1000 MW Gandikota Pumped Storage Project** is very much essential to fulfill peak power demand and justified in consideration with the requirement of excess 38870 MW peak electricity demand at Southern Zone in 2026-27 in comparison to 2016-17. Gandikota Pumped Storage Project is expected to generate 1000 MW of power for 5 hrs 22 minutes. in a day considering 355 days (considered 10 days for maintenance work) in a year. Gandikota PSP can generate 1958.83 MU of energy in a year from the said project. Pumping time is required about 6 hours 56 minutes in a day.

3.7 Capacity Addition - Ongoing & Future Projects

APGENCO has taken up a gigantic capacity addition to add 11210 consisting major power projects viz., Dr. NTTPS Stage-V (1x800MW), SDSTPS Stage-II (1x800MW) and Polavaram HEP (960MW) are under construction. Solar PV power project at Ananthapur 100MW and Ramagiri wind mills of 10MW are under various stages of development/investigation.

Table 3:13: Future Projects of APGENCO

Sl. No.	Name of Power Stations	Capacity (MW)
A.	Projects Under Construction:	
1.	Dr. NTTPS Stage - V (1 X 800 MW)	800.0 MW
2.	Krishnapatnam TPP stage-II (1 X 800 MW)	800.0 MW
3.	Polavaram HEP (12 X80 MW)	960.0 MW
	Total (A) =	2560.0 MW
B.	Projects Under Development:	
4.	Solar PV Power Project, Ananthapur	100.0 MW
5.	Ramagiri Wind Mills	10.0 MW
	Total (B) =	110.0 MW

Source: APGENCO

CHAPTER-4: HYDROLOGY

CHAPTER – 4

4. HYDROLOGY

4.1 Objective of the Study

The overall objective of the hydrological study is to assess the water availability at the present proposed pumped storage project site based on available hydrological data and design flood studies for various return periods at the proposed project site.

4.2 Background

The Main of objectives of any Water Resources developmental activities are to maximize the benefits for mankind use in the form of hydro-power generation, irrigation, ayacut development, increase in the agricultural production and productivity and protection from floods and vagaries' of nature. Pump Storage Projects (PSPs) development is also a sub-set of such activity as they aim to increase hydro-power generation during peaking time when power demands are more and utilize the renewable resource (surplus power, water etc.) during non-peaking hours. Such developmental activities too are guided by topography, hydrology, geology, climate, machines/hardware etc unlike water resources development projects. Since such PSPs utilize the energy stored in the form of potential energy/head and the vehicle viz water, so, water availability plays an important role in PSPs development.

However, in India the present trend for development of PSPs are utilizing the existing irrigation structures to the extent possible so as to harness the existing water potential and economize the cost of civil structures. It is also due to the fact that existing such water resources structures are time tested and have enough renewable resource like water. The PSPs do not consume but divert water except one time requirement (evaporation losses are negligible) to fill the new small reservoir (upper or lower) meant for recirculation.

Since PSPs do not have consumptive use of water except for re-cycling, as such these projects do not interfere with the existing operations of old projects. On the other hand, they help in meeting the energy demands during peaking hours

4.3 Introduction

The The Krishna Water Dispute Tribunal (KWDT) award of 1973 had allocated 800 TMC (22652.MCM) of Krishna water at 75% dependability to Andhra Pradesh (A.P). The Andhra Pradesh Government was entitled to utilize this water and make adjustments within this allocation including regeneration thereof for utilization of Krishna water within its territory.

The Rayalaseema region of Andhra Pradesh is drought prone and suffers from severe droughts and erratic rainfall in the region. Accordingly the Government of Andhra Pradesh initiated various projects to utilize the water and as a part of Jalayagnam started construction of several dams, small reservoirs, balancing reservoirs in the State. To supply Krishna water to Penna basin, the Andhra Pradesh Government made arrangements to transfer Krishna waters from foreshores of Srisailam dam, started Galeru-Nagari-Sujata-Sravanthi (GNSS) scheme flood flow canals and constructed several balancing reservoir enroute.

4.4 Gandikota Existing Reservoir

The Gandikota reservoir was constructed on Penna river in Kandapuram mandal as a balancing reservoir to draw 38.0 TMC (1076 MCM) of Krishna water in 30 days and store it for irrigation and ayacut development in Kadappa, Chittor and Nellore districts besides supplying drinking water to people. The daily drinking water requirement being 7000000 litres per day (0.0002 TMC per day).

The Gandikota reservoir receives water drawn from fore-shores of Srisailam reservoir through Srisailam Right Main Canal, Srisailam High Branch Canal and also through Gorakullu and Owk balancing reservoirs. The head work of Gandikota reservoir is located at Latitude 140 48’ 38” N and Longitude 780 15’ 30” E. The dam construction was started in 2000-05 and completed in 2012-13. It intercepts a catchment area of 19197 km2 (net catchment area being 6808 km2). The location map is at Fig 4.1 while the catchment area map is at Fig 4.2 below.

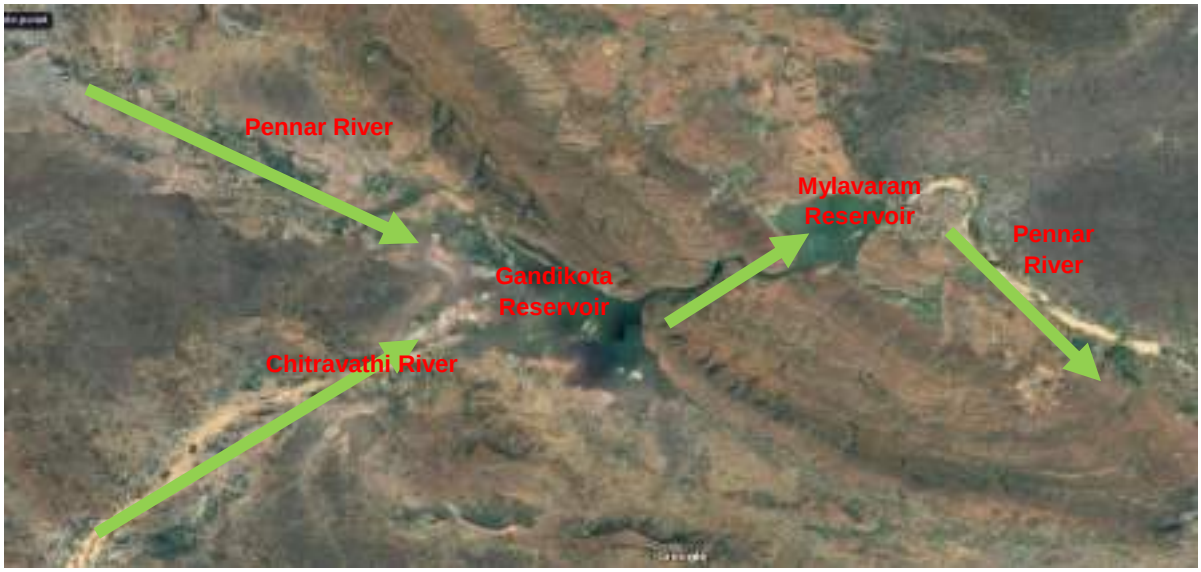


Fig 4.1: Google Earth Image showing Gandikota Reservoir

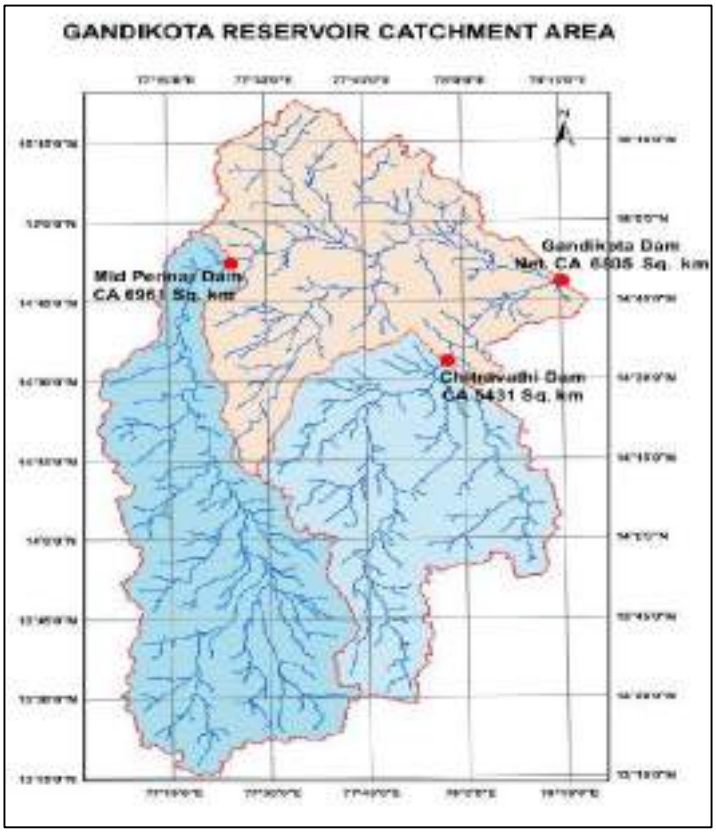


Fig4.2: Catchment Area Map of Gandikota Reservoir

The Gandikota reservoir with a Gross Storage of 26.85 TMC (760.02 MCM) acts as a balancing reservoir on Penna river. It receives water from self-catchment together with water from Chitravathi River. It also receives water from Srisailam reservoir through Srisailam Right bank Canal and feeding two balancing reservoir namely Gorakallu and Owk. It then supplies water to various schemes as and when required with details as under:

1. **Gandikota Lift Irrigation Scheme (GKLI)**

Under this scheme about 6.0 TMC (169.8 MCM) of water is lifted from fore-shores of Gandikota reservoir to irrigate 88500 acres of ayacut in six mandals.

2. **Gandikota CBR Lift Irrigation Scheme (CBR GKLI)**

Under this scheme 8.30 TMC (235 MCM) of water is lifted to Chitravathi balancing reservoir for providing facility to 12000 acres of ayacut. In addition ayacut stabilization in Kadappa and Anantapur district.

3. **Mylavaram reservoir**

It was constructed across Penna river with a gross storage of 9.96 TMC (282 MCM) near Mylavaram village in Kadappa district for providing irrigation facility to 75000 acres.

4. **Galeru-Nagari-Sujata-Sravanthi(GNSS)**

Under this scheme about 7.0 TMC (198.1 MCM) of water is being provided to meet irrigation requirements of Balaji reservoir, Padma reservoir, Srinivasa Sagar, Venugopalla Sagar and Vepagunta reservoir. This project was formulated to irrigate 2.60 lakh acres of area in Kadapa and Chittor district besides supplying drinking water to 20 lakh people living in enroute villages and towns.

5. **Drinking Water**

Providing 7000000 litres per day (0.0002 TMC i.e 0.00 566 MCM) of water for drinking purposes in Tadipatri and Maiddanur area in the region and drought prone areas of Ananthapur district.

The inflow and outflow from Gandikota reservoir is shown in Fig 4.3 below. It may be reiterated that Gandikota reservoir receives water from Srisailam as and when available at Srisailam in a limited period. Similarly Gandikota supplies water under various schemes as and when needed. There is no fixed schedule for receiving and releasing water downstream.

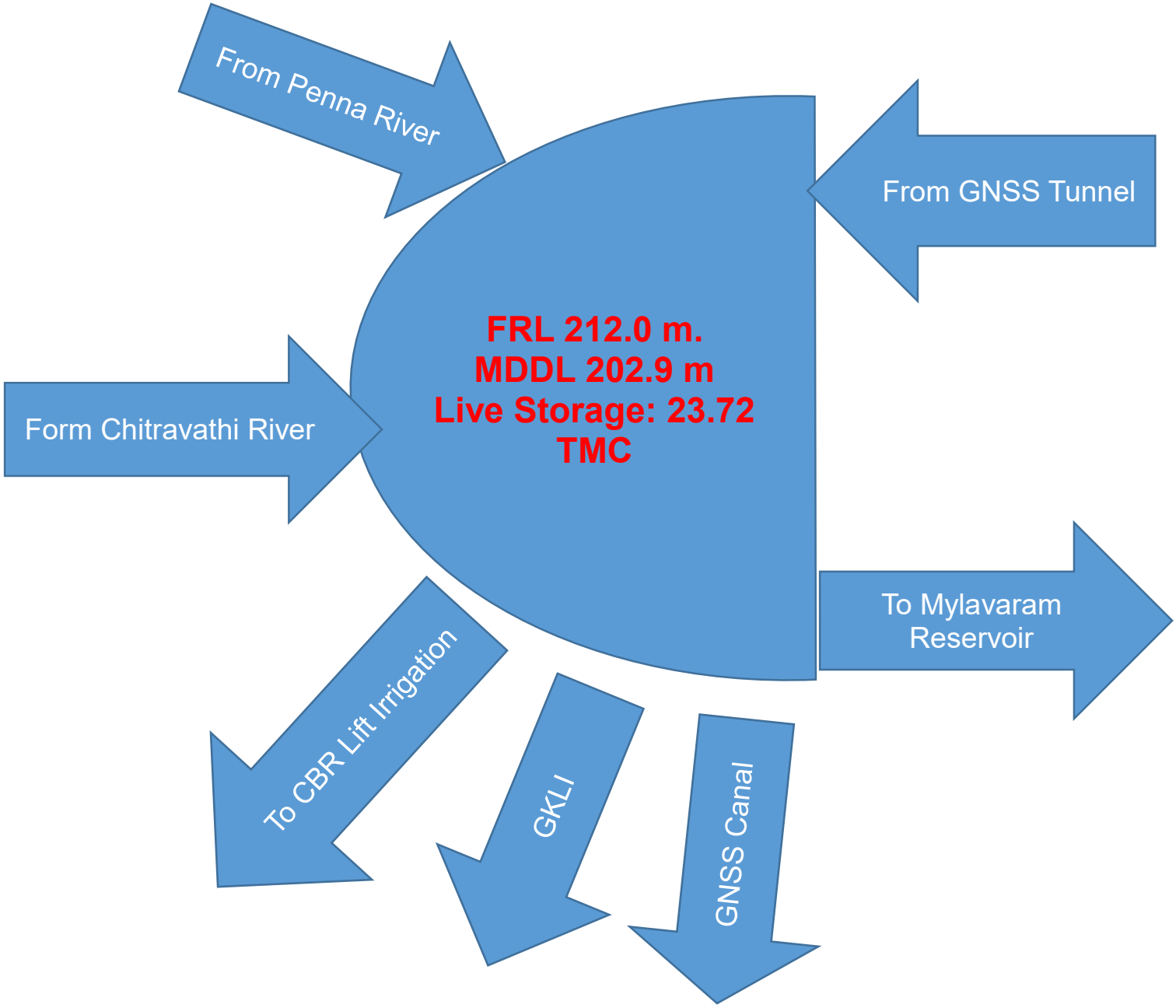


Fig 4.3: Various Inflow and Outflow from Gandikota Reservoir

4.5 Present Scheme

The present Pump Storage Project Scheme with an installed capacity of 1000 MW aims to harness the existing water potential of existing Gandikota reservoir having large storage capacity as Lower reservoir in the proposed PSP scheme. A new reservoir as Upper reservoir is proposed to be constructed for carrying out re-cycling operations of water between this proposed new reservoir and existing Gandikota reservoir. Tentatively new upper dam reservoir is proposed at Latitude 14^0 49' 47.28" N and Longitude 78^0 13' 53.13" E. It will have live storage capacity of only 8.952 MCM. This new proposed dam/reservoir would be constructed by utilizing the existing depression and cutting the earth/rock and it is not located on any stream or nallah. It will be surrounded by an earth fill embankment of about 20 m height between elevations El.462m -El. 482m. It will be filled once only by pumping water from lower Gandikota reservoir for initiating re-cycling activity. Since this proposed reservoir is not located on any stream/nallah, as such, site specific hydrological studies is insignificant. However, broad details of proposed new upper reservoir is given below:

River/ Nallah:	Not located on any river/nallah
Catchment Area	Nil
FRL:	El. 281 m
MDDL:	El. 464 m
Gross Capacity:	9.514 Mcm
Live capacity:	8.592 Mcm

Water Spread Area at FRL: 54.50 Ha

Water Spread Area at MDDL: 46.51 Ha

The proposed scheme would re-circulate the water between existing Gandikota reservoir and proposed new upper reservoir whose capacity is just above one percent (1.28%) only of existing Gandikota reservoir, as such water availability is ensured. The Area-Elevation & Capacity for Proposed new Upper Reservoir and Existing Lower Reservoir is presented at **Annexure-4.1 & Annexure 4.2** respectively.

4.6 Data availability

The Gandikota dam structure was completed in 2013 but due to R&R issues, the reservoir was not filled upto its full capacity. However, the hydrological data as available with project authorities at dam site are as under

Table 4:1: List of Data available

S.No	Details	Frequency	Data Availability
1	Water Level	Thrice daily	01-01-2012 to 31-12-2012
2	Water Level	Daily	01-01-2013 to 31-12-2013
3	Water Level, Reservoir Capacity	Daily	01-01-2014 to 31-12-2015
4	Water Level, Reservoir inflow-outflow and Capacity, Evaporation losses	Daily	04-10-2016 to 31-01-2021

The site personnel informed that inflows, outflows, capacities etc. are worked out based on reservoir water levels being observed daily and converted into flows based on nomographs which are being updated regularly.

4.6.1 Data Consistency Check

The proposed project lies in a drought prone area with mean annual rainfall of 710 mm which is insufficient for meeting the irrigation water requirements. As such, water is diverted from Srisailam Reservoir based on the water requirements in command area (as and when required) of Gandikota Reservoir and acts as balancing reservoir. Hence, as such data consistency ascertain. The elevation-area-capacity curve indicates the consistency in the data with respect to storage capacity of the existing Gandikota Reservoir.

4.7 Hydrological Studies

4.7.1 Water Availability

The proposed PSP scheme do not entail any additional consumptive water use except one time requirement of water to fill the upper reservoir. The evaporation losses are negligible as already Gandikota with large capacity is meeting the evaporative losses. The water leakages in the proposed new scheme are minimal. The scheme in nut-shell involves re-circulation of water on daily basis only. The inflow and outflow into Gandikota reservoir are not based on fixed schedule. The Gandikota reservoir receives and supplies water to ayacuts based on their specific demands as it acts only as a balancing reservoir. Thus pumping operations for the proposed PSP would depend on the storage/level available in Gandikota reservoir which are being observed by project authorities on daily basis. As such, water needed for re-circulation depends on storage and level of water in Gandikota Reservoir which receives water from Srisailam Reservoir.

However, since re-circulation will be carried out between the two reservoirs, as such there may be a possibility when the Gandikota reservoir reaches the MDDL due to its operation policy (for supply of water for irrigation). Then pumping operations need to be stopped as enough water will not be available to carry out such activity. As such simulation study has been carried out based on the entire available observed data to ascertain the water availability for carrying out pumping operation. During this operation a threshold limit of water level/capacity has been made when PSP operations have to be stopped which is equivalent to Gandikota reservoir capacity at MDDL plus one day pumping requirement for PSP operations.

The pumping water requirement is just 1.28% of the live storage of existing Gandikota reservoir which is miniscule as compared to available water. Hence, significant fluctuation in storage due to pumping is not anticipated.

The live storage of the existing lower Gandikota Reservoir is stored between MDDL 202.90 m and FRL 212.0 m. Elevation of 9.10 m stores 23.629 TMC (669.095 MCM) water. Considering the pumping operation at MDDL level, the minimum level needed

is 203.059 m. The fluctuation is of the order of 0.159 m or 15.9 cm at MDDL level (1.74% of live storage depth) which will be even less at higher storage level operation. Hence, prima facie it can be inferred that level fluctuation due to operation of pumped storage project in existing reservoir is negligible and can be operated easily.

The one time water requirement of 9.154 MCM for filling the Upper Reservoir would be easily met from Existing Gandikota Lower Reservoir.

4.7.2 Evaporation Loss

The Gandikota existing Reservoir is in operation for the last several years and meeting the irrigation and evaporation demands already. The proposed PSP scheme entails construction of a small new upper reservoir having very small surface area. As such, the additional evaporation would be from the water spread area of this new reservoir, which is miniscule as the storage capacity for this reservoir is less than 1.5% of the existing Gandikota Reservoir. Hence, evaporation demands would be met from the reservoir only and will have negligible difference with respect to existing.

4.7.3 Simulation Study

It has been indicated in earlier para that project authorities observe the inflow, outflow, losses, levels etc. on daily basis since 2017. In earlier period only levels were observed and as such this data was discarded in present study. The simulation study on daily basis utilizing the above site specific data was carried out for the period 2017 till January 2021 using the following data of Gandikota existing reservoir.

Gross catchment Area	= 19197 km2
Net Catchment Area	= 6805 km2
Gross Storage	= 26.84 TMC (760 MCM)
Live Storage	= 23.629 TMC (669 MCM)
FRL	= 212.00 m
MDDL	= 202.9 m
MDDL Capacity	= 3.211 TMC (90.9MCM)
Pumping water Requirement For 6.56 hours	= 0.303 TMC (8.592 MCM)

Storage required for operations =3.51 TMC (99.5 MCM)

The simulation carried out whose details are in Table 4.2 below reveals the following:

Table 4:2

S. No	Data utilized	Percentage Success	Remarks
1	June 2017 to Jan 2021	73.00	Utilized upto date data
2	September 2019 to Jan 2021	100.00	Change in Reservoir operation policy

The simulation studies are presented at **Annexure-4.3**

4.7.4 Diversion Flood

The proposed upper reservoir is not located on any stream/nallah and the construction of the upper dam will be done only by excavation and embankment filling hence no such diversion flood studies have been undertaken in the present study.

4.7.5 Design Flood

The Gandikota Dam was constructed several years back and is in the operation since then. No civil works are proposed in the existing dam and reservoir except an intake structure. As such, design flood computations are not required for Lower Reservoir and existing Dam,

The proposed upper reservoir is not located on any stream/nallah hence no such diversion flood studies have been undertaken in the present study.

4.7.6 Sedimentation Studies

Since the proposed new upper reservoir is not located on any river/nallah, also, water filling will be done only from the existing Gandikota reservoir which is already having

silt free water, hence such no sediment studies have been undertaken in the present study.

4.8 Conclusion

The above simulation indicates that Gandikota reservoir is meeting the existing irrigation demands including pumping water requirement after June 2017. When the project authorities have modified the reservoir operating policy (after clearance of R&R issues), the percentage success is 73% to 100%. Moreover, the overall additional requirement of water for pumped storage operation is just 1.28% of total live storage and level fluctuation is just 2.9% of live storage level (Between FRL and MDDL) for existing reservoir which is quite small and assumed to have negligible impact on day to day operation of existing Gandikota reservoir under normal condition. Thus it can be inferred that the water requirement for proposed pumped storage project will be adequately available and would not affect the existing operation of the Gandikota Reservoir.

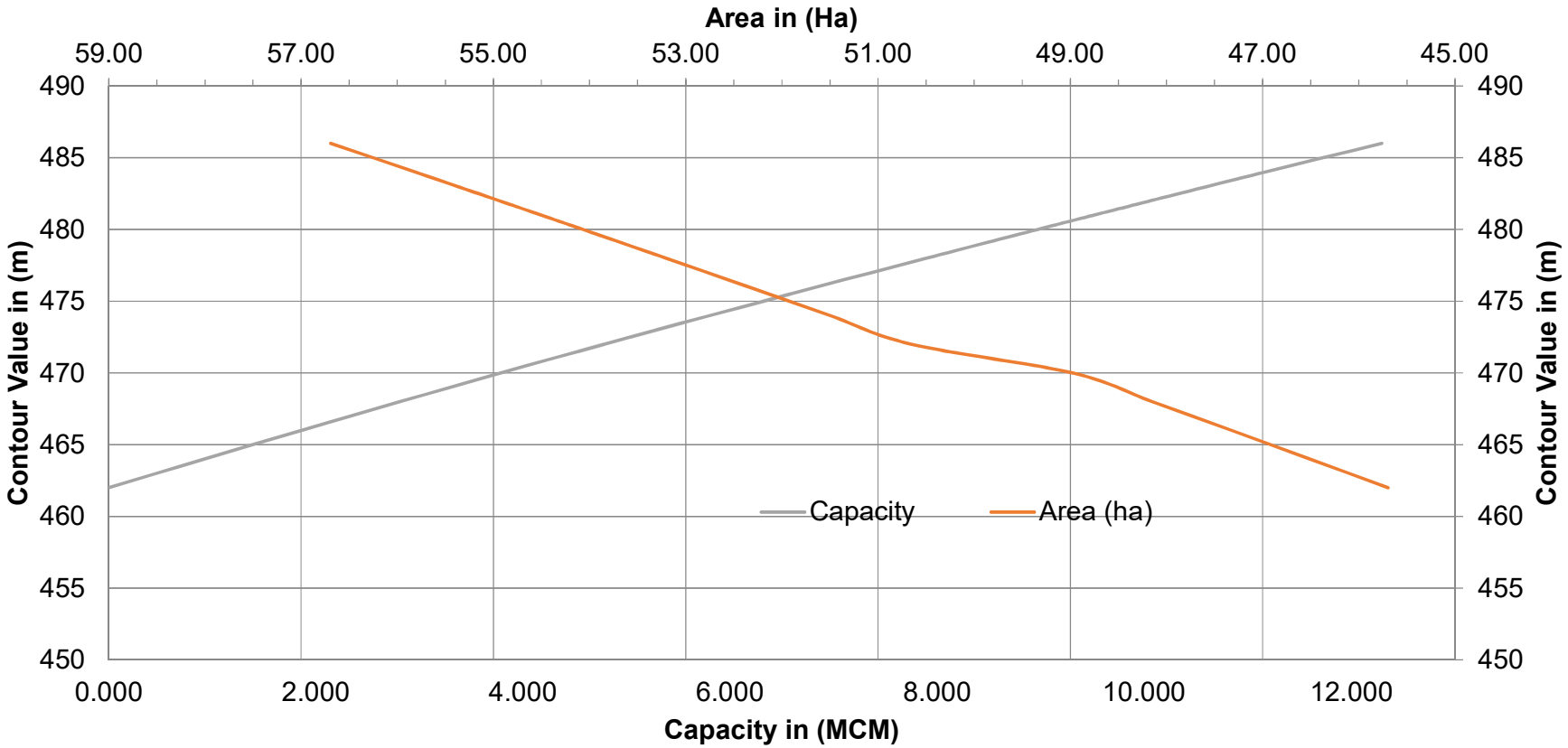
Annexure - 4.1

AREA CAPACITY CURVE FOR UPPER RESERVOIR - GANDIKOTA PSP

Annexure-4.1

S. No.	Contour Value (m)	Area (m2)	Area (ha)	Interval (m)	Capacity (m3)	Cum. Capacity (m3)	Cum. Capacity (MCM)	
1	462	456961.44	45.70	0	0.00	0.00	0.000	
2	464	465080.38	46.51	2	922029.90	922029.90	0.922	**MDDL**
3	466	473255.99	47.33	2	938324.50	1860354.40	1.860	
4	468	481488.27	48.15	2	954732.43	2815086.83	2.815	
5	470	489777.22	48.98	2	971253.70	3786340.53	3.786	
6	472	506525.15	50.65	2	996255.44	4782595.98	4.783	
7	474	514984.12	51.50	2	1021497.60	5804093.57	5.804	
8	476	523499.77	52.35	2	1038472.25	6842565.82	6.843	
9	478	532072.09	53.21	2	1055560.26	7898126.08	7.898	
10	480	540701.08	54.07	2	1072761.60	8970887.68	8.971	
11	481	545036.83	54.50	1	542867.51	9513755.19	9.514	**FRL**
12	482	549386.75	54.94	1	547210.35	10060965.54	10.061	
13	484	558129.09	55.81	2	1107504.34	11168469.88	11.168	
14	486	566928.10	56.69	2	1125045.72	12293515.60	12.294	

Area capacity Elevation Curve - Upper Reservoir



Annexure - 4.2

					Annexure- 4.2			
Existing Gandikota Reservoir Elevation-Area-Capacity Table								
Sno.	**Level (m)**	**Average Area (Sq m)**	**Average Area (Hac.)**	**Average Volume (Cub m)**	**Capacity in cft**	**Capacity in MCFT**	**Capacity in TMC**	**Capacity in MCM**
1	192.5							
2	193.0	61785.73	6.18	19387.87	684663.17	0.68	0.00	0.03
3	193.1	78808.06	7.88	30751.95	1085974.39	1.09	0.00	0.03
4	193.2	95430.38	9.54	42116.03	1487285.61	1.49	0.00	0.03
5	193.3	112252.71	11.23	53480.12	1888590.83	1.89	0.00	0.06
6	193.4	129075.03	12.91	64844.2	2289908.05	2.29	0.00	0.06
7	193.5	145897.36	14.59	70208.28	2691219.28	2.69	0.00	0.08
8	193.6	169805.74	16.98	98537.85	3479765.69	3.48	0.00	0.08
9	193.7	193714.12	19.37	120867.42	4268312.1	4.37	0.00	0.11
10	193.8	217622.49	21.76	143196.99	5056858.52	5.06	0.01	0.14
11	193.9	241530.87	24.15	165526.56	5845404.93	5.85	0.01	0.17
12	194.0	265439.25	26.54	187856.13	6633951.35	6.63	0.01	0.20
13	194.1	291691.41	29.17	223745.83	7901360.36	7.9	0.01	0.23
14	194.2	317943.56	31.79	259635.54	9168769.37	9.17	0.01	0.25
15	194.3	344195.72	34.42	295525.24	10436178.39	10.44	0.10	2.83
16	194.4	370447.87	37.04	331414.95	11703587.4	11.7	0.01	0.34
17	194.5	396700.03	39.67	367304.65	12970996.42	12.97	0.01	0.37
18	194.6	430337.85	43.03	419170.22	14802577.19	14.8	0.02	0.42
19	194.7	463975.68	46.40	471035.79	16634157.96	16.63	0.02	0.48
20	194.8	497613.51	49.76	522901.35	18465738.73	18.47	0.02	0.51
21	194.9	531251.34	53.13	574766.93	20297319.5	20.3	0.02	0.57

22	195.0	564889.17	56.49	626632.5	22128900.28	22.13	0.02	0.57
23	195.1	618812.79	61.88	680556.13	24033159.04	24.03	0.02	0.68
24	195.2	672736.41	67.27	734479.75	25937417.79	25.94	0.03	0.74
25	195.3	726660.03	72.67	788403.37	27841676.55	27.84	0.03	0.79
26	195.4	780583.65	78.06	842326.99	29745935.31	29.75	0.03	0.85
27	195.5	834507.27	83.45	1010147.56	35672350.82	35.67	0.04	1.02
28	195.6	905968.6	90.60	1120570.79	39571836.71	39.57	0.04	1.13
29	195.7	977429.93	97.74	1230994.01	43471322.6	43.47	0.04	1.22
30	195.8	1048891.26	104.89	1341417.24	47370808.48	47.37	0.05	1.33
31	195.9	1120352.59	112.04	1451840.47	5127094.37	51.27	0.05	1.44
32	196.0	1191813.92	119.18	1562263.7	55169780.26	55.17	0.06	1.56
33	196.1	1297332.96	129.73	1722473.55	60827430.83	60.83	0.06	1.73
34	196.2	1402851.99	140.29	1882663.39	66485081.4	66.49	0.07	1.87
35	196.3	1508371.03	150.84	2042893.24	72142731.97	72.14	0.07	2.04
36	196.4	1613890.07	161.39	2203103.09	77800382.53	77.8	0.08	2.21
37	196.5	1719409.1	171.94	2363312.94	83458033.1	83.46	0.08	2.35
38	196.6	1856987.56	185.70	2586673.56	91345790.03	91.35	0.09	2.58
39	196.7	1994566.02	199.46	2810034.18	99233546.96	99.23	0.10	2.80
40	196.8	2132144.48	213.21	3033394.8	107121303.9	107.12	0.11	3.03
41	196.9	2269722.93	226.97	3256755.42	115009060.8	115.01	0.12	3.26
42	197.0	2407301.39	240.73	3480116.04	122896817.7	122.9	0.12	3.48
43	197.1	2583411.98	258.34	3790621.48	133862007	133.86	0.13	3.79
44	197.2	2759522.57	275.95	4101126.93	144827196.4	144.83	0.15	4.11
45	197.3	2935633.16	293.56	4411632.37	155792385.7	155.79	0.15	4.25
46	197.4	3111743.74	311.17	4722137.82	166757575	166.76	0.17	4.73

47	197.5	3287854.33	328.79	5032643.26	177722764.3	177.72	0.18	5.04
48	197.6	3582734.8	358.27	5457740.82	192734659.2	192.73	0.19	5.47
49	197.7	3788692.63	378.87	5882838.37	207746554.2	207.75	0.21	5.89
50	197.8	4039111.78	403.91	6307935.92	222758449.1	222.76	0.22	6.31
51	197.9	4289530.93	428.95	6733033.47	237770344	237.77	0.24	6.74
52	198.0	4539950.08	454.00	7158131.02	252782239	252.78	0.25	7.16
53	198.1	4907001.17	490.70	7752609.6	273775655.3	273.78	0.27	7.76
54	198.2	5274052.26	527.41	8347088.17	294769071.6	294.77	0.30	8.35
55	198.3	5641103.35	564.11	8941566.74	315762487.9	315.76	0.32	8.95
56	198.4	6008154.44	600.82	9536045.31	336755904.2	336.76	0.34	9.54
57	198.5	6375205.53	637.52	10130523.88	357749320.5	357.75	0.36	10.14
58	198.6	6777951.79	677.80	10944218.22	386484122.1	386.48	0.39	10.93
59	198.7	7180698.05	718.07	11757912.55	415218923.8	415.22	0.42	11.75
60	198.8	7583444.31	758.34	12571606.88	443953725.5	443.95	0.44	12.57
61	198.9	7986190.57	798.62	13385301.22	472688527.1	472.69	0.47	13.39
62	199.0	8388936.83	838.89	14198995.55	501423329.8	501.42	0.50	14.19
63	199.1	8826842.23	882.68	15243741.96	538317503.6	538.32	0.54	15.23
64	199.2	9264747.64	926.47	16288488.37	5752116778	575.21	0.58	16.28
65	199.3	9702653.05	970.27	17333234.79	612105853.2	612.11	0.61	17.33
66	199.4	10140558.46	1014.06	18377981.2	649000028	649	0.65	18.38
67	199.5	10578463.87	1057.85	19422727.61	685894202.9	685.89	0.69	19.43
68	199.6	10578463.87	1057.85	20706765.7	731239783.4	731.24	0.73	20.70
69	199.7	10578463.87	1057.85	21990863.79	77658536.95	776.59	0.78	22.00
70	199.8	10578463.87	1057.85	23274931.88	821930944.5	821.93	0.82	23.28
71	199.9	10578463.87	1057.85	24558999.97	867276525.1	867.28	0.87	24.55

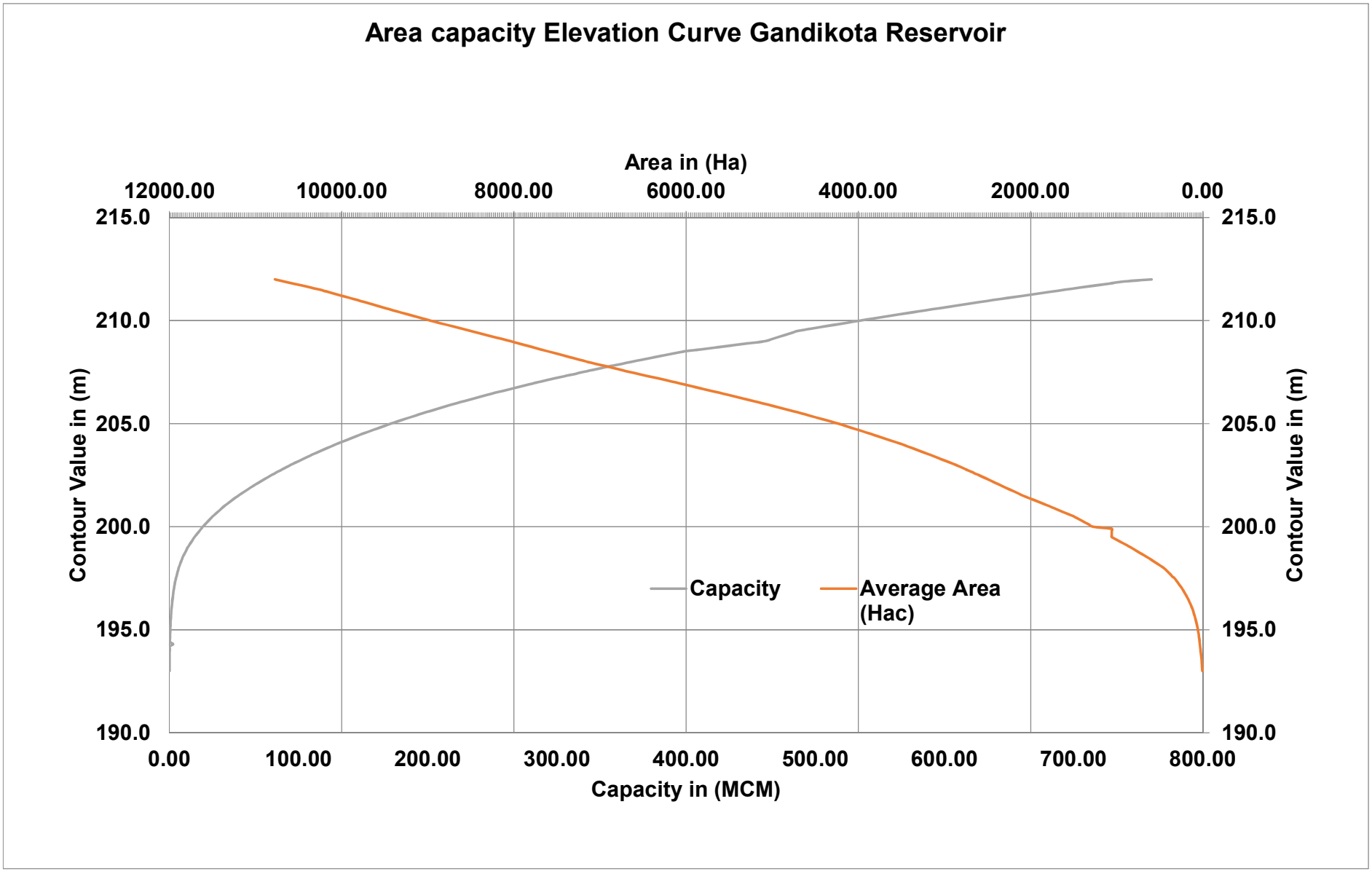
72	200.0	12768937.81	1276.89	25843068.06	912622105.6	912.62	0.91	25.85
73	200.1	13214489.48	1321.45	27365905.13	966399573.8	966.4	0.97	27.35
74	200.2	13660041.14	1366.00	28888742.2	1020177042	1020.18	1.02	28.88
75	200.3	14105592.81	1410.56	30411579.26	1073954510	1073.95	1.07	30.41
76	200.4	14551144.48	1455.11	31934416.33	1127731978	1127.73	1.13	31.94
77	200.5	14996696.14	1499.67	33457253.39	1181503446	1181.51	1.18	33.47
78	200.6	15567364.49	1556.74	35254977.15	1244994263	1244.99	1.25	35.25
79	200.7	16138032.83	1613.80	37052700.91	1308479080	1308.48	1.31	37.04
80	200.8	16708701.17	1670.87	38850424.66	1371963896	1371.96	1.37	38.85
81	200.9	17279369.52	1727.94	40648148.42	1435448713	1435.45	1.44	40.63
82	201.0	17850037.86	1785.00	42445872.17	1498933530	1498.93	1.50	42.45
83	201.1	18448765.55	1844.88	44574174.43	1574092396	1574.09	1.57	44.57
84	201.2	19047493.25	1904.75	46702476.68	1649251261	1649.25	1.65	46.69
85	201.3	19646220.95	1964.62	48830778.94	1724410127	1724.41	1.72	48.82
86	201.4	20244948.64	2024.49	50959081.19	1799568993	1799.57	1.80	50.97
87	201.5	20843676.34	2084.37	53087383.44	1874727859	1874.73	1.88	53.09
88	201.6	21361963.88	2136.20	55525973.82	1960844240	1960.84	1.96	55.53
89	201.7	21880251.42	2188.03	57964564.2	2046960620	2046.96	2.05	57.96
90	201.8	22398538.97	2239.85	60403154.58	2133077001	2133.08	2.13	60.40
91	201.9	22916826.51	2291.68	62841744.97	2219193382	2219.19	2.22	62.83
92	202.0	23435114.06	2343.51	65280335.35	2305309762	2305.31	2.31	65.27
93	202.1	23949340.22	2394.93	68002415.97	2401437318	2401.44	2.40	67.99
94	202.2	24463566.39	2446.36	70724496.6	2497564873	2497.56	2.50	70.74
95	202.3	24977792.56	2497.78	73446577.22	2593692428	2593.69	2.59	73.45
96	202.4	25492018.73	2549.20	76168657.85	2689819983	2689.82	2.69	76.17

97	202.5	26006244.56	2600.62	78890738.48	2785947539	2785.95	2.79	78.89
98	202.6	26541071.53	2654.11	81896715.47	2892100610	2892.1	2.89	81.89
99	202.7	26794584.14	2679.46	83244953.17	2939712276	2939.71	2.94	83.25
100	202.7	27075898.17	2707.59	84902692.46	2998253682	2998.25	3.00	84.89
101	202.8	27610724.8	2761.07	8908669.45	3104406753	3104.41	3.10	87.90
102	**202.9**	**28145551.43**	**2814.56**	**90914646.44**	**3210559824**	**3210.56**	**3.21**	**90.93**
103	203.0	28680378.07	2868.04	93920623.43	3316712896	3316.71	3.32	93.93
104	203.1	29294835.07	2929.48	97240646.77	3433956200	3433.96	3.43	97.24
105	203.2	29909292.07	2990.93	100560670.1	3551199504	3551.2	3.55	100.55
106	203.3	30523749.08	3052.37	103880693.5	3668442808	3668.44	3.67	103.87
107	203.4	31138206.08	3113.82	107200716.8	3785686113	3785.69	3.79	107.21
108	203.5	31752663.08	3175.27	110520740.1	3902929417	3902.93	3.90	110.52
109	203.6	32388390.95	3238.84	114185803.5	4032357463	4032.36	4.03	114.17
110	203.7	33024118.81	3302.41	117850866.8	4161785510	4161.79	4.16	117.85
111	203.8	33659846.68	3365.98	121515930.1	4291213557	4291.21	4.29	121.51
112	203.9	34295574.54	3429.56	125180993.5	4420641604	4420.64	4.42	125.19
113	204.0	34931302.4	3493.13	128846056.8	4550069650	4550.07	4.55	128.84
114	204.1	35652684.53	3565.27	132885684.7	4692725069	4692.73	4.69	132.89
115	204.2	36374066.66	3637.41	136925312.6	4835380488	4835.38	4.84	136.91
116	204.3	37095448.78	3709.54	140964940.4	4978035906	4978.04	4.98	140.96
117	204.4	37816830.91	3781.68	145004568.3	5120691325	5120.69	5.12	145.01
118	204.5	38538213.04	3853.82	149044196.2	5263346744	5263.35	5.26	149.03
119	204.6	39292449.76	3929.24	153484827.5	5420163199	5420.16	5.42	153.48
120	204.7	40046686.48	4004.67	157925458.9	5576979655	5576.98	5.58	157.92
121	204.8	40800923.2	4080.09	162366090.3	5733796111	5733.8	5.73	162.37

122	204.9	41555159.29	4155.52	166806721.6	5890612567	5890.61	5.89	166.81
123	205.0	42309396.64	4230.94	171247353	6047429022	6047.43	6.05	171.23
124	205.1	43167556.57	4316.76	176136540.7	6220085798	6220.09	6.22	176.13
125	205.2	44025736.49	4402.57	181025728.4	6392742574	6392.74	6.39	181.03
126	205.3	44883906.42	4488.39	185914916.2	6565399349	6565.4	6.57	185.90
127	205.4	45742076.35	4574.21	190804103.9	6738056125	6738.06	6.74	190.80
128	205.5	46600246.28	4660.02	195693291.6	6910712900	6910.71	6.91	195.70
129	205.6	47526865.11	4752.69	201068481.1	7100532340	7100.53	7.10	201.08
130	205.7	48453483.94	4845.35	206443670.5	7290351779	7290.35	7.29	206.43
131	205.8	49380102.77	4938.01	211818859.9	7480171219	7480.17	7.48	211.81
132	205.9	50306721.6	5030.67	217194049.3	7669990658	7669.99	7.67	217.19
133	206.0	51233340.42	5123.33	222569238.8	7859810098	7859.81	7.86	222.57
134	206.1	52215896.82	5221.59	228476476.6	8068418293	8068.42	8.07	228.46
135	206.2	53198453.21	5319.85	234383714.4	8277026489	8277.03	8.28	234.38
136	206.3	54181009.61	5418.10	240290952.1	8485634684	8485.63	8.49	240.30
137	206.4	55163566	5516.36	246198189.9	8694242879	8694.24	8.69	246.19
138	206.5	56146122.39	5614.61	252105427.7	8902851074	8902.85	8.90	252.10
139	206.6	57153574.33	5715.36	258566988.9	9131034647	9131.03	9.13	258.56
140	206.7	58161026.26	5816.10	265028550.1	9359218220	9359.22	9.36	265.02
141	206.8	59168478.19	5916.85	27149011136	9587401792	9587.4	9.59	271.47
142	206.9	60175930.12	6017.59	277951672.6	9815585365	9815.59	9.82	277.96
143	207.0	61183382.05	6118.34	284413233.8	10043768937	10043.77	10.04	284.41
144	207.1	62240207.99	6224.02	291434584.3	10291720908	10291.72	10.29	291.44
145	207.2	63297033.93	6329.70	298455934.7	10539672879	10539.67	10.54	298.46
146	207.3	64353859.86	6435.39	305477285.2	10787624849	10787.62	10.79	305.48

147	207.4	65410685.8	6541.07	312498635.7	11035576820	11035.58	11.06	313.07
148	207.5	66467511.74	6646.75	319519986.1	11283528790	11283.53	11.28	319.53
149	207.6	67464922.94	6746.49	327110958.5	11551596390	11551.6	11.55	327.12
150	207.7	68462334.15	6846.23	334701931	11819663990	11819.66	11.82	334.70
151	207.8	69459745.35	6945.97	342292903.4	12087731589	12087.73	12.09	342.29
152	207.9	70457156.55	7045.72	349883875.8	1235799189	12355.8	12.36	349.88
153	208.0	71454567.76	7145.46	357474848.2	12623866789	12623.87	12.62	357.47
154	208.1	72355181.16	7235.52	365579810.8	12910085437	12910.09	12.91	365.57
155	208.2	73255794.57	7325.58	373684773.3	13196304085	13196.3	13.20	373.67
156	208.3	74156407.98	7415.64	381789735.9	13482522733	13482.52	13.48	381.79
157	208.4	75057021.38	7505.70	389894698.5	13768741381	13768.74	13.77	389.89
158	208.5	75957634.79	7595.76	397999661	14054960029	14054.96	14.06	397.99
159	208.6	76840781.42	7684.08	410605991	14500139968	14500.14	14.50	410.59
160	208.7	77723928.05	7772.39	423212321.1	14945319907	14945.32	14.95	423.19
161	208.8	78607074.68	7860.71	435818651.1	15390499845	15390.5	15.39	435.79
162	208.9	79490221.31	7949.02	448424981.1	15835679784	15835.68	15.84	448.42
163	209.0	80373367.94	8037.34	46101311.17	16280859723	16280.86	16.28	461.02
164	209.1	81307137.38	8130.71	466118051.6	16460492874	16460.49	16.46	466.09
165	209.2	82240906.82	8224.09	471204792	16640126026	16640.13	16.64	471.19
166	209.3	83174676.26	8317.47	476291532.5	16819759177	16819.76	16.82	476.29
167	209.4	84108445.71	8410.84	481378272.9	16999392329	16999.39	17.00	481.36
168	209.5	85042215.15	8504.22	486465013.3	17179025481	17179.03	17.18	486.45
169	209.6	85976329.78	8597.63	496073962.9	17518355926	17518.36	17.52	496.05
170	209.7	86910444.41	8691.04	505682912.5	17857686371	17857.69	17.86	505.68
171	209.8	87844559.04	8784.46	515291862	18197016816	18197.02	18.20	515.28

172	209.9	88778673.66	8877.87	524900811.6	18536347261	18536.35	18.54	524.88
173	210.0	89712788.29	8971.28	534509761.2	18875677706	18875.68	18.88	534.51
174	210.1	90574989.89	9057.50	544618275.8	19232649792	19232.65	19.23	544.62
175	210.2	91437191.48	9143.72	554726790.5	19589621879	19589.62	19.59	554.73
176	210.3	92299393.08	9229.94	564835305.1	19946593965	19946.59	19.95	564.83
177	210.4	93161594.68	9316.16	574943819.8	20303566051	20303.57	20.30	574.94
178	210.5	94023796.27	9402.38	585052334.4	20660538138	20660.54	20.66	585.05
179	210.6	94860030.79	9486.00	595625035.2	21033902491	21033.9	21.03	595.61
180	210.7	95696265.31	9569.63	606197735.9	21407266845	21407.27	21.41	606.18
181	210.8	96532499.83	9653.25	616770436.6	21780631198	21780.63	21.78	616.77
182	210.9	97368734.35	9736.87	627343137.3	22153995552	22154	22.15	627.33
183	211.0	98204968.87	9820.50	637915838.1	22527359906	22527.36	22.53	637.89
184	211.1	99065854.97	9906.59	648952426.6	22917105993	22917.11	22.92	648.93
185	211.2	99926741.07	9992.67	659989015.1	23306852080	23306.85	23.31	659.98
186	211.3	100787627.2	10078.76	671025603.7	23696598168	23696.6	23.70	671.02
187	211.4	101648513.3	10164.85	682062192.2	24086344255	24086.34	24.09	682.04
188	211.5	102509399.4	10250.94	693098780.7	24476090342	24476.09	24.48	693.08
189	211.6	103555291.8	10355.53	704654958.1	24884185191	24884.19	24.88	704.63
190	211.7	104601184.2	10460.12	716211135.5	25292280040	25292.28	25.29	716.19
191	211.8	105647076.6	10564.71	727767312.9	25700374889	25700.37	25.70	727.74
192	211.9	106692968.9	10669.30	739323490.3	26108469738	26108.47	26.11	739.29
193	**212.0**	**107738861.3**	**10773.89**	**750879667.8**	**26850564587**	**26850**	**26.85**	**760.30**


Area capacity Elevation Curve Gandikota Reservoir
Area in (Ha)
12000.00
10000.00
8000.00
6000.00
4000.00
2000.00
0.00
215.0
210.0
205.0
200.0
195.0
190.0
Contour Value in (m)
Capacity
Average Area (Hac)
0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
800.00
Capacity in (MCM)

Annexure - 4.3

																	Annexure-4.3
									1 TMC	=	28.3167	MCM					
EXISTING GANDIKOTA RESERVOIR WATER AVAILABILITY STUDY FOR PROPOSED GANDIKOTA PSP														Min storage needed		**3.51**	**TMC**
	Inflows	**Out flows**															
Date	**Inflows (in Cusec)**	**GKLI (in Cusec)**	**(CBR) Lift (in Cusec)**	**GNSS Main Canal (in Cusec)**	**Mylavaram (in Cusec)**	**Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)**		**Evp. Losses (in cusec)**	**Total Inflow (TMC)**	**Total Outflow (TMC)**	**Net Inflow-Outflow**		**Initial Storage on that day**	**Final Storage on that day**	**Required Water Availability (Yes/No)**	**Water Level as per Calculated Storage (in m.)**	
1-Jun-2017						70,00,000	0.0002	30.00	0	0.00284	-0.00284		1.225	1.222	NO	200.564	
2-Jun-2017						70,00,000	0.0002	30.00	0	0.00284	-0.00284		1.222	1.219	NO	200.559	
3-Jun-2017						70,00,000	0.0002	30.00	0	0.00284	-0.00284		1.219	1.216	NO	200.555	
4-Jun-2017						70,00,000	0.0002	30.00	0	0.00284	-0.00284		1.216	1.214	NO	200.550	
5-Jun-2017						70,00,000	0.0002	30.00	0	0.00284	-0.00284		1.214	1.211	NO	200.546	
6-Jun-2017						70,00,000	0.0002	30.00	0	0.00284	-0.00284		1.211	1.208	NO	200.541	
7-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		1.208	1.206	NO	200.537	
8-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		1.206	1.203	NO	200.534	
9-Jun-2017					400.00	70,00,000	0.0002	25.00	0	0.03697	-0.03697		1.203	1.166	NO	200.471	
10-Jun-2017					400.00	70,00,000	0.0002	25.00	0	0.03697	-0.03697		1.166	1.129	NO	200.402	
11-Jun-2017					430.00	70,00,000	0.0002	25.00	0	0.03956	-0.03956		1.129	1.090	NO	200.329	
12-Jun-2017					390.00	70,00,000	0.0002	25.00	0	0.0361	-0.0361		1.090	1.054	NO	200.262	
13-Jun-2017					380.00	70,00,000	0.0002	25.00	0	0.03524	-0.03524		1.054	1.018	NO	200.197	
14-Jun-2017					360.00	70,00,000	0.0002	25.00	0	0.03351	-0.03351		1.018	0.985	NO	200.135	
15-Jun-2017					250.00	70,00,000	0.0002	25.00	0	0.02401	-0.02401		0.985	0.961	NO	200.090	
16-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.961	0.958	NO	200.086	
17-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.958	0.956	NO	200.081	
18-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.956	0.954	NO	200.077	
19-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.954	0.951	NO	200.072	
20-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.951	0.949	NO	200.067	
21-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.949	0.946	NO	200.063	
22-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.946	0.944	NO	200.058	
23-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.944	0.942	NO	200.054	
24-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.942	0.939	NO	200.049	
25-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.939	0.937	NO	200.045	
26-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.937	0.934	NO	200.040	
27-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.934	0.932	NO	200.036	
28-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.932	0.930	NO	200.031	
29-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.930	0.927	NO	200.027	
30-Jun-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.927	0.925	NO	200.022	
1-Jul-2017						70,00,000	0.0002	25.00	0	0.00241	-0.00241		0.925	0.922	NO	200.018	
2-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198		0.922	0.920	NO	200.014	
3-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198		0.920	0.918	NO	200.010	
4-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198		0.918	0.916	NO	200.006	
5-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198		0.916	0.914	NO	200.003	
6-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198		0.914	0.912	NO	199.999	
7-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198		0.912	0.910	NO	199.994	
8-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198		0.910	0.908	NO	199.990	
9-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198		0.908	0.906	NO	199.986	
10-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198		0.906	0.905	NO	199.982	
11-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198		0.905	0.903	NO	199.977	

Date	Inflows	Out flows										Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow				
12-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.903	0.901	NO	199.973
13-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.901	0.899	NO	199.969
14-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.899	0.897	NO	199.964
15-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.897	0.895	NO	199.960
16-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.895	0.893	NO	199.956
17-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.893	0.891	NO	199.951
18-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.891	0.889	NO	199.947
19-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.889	0.887	NO	199.943
20-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.887	0.885	NO	199.939
21-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.885	0.883	NO	199.934
22-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.883	0.881	NO	199.930
23-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.881	0.879	NO	199.926
24-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.879	0.877	NO	199.921
25-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.877	0.875	NO	199.917
26-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.875	0.873	NO	199.913
27-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.873	0.871	NO	199.909
28-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.871	0.869	NO	199.904
29-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.869	0.867	NO	199.900
30-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.867	0.865	NO	199.896
31-Jul-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.865	0.863	NO	199.891
1-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.863	0.861	NO	199.887
2-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.861	0.859	NO	199.882
3-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.859	0.857	NO	199.878
4-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.857	0.855	NO	199.874
5-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.855	0.853	NO	199.869
6-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.853	0.851	NO	199.865
7-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.851	0.849	NO	199.860
8-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.849	0.847	NO	199.856
9-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.847	0.845	NO	199.852
10-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.845	0.843	NO	199.847
11-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.843	0.841	NO	199.843
12-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.841	0.839	NO	199.838
13-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.839	0.837	NO	199.834
14-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.837	0.835	NO	199.830
15-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.835	0.833	NO	199.825
16-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.833	0.831	NO	199.821
17-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.831	0.829	NO	199.817
18-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.829	0.827	NO	199.812
19-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.827	0.825	NO	199.808
20-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.825	0.824	NO	199.803
21-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.824	0.822	NO	199.799
22-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.822	0.820	NO	199.795
23-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.820	0.818	NO	199.790
24-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.818	0.816	NO	199.786
25-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.816	0.814	NO	199.781
26-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.814	0.812	NO	199.777

Date	Inflows	Out flows												
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
27-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.812	0.810	NO	199.773
28-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.810	0.808	NO	199.768
29-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.808	0.806	NO	199.764
30-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.806	0.804	NO	199.759
31-Aug-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.804	0.802	NO	199.755
1-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.802	0.800	NO	199.751
2-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.800	0.798	NO	199.746
3-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.798	0.796	NO	199.742
4-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.796	0.794	NO	199.738
5-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.794	0.792	NO	199.733
6-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.792	0.790	NO	199.729
7-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.790	0.788	NO	199.724
8-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.788	0.786	NO	199.720
9-Sep-2017	100.000					70,00,000	0.0002	20.00	0.00864	0.00198	0.00666	0.786	0.793	NO	199.735
10-Sep-2017	500.000					70,00,000	0.0002	20.00	0.0432	0.00198	0.04122	0.793	0.834	NO	199.826
11-Sep-2017	200.000					70,00,000	0.0002	20.00	0.01728	0.00198	0.0153	0.834	0.849	NO	199.860
12-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.849	0.847	NO	199.856
13-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.847	0.845	NO	199.852
14-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.845	0.843	NO	199.847
15-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.843	0.841	NO	199.843
16-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.841	0.839	NO	199.838
17-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.839	0.837	NO	199.834
18-Sep-2017						70,00,000	0.0002	20.00	0	0.00198	-0.00198	0.837	0.835	NO	199.830
19-Sep-2017	300.000					70,00,000	0.0002	20.00	0.02592	0.00198	0.02394	0.835	0.859	NO	199.883
20-Sep-2017	300.000					70,00,000	0.0002	20.00	0.02592	0.00198	0.02394	0.859	0.883	NO	199.935
21-Sep-2017	200.000					70,00,000	0.0002	20.00	0.01728	0.00198	0.0153	0.883	0.899	NO	199.969
22-Sep-2017	50.000					70,00,000	0.0002	20.00	0.00432	0.00198	0.00234	0.899	0.901	NO	199.974
23-Sep-2017	50.000					70,00,000	0.0002	20.00	0.00432	0.00198	0.00234	0.901	0.903	NO	199.979
24-Sep-2017	50.000					70,00,000	0.0002	20.00	0.00432	0.00198	0.00234	0.903	0.906	NO	199.984
25-Sep-2017	50.000					70,00,000	0.0002	20.00	0.00432	0.00198	0.00234	0.906	0.908	NO	199.989
26-Sep-2017	50.000					70,00,000	0.0002	20.00	0.00432	0.00198	0.00234	0.908	0.910	NO	199.994
27-Sep-2017	100.000					70,00,000	0.0002	20.00	0.00864	0.00198	0.00666	0.910	0.917	NO	200.007
28-Sep-2017	50.000					70,00,000	0.0002	20.00	0.00432	0.00198	0.00234	0.917	0.919	NO	200.012
29-Sep-2017	250.000					70,00,000	0.0002	15.00	0.0216	0.00154	0.02006	0.919	0.939	NO	200.050
30-Sep-2017	220.000					70,00,000	0.0002	15.00	0.01901	0.00154	0.01746	0.939	0.957	NO	200.083
1-Oct-2017	300.00					70,00,000	0.0002	15.00	0.02592	0.00154	0.02438	0.957	0.981	NO	200.128
2-Oct-2017	600.00					70,00,000	0.0002	15.00	0.05184	0.00154	0.0503	0.981	1.031	NO	200.221
3-Oct-2017	891.00					70,00,000	0.0002	15.00	0.07698	0.00154	0.07544	1.031	1.107	NO	200.361
4-Oct-2017	243.00					70,00,000	0.0002	15.00	0.021	0.00154	0.01945	1.107	1.126	NO	200.397
5-Oct-2017	428.00					70,00,000	0.0002	15.00	0.03698	0.00154	0.03544	1.126	1.162	NO	200.463
6-Oct-2017	4000.00					70,00,000	0.0002	15.00	0.3456	0.00154	0.34406	1.162	1.506	NO	201.009
7-Oct-2017	1736.00					70,00,000	0.0002	15.00	0.14999	0.00154	0.14845	1.506	1.654	NO	201.207
8-Oct-2017	2778.00					70,00,000	0.0002	15.00	0.24002	0.00154	0.23848	1.654	1.893	NO	201.521
9-Oct-2017	7530.00					70,00,000	0.0002	15.00	0.65059	0.00154	0.64905	1.893	2.542	NO	202.246
10-Oct-2017	15000.00				10000.00	70,00,000	0.0002	15.00	1.296	0.86554	0.43046	2.542	2.972	NO	202.678
11-Oct-2017	10701.00					70,00,000	0.0002	15.00	0.92457	0.00154	0.92302	2.972	3.895	YES	203.493

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
12-Oct-2017	5000.00					70,00,000	0.0002	15.00	0.432	0.00154	0.43046	3.895	4.326	YES	203.827
13-Oct-2017	1547.00				1500.00	70,00,000	0.0002	15.00	0.13366	0.13114	0.00252	4.326	4.328	YES	203.829
14-Oct-2017	2000.00					70,00,000	0.0002	15.00	0.1728	0.00154	0.17126	4.328	4.500	YES	203.961
15-Oct-2017	2000.00	200.00			1800.00	70,00,000	0.0002	15.00	0.1728	0.17434	-0.00154	4.500	4.498	YES	203.960
16-Oct-2017	2000.00	300.00			1700.00	70,00,000	0.0002	15.00	0.1728	0.17434	-0.00154	4.498	4.496	YES	203.958
17-Oct-2017	2548.00	300.00			2160.00	70,00,000	0.0002	15.00	0.22015	0.21409	0.00606	4.496	4.503	YES	203.963
18-Oct-2017	2100.00	600.00			1500.00	70,00,000	0.0002	15.00	0.18144	0.18298	-0.00154	4.503	4.501	YES	203.962
19-Oct-2017	1000.00	600.00				70,00,000	0.0002	15.00	0.0864	0.05338	0.03302	4.501	4.534	YES	203.988
20-Oct-2017	800.00	450.00			200.00	70,00,000	0.0002	15.00	0.06912	0.0577	0.01142	4.534	4.545	YES	203.996
21-Oct-2017	600.00	450.00			100.00	70,00,000	0.0002	15.00	0.05184	0.04906	0.00278	4.545	4.548	YES	203.999
22-Oct-2017	700.00	350.00				70,00,000	0.0002	15.00	0.06048	0.03178	0.0287	4.548	4.577	YES	204.019
23-Oct-2017	800.00	350.00			250.00	70,00,000	0.0002	15.00	0.06912	0.05338	0.01574	4.577	4.593	YES	204.030
24-Oct-2017	850.00	350.00			370.00	70,00,000	0.0002	15.00	0.07344	0.06375	0.00969	4.593	4.602	YES	204.037
25-Oct-2017	850.00	230.00			570.00	70,00,000	0.0002	15.00	0.07344	0.07066	0.00278	4.602	4.605	YES	204.039
26-Oct-2017	900.00	350.00			580.00	70,00,000	0.0002	15.00	0.07776	0.0819	-0.00414	4.605	4.601	YES	204.036
27-Oct-2017	900.00	350.00			590.00	70,00,000	0.0002	15.00	0.07776	0.08276	-0.005	4.601	4.596	YES	204.032
28-Oct-2017	900.00	350.00			580.00	70,00,000	0.0002	15.00	0.07776	0.0819	-0.00414	4.596	4.592	YES	204.029
29-Oct-2017	900.00	350.00			650.00	70,00,000	0.0002	15.00	0.07776	0.08794	-0.01018	4.592	4.582	YES	204.022
30-Oct-2017	900.00	350.00			650.00	70,00,000	0.0002	15.00	0.07776	0.08794	-0.01018	4.582	4.571	YES	204.015
31-Oct-2017	900.00	400.00			500.00	70,00,000	0.0002	15.00	0.07776	0.0793	-0.00154	4.571	4.570	YES	204.014
1-Nov-2017	900.00	450			530.00	70,00,000	0.0002	15.00	0.07776	0.08622	-0.00846	4.570	4.561	YES	204.008
2-Nov-2017	900.00	450			480.00	70,00,000	0.0002	15.00	0.07776	0.0819	-0.00414	4.561	4.557	YES	204.005
3-Nov-2017	900.00	520			400.00	70,00,000	0.0002	15.00	0.07776	0.08103	-0.00327	4.557	4.554	YES	204.003
4-Nov-2017	880.00	570			380.00	70,00,000	0.0002	15.00	0.07603	0.08362	-0.00759	4.554	4.546	YES	203.997
5-Nov-2017	880.00	570			130.00	70,00,000	0.0002	15.00	0.07603	0.06202	0.01401	4.546	4.560	YES	204.007
6-Nov-2017	870.00	570				70,00,000	0.0002	15.00	0.07517	0.05079	0.02438	4.560	4.585	YES	204.024
7-Nov-2017	870.00	640	100			70,00,000	0.0002	15.00	0.07517	0.06548	0.00969	4.585	4.595	YES	204.031
8-Nov-2017	900.00	680	100			70,00,000	0.0002	25.00	0.07776	0.0698	0.00796	4.595	4.602	YES	204.037
9-Nov-2017	850.00	680	0			70,00,000	0.0002	25.00	0.07344	0.06116	0.01228	4.602	4.615	YES	204.045
10-Nov-2017	850.00	680	0			70,00,000	0.0002	25.00	0.07344	0.06116	0.01228	4.615	4.627	YES	204.054
11-Nov-2017	840.00	680	500			70,00,000	0.0002	25.00	0.07258	0.10436	-0.03178	4.627	4.595	YES	204.032
12-Nov-2017	820.00	680	250			70,00,000	0.0002	25.00	0.07085	0.08276	-0.01191	4.595	4.583	YES	204.023
13-Nov-2017	820.00	680	0			70,00,000	0.0002	25.00	0.07085	0.06116	0.00969	4.583	4.593	YES	204.030
14-Nov-2017	850.00	680	340			70,00,000	0.0002	25.00	0.07344	0.09054	-0.0171	4.593	4.576	YES	204.018
15-Nov-2017	1000.00	680	260			70,00,000	0.0002	25.00	0.0864	0.08362	0.00278	4.576	4.579	YES	204.020
16-Nov-2017	1100.00	680	350			70,00,000	0.0002	25.00	0.09504	0.0914	0.00364	4.579	4.582	YES	204.023
17-Nov-2017	1350.00	680	570			70,00,000	0.0002	25.00	0.11664	0.11041	0.00623	4.582	4.589	YES	204.027
18-Nov-2017	1550.00	680	500			70,00,000	0.0002	25.00	0.13392	0.10436	0.02956	4.589	4.618	YES	204.048
19-Nov-2017	2570.00	740	500			70,00,000	0.0002	25.00	0.22205	0.10954	0.1125	4.618	4.731	YES	204.127
20-Nov-2017	2933.00	790	500			70,00,000	0.0002	25.00	0.25341	0.11386	0.13955	4.731	4.870	YES	204.225
21-Nov-2017	3357.00	790	577			70,00,000	0.0002	25.00	0.29004	0.12052	0.16953	4.870	5.040	YES	204.343
22-Nov-2017	3859.00	790	500			70,00,000	0.0002	25.00	0.33342	0.11386	0.21955	5.040	5.259	YES	204.497
23-Nov-2017	3852.00	790	700			70,00,000	0.0002	25.00	0.33281	0.13114	0.20167	5.259	5.461	YES	204.626
24-Nov-2017	3425.00	790	1000			70,00,000	0.0002	25.00	0.29592	0.15706	0.13886	5.461	5.600	YES	204.715
25-Nov-2017	4106.00	790	770			70,00,000	0.0002	25.00	0.35476	0.13719	0.21757	5.600	5.817	YES	204.853
26-Nov-2017	4275.00	790	500			70,00,000	0.0002	25.00	0.36936	0.11386	0.2555	5.817	6.073	YES	205.015

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
27-Nov-2017	4075.00	790	700			70,00,000	0.0002	25.00	0.35208	0.13114	0.22094	6.073	6.294	YES	205.143
28-Nov-2017	4409.00	790	1000			70,00,000	0.0002	25.00	0.38094	0.15706	0.22387	6.294	6.518	YES	205.273
29-Nov-2017	4567.00	790	1000	100.00	700.00	70,00,000	0.0002	25.00	0.39459	0.22618	0.16841	6.518	6.686	YES	205.370
30-Nov-2017	4300.00	790	1000	100.00	2410.00	70,00,000	0.0002	25.00	0.37152	0.37393	-0.00241	6.686	6.684	YES	205.369
1-Dec-2017	4490.00	490	1000	180.00	1510.00	70,00,000	0.0002	25.00	0.38794	0.27716	0.11078	6.684	6.794	YES	205.433
2-Dec-2017	4420.00	290	1000	230.00	1550.00	70,00,000	0.0002	25.00	0.38189	0.26766	0.11423	6.794	6.909	YES	205.499
3-Dec-2017	4330.00	350	1000	230.00	1350.00	70,00,000	0.0002	25.00	0.37411	0.25556	0.11855	6.909	7.027	YES	205.561
4-Dec-2017	4360.00	350	1000	280.00	1410.00	70,00,000	0.0002	25.00	0.3767	0.26506	0.11164	7.027	7.139	YES	205.620
5-Dec-2017	4520.00	350	1000	280.00	1800.00	70,00,000	0.0002	25.00	0.39053	0.29876	0.09177	7.139	7.231	YES	205.669
6-Dec-2017	4450.00	350	1000	300.00	2770.00	70,00,000	0.0002	30.00	0.38448	0.38473	-0.00025	7.231	7.230	YES	205.668
7-Dec-2017	4480.00	350	1000	300.00	2800.00	70,00,000	0.0002	30.00	0.38707	0.38732	-0.00025	7.230	7.230	YES	205.668
8-Dec-2017	4580.00	550	1000	300.00	2700.00	70,00,000	0.0002	30.00	0.39571	0.39596	-0.00025	7.230	7.230	YES	205.668
9-Dec-2017	4580.00	790	1000	280.00	2470.00	70,00,000	0.0002	30.00	0.39571	0.3951	0.00062	7.230	7.231	YES	205.669
10-Dec-2017	4540.00	680	1000	280.00	2150.00	70,00,000	0.0002	30.00	0.39226	0.35794	0.03431	7.231	7.265	YES	205.687
11-Dec-2017	4420.00	680	1000	280.00	2500.00	70,00,000	0.0002	30.00	0.38189	0.38818	-0.0063	7.265	7.259	YES	205.683
12-Dec-2017	4420.00	750	1000	240.00	1800.00	70,00,000	0.0002	30.00	0.38189	0.3303	0.05159	7.259	7.310	YES	205.711
13-Dec-2017	4350.00	684	1000	190.00	1780.00	70,00,000	0.0002	30.00	0.37584	0.31854	0.0573	7.310	7.367	YES	205.741
14-Dec-2017	4350.00	684	1000	150.00	500.00	70,00,000	0.0002	30.00	0.37584	0.2045	0.17134	7.367	7.539	YES	205.831
15-Dec-2017	3600.00	770	1000	150.00		70,00,000	0.0002	30.00	0.31104	0.16873	0.14231	7.539	7.681	YES	205.906
16-Dec-2017	3500.00	790	1000	130.00		70,00,000	0.0002	30.00	0.3024	0.16873	0.13367	7.681	7.815	YES	205.976
17-Dec-2017	2850.00	700	1000	130.00	1000.00	70,00,000	0.0002	30.00	0.24624	0.24735	-0.00111	7.815	7.814	YES	205.976
18-Dec-2017	2100.00	680	1000	130.00	150.00	70,00,000	0.0002	30.00	0.18144	0.17218	0.00926	7.814	7.823	YES	205.980
19-Dec-2017	2700.00	500	1000	130.00	1050.00	70,00,000	0.0002	30.00	0.23328	0.23439	-0.00111	7.823	7.822	YES	205.980
20-Dec-2017	3400.00	450	1000	130.00	1750.00	70,00,000	0.0002	30.00	0.29376	0.29055	0.00321	7.822	7.825	YES	205.982
21-Dec-2017	4650.00	230	1000	80.00	3230.00	70,00,000	0.0002	30.00	0.40176	0.3951	0.00666	7.825	7.832	YES	205.985
22-Dec-2017	4100.00	0	1000	70.00	3020.00	70,00,000	0.0002	30.00	0.35424	0.35622	-0.00198	7.832	7.830	YES	205.984
23-Dec-2017	2980.00	0	1000	70.00	1900.00	70,00,000	0.0002	30.00	0.25747	0.25945	-0.00198	7.830	7.828	YES	205.983
24-Dec-2017	2350.00	0	1000	70.00	1250.00	70,00,000	0.0002	30.00	0.20304	0.20329	-0.00025	7.828	7.827	YES	205.983
25-Dec-2017	1980.00	0	1000	70.00	900.00	70,00,000	0.0002	30.00	0.17107	0.17305	-0.00198	7.827	7.826	YES	205.982
26-Dec-2017	1750.00	0	1250	150.00	300.00	70,00,000	0.0002	30.00	0.1512	0.14972	0.00148	7.826	7.827	YES	205.983
27-Dec-2017	1700.00	0	1500	150.00		70,00,000	0.0002	30.00	0.14688	0.1454	0.00148	7.827	7.828	YES	205.983
28-Dec-2017	1700.00	0	1500	150.00		70,00,000	0.0002	30.00	0.14688	0.1454	0.00148	7.828	7.830	YES	205.984
29-Dec-2017	1600.00	0	1500	150.00		70,00,000	0.0002	30.00	0.13824	0.1454	-0.00716	7.830	7.823	YES	205.980
30-Dec-2017	500.00	0	1500	150.00		70,00,000	0.0002	30.00	0.0432	0.1454	-0.1022	7.823	7.721	YES	205.927
31-Dec-2017	50.00	0	1500	180.00		70,00,000	0.0002	30.00	0.00432	0.14799	-0.14367	7.721	7.577	YES	205.851
1-Jan-2018	0.00		1500	200		70,00,000	0.0002	30.00	0	0.14972	-0.14972	7.577	7.427	YES	205.772
2-Jan-2018	1000.00		1500	200		70,00,000	0.0002	30.00	0.0864	0.14972	-0.06332	7.427	7.364	YES	205.739
3-Jan-2018	1100.00		1500	200		70,00,000	0.0002	30.00	0.09504	0.14972	-0.05468	7.364	7.309	YES	205.710
4-Jan-2018	520.00		1500	180		70,00,000	0.0002	30.00	0.04493	0.14799	-0.10306	7.309	7.206	YES	205.656
5-Jan-2018	120.00		1500	180		70,00,000	0.0002	30.00	0.01037	0.14799	-0.13762	7.206	7.069	YES	205.583
6-Jan-2018	0.00		1500	150		70,00,000	0.0002	30.00	0	0.1454	-0.1454	7.069	6.923	YES	205.506
7-Jan-2018	200.00		1000	150		70,00,000	0.0002	30.00	0.01728	0.1022	-0.08492	6.923	6.838	YES	205.458
8-Jan-2018	341.00		800	200		70,00,000	0.0002	30.00	0.02946	0.08924	-0.05978	6.838	6.778	YES	205.423
9-Jan-2018	180.00		1000	200		70,00,000	0.0002	30.00	0.01555	0.10652	-0.09097	6.778	6.687	YES	205.371
10-Jan-2018	310.00		1000	200		70,00,000	0.0002	30.00	0.02678	0.10652	-0.07974	6.687	6.608	YES	205.325
11-Jan-2018	25.00		1000	200		70,00,000	0.0002	30.00	0.00216	0.10652	-0.10436	6.608	6.503	YES	205.264

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
12-Jan-2018	20.00		1000	200		70,00,000	0.0002	30.00	0.00173	0.10652	-0.10479	6.503	6.399	YES	205.203
13-Jan-2018	20.00		1000	180		70,00,000	0.0002	30.00	0.00173	0.10479	-0.10306	6.399	6.296	YES	205.144
14-Jan-2018	10.00		1000	180		70,00,000	0.0002	30.00	0.00086	0.10479	-0.10393	6.296	6.192	YES	205.084
15-Jan-2018	0.00		1000	160		70,00,000	0.0002	30.00	0	0.10306	-0.10306	6.192	6.089	YES	205.024
16-Jan-2018	0.00		1000	160		70,00,000	0.0002	30.00	0	0.10306	-0.10306	6.089	5.985	YES	204.961
17-Jan-2018	0.00		1000	160		70,00,000	0.0002	40.00	0	0.10393	-0.10393	5.985	5.882	YES	204.894
18-Jan-2018	0.00		900	160		70,00,000	0.0002	40.00	0	0.09529	-0.09529	5.882	5.786	YES	204.833
19-Jan-2018	0.00		500	160		70,00,000	0.0002	40.00	0	0.06073	-0.06073	5.786	5.726	YES	204.795
20-Jan-2018	0.00		500	180		70,00,000	0.0002	40.00	0	0.06246	-0.06246	5.726	5.663	YES	204.755
21-Jan-2018	0.00		500	210		70,00,000	0.0002	40.00	0	0.06505	-0.06505	5.663	5.598	YES	204.713
22-Jan-2018	0.00		500	210		70,00,000	0.0002	40.00	0	0.06505	-0.06505	5.598	5.533	YES	204.672
23-Jan-2018	0.00		500	190		70,00,000	0.0002	40.00	0	0.06332	-0.06332	5.533	5.470	YES	204.632
24-Jan-2018	0.00		500	180		70,00,000	0.0002	40.00	0	0.06246	-0.06246	5.470	5.407	YES	204.592
25-Jan-2018	0.00		500	160		70,00,000	0.0002	40.00	0	0.06073	-0.06073	5.407	5.346	YES	204.553
26-Jan-2018	0.00		500	160		70,00,000	0.0002	40.00	0	0.06073	-0.06073	5.346	5.286	YES	204.514
27-Jan-2018	0.00		500	160		70,00,000	0.0002	40.00	0	0.06073	-0.06073	5.286	5.225	YES	204.473
28-Jan-2018	0.00		500	130		70,00,000	0.0002	40.00	0	0.05814	-0.05814	5.225	5.167	YES	204.432
29-Jan-2018	0.00		500	0		70,00,000	0.0002	40.00	0	0.0469	-0.0469	5.167	5.120	YES	204.399
30-Jan-2018	0.00		750	0		70,00,000	0.0002	40.00	0	0.0685	-0.0685	5.120	5.051	YES	204.351
31-Jan-2018	0.00		1000			70,00,000	0.0002	40.00	0	0.0901	-0.0901	5.051	4.961	YES	204.288
1-Feb-2018	0.00		1000			70,00,000	0.0002	40.00	0	0.0901	-0.0901	4.961	4.871	YES	204.225
2-Feb-2018			1000			70,00,000	0.0002	40.00	0	0.0901	-0.0901	4.871	4.781	YES	204.162
3-Feb-2018			1000			70,00,000	0.0002	40.00	0	0.0901	-0.0901	4.781	4.691	YES	204.099
4-Feb-2018			1000			70,00,000	0.0002	40.00	0	0.0901	-0.0901	4.691	4.601	YES	204.036
5-Feb-2018			560			70,00,000	0.0002	40.00	0	0.05209	-0.05209	4.601	4.549	YES	203.999
6-Feb-2018			500			70,00,000	0.0002	40.00	0	0.0469	-0.0469	4.549	4.502	YES	203.963
7-Feb-2018			500			70,00,000	0.0002	40.00	0	0.0469	-0.0469	4.502	4.455	YES	203.926
8-Feb-2018			250			70,00,000	0.0002	40.00	0	0.0253	-0.0253	4.455	4.430	YES	203.907
9-Feb-2018			0			70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.430	4.426	YES	203.904
10-Feb-2018			0			70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.426	4.422	YES	203.901
11-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.422	4.419	YES	203.898
12-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.419	4.415	YES	203.895
13-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.415	4.411	YES	203.892
14-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.411	4.408	YES	203.890
15-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.408	4.404	YES	203.887
16-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.404	4.400	YES	203.884
17-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.400	4.396	YES	203.881
18-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.396	4.393	YES	203.878
19-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.393	4.389	YES	203.875
20-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.389	4.385	YES	203.873
21-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.385	4.382	YES	203.870
22-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.382	4.378	YES	203.867
23-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.378	4.374	YES	203.864
24-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.374	4.371	YES	203.861
25-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.371	4.367	YES	203.858
26-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.367	4.363	YES	203.855

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
27-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.363	4.359	YES	203.853
28-Feb-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.359	4.356	YES	203.850
1-Mar-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.356	4.352	YES	203.847
2-Mar-2018		30.00				70,00,000	0.0002	40.00	0	0.0063	-0.0063	4.352	4.346	YES	203.842
3-Mar-2018		100.00				70,00,000	0.0002	40.00	0	0.01234	-0.01234	4.346	4.333	YES	203.833
4-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.333	4.320	YES	203.822
5-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.320	4.306	YES	203.812
6-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.306	4.293	YES	203.801
7-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.293	4.279	YES	203.791
8-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.279	4.266	YES	203.780
9-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.266	4.252	YES	203.770
10-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.252	4.238	YES	203.759
11-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.238	4.225	YES	203.749
12-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.225	4.211	YES	203.738
13-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.211	4.198	YES	203.728
14-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.198	4.184	YES	203.717
15-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.184	4.171	YES	203.707
16-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.171	4.157	YES	203.696
17-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.157	4.144	YES	203.686
18-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.144	4.130	YES	203.675
19-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.130	4.117	YES	203.665
20-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.117	4.103	YES	203.655
21-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.103	4.089	YES	203.644
22-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.089	4.076	YES	203.634
23-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.076	4.062	YES	203.623
24-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.062	4.049	YES	203.613
25-Mar-2018		114.00				70,00,000	0.0002	40.00	0	0.01355	-0.01355	4.049	4.035	YES	203.602
26-Mar-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.035	4.031	YES	203.600
27-Mar-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.031	4.028	YES	203.597
28-Mar-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.028	4.024	YES	203.594
29-Mar-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.024	4.020	YES	203.591
30-Mar-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.020	4.017	YES	203.588
31-Mar-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.017	4.013	YES	203.585
1-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.013	4.009	YES	203.582
2-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.009	4.006	YES	203.580
3-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.006	4.002	YES	203.577
4-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	4.002	3.998	YES	203.574
5-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.998	3.994	YES	203.571
6-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.994	3.991	YES	203.568
7-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.991	3.987	YES	203.565
8-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.987	3.983	YES	203.562
9-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.983	3.980	YES	203.559
10-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.980	3.976	YES	203.557
11-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.976	3.972	YES	203.554
12-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.972	3.969	YES	203.551
13-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.969	3.965	YES	203.548

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
14-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.965	3.961	YES	203.545
15-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.961	3.957	YES	203.542
16-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.957	3.954	YES	203.539
17-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.954	3.950	YES	203.536
18-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.950	3.946	YES	203.534
19-Apr-2018						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.946	3.943	YES	203.531
20-Apr-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.943	3.936	YES	203.526
21-Apr-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.936	3.930	YES	203.521
22-Apr-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.930	3.924	YES	203.516
23-Apr-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.924	3.917	YES	203.511
24-Apr-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.917	3.911	YES	203.506
25-Apr-2018				50.00		70,00,000	0.0002	70.00	0	0.01062	-0.01062	3.911	3.901	YES	203.498
26-Apr-2018				50.00		70,00,000	0.0002	70.00	0	0.01062	-0.01062	3.901	3.890	YES	203.489
27-Apr-2018				50.00		70,00,000	0.0002	70.00	0	0.01062	-0.01062	3.890	3.879	YES	203.480
28-Apr-2018				50.00		70,00,000	0.0002	70.00	0	0.01062	-0.01062	3.879	3.869	YES	203.471
29-Apr-2018				70.00		70,00,000	0.0002	70.00	0	0.01234	-0.01234	3.869	3.856	YES	203.460
30-Apr-2018				70.00		70,00,000	0.0002	70.00	0	0.01234	-0.01234	3.856	3.844	YES	203.450
1-May-2018				70.00		70,00,000	0.0002	70.00	0	0.01234	-0.01234	3.844	3.832	YES	203.439
2-May-2018				70.00		70,00,000	0.0002	70.00	0	0.01234	-0.01234	3.832	3.819	YES	203.428
3-May-2018				70.00		70,00,000	0.0002	70.00	0	0.01234	-0.01234	3.819	3.807	YES	203.418
4-May-2018				70.00		70,00,000	0.0002	70.00	0	0.01234	-0.01234	3.807	3.795	YES	203.407
5-May-2018				70.00		70,00,000	0.0002	70.00	0	0.01234	-0.01234	3.795	3.782	YES	203.397
6-May-2018				40.00		70,00,000	0.0002	70.00	0	0.00975	-0.00975	3.782	3.773	YES	203.389
7-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.773	3.766	YES	203.383
8-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.766	3.760	YES	203.378
9-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.760	3.754	YES	203.373
10-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.754	3.747	YES	203.367
11-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.747	3.741	YES	203.362
12-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.741	3.735	YES	203.357
13-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.735	3.728	YES	203.351
14-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.728	3.722	YES	203.346
15-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.722	3.716	YES	203.341
16-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.716	3.710	YES	203.335
17-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.710	3.703	YES	203.330
18-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.703	3.697	YES	203.325
19-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.697	3.691	YES	203.319
20-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.691	3.684	YES	203.314
21-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.684	3.678	YES	203.309
22-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.678	3.672	YES	203.303
23-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.672	3.666	YES	203.298
24-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.666	3.659	YES	203.292
25-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.659	3.653	YES	203.287
26-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.653	3.647	YES	203.282
27-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.647	3.640	YES	203.276
28-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.640	3.634	YES	203.271
29-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.634	3.628	YES	203.266

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
30-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.628	3.621	YES	203.260
31-May-2018						70,00,000	0.0002	70.00	0	0.0063	-0.0063	3.621	3.615	YES	203.255
1-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.615	3.611	YES	203.251
2-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.611	3.606	YES	203.247
3-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.606	3.601	YES	203.243
4-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.601	3.597	YES	203.239
5-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.597	3.592	YES	203.235
6-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.592	3.588	YES	203.231
7-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.588	3.583	YES	203.227
8-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.583	3.579	YES	203.224
9-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.579	3.574	YES	203.220
10-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.574	3.569	YES	203.216
11-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.569	3.565	YES	203.212
12-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.565	3.560	YES	203.208
13-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.560	3.556	YES	203.204
14-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.556	3.551	YES	203.200
15-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.551	3.547	YES	203.196
16-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.547	3.542	YES	203.192
17-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.542	3.537	YES	203.188
18-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.537	3.533	YES	203.185
19-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.533	3.528	YES	203.181
20-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.528	3.524	YES	203.177
21-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.524	3.519	YES	203.173
22-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.519	3.515	YES	203.169
23-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.515	3.510	NO	203.165
24-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.510	3.506	NO	203.161
25-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.506	3.501	NO	203.157
26-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.501	3.496	NO	203.153
27-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.496	3.492	NO	203.149
28-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.492	3.487	NO	203.146
29-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.487	3.483	NO	203.142
30-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.483	3.478	NO	203.138
31-Jul-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.478	3.474	NO	203.134
1-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.474	3.469	NO	203.130
2-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.469	3.464	NO	203.126
3-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.464	3.460	NO	203.122
4-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.460	3.455	NO	203.118
5-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.455	3.451	NO	203.114
6-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.451	3.446	NO	203.110
7-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.446	3.442	NO	203.106
8-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.442	3.437	NO	203.103
9-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.437	3.432	NO	203.099
10-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.432	3.428	NO	203.095
11-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.428	3.423	NO	203.091
12-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.423	3.419	NO	203.087
13-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.419	3.414	NO	203.083

Date	Inflows	Out flows										Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow				
14-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.414	3.410	NO	203.079
15-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.410	3.405	NO	203.075
16-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.405	3.400	NO	203.071
17-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.400	3.396	NO	203.067
18-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.396	3.391	NO	203.064
19-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.391	3.387	NO	203.060
20-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.387	3.382	NO	203.056
21-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.382	3.378	NO	203.052
22-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.378	3.373	NO	203.048
23-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.373	3.369	NO	203.044
24-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.369	3.364	NO	203.040
25-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.364	3.359	NO	203.036
26-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.359	3.355	NO	203.032
27-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.355	3.350	NO	203.028
28-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.350	3.346	NO	203.025
29-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.346	3.341	NO	203.021
30-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.341	3.337	NO	203.017
31-Aug-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.337	3.332	NO	203.013
1-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.332	3.332	NO	203.013
2-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.332	3.331	NO	203.012
3-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.331	3.331	NO	203.012
4-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.331	3.331	NO	203.012
5-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.331	3.331	NO	203.012
6-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.331	3.330	NO	203.012
7-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.330	3.330	NO	203.011
8-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.330	3.330	NO	203.011
9-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.330	3.330	NO	203.011
10-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.330	3.330	NO	203.011
11-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.330	3.329	NO	203.010
12-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.329	3.329	NO	203.010
13-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.329	3.329	NO	203.010
14-Sep-2018						70,00,000	0.0002		0	0.00025	-0.00025	3.329	3.329	NO	203.010
15-Sep-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.329	3.324	NO	203.006
16-Sep-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.324	3.319	NO	203.002
17-Sep-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.319	3.315	NO	202.998
18-Sep-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.315	3.310	NO	202.994
19-Sep-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.310	3.306	NO	202.989
20-Sep-2018						70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.306	3.301	NO	202.985
21-Sep-2018	200.00					70,00,000	0.0002	50.00	0.01728	0.00457	0.01271	3.301	3.314	NO	202.997
22-Sep-2018	200.00					70,00,000	0.0002	50.00	0.01728	0.00457	0.01271	3.314	3.327	NO	203.008
23-Sep-2018	0.00					70,00,000	0.0002	50.00	0	0.00457	-0.00457	3.327	3.322	NO	203.004
24-Sep-2018	2800.00					70,00,000	0.0002	50.00	0.24192	0.00457	0.23735	3.322	3.559	YES	203.207
25-Sep-2018	3356.00					70,00,000	0.0002	50.00	0.28996	0.00457	0.28539	3.559	3.845	YES	203.450
26-Sep-2018	4224.00					70,00,000	0.0002	50.00	0.36495	0.00457	0.36039	3.845	4.205	YES	203.733
27-Sep-2018	8044.00					70,00,000	0.0002	50.00	0.695	0.00457	0.69043	4.205	4.896	YES	204.242
28-Sep-2018	7060.00					70,00,000	0.0002	50.00	0.60998	0.00457	0.60542	4.896	5.501	YES	204.652

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
29-Sep-2018	8010.00					70,00,000	0.0002	80.00	0.69206	0.00716	0.6849	5.501	6.186	YES	205.080
30-Sep-2018	9320.00					70,00,000	0.0002	80.00	0.80525	0.00716	0.79809	6.186	6.984	YES	205.538
1-Oct-2018	8760.00					70,00,000	0.0002	80.00	0.75686	0.00716	0.7497	6.984	7.734	YES	205.933
2-Oct-2018	9128.00					70,00,000	0.0002	100.00	0.78866	0.00889	0.77977	7.734	8.513	YES	206.313
3-Oct-2018	9047.00					70,00,000	0.0002	100.00	0.78166	0.00889	0.77277	8.513	9.286	YES	206.668
4-Oct-2018	10023.00					70,00,000	0.0002	100.00	0.86599	0.00889	0.8571	9.286	10.143	YES	207.040
5-Oct-2018	8102.00					70,00,000	0.0002	100.00	0.70001	0.00889	0.69113	10.143	10.834	YES	207.317
6-Oct-2018	8830.00					70,00,000	0.0002	100.00	0.76291	0.00889	0.75402	10.834	11.588	YES	207.614
7-Oct-2018	7450.00		1000.00		0.00	70,00,000	0.0002	100.00	0.64368	0.09529	0.54839	11.588	12.137	YES	207.818
8-Oct-2018	7170.00		1000.00	450.00	5670.00	70,00,000	0.0002	91.00	0.61949	0.62328	-0.00379	12.137	12.133	YES	207.817
9-Oct-2018	7230.00		1000.00	400.00	5900.00	70,00,000	0.0002	91.00	0.62467	0.63883	-0.01416	12.133	12.119	YES	207.812
10-Oct-2018	6500.00	200.00	1000.00	400.00	4900.00	70,00,000	0.0002	50.00	0.5616	0.56617	-0.00457	12.119	12.114	YES	207.810
11-Oct-2018	6250.00	300.00	1000.00	300.00	4650.00	70,00,000	0.0002	50.00	0.54	0.54457	-0.00457	12.114	12.110	YES	207.808
12-Oct-2018	5900.00	400.00	1000.00	300.00	4200.00	70,00,000	0.0002	50.00	0.50976	0.51433	-0.00457	12.110	12.105	YES	207.806
13-Oct-2018	4200.00	400.00	1000.00	300.00	3500.00	70,00,000	0.0002	50.00	0.36288	0.45385	-0.09097	12.105	12.014	YES	207.772
14-Oct-2018	2300.00	600.00	1000.00	300.00	400.00	70,00,000	0.0002	50.00	0.19872	0.20329	-0.00457	12.014	12.010	YES	207.771
15-Oct-2018	1600.00	600.00	1000.00	300.00		70,00,000	0.0002	50.00	0.13824	0.16873	-0.03049	12.010	11.979	YES	207.759
16-Oct-2018	1000.00	600.00	1000.00	300.00		70,00,000	0.0002	50.00	0.0864	0.16873	-0.08233	11.979	11.897	YES	207.729
17-Oct-2018	600.00	600.00	1000.00	300.00		70,00,000	0.0002	50.00	0.05184	0.16873	-0.11689	11.897	11.780	YES	207.685
18-Oct-2018	200.00	600.00	1000.00	300.00		70,00,000	0.0002	50.00	0.01728	0.16873	-0.15145	11.780	11.629	YES	207.629
19-Oct-2018	200.00	600.00		300.00		70,00,000	0.0002	50.00	0.01728	0.08233	-0.06505	11.629	11.563	YES	207.604
20-Oct-2018	200.00	600.00		300.00		70,00,000	0.0002	50.00	0.01728	0.08233	-0.06505	11.563	11.498	YES	207.580
21-Oct-2018	350.00	600.00	1000.00	300.00		70,00,000	0.0002	50.00	0.03024	0.16873	-0.13849	11.498	11.360	YES	207.528
22-Oct-2018		600.00	1000.00	300.00		70,00,000	0.0002	50.00	0	0.16873	-0.16873	11.360	11.191	YES	207.459
23-Oct-2018		600.00	1000.00	300.00		70,00,000	0.0002	50.00	0	0.16873	-0.16873	11.191	11.022	YES	207.387
24-Oct-2018		600.00	1000.00	300.00		70,00,000	0.0002	50.00	0	0.16873	-0.16873	11.022	10.854	YES	207.325
25-Oct-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	10.854	10.642	YES	207.241
26-Oct-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	10.642	10.430	YES	207.156
27-Oct-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	10.430	10.218	YES	207.070
28-Oct-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	10.218	10.006	YES	206.983
29-Oct-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	10.006	9.794	YES	206.890
30-Oct-2018		600.00	1000.00	300.00		70,00,000	0.0002	50.00	0	0.16873	-0.16873	9.794	9.625	YES	206.817
31-Oct-2018		600.00	1000.00	300.00		70,00,000	0.0002	50.00	0	0.16873	-0.16873	9.625	9.457	YES	206.743
1-Nov-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	9.457	9.245	YES	206.650
2-Nov-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	9.245	9.033	YES	206.557
3-Nov-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	9.033	8.821	YES	206.461
4-Nov-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	8.821	8.609	YES	206.359
5-Nov-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	8.609	8.397	YES	206.257
6-Nov-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	8.397	8.185	YES	206.156
7-Nov-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	8.185	7.973	YES	206.054
8-Nov-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	7.973	7.761	YES	205.948
9-Nov-2018		600.00	1500.00	300.00		70,00,000	0.0002	50.00	0	0.21193	-0.21193	7.761	7.549	YES	205.836
10-Nov-2018		600.00	1500.00	260.00		70,00,000	0.0002	50.00	0	0.20847	-0.20847	7.549	7.341	YES	205.727
11-Nov-2018		600.00	1500.00	260.00		70,00,000	0.0002	50.00	0	0.20847	-0.20847	7.341	7.132	YES	205.617
12-Nov-2018		600.00	1130.00	260.00		70,00,000	0.0002	50.00	0	0.1765	-0.1765	7.132	6.956	YES	205.524
13-Nov-2018		660.00	1070.00	260.00		70,00,000	0.0002	85.00	0	0.17953	-0.17953	6.956	6.776	YES	205.422

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
14-Nov-2018		660.00	790.00	260.00		70,00,000	0.0002	85.00	0	0.15534	-0.15534	6.776	6.621	YES	205.332
15-Nov-2018		660.00	100.00	260.00		70,00,000	0.0002	85.00	0	0.09572	-0.09572	6.621	6.525	YES	205.277
16-Nov-2018		660.00		260.00		70,00,000	0.0002	85.00	0	0.08708	-0.08708	6.525	6.438	YES	205.226
17-Nov-2018		660.00	1070.00	220.00		70,00,000	0.0002	85.00	0	0.17607	-0.17607	6.438	6.262	YES	205.124
18-Nov-2018		330.00	600.00	200.00		70,00,000	0.0002	85.00	0	0.10522	-0.10522	6.262	6.157	YES	205.064
19-Nov-2018		220.00	100.00	200.00		70,00,000	0.0002	85.00	0	0.05252	-0.05252	6.157	6.104	YES	205.033
20-Nov-2018		220.00	0.00	160.00		70,00,000	0.0002	85.00	0	0.04042	-0.04042	6.104	6.064	YES	205.010
21-Nov-2018				160.00		70,00,000	0.0002	85.00	0	0.02142	-0.02142	6.064	6.043	YES	204.997
22-Nov-2018						70,00,000	0.0002	60.00	0	0.00543	-0.00543	6.043	6.037	YES	204.994
23-Nov-2018						70,00,000	0.0002	60.00	0	0.00543	-0.00543	6.037	6.032	YES	204.990
24-Nov-2018						70,00,000	0.0002	60.00	0	0.00543	-0.00543	6.032	6.026	YES	204.987
25-Nov-2018			450.00			70,00,000	0.0002	75.00	0	0.04561	-0.04561	6.026	5.981	YES	204.957
26-Nov-2018			534.00			70,00,000	0.0002	85.00	0	0.05373	-0.05373	5.981	5.927	YES	204.923
27-Nov-2018		50.00	534.00			70,00,000	0.0002	85.00	0	0.05805	-0.05805	5.927	5.869	YES	204.886
28-Nov-2018		220.00	534.00			70,00,000	0.0002	85.00	0	0.07274	-0.07274	5.869	5.796	YES	204.840
29-Nov-2018		220.00	534.00			70,00,000	0.0002	85.00	0	0.07274	-0.07274	5.796	5.723	YES	204.793
30-Nov-2018		220.00	534.00			70,00,000	0.0002	85.00	0	0.07274	-0.07274	5.723	5.651	YES	204.747
1-Dec-2018		220.00	534			70,00,000	0.0002	85.00	0	0.07274	-0.07274	5.651	5.578	YES	204.701
2-Dec-2018		220.00	534			70,00,000	0.0002	85.00	0	0.07274	-0.07274	5.578	5.505	YES	204.654
3-Dec-2018		220.00	534			70,00,000	0.0002	85.00	0	0.07274	-0.07274	5.505	5.432	YES	204.608
4-Dec-2018		280.00	534			70,00,000	0.0002	85.00	0	0.07792	-0.07792	5.432	5.355	YES	204.558
5-Dec-2018		220.00	534	150.00		70,00,000	0.0002	85.00	0	0.0857	-0.0857	5.355	5.269	YES	204.504
6-Dec-2018		220.00	700	150.00		70,00,000	0.0002	85.00	0	0.10004	-0.10004	5.269	5.169	YES	204.434
7-Dec-2018		220.00		150.00		70,00,000	0.0002	85.00	0	0.03956	-0.03956	5.169	5.129	YES	204.406
8-Dec-2018		220.00	350	150.00		70,00,000	0.0002	85.00	0	0.0698	-0.0698	5.129	5.059	YES	204.357
9-Dec-2018		220.00	270	150.00		70,00,000	0.0002	85.00	0	0.06289	-0.06289	5.059	4.997	YES	204.313
10-Dec-2018		220.00		100.00		70,00,000	0.0002	85.00	0	0.03524	-0.03524	4.997	4.961	YES	204.288
11-Dec-2018		220.00		150.00		70,00,000	0.0002	85.00	0	0.03956	-0.03956	4.961	4.922	YES	204.261
12-Dec-2018		220.00		100.00		70,00,000	0.0002	85.00	0	0.03524	-0.03524	4.922	4.887	YES	204.236
13-Dec-2018		220.00		80.00		70,00,000	0.0002	85.00	0	0.03351	-0.03351	4.887	4.853	YES	204.213
14-Dec-2018		220.00				70,00,000	0.0002	70.00	0	0.0253	-0.0253	4.853	4.828	YES	204.195
15-Dec-2018		220.00				70,00,000	0.0002	70.00	0	0.0253	-0.0253	4.828	4.802	YES	204.177
16-Dec-2018		220.00				70,00,000	0.0002	70.00	0	0.0253	-0.0253	4.802	4.777	YES	204.159
17-Dec-2018		220.00				70,00,000	0.0002	70.00	0	0.0253	-0.0253	4.777	4.752	YES	204.141
18-Dec-2018				100.00		70,00,000	0.0002	60.00	0	0.01407	-0.01407	4.752	4.738	YES	204.131
19-Dec-2018				100.00		70,00,000	0.0002	50.00	0	0.01321	-0.01321	4.738	4.725	YES	204.122
20-Dec-2018				100.00		70,00,000	0.0002	50.00	0	0.01321	-0.01321	4.725	4.711	YES	204.113
21-Dec-2018				100.00		70,00,000	0.0002	50.00	0	0.01321	-0.01321	4.711	4.698	YES	204.104
22-Dec-2018				100.00		70,00,000	0.0002	50.00	0	0.01321	-0.01321	4.698	4.685	YES	204.094
23-Dec-2018				60.00		70,00,000	0.0002	50.00	0	0.00975	-0.00975	4.685	4.675	YES	204.088
24-Dec-2018				60.00		70,00,000	0.0002	50.00	0	0.00975	-0.00975	4.675	4.665	YES	204.081
25-Dec-2018				60.00		70,00,000	0.0002	50.00	0	0.00975	-0.00975	4.665	4.656	YES	204.074
26-Dec-2018				60.00		70,00,000	0.0002	50.00	0	0.00975	-0.00975	4.656	4.646	YES	204.067
27-Dec-2018				60.00		70,00,000	0.0002	50.00	0	0.00975	-0.00975	4.646	4.636	YES	204.060
28-Dec-2018				60.00		70,00,000	0.0002	45.00	0	0.00932	-0.00932	4.636	4.627	YES	204.054
29-Dec-2018				60.00		70,00,000	0.0002	45.00	0	0.00932	-0.00932	4.627	4.617	YES	204.047

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
30-Dec-2018				60.00		70,00,000	0.0002	45.00	0	0.00932	-0.00932	4.617	4.608	YES	204.041
31-Dec-2018				60.00		70,00,000	0.0002	45.00	0	0.00932	-0.00932	4.608	4.599	YES	204.034
1-Jan-2019			60.00			70,00,000	0.0002	45	0	0.00932	-0.00932	4.599	4.590	YES	204.028
2-Jan-2019			60.00			70,00,000	0.0002	45	0	0.00932	-0.00932	4.590	4.580	YES	204.021
3-Jan-2019			60.00			70,00,000	0.0002	45	0	0.00932	-0.00932	4.580	4.571	YES	204.015
4-Jan-2019			60.00			70,00,000	0.0002	45	0	0.00932	-0.00932	4.571	4.562	YES	204.008
5-Jan-2019			60.00			70,00,000	0.0002	45	0	0.00932	-0.00932	4.562	4.552	YES	204.002
6-Jan-2019			60.00			70,00,000	0.0002	45	0	0.00932	-0.00932	4.552	4.543	YES	203.995
7-Jan-2019			50.00			70,00,000	0.0002	40	0	0.00802	-0.00802	4.543	4.535	YES	203.988
8-Jan-2019			50.00			70,00,000	0.0002	40	0	0.00802	-0.00802	4.535	4.527	YES	203.982
9-Jan-2019			50.00			70,00,000	0.0002	40	0	0.00802	-0.00802	4.527	4.519	YES	203.976
10-Jan-2019			50.00			70,00,000	0.0002	40	0	0.00802	-0.00802	4.519	4.511	YES	203.970
11-Jan-2019			50.00			70,00,000	0.0002	40	0	0.00802	-0.00802	4.511	4.503	YES	203.963
12-Jan-2019			30.00			70,00,000	0.0002	40	0	0.0063	-0.0063	4.503	4.497	YES	203.959
13-Jan-2019			30.00			70,00,000	0.0002	40	0	0.0063	-0.0063	4.497	4.490	YES	203.954
14-Jan-2019			30.00			70,00,000	0.0002	40	0	0.0063	-0.0063	4.490	4.484	YES	203.949
15-Jan-2019			30.00			70,00,000	0.0002	40	0	0.0063	-0.0063	4.484	4.478	YES	203.944
16-Jan-2019			30.00			70,00,000	0.0002	35	0	0.00586	-0.00586	4.478	4.472	YES	203.939
17-Jan-2019			30.00			70,00,000	0.0002	35	0	0.00586	-0.00586	4.472	4.466	YES	203.935
18-Jan-2019			30.00			70,00,000	0.0002	35	0	0.00586	-0.00586	4.466	4.460	YES	203.930
19-Jan-2019			0.00			70,00,000	0.0002	35	0	0.00327	-0.00327	4.460	4.457	YES	203.928
20-Jan-2019			0.00			70,00,000	0.0002	35	0	0.00327	-0.00327	4.457	4.454	YES	203.925
21-Jan-2019			50.00			70,00,000	0.0002	35	0	0.00759	-0.00759	4.454	4.446	YES	203.919
22-Jan-2019			80.00			70,00,000	0.0002	35	0	0.01018	-0.01018	4.446	4.436	YES	203.911
23-Jan-2019			80.00			70,00,000	0.0002	35	0	0.01018	-0.01018	4.436	4.426	YES	203.904
24-Jan-2019			60.00			70,00,000	0.0002	35	0	0.00846	-0.00846	4.426	4.417	YES	203.897
25-Jan-2019			60.00			70,00,000	0.0002	35	0	0.00846	-0.00846	4.417	4.409	YES	203.890
26-Jan-2019			60.00			70,00,000	0.0002	35	0	0.00846	-0.00846	4.409	4.400	YES	203.884
27-Jan-2019			50.00			70,00,000	0.0002	35	0	0.00759	-0.00759	4.400	4.393	YES	203.878
28-Jan-2019			50.00			70,00,000	0.0002	35	0	0.00759	-0.00759	4.393	4.385	YES	203.872
29-Jan-2019			50.00			70,00,000	0.0002	30	0	0.00716	-0.00716	4.385	4.378	YES	203.867
30-Jan-2019			50.00			70,00,000	0.0002	30	0	0.00716	-0.00716	4.378	4.371	YES	203.861
31-Jan-2019			50.00			70,00,000	0.0002	30	0	0.00716	-0.00716	4.371	4.364	YES	203.856
1-Feb-2019				50.00		70,00,000	0.0002	30	0	0.00716	-0.00716	4.364	4.356	YES	203.850
2-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.356	4.354	YES	203.848
3-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.354	4.351	YES	203.846
4-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.351	4.348	YES	203.844
5-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.348	4.345	YES	203.842
6-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.345	4.342	YES	203.839
7-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.342	4.339	YES	203.837
8-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.339	4.336	YES	203.835
9-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.336	4.334	YES	203.833
10-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.334	4.331	YES	203.831
11-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.331	4.328	YES	203.828
12-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.328	4.325	YES	203.826
13-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.325	4.322	YES	203.824

Date	Inflows	Out flows												
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
14-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.322	4.319	YES	203.822
15-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.319	4.317	YES	203.820
16-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.317	4.314	YES	203.818
17-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.314	4.311	YES	203.815
18-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.311	4.308	YES	203.813
19-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.308	4.305	YES	203.811
20-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.305	4.302	YES	203.809
21-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.302	4.300	YES	203.807
22-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.300	4.297	YES	203.804
23-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.297	4.294	YES	203.802
24-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.294	4.291	YES	203.800
25-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.291	4.288	YES	203.798
26-Feb-2019				0.00		70,00,000	0.0002	30	0	0.00284	-0.00284	4.288	4.285	YES	203.796
27-Feb-2019				0.00		70,00,000	0.0002	35	0	0.00327	-0.00327	4.285	4.282	YES	203.793
28-Feb-2019				0.00		70,00,000	0.0002	35	0	0.00327	-0.00327	4.282	4.279	YES	203.791
1-Mar-2019				0.00		70,00,000	0.0002	35.00	0	0.00327	-0.00327	4.279	4.276	YES	203.788
2-Mar-2019				0.00		70,00,000	0.0002	35.00	0	0.00327	-0.00327	4.276	4.272	YES	203.786
3-Mar-2019				0.00		70,00,000	0.0002	35.00	0	0.00327	-0.00327	4.272	4.269	YES	203.783
4-Mar-2019				0.00		70,00,000	0.0002	35.00	0	0.00327	-0.00327	4.269	4.266	YES	203.780
5-Mar-2019				0.00		70,00,000	0.0002	35.00	0	0.00327	-0.00327	4.266	4.262	YES	203.778
6-Mar-2019				0.00		70,00,000	0.0002	35.00	0	0.00327	-0.00327	4.262	4.259	YES	203.775
7-Mar-2019				0.00		70,00,000	0.0002	35.00	0	0.00327	-0.00327	4.259	4.256	YES	203.773
8-Mar-2019				0.00	600.00	70,00,000	0.0002	35.00	0	0.05511	-0.05511	4.256	4.201	YES	203.730
9-Mar-2019				0.00	600.00	70,00,000	0.0002	35.00	0	0.05511	-0.05511	4.201	4.146	YES	203.687
10-Mar-2019				0.00	590.00	70,00,000	0.0002	35.00	0	0.05425	-0.05425	4.146	4.091	YES	203.646
11-Mar-2019				0.00	520.00	70,00,000	0.0002	40.00	0	0.04863	-0.04863	4.091	4.043	YES	203.608
12-Mar-2019				0.00	700.00	70,00,000	0.0002	40.00	0	0.06418	-0.06418	4.043	3.979	YES	203.559
13-Mar-2019				0.00	850.00	70,00,000	0.0002	40.00	0	0.07714	-0.07714	3.979	3.902	YES	203.499
14-Mar-2019				0.00	1010.00	70,00,000	0.0002	40.00	0	0.09097	-0.09097	3.902	3.811	YES	203.421
15-Mar-2019				0.00	1030.00	70,00,000	0.0002	40.00	0	0.0927	-0.0927	3.811	3.718	YES	203.342
16-Mar-2019				0.00	1068.00	70,00,000	0.0002	40.00	0	0.09598	-0.09598	3.718	3.622	YES	203.261
17-Mar-2019				0.00	926.00	70,00,000	0.0002	40.00	0	0.08371	-0.08371	3.622	3.538	YES	203.189
18-Mar-2019				0.00	636.00	70,00,000	0.0002	40.00	0	0.05865	-0.05865	3.538	3.480	NO	203.139
19-Mar-2019				0.00	580.00	70,00,000	0.0002	40.00	0	0.05382	-0.05382	3.480	3.426	NO	203.093
20-Mar-2019				0.00	400.00	70,00,000	0.0002	40.00	0	0.03826	-0.03826	3.426	3.387	NO	203.060
21-Mar-2019				0.00	272.00	70,00,000	0.0002	40.00	0	0.0272	-0.0272	3.387	3.360	NO	203.037
22-Mar-2019				0.00	191.00	70,00,000	0.0002	40.00	0	0.02021	-0.02021	3.360	3.340	NO	203.020
23-Mar-2019				0.00	120.00	70,00,000	0.0002	40.00	0	0.01407	-0.01407	3.340	3.326	NO	203.008
24-Mar-2019				0.00	0.00	70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.326	3.322	NO	203.004
25-Mar-2019				0.00	0.00	70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.322	3.319	NO	203.001
26-Mar-2019				0.00	0.00	70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.319	3.315	NO	202.998
27-Mar-2019				0.00	0.00	70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.315	3.311	NO	202.994
28-Mar-2019				0.00	0.00	70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.311	3.307	NO	202.991
29-Mar-2019				0.00		70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.307	3.304	NO	202.987
30-Mar-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.304	3.300	NO	202.984
31-Mar-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	3.300	3.296	NO	202.980

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow		Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
1-Apr-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.296	3.293	NO	202.977
2-Apr-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.293	3.289	NO	202.974
3-Apr-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.289	3.285	NO	202.970
4-Apr-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.285	3.282	NO	202.967
5-Apr-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.282	3.278	NO	202.963
6-Apr-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.278	3.274	NO	202.960
7-Apr-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.274	3.270	NO	202.956
8-Apr-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.270	3.267	NO	202.953
9-Apr-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.267	3.263	NO	202.949
10-Apr-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.263	3.259	NO	202.946
11-Apr-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.259	3.256	NO	202.942
12-Apr-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.256	3.252	NO	202.939
13-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.252	3.248	NO	202.935
14-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.248	3.244	NO	202.931
15-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.244	3.239	NO	202.927
16-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.239	3.235	NO	202.923
17-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.235	3.231	NO	202.919
18-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.231	3.227	NO	202.915
19-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.227	3.223	NO	202.911
20-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.223	3.219	NO	202.907
21-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.219	3.215	NO	202.903
22-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.215	3.211	NO	202.900
23-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.211	3.206	NO	202.896
24-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.206	3.202	NO	202.892
25-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.202	3.198	NO	202.888
26-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.198	3.194	NO	202.884
27-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.194	3.190	NO	202.880
28-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.190	3.186	NO	202.876
29-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.186	3.182	NO	202.873
30-Apr-2019						70,00,000	0.0002	45.00	0	0.00414	-0.00414		3.182	3.177	NO	202.869
1-May-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.177	3.174	NO	202.865
2-May-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.174	3.170	NO	202.862
3-May-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.170	3.166	NO	202.858
4-May-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.166	3.163	NO	202.855
5-May-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.163	3.159	NO	202.851
6-May-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.159	3.155	NO	202.848
7-May-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		3.155	3.152	NO	202.844
8-May-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		3.152	3.147	NO	202.840
9-May-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		3.147	3.142	NO	202.836
10-May-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		3.142	3.138	NO	202.832
11-May-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		3.138	3.133	NO	202.827
12-May-2019					700.00	70,00,000	0.0002	50.00	0	0.06505	-0.06505		3.133	3.068	NO	202.766
13-May-2019					1000.00	70,00,000	0.0002	50.00	0	0.09097	-0.09097		3.068	2.977	NO	202.682
14-May-2019					810.00	70,00,000	0.0002	50.00	0	0.07455	-0.07455		2.977	2.903	NO	202.611
15-May-2019					1040.00	70,00,000	0.0002	50.00	0	0.09442	-0.09442		2.903	2.808	NO	202.521
16-May-2019					868.00	70,00,000	0.0002	50.00	0	0.07956	-0.07956		2.808	2.729	NO	202.440

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow		Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
17-May-2019					850.00	70,00,000	0.0002	50.00	0	0.07801	-0.07801		2.729	2.651	NO	202.359
18-May-2019					694.00	70,00,000	0.0002	50.00	0	0.06453	-0.06453		2.651	2.586	NO	202.292
19-May-2019					868.00	70,00,000	0.0002	50.00	0	0.07956	-0.07956		2.586	2.507	NO	202.209
20-May-2019					810.00	70,00,000	0.0002	50.00	0	0.07455	-0.07455		2.507	2.432	NO	202.132
21-May-2019					702.00	70,00,000	0.0002	50.00	0	0.06522	-0.06522		2.432	2.367	NO	202.064
22-May-2019					750.00	70,00,000	0.0002	50.00	0	0.06937	-0.06937		2.367	2.297	NO	201.991
23-May-2019					670.00	70,00,000	0.0002	50.00	0	0.06246	-0.06246		2.297	2.235	NO	201.919
24-May-2019					586.00	70,00,000	0.0002	50.00	0	0.0552	-0.0552		2.235	2.180	NO	201.854
25-May-2019					480.00	70,00,000	0.0002	50.00	0	0.04604	-0.04604		2.180	2.134	NO	201.801
26-May-2019						70,00,000	0.0002	150.00	0	0.01321	-0.01321		2.134	2.121	NO	201.786
27-May-2019						70,00,000	0.0002	150.00	0	0.01321	-0.01321		2.121	2.107	NO	201.770
28-May-2019						70,00,000	0.0002	150.00	0	0.01321	-0.01321		2.107	2.094	NO	201.755
29-May-2019						70,00,000	0.0002	150.00	0	0.01321	-0.01321		2.094	2.081	NO	201.739
30-May-2019						70,00,000	0.0002	150.00	0	0.01321	-0.01321		2.081	2.068	NO	201.724
31-May-2019						70,00,000	0.0002	150.00	0	0.01321	-0.01321		2.068	2.055	NO	201.709
1-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.055	2.050	NO	201.703
2-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.050	2.045	NO	201.698
3-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.045	2.041	NO	201.693
4-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.041	2.036	NO	201.688
5-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.036	2.032	NO	201.682
6-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.032	2.027	NO	201.677
7-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.027	2.023	NO	201.672
8-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.023	2.018	NO	201.666
9-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.018	2.013	NO	201.661
10-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.013	2.009	NO	201.656
11-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.009	2.004	NO	201.650
12-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.004	2.000	NO	201.645
13-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		2.000	1.995	NO	201.640
14-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.995	1.991	NO	201.634
15-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.991	1.986	NO	201.629
16-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.986	1.981	NO	201.624
17-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.981	1.977	NO	201.618
18-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.977	1.972	NO	201.613
19-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.972	1.968	NO	201.608
20-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.968	1.963	NO	201.603
21-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.963	1.959	NO	201.597
22-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.959	1.954	NO	201.592
23-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.954	1.949	NO	201.587
24-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.949	1.945	NO	201.581
25-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.945	1.940	NO	201.576
26-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.940	1.936	NO	201.571
27-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.936	1.931	NO	201.565
28-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.931	1.927	NO	201.560
29-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.927	1.922	NO	201.555
30-Jun-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.922	1.918	NO	201.549
1-Jul-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457		1.918	1.913	NO	201.544

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
2-Jul-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457	1.913	1.908	NO	201.539
3-Jul-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457	1.908	1.904	NO	201.534
4-Jul-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457	1.904	1.899	NO	201.528
5-Jul-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457	1.899	1.895	NO	201.523
6-Jul-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457	1.895	1.890	NO	201.518
7-Jul-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457	1.890	1.886	NO	201.512
8-Jul-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457	1.886	1.881	NO	201.507
9-Jul-2019						70,00,000	0.0002	50.00	0	0.00457	-0.00457	1.881	1.876	NO	201.502
10-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.876	1.873	NO	201.497
11-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.873	1.869	NO	201.492
12-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.869	1.865	NO	201.487
13-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.865	1.862	NO	201.482
14-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.862	1.858	NO	201.477
15-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.858	1.854	NO	201.472
16-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.854	1.850	NO	201.467
17-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.850	1.847	NO	201.462
18-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.847	1.843	NO	201.457
19-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.843	1.839	NO	201.453
20-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.839	1.836	NO	201.448
21-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.836	1.832	NO	201.443
22-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.832	1.828	NO	201.438
23-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.828	1.825	NO	201.433
24-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.825	1.821	NO	201.428
25-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.821	1.817	NO	201.423
26-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.817	1.813	NO	201.418
27-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.813	1.810	NO	201.413
28-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.810	1.806	NO	201.408
29-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.806	1.802	NO	201.403
30-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.802	1.799	NO	201.398
31-Jul-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.799	1.795	NO	201.393
1-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.795	1.791	NO	201.388
2-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.791	1.788	NO	201.384
3-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.788	1.784	NO	201.379
4-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.784	1.780	NO	201.374
5-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.780	1.776	NO	201.369
6-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.776	1.773	NO	201.364
7-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.773	1.769	NO	201.359
8-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.769	1.765	NO	201.354
9-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.765	1.762	NO	201.350
10-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.762	1.758	NO	201.345
11-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.758	1.754	NO	201.340
12-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.754	1.751	NO	201.335
13-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.751	1.747	NO	201.330
14-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.747	1.743	NO	201.325
15-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.743	1.739	NO	201.320
16-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037	1.739	1.736	NO	201.315

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow		Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
17-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		1.736	1.732	NO	201.311
18-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		1.732	1.728	NO	201.306
19-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		1.728	1.725	NO	201.301
20-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		1.725	1.721	NO	201.296
21-Aug-2019						70,00,000	0.0002	40.00	0	0.0037	-0.0037		1.721	1.717	NO	201.291
22-Aug-2019	8206.00					70,00,000	0.0002	40.00	0.709	0.0037	0.7053		1.717	2.422	NO	202.122
23-Aug-2019	10100.00					70,00,000	0.0002	40.00	0.87264	0.0037	0.86894		2.422	3.291	NO	202.976
24-Aug-2019	10731.00					70,00,000	0.0002	40.00	0.92716	0.0037	0.92346		3.291	4.215	YES	203.741
25-Aug-2019	10857.00					70,00,000	0.0002	40.00	0.93804	0.0037	0.93434		4.215	5.149	YES	204.420
26-Aug-2019	9872.00	100.00	300.00	500.00	500.00	70,00,000	0.0002	40.00	0.85294	0.12466	0.72828		5.149	5.877	YES	204.891
27-Aug-2019	8428.00	400.00	500.00	500.00	500.00	70,00,000	0.0002	40.00	0.72818	0.16786	0.56032		5.877	6.438	YES	205.226
28-Aug-2019	7725.00	600.00	500.00	1000.00	500.00	70,00,000	0.0002	40.00	0.66744	0.22834	0.4391		6.438	6.877	YES	205.480
29-Aug-2019	7893.00	600.00	700.00	1000.00	500.00	70,00,000	0.0002	40.00	0.68196	0.24562	0.43633		6.877	7.313	YES	205.712
30-Aug-2019	8300.00	700.00	700.00	1500.00	1200.00	70,00,000	0.0002	40.00	0.71712	0.35794	0.35918		7.313	7.672	YES	205.901
31-Aug-2019	7832.00	770.00	900.00	1500.00	2000.00	70,00,000	0.0002	40.00	0.67668	0.45039	0.22629		7.672	7.899	YES	206.019
1-Sep-2019	7700.00	850.00	1500.00	900.00	4000.00	70,00,000	0.0002	40.00	0.66528	0.6301	0.03518		7.899	7.934	YES	206.036
2-Sep-2019	9300.00	850.00	1500.00	1000.00	5000.00	70,00,000	0.0002	40.00	0.80352	0.72514	0.07838		7.934	8.012	YES	206.073
3-Sep-2019	8900.00	770.00	1000.00	1000.00	5060.00	70,00,000	0.0002	40.00	0.76896	0.68022	0.08874		8.012	8.101	YES	206.116
4-Sep-2019	8830.00	770.00	1000.00	1100.00	5100.00	70,00,000	0.0002	40.00	0.76291	0.69231	0.0706		8.101	8.172	YES	206.150
5-Sep-2019	9470.00	770.00	1000.00	1000.00	2500.00	70,00,000	0.0002	40.00	0.81821	0.45903	0.35918		8.172	8.531	YES	206.322
6-Sep-2019	9921.00	770.00	1500.00	1000.00	2600.00	70,00,000	0.0002	40.00	0.85717	0.51087	0.3463		8.531	8.877	YES	206.488
7-Sep-2019	10030.00	770.00	1500.00	700.00	0.00	70,00,000	0.0002	40.00	0.86659	0.26031	0.60628		8.877	9.483	YES	206.755
8-Sep-2019	10267.00	770.00	1500.00	700.00		70,00,000	0.0002	40.00	0.88707	0.26031	0.62676		9.483	10.110	YES	207.027
9-Sep-2019	10210.00	770.00	1500.00	800.00		70,00,000	0.0002	40.00	0.88214	0.26895	0.61319		10.110	10.723	YES	207.274
10-Sep-2019	10370.00	770.00	1500.00	1000.00		70,00,000	0.0002	60.00	0.89597	0.28796	0.60801		10.723	11.331	YES	207.518
11-Sep-2019	10650.00	770.00	1500.00	1100.00	3000.00	70,00,000	0.0002	60.00	0.92016	0.5558	0.36436		11.331	11.696	YES	207.654
12-Sep-2019	10400.00	810.00	1500.00	1100.00	3510.00	70,00,000	0.0002	60.00	0.89856	0.60332	0.29524		11.696	11.991	YES	207.764
13-Sep-2019	10200.00	880.00	1500.00	1100.00	5531.00	70,00,000	0.0002	60.00	0.88128	0.78398	0.0973		11.991	12.088	YES	207.800
14-Sep-2019	10300.00	880.00	1500.00	1100.00	5600.00	70,00,000	0.0002	60.00	0.88992	0.78994	0.09998		12.088	12.188	YES	207.837
15-Sep-2019	10100.00	880.00	2200.00	1000.00	5731.00	70,00,000	0.0002	60.00	0.87264	0.8531	0.01954		12.188	12.208	YES	207.845
16-Sep-2019	12600.00	880.00	2200.00	1000.00	8000.00	70,00,000	0.0002	60.00	1.08864	1.04914	0.0395		12.208	12.247	YES	207.859
17-Sep-2019	22700.00	880.00	1650.00	600.00	22000.00	70,00,000	0.0002	60.00	1.96128	2.17666	-0.21538		12.247	12.032	YES	207.779
18-Sep-2019	16600.00	880.00	1650.00	600.00	13500.00	70,00,000	0.0002	60.00	1.43424	1.44226	-0.00802		12.032	12.024	YES	207.776
19-Sep-2019	13100.00	880.00	1650.00	600.00	10000.00	70,00,000	0.0002	60.00	1.13184	1.13986	-0.00802		12.024	12.016	YES	207.773
20-Sep-2019	13050.00	880.00	1650.00	600.00	9000.00	70,00,000	0.0002	60.00	1.12752	1.05346	0.07406		12.016	12.090	YES	207.801
21-Sep-2019	10500.00	880.00	1650.00	400.00	7000.00	70,00,000	0.0002	60.00	0.9072	0.86338	0.04382		12.090	12.134	YES	207.817
22-Sep-2019	6000.00	880.00	1650.00	400.00	7000.00	70,00,000	0.0002	60.00	0.5184	0.86338	-0.34498		12.134	11.789	YES	207.688
23-Sep-2019	6800.00	880.00	1650.00	400.00		70,00,000	0.0002	60.00	0.58752	0.25858	0.32894		11.789	12.118	YES	207.811
24-Sep-2019	7426.00	880.00	1650.00	400.00	4000.00	70,00,000	0.0002	60.00	0.64161	0.60418	0.03742		12.118	12.155	YES	207.825
25-Sep-2019	6900.00	880.00	1100.00	400.00	6600.00	70,00,000	0.0002	60.00	0.59616	0.7813	-0.18514		12.155	11.970	YES	207.756
26-Sep-2019	6250.00	950.00	1650.00	400.00	5581.00	70,00,000	0.0002	60.00	0.54	0.74683	-0.20683		11.970	11.763	YES	207.679
27-Sep-2019	8700.00	990.00	1650.00	400.00	3400.00	70,00,000	0.0002	60.00	0.75168	0.56185	0.18983		11.763	11.953	YES	207.750
28-Sep-2019	9550.00	990.00	2200.00	400.00	7000.00	70,00,000	0.0002	60.00	0.82512	0.92041	-0.09529		11.953	11.858	YES	207.714
29-Sep-2019	10100.00	990.00	2200.00	400.00	6500.00	70,00,000	0.0002	60.00	0.87264	0.87721	-0.00457		11.858	11.853	YES	207.712
30-Sep-2019	6700.00	990.00	2200.00	400.00	3700.00	70,00,000	0.0002	60.00	0.57888	0.63529	-0.05641		11.853	11.797	YES	207.691
1-Oct-2019	6440.00	990.00	1650.00	400.00	2000.00	70,00,000	0.0002	60.00	0.55642	0.44089	0.11553		11.797	11.912	YES	207.734

Date	Inflows	Out flows												
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
2-Oct-2019	7850.00	990.00	2200.00	400.00	3700.00	70,00,000	0.0002	60.00	0.67824	0.63529	0.04295	11.912	11.955	YES	207.750
3-Oct-2019	8700.00	990.00	2200.00	400.00	6600.00	70,00,000	0.0002	60.00	0.75168	0.88585	-0.13417	11.955	11.821	YES	207.700
4-Oct-2019	9600.00	990.00	1650.00	400.00	6250.00	70,00,000	0.0002	60.00	0.82944	0.80809	0.02135	11.821	11.842	YES	207.708
5-Oct-2019	12400.00	990.00	1100.00	400.00	9500.00	70,00,000	0.0002	60.00	1.07136	1.04137	0.02999	11.842	11.872	YES	207.720
6-Oct-2019	12000.00	1000.00	1100.00	500.00	10000.00	70,00,000	0.0002	60.00	1.0368	1.09407	-0.05727	11.872	11.815	YES	207.698
7-Oct-2019	10500.00	1000.00	1100.00	500.00	8800.00	70,00,000	0.0002	60.00	0.9072	0.99039	-0.08319	11.815	11.732	YES	207.667
8-Oct-2019	7500.00	1000.00	1100.00	400.00	4500.00	70,00,000	0.0002	60.00	0.648	0.61023	0.03777	11.732	11.770	YES	207.681
9-Oct-2019	6000.00	1000.00	1100.00	400.00	2100.00	70,00,000	0.0002	60.00	0.5184	0.40287	0.11553	11.770	11.885	YES	207.724
10-Oct-2019	9300.00	1000.00	1100.00	400.00	6800.00	70,00,000	0.0002	60.00	0.80352	0.80895	-0.00543	11.885	11.880	YES	207.722
11-Oct-2019	10000.00	880.00	1100.00	400.00	7600.00	70,00,000	0.0002	60.00	0.864	0.8677	-0.0037	11.880	11.876	YES	207.721
12-Oct-2019	9700.00	880.00	1100.00	400.00	8000.00	70,00,000	0.0002	60.00	0.83808	0.90226	-0.06418	11.876	11.812	YES	207.697
13-Oct-2019	8000.00	880.00	1100.00	400.00	6000.00	70,00,000	0.0002	60.00	0.6912	0.72946	-0.03826	11.812	11.774	YES	207.683
14-Oct-2019	10600.00	880.00	1100.00	400.00	5200.00	70,00,000	0.0002	60.00	0.91584	0.66034	0.2555	11.774	12.029	YES	207.778
15-Oct-2019	6400.00	880.00	1100.00	400.00	4000.00	70,00,000	0.0002	60.00	0.55296	0.55666	-0.0037	12.029	12.025	YES	207.777
16-Oct-2019	4200.00	880.00	1100.00	400.00	1100.00	70,00,000	0.0002	60.00	0.36288	0.3061	0.05678	12.025	12.082	YES	207.798
17-Oct-2019	4850.00	1000.00	1650.00	400.00	1700.00	70,00,000	0.0002	60.00	0.41904	0.41583	0.00321	12.082	12.085	YES	207.799
18-Oct-2019	5500.00	1000.00	1650.00	400.00	2700.00	70,00,000	0.0002	60.00	0.4752	0.50223	-0.02703	12.085	12.058	YES	207.789
19-Oct-2019	5200.00	1000.00	1650.00	400.00	2500.00	70,00,000	0.0002	60.00	0.44928	0.48495	-0.03567	12.058	12.023	YES	207.776
20-Oct-2019	4900.00	1000.00	1650.00	200.00	2300.00	70,00,000	0.0002	60.00	0.42336	0.45039	-0.02703	12.023	11.996	YES	207.766
21-Oct-2019	4000.00	1000.00	1650.00		1400.00	70,00,000	0.0002	60.00	0.3456	0.35535	-0.00975	11.996	11.986	YES	207.762
22-Oct-2019	3000.00	1000.00	1650.00		350.00	70,00,000	0.0002	60.00	0.2592	0.26463	-0.00543	11.986	11.980	YES	207.760
23-Oct-2019	3500.00	1000.00	1300.00		1000.00	70,00,000	0.0002	60.00	0.3024	0.29055	0.01185	11.980	11.992	YES	207.764
24-Oct-2019	5700.00	1000.00	1100.00		2800.00	70,00,000	0.0002	60.00	0.49248	0.42879	0.06369	11.992	12.056	YES	207.788
25-Oct-2019	8600.00	1000.00	1100.00		6500.00	70,00,000	0.0002	60.00	0.74304	0.74847	-0.00543	12.056	12.051	YES	207.786
26-Oct-2019	7300.00	1000.00	1100.00		6000.00	70,00,000	0.0002	60.00	0.63072	0.70527	-0.07455	12.051	11.976	YES	207.758
27-Oct-2019	7500.00	400.00	1100.00		5200.00	70,00,000	0.0002	60.00	0.648	0.58431	0.06369	11.976	12.040	YES	207.782
28-Oct-2019	9200.00		1600.00		7600.00	70,00,000	0.0002	60.00	0.79488	0.80031	-0.00543	12.040	12.034	YES	207.780
29-Oct-2019	9000.00		300.00		9100.00	70,00,000	0.0002	60.00	0.7776	0.81759	-0.03999	12.034	11.994	YES	207.765
30-Oct-2019	9400.00		850.00		9200.00	70,00,000	0.0002	60.00	0.81216	0.87375	-0.06159	11.994	11.933	YES	207.742
31-Oct-2019	9500.00		1500.00		8250.00	70,00,000	0.0002	60.00	0.8208	0.84783	-0.02703	11.933	11.906	YES	207.732
1-Nov-2019	7650.00		1650.00		6000.00	70,00,000	0.0002	60.00	0.66096	0.66639	-0.00543	11.906	11.900	YES	207.730
2-Nov-2019	4900.00		1650.00		3200.00	70,00,000	0.0002	60.00	0.42336	0.42447	-0.00111	11.900	11.899	YES	207.730
3-Nov-2019	3200.00		1650.00		1100.00	70,00,000	0.0002	60.00	0.27648	0.24303	0.03345	11.899	11.933	YES	207.742
4-Nov-2019	5800.00		1650.00		5000.00	70,00,000	0.0002	60.00	0.50112	0.57999	-0.07887	11.933	11.854	YES	207.713
5-Nov-2019	4400.00		1650.00		2600.00	70,00,000	0.0002	60.00	0.38016	0.37263	0.00753	11.854	11.861	YES	207.715
6-Nov-2019	3900.00	500.00	1650.00		1800.00	70,00,000	0.0002	60.00	0.33696	0.34671	-0.00975	11.861	11.851	YES	207.712
7-Nov-2019	2500.00	880.00	1650.00			70,00,000	0.0002	60.00	0.216	0.22402	-0.00802	11.851	11.843	YES	207.709
8-Nov-2019	3200.00	880.00	1650.00		700.00	70,00,000	0.0002	60.00	0.27648	0.2845	-0.00802	11.843	11.835	YES	207.706
9-Nov-2019	3200.00	880.00	550.00		1800.00	70,00,000	0.0002	60.00	0.27648	0.2845	-0.00802	11.835	11.827	YES	207.703
10-Nov-2019	3300.00	950.00	950.00		1800.00	70,00,000	0.0002	60.00	0.28512	0.32511	-0.03999	11.827	11.787	YES	207.688
11-Nov-2019	3400.00	1000.00	550.00		1900.00	70,00,000	0.0002	60.00	0.29376	0.30351	-0.00975	11.787	11.778	YES	207.684
12-Nov-2019	3400.00	1000.00	550.00		1900.00	70,00,000	0.0002	60.00	0.29376	0.30351	-0.00975	11.778	11.768	YES	207.681
13-Nov-2019	3700.00	1000.00	550.00		2200.00	70,00,000	0.0002	60.00	0.31968	0.32943	-0.00975	11.768	11.758	YES	207.677
14-Nov-2019	4000.00	880.00	550.00		2600.00	70,00,000	0.0002	60.00	0.3456	0.35362	-0.00802	11.758	11.750	YES	207.674
15-Nov-2019	4000.00	470.00	550.00		2700.00	70,00,000	0.0002	60.00	0.3456	0.32684	0.01876	11.750	11.769	YES	207.681
16-Nov-2019	3900.00	330.00	550.00		3000.00	70,00,000	0.0002	60.00	0.33696	0.34066	-0.0037	11.769	11.765	YES	207.680

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow		Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
17-Nov-2019	3400.00	330.00	550.00		2700.00	70,00,000	0.0002	60.00	0.29376	0.31474	-0.02098		11.765	11.744	YES	207.672
18-Nov-2019	2600.00	330.00	550.00		2600.00	70,00,000	0.0002	60.00	0.22464	0.3061	-0.08146		11.744	11.663	YES	207.641
19-Nov-2019	1600.00	330.00	550.00		1300.00	70,00,000	0.0002	60.00	0.13824	0.19378	-0.05554		11.663	11.607	YES	207.621
20-Nov-2019	1500.00	330.00	550.00	200.00	400.00	70,00,000	0.0002	60.00	0.1296	0.1333	-0.0037		11.607	11.603	YES	207.619
21-Nov-2019	1700.00	330.00	550.00	200.00	400.00	70,00,000	0.0002	60.00	0.14688	0.1333	0.01358		11.603	11.617	YES	207.624
22-Nov-2019	1900.00	330.00	550.00	200.00	800.00	70,00,000	0.0002	60.00	0.16416	0.16786	-0.0037		11.617	11.613	YES	207.623
23-Nov-2019	1800.00	220.00	550.00	200.00	1100.00	70,00,000	0.0002	60.00	0.15552	0.18428	-0.02876		11.613	11.585	YES	207.612
24-Nov-2019	1600.00	330.00	550.00	200.00	500.00	70,00,000	0.0002	60.00	0.13824	0.14194	-0.0037		11.585	11.581	YES	207.611
25-Nov-2019	1900.00	330.00	550.00	200.00	600.00	70,00,000	0.0002	60.00	0.16416	0.15058	0.01358		11.581	11.594	YES	207.616
26-Nov-2019	1900.00	330.00	550.00	200.00	800.00	70,00,000	0.0002	60.00	0.16416	0.16786	-0.0037		11.594	11.591	YES	207.614
27-Nov-2019	1500.00	330.00	980.00	200.00	800.00	70,00,000	0.0002	60.00	0.1296	0.20502	-0.07542		11.591	11.515	YES	207.586
28-Nov-2019	1400.00	320.00	0.00	200.00	800.00	70,00,000	0.0002	60.00	0.12096	0.11948	0.00148		11.515	11.517	YES	207.587
29-Nov-2019	1500.00	110.00	500.00	200.00	900.00	70,00,000	0.0002	60.00	0.1296	0.15318	-0.02358		11.517	11.493	YES	207.578
30-Nov-2019	1500.00	110.00	550.00	200.00	900.00	70,00,000	0.0002	60.00	0.1296	0.1575	-0.0279		11.493	11.465	YES	207.568
1-Dec-2019	1500.00	110.00	550		700.00	70,00,000	0.0002	60.00	0.1296	0.12294	0.00666		11.465	11.472	YES	207.570
2-Dec-2019	1500.00	110.00	550		900.00	70,00,000	0.0002	60.00	0.1296	0.14022	-0.01062		11.472	11.461	YES	207.566
3-Dec-2019	1500.00	110.00	550		1000.00	70,00,000	0.0002	60.00	0.1296	0.14886	-0.01926		11.461	11.442	YES	207.559
4-Dec-2019	1800.00	110.00	550		1800.00	70,00,000	0.0002	60.00	0.15552	0.21798	-0.06246		11.442	11.380	YES	207.536
5-Dec-2019	1900.00	110.00	550		1000.00	70,00,000	0.0002	60.00	0.16416	0.14886	0.0153		11.380	11.395	YES	207.541
6-Dec-2019	1900.00	110.00	550		1200.00	70,00,000	0.0002	60.00	0.16416	0.16614	-0.00198		11.395	11.393	YES	207.541
7-Dec-2019	2000.00	110.00	550		1300.00	70,00,000	0.0002	60.00	0.1728	0.17478	-0.00198		11.393	11.391	YES	207.540
8-Dec-2019	2000.00	110.00			1400.00	70,00,000	0.0002	60.00	0.1728	0.1359	0.0369		11.391	11.428	YES	207.554
9-Dec-2019	2000.00	110.00			2000.00	70,00,000	0.0002	60.00	0.1728	0.18774	-0.01494		11.428	11.413	YES	207.548
10-Dec-2019	2000.00	110.00	400		1500.00	70,00,000	0.0002	60.00	0.1728	0.1791	-0.0063		11.413	11.407	YES	207.546
11-Dec-2019	0.00	110.00	550			70,00,000	0.0002	60.00	0	0.06246	-0.06246		11.407	11.344	YES	207.522
12-Dec-2019	0.00	110.00	550			70,00,000	0.0002	60.00	0	0.06246	-0.06246		11.344	11.282	YES	207.499
13-Dec-2019		110.00	550			70,00,000	0.0002	60.00	0	0.06246	-0.06246		11.282	11.219	YES	207.472
14-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		11.219	11.155	YES	207.443
15-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		11.155	11.091	YES	207.415
16-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		11.091	11.027	YES	207.389
17-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		11.027	10.963	YES	207.365
18-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		10.963	10.898	YES	207.341
19-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		10.898	10.834	YES	207.317
20-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		10.834	10.770	YES	207.293
21-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		10.770	10.706	YES	207.267
22-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		10.706	10.642	YES	207.241
23-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		10.642	10.578	YES	207.215
24-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		10.578	10.513	YES	207.189
25-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		10.513	10.449	YES	207.163
26-Dec-2019		110.00	550			70,00,000	0.0002	80.00	0	0.06418	-0.06418		10.449	10.385	YES	207.137
27-Dec-2019		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666		10.385	10.368	YES	207.131
28-Dec-2019		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666		10.368	10.352	YES	207.124
29-Dec-2019		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666		10.352	10.335	YES	207.117
30-Dec-2019		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666		10.335	10.318	YES	207.111
31-Dec-2019		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666		10.318	10.302	YES	207.104
1-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666		10.302	10.285	YES	207.097

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
2-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	10.285	10.268	YES	207.090
3-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	10.268	10.252	YES	207.084
4-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	10.252	10.235	YES	207.077
5-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	10.235	10.218	YES	207.070
6-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	10.218	10.202	YES	207.064
7-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	10.202	10.185	YES	207.057
8-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	10.185	10.168	YES	207.050
9-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	10.168	10.152	YES	207.043
10-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	10.152	10.135	YES	207.037
11-Jan-2020		110.00		400.00		70,00,000	0.0002	80.00	0	0.05122	-0.05122	10.135	10.084	YES	207.016
12-Jan-2020		110.00		400.00		70,00,000	0.0002	80.00	0	0.05122	-0.05122	10.084	10.033	YES	206.995
13-Jan-2020		110.00		400.00		70,00,000	0.0002	80.00	0	0.05122	-0.05122	10.033	9.981	YES	206.973
14-Jan-2020		110.00		1000.00		70,00,000	0.0002	80.00	0	0.10306	-0.10306	9.981	9.878	YES	206.927
15-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.878	9.862	YES	206.920
16-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.862	9.845	YES	206.913
17-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.845	9.828	YES	206.905
18-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.828	9.812	YES	206.898
19-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.812	9.795	YES	206.891
20-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.795	9.778	YES	206.884
21-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.778	9.762	YES	206.876
22-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.762	9.745	YES	206.869
23-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.745	9.728	YES	206.862
24-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.728	9.712	YES	206.854
25-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.712	9.695	YES	206.847
26-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.695	9.678	YES	206.840
27-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.678	9.662	YES	206.833
28-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.662	9.645	YES	206.825
29-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.645	9.628	YES	206.818
30-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.628	9.612	YES	206.811
31-Jan-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.612	9.595	YES	206.804
1-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.595	9.578	YES	206.796
2-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.578	9.562	YES	206.789
3-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.562	9.545	YES	206.782
4-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.545	9.528	YES	206.774
5-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.528	9.512	YES	206.767
6-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.512	9.495	YES	206.760
7-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.495	9.478	YES	206.752
8-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.478	9.462	YES	206.745
9-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.462	9.445	YES	206.738
10-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.445	9.428	YES	206.730
11-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.428	9.412	YES	206.723
12-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.412	9.395	YES	206.716
13-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.395	9.378	YES	206.709
14-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.378	9.362	YES	206.701
15-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.362	9.345	YES	206.694
16-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.345	9.328	YES	206.687

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
17-Feb-2020		110.00				70,00,000	0.0002	80.00	0	0.01666	-0.01666	9.328	9.312	YES	206.679
18-Feb-2020		110.00	1100			70,00,000	0.0002	80.00	0	0.1117	-0.1117	9.312	9.200	YES	206.630
19-Feb-2020		110.00	1100			70,00,000	0.0002	80.00	0	0.1117	-0.1117	9.200	9.088	YES	206.581
20-Feb-2020		110.00	1100			70,00,000	0.0002	80.00	0	0.1117	-0.1117	9.088	8.977	YES	206.532
21-Feb-2020		110.00	1100			70,00,000	0.0002	80.00	0	0.1117	-0.1117	8.977	8.865	YES	206.482
22-Feb-2020		110.00	1100			70,00,000	0.0002	80.00	0	0.1117	-0.1117	8.865	8.753	YES	206.428
23-Feb-2020		110.00	1100			70,00,000	0.0002	80.00	0	0.1117	-0.1117	8.753	8.642	YES	206.375
24-Feb-2020		110.00	1100			70,00,000	0.0002	80.00	0	0.1117	-0.1117	8.642	8.530	YES	206.321
25-Feb-2020		110.00	1100			70,00,000	0.0002	80.00	0	0.1117	-0.1117	8.530	8.418	YES	206.268
26-Feb-2020		110.00	1100			70,00,000	0.0002	80.00	0	0.1117	-0.1117	8.418	8.306	YES	206.214
27-Feb-2020		110.00	1100			70,00,000	0.0002	80.00	0	0.1117	-0.1117	8.306	8.195	YES	206.161
28-Feb-2020		110.00	1100			70,00,000	0.0002	80.00	0	0.1117	-0.1117	8.195	8.083	YES	206.107
29-Feb-2020		110.00	1100			70,00,000	0.0002	80.00	0	0.1117	-0.1117	8.083	7.971	YES	206.054
1-Mar-2020		110.00	1100.00			70,00,000	0.0002	80.00	0	0.1117	-0.1117	7.971	7.860	YES	206.000
2-Mar-2020		0.00	550.00			70,00,000	0.0002	80.00	0	0.05468	-0.05468	7.860	7.805	YES	205.971
3-Mar-2020		0.00	1100.00			70,00,000	0.0002	80.00	0	0.1022	-0.1022	7.805	7.703	YES	205.917
4-Mar-2020		0.00	1100.00			70,00,000	0.0002	80.00	0	0.1022	-0.1022	7.703	7.601	YES	205.863
5-Mar-2020		0.00	1100.00			70,00,000	0.0002	80.00	0	0.1022	-0.1022	7.601	7.498	YES	205.810
6-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.498	7.491	YES	205.806
7-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.491	7.484	YES	205.802
8-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.484	7.477	YES	205.798
9-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.477	7.470	YES	205.795
10-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.470	7.463	YES	205.791
11-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.463	7.455	YES	205.787
12-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.455	7.448	YES	205.783
13-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.448	7.441	YES	205.780
14-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.441	7.434	YES	205.776
15-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.434	7.427	YES	205.772
16-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.427	7.420	YES	205.768
17-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.420	7.412	YES	205.764
18-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.412	7.405	YES	205.761
19-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.405	7.398	YES	205.757
20-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.398	7.391	YES	205.753
21-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.391	7.384	YES	205.749
22-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.384	7.377	YES	205.746
23-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.377	7.369	YES	205.742
24-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.369	7.362	YES	205.738
25-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.362	7.355	YES	205.734
26-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.355	7.348	YES	205.731
27-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.348	7.341	YES	205.727
28-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.341	7.334	YES	205.723
29-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.334	7.327	YES	205.719
30-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.327	7.319	YES	205.715
31-Mar-2020		0.00	0.00			70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.319	7.312	YES	205.712
1-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.312	7.305	YES	205.708
2-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.305	7.298	YES	205.704

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
3-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.298	7.291	YES	205.700
4-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.291	7.284	YES	205.697
5-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.284	7.276	YES	205.693
6-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.276	7.269	YES	205.689
7-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.269	7.262	YES	205.685
8-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.262	7.255	YES	205.681
9-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.255	7.248	YES	205.678
10-Apr-2020				400.00		70,00,000	0.0002	80.00	0	0.04172	-0.04172	7.248	7.206	YES	205.656
11-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.206	7.199	YES	205.652
12-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.199	7.192	YES	205.648
13-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.192	7.185	YES	205.644
14-Apr-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	7.185	7.177	YES	205.640
15-Apr-2020		220.00				70,00,000	0.0002	80.00	0	0.02617	-0.02617	7.177	7.151	YES	205.627
16-Apr-2020		330.00	300.00			70,00,000	0.0002	80.00	0	0.06159	-0.06159	7.151	7.090	YES	205.594
17-Apr-2020		330.00	550.00			70,00,000	0.0002	80.00	0	0.08319	-0.08319	7.090	7.006	YES	205.550
18-Apr-2020		330.00	1100.00			70,00,000	0.0002	80.00	0	0.13071	-0.13071	7.006	6.876	YES	205.480
19-Apr-2020		330.00	1100.00			70,00,000	0.0002	80.00	0	0.13071	-0.13071	6.876	6.745	YES	205.404
20-Apr-2020		330.00	1100.00			70,00,000	0.0002	80.00	0	0.13071	-0.13071	6.745	6.614	YES	205.329
21-Apr-2020		330.00	1100.00			70,00,000	0.0002	80.00	0	0.13071	-0.13071	6.614	6.484	YES	205.253
22-Apr-2020		330.00	1100.00			70,00,000	0.0002	80.00	0	0.13071	-0.13071	6.484	6.353	YES	205.177
23-Apr-2020		330.00	750.00			70,00,000	0.0002	80.00	0	0.10047	-0.10047	6.353	6.252	YES	205.119
24-Apr-2020		330.00	550.00			70,00,000	0.0002	80.00	0	0.08319	-0.08319	6.252	6.169	YES	205.071
25-Apr-2020		330.00	550.00			70,00,000	0.0002	80.00	0	0.08319	-0.08319	6.169	6.086	YES	205.023
26-Apr-2020		330.00	550.00			70,00,000	0.0002	80.00	0	0.08319	-0.08319	6.086	6.003	YES	204.972
27-Apr-2020		330.00	550.00			70,00,000	0.0002	80.00	0	0.08319	-0.08319	6.003	5.920	YES	204.918
28-Apr-2020		330.00	550.00			70,00,000	0.0002	80.00	0	0.08319	-0.08319	5.920	5.836	YES	204.865
29-Apr-2020		330.00	540.00			70,00,000	0.0002	80.00	0	0.08233	-0.08233	5.836	5.754	YES	204.813
30-Apr-2020		330.00	540.00			70,00,000	0.0002	80.00	0	0.08233	-0.08233	5.754	5.672	YES	204.760
1-May-2020		330.00	550.00			70,00,000	0.0002	80.00	0	0.08319	-0.08319	5.672	5.589	YES	204.707
2-May-2020		330.00	550.00			70,00,000	0.0002	80.00	0	0.08319	-0.08319	5.589	5.505	YES	204.654
3-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.505	5.498	YES	204.650
4-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.498	5.491	YES	204.645
5-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.491	5.484	YES	204.641
6-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.484	5.477	YES	204.636
7-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.477	5.470	YES	204.632
8-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.470	5.462	YES	204.627
9-May-2020		660.00	1100.00			70,00,000	0.0002	80.00	0	0.15922	-0.15922	5.462	5.303	YES	204.526
10-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.303	5.296	YES	204.521
11-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.296	5.289	YES	204.517
12-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.289	5.282	YES	204.512
13-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.282	5.275	YES	204.507
14-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.275	5.267	YES	204.503
15-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.267	5.260	YES	204.498
16-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.260	5.253	YES	204.493
17-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.253	5.246	YES	204.488
18-May-2020						70,00,000	0.0002	80.00	0	0.00716	-0.00716	5.246	5.239	YES	204.483

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
19-May-2020				300.00		70,00,000	0.0002	80.00	0	0.03308	-0.03308	5.239	5.206	YES	204.460
20-May-2020				300.00		70,00,000	0.0002	80.00	0	0.03308	-0.03308	5.206	5.173	YES	204.436
21-May-2020				300.00		70,00,000	0.0002	80.00	0	0.03308	-0.03308	5.173	5.140	YES	204.413
22-May-2020				300.00		70,00,000	0.0002	80.00	0	0.03308	-0.03308	5.140	5.106	YES	204.390
23-May-2020				300.00		70,00,000	0.0002	80.00	0	0.03308	-0.03308	5.106	5.073	YES	204.367
24-May-2020				300.00		70,00,000	0.0002	80.00	0	0.03308	-0.03308	5.073	5.040	YES	204.344
25-May-2020				300.00		70,00,000	0.0002	80.00	0	0.03308	-0.03308	5.040	5.007	YES	204.320
26-May-2020				300.00		70,00,000	0.0002	80.00	0	0.03308	-0.03308	5.007	4.974	YES	204.297
27-May-2020				300.00		70,00,000	0.0002	80.00	0	0.03308	-0.03308	4.974	4.941	YES	204.274
28-May-2020				250.00		70,00,000	0.0002	80.00	0	0.02876	-0.02876	4.941	4.912	YES	204.254
29-May-2020				250.00		70,00,000	0.0002	80.00	0	0.02876	-0.02876	4.912	4.884	YES	204.234
30-May-2020				250.00		70,00,000	0.0002	80.00	0	0.02876	-0.02876	4.884	4.855	YES	204.214
31-May-2020				250.00		70,00,000	0.0002	80.00	0	0.02876	-0.02876	4.855	4.826	YES	204.194
1-Jun-2020				200.00		70,00,000	0.0002	80.00	0	0.02444	-0.02444	4.826	4.802	YES	204.176
2-Jun-2020				200.00		70,00,000	0.0002	80.00	0	0.02444	-0.02444	4.802	4.777	YES	204.159
3-Jun-2020				200.00		70,00,000	0.0002	80.00	0	0.02444	-0.02444	4.777	4.753	YES	204.142
4-Jun-2020				200.00		70,00,000	0.0002	80.00	0	0.02444	-0.02444	4.753	4.728	YES	204.125
5-Jun-2020				160.00		70,00,000	0.0002	80.00	0	0.02098	-0.02098	4.728	4.707	YES	204.110
6-Jun-2020				130.00		70,00,000	0.0002	80.00	0	0.01839	-0.01839	4.707	4.689	YES	204.097
7-Jun-2020				120.00		70,00,000	0.0002	80.00	0	0.01753	-0.01753	4.689	4.671	YES	204.085
8-Jun-2020				120.00		70,00,000	0.0002	80.00	0	0.01753	-0.01753	4.671	4.654	YES	204.073
9-Jun-2020				100.00		70,00,000	0.0002	80.00	0	0.0158	-0.0158	4.654	4.638	YES	204.062
10-Jun-2020				100.00		70,00,000	0.0002	80.00	0	0.0158	-0.0158	4.638	4.622	YES	204.051
11-Jun-2020				100.00		70,00,000	0.0002	80.00	0	0.0158	-0.0158	4.622	4.606	YES	204.039
12-Jun-2020				100.00		70,00,000	0.0002	70.00	0	0.01494	-0.01494	4.606	4.592	YES	204.029
13-Jun-2020				100.00		70,00,000	0.0002	70.00	0	0.01494	-0.01494	4.592	4.577	YES	204.019
14-Jun-2020				90.00		70,00,000	0.0002	70.00	0	0.01407	-0.01407	4.577	4.563	YES	204.009
15-Jun-2020				90.00		70,00,000	0.0002	70.00	0	0.01407	-0.01407	4.563	4.548	YES	203.999
16-Jun-2020				90.00		70,00,000	0.0002	70.00	0	0.01407	-0.01407	4.548	4.534	YES	203.988
17-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.534	4.521	YES	203.978
18-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.521	4.508	YES	203.967
19-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.508	4.495	YES	203.957
20-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.495	4.482	YES	203.947
21-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.482	4.468	YES	203.937
22-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.468	4.455	YES	203.926
23-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.455	4.442	YES	203.916
24-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.442	4.429	YES	203.906
25-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.429	4.416	YES	203.896
26-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.416	4.402	YES	203.886
27-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.402	4.389	YES	203.875
28-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.389	4.376	YES	203.865
29-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.376	4.363	YES	203.855
30-Jun-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.363	4.349	YES	203.845
1-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.349	4.336	YES	203.835
2-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.336	4.323	YES	203.825
3-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.323	4.310	YES	203.815

Date	Inflows	Out flows												
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
4-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.310	4.297	YES	203.804
5-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.297	4.283	YES	203.794
6-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.283	4.270	YES	203.784
7-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.270	4.257	YES	203.774
8-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.257	4.244	YES	203.763
9-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.244	4.231	YES	203.753
10-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.231	4.217	YES	203.743
11-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.217	4.204	YES	203.733
12-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.204	4.191	YES	203.722
13-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.191	4.178	YES	203.712
14-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.178	4.165	YES	203.702
15-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.165	4.151	YES	203.692
16-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.151	4.138	YES	203.682
17-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.138	4.125	YES	203.672
18-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.125	4.112	YES	203.661
19-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.112	4.099	YES	203.651
20-Jul-2020				80.00		70,00,000	0.0002	70.00	0	0.01321	-0.01321	4.099	4.085	YES	203.641
21-Jul-2020						70,00,000	0.0002	70.00	0	0.0063	-0.0063	4.085	4.079	YES	203.636
22-Jul-2020						70,00,000	0.0002	70.00	0	0.0063	-0.0063	4.079	4.073	YES	203.631
23-Jul-2020						70,00,000	0.0002	70.00	0	0.0063	-0.0063	4.073	4.066	YES	203.627
24-Jul-2020						70,00,000	0.0002	70.00	0	0.0063	-0.0063	4.066	4.060	YES	203.622
25-Jul-2020						70,00,000	0.0002	70.00	0	0.0063	-0.0063	4.060	4.054	YES	203.617
26-Jul-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.054	4.048	YES	203.613
27-Jul-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.048	4.043	YES	203.608
28-Jul-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.043	4.038	YES	203.604
29-Jul-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.038	4.032	YES	203.600
30-Jul-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.032	4.027	YES	203.596
31-Jul-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.027	4.021	YES	203.592
1-Aug-2020						70,00,000	0.0002	60	0	0.00543	-0.00543	4.021	4.016	YES	203.587
2-Aug-2020	600					70,00,000	0.0002	60.00	0.05184	0.00543	0.04641	4.016	4.062	YES	203.623
3-Aug-2020	500					70,00,000	0.0002	60.00	0.0432	0.00543	0.03777	4.062	4.100	YES	203.652
4-Aug-2020	810					70,00,000	0.0002	60.00	0.06998	0.00543	0.06455	4.100	4.165	YES	203.702
5-Aug-2020	1400					70,00,000	0.0002	60.00	0.12096	0.00543	0.11553	4.165	4.280	YES	203.792
6-Aug-2020	300					70,00,000	0.0002	60.00	0.02592	0.00543	0.02049	4.280	4.301	YES	203.807
7-Aug-2020	300					70,00,000	0.0002	60.00	0.02592	0.00543	0.02049	4.301	4.321	YES	203.823
8-Aug-2020	0					70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.321	4.316	YES	203.819
9-Aug-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.316	4.310	YES	203.815
10-Aug-2020	1064					70,00,000	0.0002	60.00	0.09193	0.00543	0.0865	4.310	4.397	YES	203.881
11-Aug-2020	450					70,00,000	0.0002	60.00	0.03888	0.00543	0.03345	4.397	4.430	YES	203.907
12-Aug-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.430	4.425	YES	203.903
13-Aug-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.425	4.419	YES	203.899
14-Aug-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.419	4.414	YES	203.895
15-Aug-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.414	4.408	YES	203.890
16-Aug-2020	0					70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.408	4.403	YES	203.886
17-Aug-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.403	4.398	YES	203.882
18-Aug-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.398	4.392	YES	203.878

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
19-Aug-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.392	4.387	YES	203.874
20-Aug-2020						70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.387	4.381	YES	203.869
21-Aug-2020	0					70,00,000	0.0002	60.00	0	0.00543	-0.00543	4.381	4.376	YES	203.865
22-Aug-2020	100					70,00,000	0.0002	60.00	0.00864	0.00543	0.00321	4.376	4.379	YES	203.868
23-Aug-2020	1000					70,00,000	0.0002	60.00	0.0864	0.00543	0.08097	4.379	4.460	YES	203.930
24-Aug-2020	900					70,00,000	0.0002	60.00	0.07776	0.00543	0.07233	4.460	4.532	YES	203.986
25-Aug-2020	360					70,00,000	0.0002	60.00	0.0311	0.00543	0.02567	4.532	4.558	YES	204.006
26-Aug-2020						70,00,000	0.0002	60.00	0.80006	0.00543	0.79463	4.558	5.353	YES	204.557
27-Aug-2020						70,00,000	0.0002	60.00	0.88992	0.00543	0.88449	5.353	6.237	YES	205.110
28-Aug-2020		440.00	550.00			70,00,000	0.0002	60.00	0.89856	0.09097	0.80759	6.237	7.045	YES	205.570
29-Aug-2020		770.00	300.00			70,00,000	0.0002	60.00	0.85251	0.09788	0.75463	7.045	7.799	YES	205.968
30-Aug-2020	350	770.00	550.00			70,00,000	0.0002	60.00	0.96034	0.11948	0.84086	7.799	8.640	YES	206.374
31-Aug-2020	700	880.00	550.00			70,00,000	0.0002	60.00	0.96768	0.12898	0.8387	8.640	9.479	YES	206.753
1-Sep-2020	500.00	880.00	1100.00			70,00,000	0.0002	60	0.94176	0.1765	0.76526	9.479	10.244	YES	207.081
2-Sep-2020	1200.00	880.00	1100.00			70,00,000	0.0002	60.00	1.00224	0.1765	0.82574	10.244	11.070	YES	207.406
3-Sep-2020	1000.00	880.00	1100.00	350.00	2500.00	70,00,000	0.0002	60.00	0.96768	0.42274	0.54494	11.070	11.615	YES	207.623
4-Sep-2020	400.00	880.00	1100.00	600.00	3000.00	70,00,000	0.0002	60.00	0.91584	0.48754	0.4283	11.615	12.043	YES	207.783
5-Sep-2020	300.00	880.00	1100.00	600.00	3800.00	70,00,000	0.0002	60.00	0.9072	0.55666	0.35054	12.043	12.394	YES	207.914
6-Sep-2020		880.00	1100.00	700.00	5500.00	70,00,000	0.0002	60.00	0.84672	0.71218	0.13454	12.394	12.528	YES	207.964
7-Sep-2020		880.00	1100.00	800.00	5800.00	70,00,000	0.0002	60.00	0.8208	0.74674	0.07406	12.528	12.602	YES	207.992
8-Sep-2020	300.00	880.00	1100.00	800.00	6800.00	70,00,000	0.0002	60.00	0.88128	0.83314	0.04814	12.602	12.650	YES	208.009
9-Sep-2020	160.00	880.00	1100.00	700.00	7500.00	70,00,000	0.0002	60.00	0.80006	0.88498	-0.08492	12.650	12.566	YES	207.978
10-Sep-2020		880.00	1100.00	700.00	4800.00	70,00,000	0.0002	60.00	0.69984	0.6517	0.04814	12.566	12.614	YES	207.996
11-Sep-2020	300.00	880.00	1100.00	700.00	6100.00	70,00,000	0.0002	60.00	0.8208	0.76402	0.05678	12.614	12.670	YES	208.016
12-Sep-2020		770.00	1100.00	600.00	7000.00	70,00,000	0.0002	60.00	0.81821	0.82364	-0.00543	12.670	12.665	YES	208.014
13-Sep-2020	3000.00	770.00	1100.00	600.00	7700.00	70,00,000	0.0002	60.00	1.0368	0.88412	0.15268	12.665	12.818	YES	208.068
14-Sep-2020	4800.00	880.00	1100.00	600.00	13000.00	70,00,000	0.0002	60.00	1.21824	1.35154	-0.1333	12.818	12.684	YES	208.021
15-Sep-2020	2500.00	990.00		600.00	12500.00	70,00,000	0.0002	60.00	1.06272	1.22281	-0.16009	12.684	12.524	YES	207.963
16-Sep-2020		990.00		300.00	9800.00	70,00,000	0.0002	60.00	0.95904	0.96361	-0.00457	12.524	12.520	YES	207.961
17-Sep-2020	600.00	990.00		300.00	8000.00	70,00,000	0.0002	60.00	1.04544	0.80809	0.23735	12.520	12.757	YES	208.047
18-Sep-2020	600.00	990.00	800.00	400.00	3000.00	70,00,000	0.0002	60.00	0.69984	0.45385	0.24599	12.757	13.003	YES	208.133
19-Sep-2020	3000.00	990.00	1100.00	400.00	4500.00	70,00,000	0.0002	60.00	0.864	0.60937	0.25463	13.003	13.258	YES	208.221
20-Sep-2020	16000.00	990.00		400.00	23000.00	70,00,000	0.0002	60.00	2.2464	2.11273	0.13367	13.258	13.391	YES	208.268
21-Sep-2020	7100.00	990.00		400.00	7300.00	70,00,000	0.0002	60.00	1.14912	0.75625	0.39287	13.391	13.784	YES	208.405
22-Sep-2020	5200.00	990.00		400.00	8000.00	70,00,000	0.0002	60.00	0.98496	0.81673	0.16823	13.784	13.952	YES	208.464
23-Sep-2020	4500.00	990.00	550.00	400.00	7400.00	70,00,000	0.0002	60.00	0.92448	0.81241	0.11207	13.952	14.065	YES	208.502
24-Sep-2020		990.00	1100.00	400.00		70,00,000	0.0002	60.00	0.61344	0.22057	0.39287	14.065	14.457	YES	208.590
25-Sep-2020		990.00	800.00		150.00	70,00,000	0.0002	60.00	0.71712	0.17305	0.54407	14.457	15.002	YES	208.713
26-Sep-2020	3000.00	880.00	550.00	200.00	1000.00	70,00,000	0.0002	60.00	0.61344	0.23266	0.38078	15.002	15.382	YES	208.798
27-Sep-2020	11600.00	880.00	200.00	400.00	7300.00	70,00,000	0.0002	60.00	1.56384	0.76402	0.79982	15.382	16.182	YES	208.978
28-Sep-2020	9500.00	880.00		400.00	15200.00	70,00,000	0.0002	60.00	1.4256	1.4293	-0.0037	16.182	16.178	YES	208.977
29-Sep-2020	8000.00	880.00		400.00	13700.00	70,00,000	0.0002	60.00	1.296	1.2997	-0.0037	16.178	16.175	YES	208.976
30-Sep-2020	4200.00	880.00		400.00	8700.00	70,00,000	0.0002	60.00	0.864	0.8677	-0.0037	16.175	16.171	YES	208.975
1-Oct-2020	8300	880.00		400.00	11500.00	70,00,000	0.0002	60.00	1.10592	1.10962	-0.0037	16.171	16.167	YES	208.974
2-Oct-2020	15800	880.00		400.00	21000.00	70,00,000	0.0002	60.00	1.92672	1.93042	-0.0037	16.167	16.164	YES	208.974
3-Oct-2020	7400	880.00		400.00	10300.00	70,00,000	0.0002	60.00	1.20096	1.00594	0.19502	16.164	16.359	YES	209.043

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
4-Oct-2020	1300	880.00		400.00	2800.00	70,00,000	0.0002	60.00	0.35424	0.35794	-0.0037	16.359	16.355	YES	209.041
5-Oct-2020	4100	880.00		400.00	1700.00	70,00,000	0.0002	60.00	0.35424	0.2629	0.09134	16.355	16.446	YES	209.092
6-Oct-2020	500	880.00		400.00	400.00	70,00,000	0.0002	60.00	0.14688	0.15058	-0.0037	16.446	16.443	YES	209.090
7-Oct-2020	500	880.00		400.00	2000.00	70,00,000	0.0002	60.00	0.28512	0.28882	-0.0037	16.443	16.439	YES	209.088
8-Oct-2020	1000	990.00		400.00	1200.00	70,00,000	0.0002	60.00	0.31968	0.22921	0.09047	16.439	16.529	YES	209.138
9-Oct-2020	750	990.00		300.00	500.00	70,00,000	0.0002	60.00	0.25488	0.16009	0.09479	16.529	16.624	YES	209.191
10-Oct-2020	800	990.00		200.00	1100.00	70,00,000	0.0002	60.00	0.2592	0.20329	0.05591	16.624	16.680	YES	209.222
11-Oct-2020	1150	990.00		200.00	1000.00	70,00,000	0.0002	60.00	0.28944	0.19465	0.09479	16.680	16.775	YES	209.275
12-Oct-2020	1900	990.00		200.00	1200.00	70,00,000	0.0002	60.00	0.3888	0.21193	0.17687	16.775	16.952	YES	209.374
13-Oct-2020	5100	440.00			7500.00	70,00,000	0.0002	60.00	0.8208	0.69145	0.12935	16.952	17.081	YES	209.446
14-Oct-2020	1850	440.00			5200.00	70,00,000	0.0002	60.00	0.48816	0.49273	-0.00457	17.081	17.076	YES	209.443
15-Oct-2020	1200	440.00			2000.00	70,00,000	0.0002	60.00	0.3888	0.21625	0.17255	17.076	17.249	YES	209.521
16-Oct-2020	1200	440.00			2500.00	70,00,000	0.0002	60.00	0.37152	0.25945	0.11207	17.249	17.361	YES	209.554
17-Oct-2020	1400	440.00			4060.00	70,00,000	0.0002	60.00	0.3888	0.39423	-0.00543	17.361	17.356	YES	209.552
18-Oct-2020	1600	440.00			4260.00	70,00,000	0.0002	60.00	0.40608	0.41151	-0.00543	17.356	17.350	YES	209.551
19-Oct-2020	1200	330.00			3800.00	70,00,000	0.0002	60.00	0.35424	0.36226	-0.00802	17.350	17.342	YES	209.548
20-Oct-2020	1000	220.00			2200.00	70,00,000	0.0002	60.00	0.20736	0.21452	-0.00716	17.342	17.335	YES	209.546
21-Oct-2020	3300	220.00			5700.00	70,00,000	0.0002	60.00	0.59616	0.51692	0.07924	17.335	17.414	YES	209.569
22-Oct-2020	10200				12600.00	70,00,000	0.0002	60.00	1.296	1.09407	0.20193	17.414	17.616	YES	209.629
23-Oct-2020	8400				14000.00	70,00,000	0.0002	60.00	1.2096	1.21503	-0.00543	17.616	17.611	YES	209.627
24-Oct-2020	4500	220.00	500.00		6200.00	70,00,000	0.0002	60.00	0.59616	0.60332	-0.00716	17.611	17.604	YES	209.625
25-Oct-2020	1700		550.00			70,00,000	0.0002	60.00	0.14688	0.05295	0.09393	17.604	17.698	YES	209.653
26-Oct-2020	1800		550.00		1500.00	70,00,000	0.0002	60.00	0.18144	0.18255	-0.00111	17.698	17.696	YES	209.652
27-Oct-2020	2850		550.00		3600.00	70,00,000	0.0002	60.00	0.35856	0.36399	-0.00543	17.696	17.691	YES	209.651
28-Oct-2020	2250		550.00		3000.00	70,00,000	0.0002	60.00	0.30672	0.31215	-0.00543	17.691	17.686	YES	209.649
29-Oct-2020	500		200.00		1600.00	70,00,000	0.0002	60.00	0.15552	0.16095	-0.00543	17.686	17.680	YES	209.648
30-Oct-2020	1600				2800.00	70,00,000	0.0002	60.00	0.24192	0.24735	-0.00543	17.680	17.675	YES	209.646
31-Oct-2020	1400.000				2500.000	70,00,000	0.0002	60.000	0.216	0.22143	-0.00543	17.675	17.669	YES	209.644
1-Nov-2020	500		1100.00		1200.00	70,00,000	0.0002	60	0.19872	0.20415	-0.00543	17.669	17.664	YES	209.643
2-Nov-2020	600		1100.00		1700.00	70,00,000	0.0002	60.00	0.24192	0.24735	-0.00543	17.664	17.658	YES	209.641
3-Nov-2020	1450		1650.00		2200.00	70,00,000	0.0002	60.00	0.33264	0.33807	-0.00543	17.658	17.653	YES	209.640
4-Nov-2020	1350		1650.00		1900.00	70,00,000	0.0002	60.00	0.30672	0.31215	-0.00543	17.653	17.648	YES	209.638
5-Nov-2020	1250		1650.00		1100.00	70,00,000	0.0002	60.00	0.2376	0.24303	-0.00543	17.648	17.642	YES	209.637
6-Nov-2020	750		1650.00		800.00	70,00,000	0.0002	60.00	0.21168	0.21711	-0.00543	17.642	17.637	YES	209.635
7-Nov-2020	100		1400.00		1200.00	70,00,000	0.0002	60.00	0.22464	0.23007	-0.00543	17.637	17.631	YES	209.633
8-Nov-2020	900		1100.00		2500.00	70,00,000	0.0002	60.00	0.31104	0.31647	-0.00543	17.631	17.626	YES	209.632
9-Nov-2020	900		1100.00		2100.00	70,00,000	0.0002	60.00	0.27648	0.28191	-0.00543	17.626	17.620	YES	209.630
10-Nov-2020	1000		1100.00		500.00	70,00,000	0.0002	60.00	0.23328	0.14367	0.08961	17.620	17.710	YES	209.656
11-Nov-2020			600.00		700.00	70,00,000	0.0002	60.00	0.11232	0.11775	-0.00543	17.710	17.705	YES	209.655
12-Nov-2020					1000.00	70,00,000	0.0002	60.00	0.0864	0.09183	-0.00543	17.705	17.699	YES	209.653
13-Nov-2020	400				400.00	70,00,000	0.0002	60.00	0.03456	0.03999	-0.00543	17.699	17.694	YES	209.652
14-Nov-2020	100					70,00,000	0.0002	60.00	0.00864	0.00543	0.00321	17.694	17.697	YES	209.653
15-Nov-2020	80					70,00,000	0.0002	80.00	0.00691	0.00716	-0.00025	17.697	17.697	YES	209.653
16-Nov-2020	80					70,00,000	0.0002	80.00	0.00691	0.00716	-0.00025	17.697	17.696	YES	209.652
17-Nov-2020	80					70,00,000	0.0002	80.00	0.00691	0.00716	-0.00025	17.696	17.696	YES	209.652
18-Nov-2020	680				600.00	70,00,000	0.0002	80.00	0.05875	0.059	-0.00025	17.696	17.696	YES	209.652

Date	Inflows	Out flows												
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
19-Nov-2020	280				1000.00	70,00,000	0.0002	80.00	0.09331	0.09356	-0.00025	17.696	17.696	YES	209.652
20-Nov-2020	380				600.00	70,00,000	0.0002	80.00	0.05875	0.059	-0.00025	17.696	17.695	YES	209.652
21-Nov-2020	3200					70,00,000	0.0002	80.00	0.3024	0.00716	0.29524	17.695	17.991	YES	209.739
22-Nov-2020	1500					70,00,000	0.0002	80.00	0.1296	0.00716	0.12244	17.991	18.113	YES	209.775
23-Nov-2020	810					70,00,000	0.0002	80.00	0.06998	0.00716	0.06282	18.113	18.176	YES	209.794
24-Nov-2020	610					70,00,000	0.0002	80.00	0.06998	0.00716	0.06282	18.176	18.239	YES	209.812
25-Nov-2020	300					70,00,000	0.0002	80.00	0.06048	0.00716	0.05332	18.239	18.292	YES	209.828
26-Nov-2020	300					70,00,000	0.0002	80.00	0.06912	0.00716	0.06196	18.292	18.354	YES	209.846
27-Nov-2020	1800					70,00,000	0.0002	80.00	0.19872	0.00716	0.19156	18.354	18.546	YES	209.903
28-Nov-2020	3000					70,00,000	0.0002	80.00	0.3024	0.00716	0.29524	18.546	18.841	YES	209.990
29-Nov-2020	2700				2000.00	70,00,000	0.0002	80.00	0.27648	0.17996	0.09652	18.841	18.937	YES	210.017
30-Nov-2020	1700				2200.00	70,00,000	0.0002	80.00	0.19008	0.19724	-0.00716	18.937	18.930	YES	210.015
1-Dec-2020	1500				1800.00	70,00,000	0.0002	80	0.15552	0.16268	-0.00716	18.930	18.923	YES	210.013
2-Dec-2020	3000				1000.00	70,00,000	0.0002	80.00	0.28512	0.09356	0.19156	18.923	19.115	YES	210.067
3-Dec-2020	1000				1000.00	70,00,000	0.0002	80.00	0.0864	0.09356	-0.00716	19.115	19.107	YES	210.065
4-Dec-2020	850					70,00,000	0.0002	80.00	0.09936	0.00716	0.0922	19.107	19.200	YES	210.091
5-Dec-2020	1200					70,00,000	0.0002	80.00	0.14688	0.00716	0.13972	19.200	19.339	YES	210.130
6-Dec-2020	1200					70,00,000	0.0002	80.00	0.14688	0.00716	0.13972	19.339	19.479	YES	210.169
7-Dec-2020	850				200.00	70,00,000	0.0002	80.00	0.11664	0.02444	0.0922	19.479	19.571	YES	210.195
8-Dec-2020	1450				700.00	70,00,000	0.0002	80.00	0.16848	0.06764	0.10084	19.571	19.672	YES	210.223
9-Dec-2020	900				450.00	70,00,000	0.0002	80.00	0.12096	0.04604	0.07492	19.672	19.747	YES	210.244
10-Dec-2020	1050					70,00,000	0.0002	80.00	0.13392	0.00716	0.12676	19.747	19.874	YES	210.280

Date	Inflows	Out flows												
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
11-Dec-2020	2000					70,00,000	0.0002	80.00	0.216	0.00716	0.20884	19.874	20.083	YES	210.338
12-Dec-2020	1800				500.00	70,00,000	0.0002	80.00	0.18144	0.05036	0.13108	20.083	20.214	YES	210.375
13-Dec-2020	2500					70,00,000	0.0002	80.00	0.2592	0.00716	0.25204	20.214	20.466	YES	210.445
14-Dec-2020	1000					70,00,000	0.0002	80.00	0.19008	0.00716	0.18292	20.466	20.649	YES	210.497
15-Dec-2020	700					70,00,000	0.0002	80.00	0.67392	0.00716	0.66676	20.649	21.315	YES	210.675
16-Dec-2020	500					70,00,000	0.0002	80.00	0.5616	0.00716	0.55444	21.315	21.870	YES	210.824
17-Dec-2020	1600					70,00,000	0.0002	80.00	0.65664	0.00716	0.64948	21.870	22.519	YES	210.998
18-Dec-2020	1900					70,00,000	0.0002	80.00	0.69984	0.00716	0.69268	22.519	23.212	YES	211.176
19-Dec-2020	1600					70,00,000	0.0002	80.00	0.65664	0.00716	0.64948	23.212	23.862	YES	211.342
20-Dec-2020	500					70,00,000	0.0002	80.00	0.52704	0.00716	0.51988	23.862	24.381	YES	211.476
21-Dec-2020	600					70,00,000	0.0002	80.00	0.93312	0.00716	0.92596	24.381	25.307	YES	211.704
22-Dec-2020	600				750.00	70,00,000	0.0002	80.00	0.75168	0.07196	0.67972	25.307	25.987	YES	211.870
23-Dec-2020	600				3600.00	70,00,000	0.0002	80.00	0.31104	0.3182	-0.00716	25.987	25.980	YES	211.869
24-Dec-2020	600				2500.00	70,00,000	0.0002	80.00	0.216	0.22316	-0.00716	25.980	25.973	YES	211.867
25-Dec-2020	600				4000.00	70,00,000	0.0002	80.00	0.3456	0.35276	-0.00716	25.973	25.966	YES	211.865
26-Dec-2020	500				2000.00	70,00,000	0.0002	80.00	0.1728	0.17996	-0.00716	25.966	25.958	YES	211.863
27-Dec-2020	500				500.00	70,00,000	0.0002	80.00	0.0432	0.05036	-0.00716	25.958	25.951	YES	211.862
28-Dec-2020	500				900.00	70,00,000	0.0002	80.00	0.07776	0.08492	-0.00716	25.951	25.944	YES	211.860
29-Dec-2020	500				1100.00	70,00,000	0.0002	80.00	0.09504	0.1022	-0.00716	25.944	25.937	YES	211.858
30-Dec-2020	500				1000.00	70,00,000	0.0002	80.00	0.0864	0.09356	-0.00716	25.937	25.930	YES	211.856
31-Dec-2020	400				700	70,00,000	0.0002	80	0.06048	0.06764	-0.00716	25.930	25.923	YES	211.855
1-Jan-2021	400				700.00	70,00,000	0.0002	80	0.06048	0.06764	-0.00716	25.923	25.916	YES	211.853
2-Jan-2021	400				700.00	70,00,000	0.0002	80.00	0.06048	0.06764	-0.00716	25.916	25.908	YES	211.851
3-Jan-2021	500				1300.00	70,00,000	0.0002	80.00	0.11232	0.11948	-0.00716	25.908	25.901	YES	211.849
4-Jan-2021	500				1600.00	70,00,000	0.0002	80.00	0.13824	0.1454	-0.00716	25.901	25.894	YES	211.848
5-Jan-2021	500				2000.00	70,00,000	0.0002	80.00	0.1728	0.17996	-0.00716	25.894	25.887	YES	211.846
6-Jan-2021	500				1000.00	70,00,000	0.0002	80.00	0.0864	0.09356	-0.00716	25.887	25.880	YES	211.844
7-Jan-2021	1000				1000.00	70,00,000	0.0002	80.00	0.0864	0.09356	-0.00716	25.880	25.873	YES	211.842
8-Jan-2021	1000				1000.00	70,00,000	0.0002	80.00	0.0864	0.09356	-0.00716	25.873	25.865	YES	211.841
9-Jan-2021	800				800.00	70,00,000	0.0002	80.00	0.06912	0.07628	-0.00716	25.865	25.858	YES	211.839
10-Jan-2021	800				800.00	70,00,000	0.0002	80.00	0.06912	0.07628	-0.00716	25.858	25.851	YES	211.837
11-Jan-2021	800				800.00	70,00,000	0.0002	80.00	0.06912	0.07628	-0.00716	25.851	25.844	YES	211.835
12-Jan-2021	700				1000.00	70,00,000	0.0002	80.00	0.0864	0.09356	-0.00716	25.844	25.837	YES	211.834
13-Jan-2021	600				1220.00	70,00,000	0.0002	80.00	0.11232	0.11257	-0.00025	25.837	25.837	YES	211.833
14-Jan-2021	600				1520.00	70,00,000	0.0002	80.00	0.13824	0.13849	-0.00025	25.837	25.836	YES	211.833
15-Jan-2021	600				1520.00	70,00,000	0.0002	80.00	0.13824	0.13849	-0.00025	25.836	25.836	YES	211.833
16-Jan-2021	600				1520.00	70,00,000	0.0002	80.00	0.13824	0.13849	-0.00025	25.836	25.836	YES	211.833
17-Jan-2021	600				1120.00	70,00,000	0.0002	80.00	0.10368	0.10393	-0.00025	25.836	25.836	YES	211.833
18-Jan-2021	600				820.00	70,00,000	0.0002	80.00	0.07776	0.07801	-0.00025	25.836	25.835	YES	211.833
19-Jan-2021	600				520.00	70,00,000	0.0002	80.00	0.05184	0.05209	-0.00025	25.835	25.835	YES	211.833
20-Jan-2021	400				320.00	70,00,000	0.0002	80.00	0.03456	0.03481	-0.00025	25.835	25.835	YES	211.833
21-Jan-2021	300				220.00	70,00,000	0.0002	80.00	0.02592	0.02617	-0.00025	25.835	25.835	YES	211.833
22-Jan-2021	300				220.00	70,00,000	0.0002	80.00	0.02592	0.02617	-0.00025	25.835	25.834	YES	211.833
23-Jan-2021	300				220.00	70,00,000	0.0002	80.00	0.02592	0.02617	-0.00025	25.834	25.834	YES	211.833
24-Jan-2021	500				420.00	70,00,000	0.0002	80.00	0.0432	0.04345	-0.00025	25.834	25.834	YES	211.833
25-Jan-2021	300				220.00	70,00,000	0.0002	80.00	0.02592	0.02617	-0.00025	25.834	25.834	YES	211.833

Date	Inflows	Out flows													
	Inflows (in Cusec)	GKLI (in Cusec)	(CBR) Lift (in Cusec)	GNSS Main Canal (in Cusec)	Mylavaram (in Cusec)	Drinking suply (Tadipatri & Muddanur) (Daily agreegate in Litres & TMC)		Evp. Losses (in cusec)	Total Inflow (TMC)	Total Outflow (TMC)	Net Inflow-Outflow	Initial Storage on that day	Final Storage on that day	Required Water Availability (Yes/No)	Water Level as per Calculated Storage (in m.)
26-Jan-2021	300				220.00	70,00,000	0.0002	80.00	0.02592	0.02617	-0.00025	25.834	25.833	YES	211.833
27-Jan-2021	300				220.00	70,00,000	0.0002	80.00	0.02592	0.02617	-0.00025	25.833	25.833	YES	211.833
28-Jan-2021	80				0.00	70,00,000	0.0002	80.00	0.00691	0.00716	-0.00025	25.833	25.833	YES	211.833
29-Jan-2021	80				0.00	70,00,000	0.0002	80.00	0.00691	0.00716	-0.00025	25.833	25.833	YES	211.832
30-Jan-2021	0				0.00	70,00,000	0.0002	80.00	0	0.00716	-0.00716	25.833	25.825	YES	211.831
31-Jan-2021	0				0	70,00,000	0.0002	80.00	0	0.00716	-0.00716	25.825	25.818	YES	211.829

CHAPTER-5: GEOLOGICAL STUDIES

CHAPTER – 5

5. GEOLOGICAL STUDIES

5.1 Introduction

The proposed Gandikota Pumped Storage Project is located in YSR Kadapa (earlier Cuddapah) district, Andhra Pradesh, India. Cuddapah falls in Quandrangle sheet no. 57J and the project area is bounded by Lat. N 14°46'to 14°50'and Long. E 77°10' to 78°16' (**Fig-1**). The proposed project envisages utilization of water from an artificial bund type reservoir as upper reservoir, which will be created by composite of excavating a Pit and constructing a bund to divert the water through an Intake-HRT-Pressure shaft to an underground powerhouse to generate 1000MW of power by utilizing a gross head of 263.410m.

Fig.5.1. Google Earth image showing the proposed project area of Gandikota PSP

The water from Power House will be diverted through a TRT and will be stored in an existing reservoir known as Gandikota reservoir on confluence of River Chitravathi and River Pennar at lower reaches. Owing to pumped storage nature of the project, the

water from lower reservoir will be pumped through TRT-Reversible Turbines-Pressure Shaft-HRT to upper reservoir in off peak hours for recycling it during peak hours.

Kadapa district is the southern district of Andhra Pradesh. It is bordered by Chittoor district in the South, Kurnool and Prakasam districts in the north, Nellor district in the east and Anantapur district of Andhra Pradesh in the South.

The main aim of this chapter is geological feasibility study of the project components using District Resource Map of GSI for preparation of PFR and to formulate DPR stage investigation in future.

5.2 Regional Geomorphology and Geology

The district is mainly drained by the Penner River and its major tributaries like Cheyyeru and Kunderu and Sagileru. The southern granitic terrain is drained by Mandvi River, a tributary of Cheyyeru River. The drainage is parallel to sub-parallel in nature and controlled by structure. Numerous straight courses reflect that they are flowing along synclinal axis, litho-contact zones, faults/ major discontinuity zones etc.

The southern part is mainly comprises pediplain- pediment complex with residual hills of granite gneiss and structural ridges represented by dykes traversing ENE-WSW and NNW-SSE directions. There is an alternate sequence (Hogbacks) made up mostly by highly resistant quartzite and low lying structural valleys made by shale and dolomitic limestone. At places, quartzites occur as plateaus owing to high resistance to weathering and low dip.

In the eastern segment belongs to the Nallamlai hill ranges where steeply dipping structural ridges formed by quartzites with inter-ridge low area known as “structural valleys’ where less resistant Cumbum Shales and Phyllites are present.

The oldest rocks in the area belongs to mainly late Archaean or late Proterozoic age which are succeeded by rock of Dharwarian age and both are traversed by dolerite dykes as intrusive. The major part of the Cuddapah District is occupied by Cuddapah basin, which is a huge depression formed over the denuded surfaces of older rocks extending into neighbouring districts. The Archaean comprises the Peninsular Gneissic Complex represented by granite, granite gneiss, granodiorite and migmatite.

The Cuddapah Supergroup of rocks comprising of Papaghni, Chitravati and Nallamalai groups occur to the east and north of the Archaeans and Dharwars and occupy the major portion of the district. Mainly meta-sedimentary rocks comprising of quartzite, conglomerate, shale, tuff, chert, limestone, slate with phyllite are the major types of rocks also found in the area.

A series of NW-SE, NE-SW & E-W trending lineaments (shear, fault) are also present in the area as reflected in the District Resource Map of GSI on 1:2,50000 scale (Plate-I)**.**

5.2.1 Seismicity

Gandikota Pumped Storage Project is located within meta-sedimentary terrain comprises of Quartzite, conglomerate, shale, chert, limestone, slate with phyllite of late Proterozoic age. The area falls under seismic zone-II as per Seismic Zonation Map of India (IS: 1893-2002, Part-1) (**Fig.5.2**).

Fig.5.2. Seismic Zonation Map of India showing project area

Both deterministic and probabilistic approaches for evaluation of design ground motion for a project site require a comprehensive database on past earthquakes in the region

of the project. It is proposed to consider the seismic design parameters of the existing Gandikota Lower dam. The analysis of seismicity of Gandikota PSP is to be carried out to determine the detail seismic design parameter to be undertaken in the DPR stage. These studies are to be carried out following the guidelines of NCSDP. The seismo-tectonic map of the area (SEISAT-34) from Seismotectonic Atlas of India and its Environ, 2000, GSI is enclosed as **Fig.5.3.**.

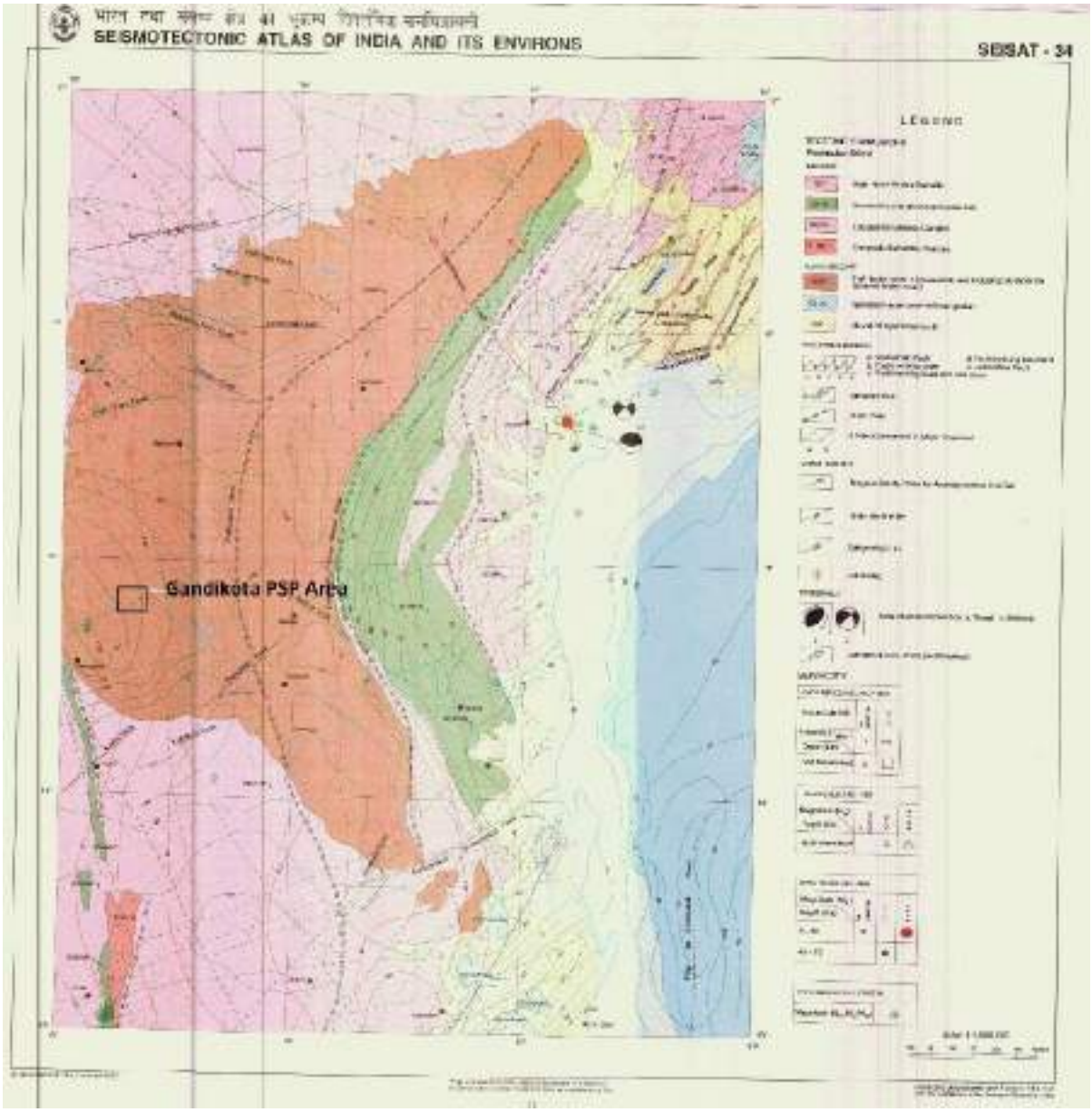


Fig.5.3: Seismotectonic map showing project area

5.2.2 Geomorphology and Geology of the Project Area

The project area lies in the south-western part of the Kadapa district of Andhra Pradesh. Different types of landforms like structural hills, pediment-pediplain, plateau etc. are found in and around the project area.

Quartzite belonging to Gandikota Quartzite Formation, shale and tuff of Tedpatri Formation, both under Chitravati Group are present in and around the project site. The general strike of the rock is N40°W-S40°E and dip 5°-15° towards N50°E.

The proposed project envisages construction of an artificial reservoir at the upper reaches from where the water will be diverted through a HRT-Pressure shaft- penstock to an Underground powerhouse for generation of power, and thereafter tail water will be taken through TRT to the existing Lower Reservoir located at the lower reaches. Two alternate proposals of combined bund & pit upper reservoir have been studied by WAPCOS. A comparative preliminary analysis of option-1 & option 2 is presented in **Table-5.1.**

Table-5.1: comparative analysis of proposed Option-1 & 2

Gandikota PSP			
Basic Data		**Basic Data**	
Lower Reservoir (Existing)		**Lower Reservoir (Existing)**	
FRL	El. 212 m	FRL(m)	El. 212 m
MDDL	El. 202.9 m	MDDL(m)	El. 202.9 m
Upper Reservoir (Option-1)		**Upper Reservoir (Option-2)**	
Reservoir Type – Bund & Pit Combined		**Reservoir Type – Bund & Pit Combined**	
FRL	El. 481m	FRL(m)	El. 515 m

MDDL	El. 464 m	MDDL(m)	El. 505 m
Gross Head(m)	263.41 m	Head(m)	302.55 m
Length(m)	1837 m	Length(m)	2812 m
L/H Ratio	6.98	L/H Ratio	9.29

The preliminary comparative study indicate that the L/H ratio in option-1 is minimum. Moreover, during site visit, it was observed that in Option-2, the Gandikota Village and Wind mill are situated near proposed upper reservoir. Hence, Private Land acquisition will impose additional cost and may involve R&R issues. After considering all the above mentioned criteria, Option-1 is selected for feasibility study. However, detailed study of all alternative options will also be done at DPR stage.

The preliminary geological assessment of project components are given subsequently.

5.3 Upper Reservoir

A1180 m long and 722 m wide pool is to be created by excavation for the artificial reservoir at the upper reaches. The proposed FRL of the upper reservoir will be at EI.481.0m and MDDL is at EI.464.0m. The average surface elevation in the upper reservoir area is El.465.0m and heighest being El.468.0m. Therefore, about 6m deep pit will be excavated from 468.0m and at about 20.0m high bund have been proposed upto EI.482.0m which will serve the purpose of upper reservoir. Hard, competent quartzite having high bearing capacity is the major rock type in this area. The general strike is N41°W-S41°E with dip amount of 5-10° towards N49°E.The majority of rock mass may belongs to Class-II/III category, however class-IV/V type rockmass may also be present at weak/shear zones. Necessary slope protection for reservoir rim stability and competency studies for leakage/seepage along major discontinuity planes is required and has to be studied. At the excavated slope, benches at certain interval may also be required to avoid slope failure. At this feasibility report level, a 3m wide bench is provided at 10 m height. Stitching of wedges through rock bolts/anchors

may also be required to prevent failure of vulnerable wedges. All these studies will be carried out during DPR stage investigations. The excavated muck may be utilized as coarse aggregate during construction.

5.4 Geology of Intake:

Two intakes of size 24.0 m x 79.4m (W x L) with sill elevation at 441.04m has been proposed. The intake will be connected to 2 Nos of 8.90 dia. HRT of length 532.0m with transition. The maximum discharging capacity of the tunnel will be 222Cumec (each). At the intake area quartzite will be present below a thin cover of overburden.

5.5 Geology of Head Race Tunnel & Pressure Shaft

Two Nos. of 532 m long and 8.90 m dia. concrete lined Head Race Tunnel (HRT) has been proposed to carry a max discharge of 222cumec of water by each HRT. The cover of HRT varies from 18.0 m to 53.0m.

Two (2 Nos.) of steel lined pressure shaft with diameter of 7.00 m and length 383 m each is provided at 50-degree angle with horizontal. Each-pressure shaft will bifurcates into 4.95 m diameter steel lined of 92 m length each.

Study of District Resource Map (1:2,50,000 scale) reveals that mainly quartzite will be present along the HRT alignment. Dolerite dykes may also be present at some places. A tentative geological L-section has been prepared (Plate-2), where it shows the tunnel is passing under a minimum cover of 18.0m and maximum cover of 53.0m. Since, at initial reaches, the cover above the HRT is around two times diameter, cut & cover may be required at based on the geotechnical investigations to be taken at DPR stage. Detailed subsurface exploration will be required to ascertain the rockmass condition. In the tunnel portion, it appears that the rockmass belong to Class-IV/V categories may be present at the tunnel grade. Class-VI rockmass may also be present at certain reaches and at the weak/shear zones. Due to insufficient safe cover above the HRT, option for steel lined HRT may also be explored at DPR stage if required. Installation of adequate and timely support system in form of shotcrete, and rock bolts as construction support along with installation of steel ribs at certain reaches and drainage of water away from the face by providing drainage holes prior to face

advancement in water charged strata, with simultaneous monitoring of rock mass behaviour by aid of geotechnical instrumentation may be required. However, actual support system will be decided after geological investigations at DPR stage.

It appears that quartzite may present along the top half portion of the inclined shaft whereas incompetent shale and tuff along the bottom portion. Along the horizontal pressure shaft/tunnel at the bottom of the inclined shafts, incompetent shale and tuff will be present. However, detail investigations will be required to confirm the same. In general, rock-bolts, shotcrete and steel lining will be required as support system. Actual support system will be decided after geological investigations and analysis at DPR stage.

The detail surface and subsurface geological investigations along the proposed HRT – pressure shaft alignment will be carried out in the DPR stage to decipher the subsurface geology and rockmass characterisation to work out a realistic support system.

5.6 Powerhouse & Transformer Cavern

An underground powerhouse (UGPH) of 160m (L) x 24m (W) x 55m (H) and a transformer cavern hall of 137m (L) x 18m (W) x 22.5m (H) have been proposed for this project. The power house will have four Francis type vertical shaft reversible units of 250 MW each. The design head for turbine mode as 258.41 m and pumping mode as 268.80 m has been assessed. Mainly weak shale and tuff may be present at the caverns. The general strike of the rocks are N41°W-S41°E with dip amount of 5-10° towards N49°E. The L-axis of powerhouse has been aligned along N83°W-S83°E. Therefore, the L-axis of powerhouse making an angle of 42° with the strike of the foliation, which appears to be favourable. A tentative geological L-section has been prepared (**Plate-2**), where 235.0m cover has been observed. It appears that poor rockmass may be present at the caverns. Squeezing condition may also develop due to high cover. Detailed surface and sub-surface geological investigations will be required to ascertain the rockmass condition, principal horizontal stress verses vertical stress etc. to optimise suitable orientation and support system. The same is proposed at DPR stage.

5.7 Tail Race Tunnel

Initially four horizontal unit of tail race tunnels are proposed. The length of unit tail race tunnel will be 75 m and 5.50 m dia. Thereafter, two 8.90 m dia and 755 m long concrete lined TRT has been proposed. The rock cover along TRT will vary from 30.0m to 266.0m. Shale and tuff belonging to mainly poor rockmass (Class-IV) is anticipated along the TRT. TRT will be provided with suitable rock support system depending upon the geological strata. Relatively competent rock like dolomite, tuff, and less competent shales form the tunnelling media. The rockmass belong to Class-III/IV category whereas Class-V/VI category rockmass may be present at weak/shear zones. Ingress of water along major discontinuities cannot be ruled out. Surface geological mapping and sub-surface explorations will be required to decipher rockmass condition and support system. The same is proposed at the DPR stage.

5.8 Geology of Construction Material

5.8.1 Coarse aggregate

A number of mafic rocks of volcanic origin are present in and around the project (**Plate-II**). Fresh mafic rocks can be used as coarse aggregate of concrete. Again, quartzite outcrops are also present in the vicinity of project site which can also be used. However, determination of engineering properties and quantity assessment will be undertaken during DPR stage to know their suitability for wearing and non-wearing surfaces as well as availability of sufficient quantities.

5.8.2 Fine aggregate

The sand deposit of Chitravathi River may be utilized as fine aggregates. However, suitable quarry sites will be selected in DPR stage. The required tests will be done to know their suitability. In addition, the material from crushing of fresh rock (mafic rocks & quartzite) may also be used as fine aggregate, if found suitable.

5.9 Conclusions and Recommendations

The proposed Gandikota Pumped Storage Project is located in Kadapa District, Andhra Pradesh, India. The proposed project envisages utilization of water from an

artificial reservoir proposed as Upper Reservoir, which will be constructed by excavating a composite Pit with bund type reservoir from which the water will be diverted through an Intake-HRT-pressure shaft to an underground powerhouse to generate 1000MW of power by utilizing gross head of 263.41 m. Out of two options, the option-1 has been chosen depending upon the techno-economic feasibility.

Option-1 envisages an artificial combined bund and pit type reservoir at higher reaches (MDDL EI.464.0m). This reservoir is required to be created through excavation within quartzite. At the cut slope benches at certain intervals, rock bolts to stitch planes and wedges may be required on stability consideration. Competency study to prevent seepage/leakage will also be required. Quartzite is present along the HRT alignment, but due low cover, poor to very poor rockmass is anticipated at HRT grade. Presently concrete lined HRT is proposed and steel lining HRT option will be explored based on results of geotechnical investigations. Cut and cover duct may be required at certain initial reaches of HRT. Along the upper portion of the inclined pressure shaft fair quality (Class-III) quartzite is anticipated whereas weak shale and tuff may be present in rest of the portion. Weak shale and tuff may also be present at the underground powerhouse complex. Squeezing condition may also develop due to high cover. Same rock types (weak shale and tuff) will be present along TRT. Detailed investigations will be required for realistic characterisation of rockmass for the underground civil structures to decipher support system. Prima facie, on the basis of the preliminary geological studies, it appears that the project is feasible. Geological setup is conducive for underground works. Considering the overall geology of the project area, shorter water conductor system, only one low height bund type reservoir etc indicate that the project has merits on techno-economic considerations and suggested to take up for DPR stage investigations.

Quartzite and basic volcanics for coarse aggregate and sand of Chitravathi River and other rivers for fine aggregates of concrete may be suitable. Detailed study for optimization of layout including availability of required quantity of construction materials will be assessed during DPR stage investigations.

CHAPTER-6: PROJECT PLANNING & IC

CHAPTER – 6

6. POWER POTENTIAL & INSTALLED CAPACITY

6.1 Introduction

The Existing Gandikota Reservoir is located near Kondapuram Village in Kadapa district, Andhra Pradesh on the intersection of Pennar River and Chitravathi River. The purpose of this project is an irrigation and Kadapa district is benefitted.

The catchment area at the dam site is 19197 sq. km. The reservoir with Gross storage of 760.31 MCM and Dead storage 90.93 MCM. The Gandikota dam of having length 320.00m. The Max. Flood discharge is 8180 Cumec.

6.2 Gandikota Pump Storage Project

The proposed pump storage project has been planned by using the existing Gandikota Reservoir as lower reservoir for the Pumped storage scheme with Full Reservoir Level of 212 m and Minimum draw down level of 202.9 m. A new upper reservoir of composite bund and pit type will be formed. The optimum possible live storage capacity for pump storage scheme required is 8.592 MCM finalised based on the topography and geology of the upper dam. The proposed project will generate 1000 MW of power.

6.3 Gandikota PSP Project- Upper Reservoir

The upper reservoir of pumped storage operation of the project. The reservoir has a live storage capacity of 8.592 million m^3 as under.

Table 6:1

Particulars	Elevation (m)	Storage (million m^3)
FRL	481	9.514
MDDL	464	0.922
Live Storage		8.592

6.4 Gandikota PSP Project -Lower Reservoir (Existing)

Lower Gandikota Reservoir is existing and is being used for multiple purposes including lift irrigation, drinking water etc. Since the overall live capacity of lower reservoir is 669.38 MCM which is very high compared to live storage of upper reservoir i.e. 8.59 MCM. 8.59 MCM drawdown (during pumping) or supply (during generation) in lower reservoir results in only 26.8 cm level change at MDDL level and 4.08 cm level difference at FRL level. Moreover, water availability in lower reservoir will be somewhere in between FRL and MDDL during any operating day. Hence, an average level is assumed for lower reservoir for pumping as well as generation simulation. Average level is calculated using MDDL + 2*(FRL-MDDL)/3.

Table 6:2

Particulars	**Elevation (m)**	**Storage (million m^3)**
FRL	212	760.30
MDDL	202.90	90.93
Live Storage		**669.38**
Average Level	**208.97**	**456.82**

6.5 Operating Gross Head

Gross operating head on the pumped storage units would vary from 271.80 m to 255.03 m. The minimum gross head is 93.83% of the maximum gross head. The head loss in the water conductor system has been estimated as 5.0 m. accordingly, the net head on the machine would vary from 266.80 m to 250.03 m.

6.6 Installed Capacity

Considering the availability of the diurnal storage capacity in lower reservoir an installation of 1000 MW comprising 4 units of 250 MW has been provided. The project would provide peaking capacity of 1000 MW for 5.38 hours' block.

6.7 Power Scenario in Andhra Pradesh

The installed generating capacity in Andhra Pradesh as on 31th January 2021 was 25251.17 MW comprising as under:

Table 6:3

Type	Installed Capacity	
	(MW)	(%)
Thermal	14688.21	58.17%
Nuclear	127.27	0.50%
Hydro	1673.6	6.63%
RES	8762.09	34.70%
Total	**25251.17**	**100%**

The share of hydro in the present installed capacity is about 6.63% which is quite less. Therefore, to ameliorate the situation, development of pumped storage project would need to be considered to meet the growth in the peaking capacity requirement of the power system.

6.8 Operation Simulation

The operation simulation of the two reservoirs for pumped storage operation has been carried out considering the storage characteristics. The simulation has been carried out considering a shorter time interval of 10 minutes to take into account the level variations in the two reservoirs.

6.8.1 Lower Reservoir

The live storage of lower reservoir is 669.38 million m^3 has been available in the Lower reservoir for pump-storage operation. However, considering the utilisation of Lower reservoir for various purposes, fluctuation of level and storage is envisaged. Hence, an average level and corresponding storage has been considered available in the Lower reservoir for pump-storage operation for a particular day.

6.8.2 Generator Turbine efficiency

The efficiency of the pump-turbine unit during generating mode is adopted as 89% and during the pumping mode is adopted as 91%.

6.8.3 Losses in the Water Conductor System

The losses in the water conductor system have been considered as 5.0 m.

6.9 Operation Simulation Studies

The studies have been carried out at the beginning of generating cycle, the Upper Gandikota reservoir is at FRL and Lower reservoir at MDDL.

The simulation studies have been carried out for the initial reservoir levels as under.

Table 6:4

Reservoir	**Initial Reservoir Level**
Upper Reservoir	FRL El. 481 m
Gandikota Lower reservoir	Avg. Water availability El. 208.97 m

The results of the simulation studies for generating mode are given in **Annex- 6.1** and summarized below.

Generation

- At the beginning of the generation, the Upper reservoir is at FRL El. 481 m and average water level of the Lower Reservoir i.e El. 208.97m is considered. The upper reservoir draws down to El. 464.03 m in 5 hours 23 minutes of full load operation representing a drawdown of 16.97 m.
- The storage utilized for operation is 8.59 million m^3.

- At the start of generation, the Lower reservoir is at its MDDL El. 208.97 m and a rise of 12 cm in the reservoir level takes place during generation considering average level of the Lower Reservoir available for operation.

- The energy generation during the period is 5383.33 MWh.

Pumping

- At the beginning of the pumping, the Upper reservoir is at MDDL El. 464 m and average water level of the Lower Reservoir i.e El. 208.97m is considered. The upper reservoir gets filled to El. 481.19 m in 7 hours 03 minutes of full load operation representing a increase of 17.19 m.

- The pumping required for operation is 8.75 million m^3 considering 2% extra water to be pumped to account for the evaporation, seepage, water conductor leakage etc.

- At the start of pumping, the Lower reservoir is at its average water availability El. 208.97 m and a drawdown of 7 cm in the reservoir level takes place during pumping considering average level of the Lower Reservoir available for operation.

- The pumping energy required during the period is 7050.0 MWh.

The simulation studies for pumping mode are given in **Annex-6.2**. The cycle efficiency of the project is 76.36%.

6.10 Source of Pumping

The hydro power share in Andhra Pradesh is 6.63% whereas the state depends mainly on thermal power generation. Moreoevr, there are multiple wind turbine and solar projects in pipeline nearby the Gandikota site. In view of the large capacity proposed and operational RE in the region, there would be adequate availability of off-peak power for pumping operation.

Annexure - 6.1

Gandikota Pumped Storage Project (1000 MW)

Annexure-6.1

Generation Operation Simulation Studies

Operating Levels and Storage available at Reservoirs

Upper reservoir			Lower reservoir		
	Level	Storage		Level	Storage
	m	MCM		m	MCM
FRL	481	9.514	FRL	212	760.30
MDDL	464	0.922	MDDL	202.9	90.93
Live Storage		8.59	Live Storage		669.38
			Average Level	208.97	456.82

Scenario: Operating Levels considered for Operation Simulation

Upper reservoir		Lower reservoir		
	Level		Level	Storage
	m		m	(MCM)
FRL - PS Operation	481	FRL - PS Operation	209.09	
MDDL- PS Operation	464.03	MDDL- PS Operation	208.97	
Pondage for PS Operation	8.58	Pondage for PS Operation		8.58

Interval No	Time Interval (Minutes)	Station Output (MW)	Discharge (cumecs)	Upper Pond				Lower Pond				Average Net Head (m)	Energy Generation (MWh)
				Initial Pond Level (m)	Outflow from Pond (MCum)	Final Pond Level (m)	Average Pond Level (m)	Initial Pond Level (m)	Inflow into Pond (MCum)	Final Pond Level (m)	Average Pond Level (m)		
1	10	1000	429.30	481.00	0.26	480.53	480.76	208.97	0.26	208.97	208.97	266.80	166.67
2	10	1000	430.07	480.53	0.26	480.05	480.29	208.97	0.26	208.97	208.97	266.32	166.67
3	10	1000	430.85	480.05	0.26	479.57	479.81	208.97	0.26	208.97	208.97	265.84	166.67
4	10	1000	431.63	479.57	0.26	479.09	479.33	208.97	0.26	208.97	208.97	265.35	166.67
5	10	1000	432.43	479.09	0.26	478.60	478.84	208.97	0.26	208.98	208.98	264.87	166.67
6	10	1000	433.22	478.60	0.26	478.12	478.36	208.98	0.26	208.98	208.98	264.38	166.67
7	10	1000	434.03	478.12	0.26	477.63	477.87	208.98	0.26	208.98	208.98	263.89	166.67
8	10	1000	434.84	477.63	0.26	477.13	477.38	208.98	0.26	208.98	208.98	263.40	166.67
9	10	1000	435.66	477.13	0.26	476.64	476.88	208.98	0.26	208.99	208.98	262.90	166.67
10	10	1000	436.49	476.64	0.26	476.14	476.39	208.99	0.26	208.99	208.99	262.40	166.67
11	10	1000	437.33	476.14	0.26	475.64	475.89	208.99	0.26	208.99	208.99	261.90	166.67
12	10	1000	438.17	475.64	0.26	475.13	475.38	208.99	0.26	208.99	208.99	261.39	166.67
13	10	1000	439.03	475.13	0.26	474.62	474.88	208.99	0.26	208.99	208.99	260.88	166.67
14	10	1000	439.89	474.62	0.26	474.12	474.37	208.99	0.26	209.00	208.99	260.37	166.67
15	10	1000	440.76	474.12	0.26	473.60	473.86	209.00	0.26	209.00	209.00	259.86	166.67
16	10	1000	441.64	473.60	0.26	473.08	473.34	209.00	0.26	209.00	209.00	259.34	166.67
17	10	1000	442.53	473.08	0.27	472.56	472.82	209.00	0.27	209.00	209.00	258.82	166.67
18	10	1000	443.43	472.56	0.27	472.04	472.30	209.00	0.27	209.01	209.01	258.29	166.67
19	10	1000	444.35	472.04	0.27	471.51	471.77	209.01	0.27	209.02	209.01	257.76	166.67
20	10	1000	445.28	471.51	0.27	470.97	471.24	209.02	0.27	209.02	209.02	257.22	166.67
21	10	1000	446.22	470.97	0.27	470.43	470.70	209.02	0.27	209.03	209.02	256.68	166.67
22	10	1000	447.17	470.43	0.27	469.89	470.16	209.03	0.27	209.03	209.03	256.13	166.67
23	10	1000	448.14	469.89	0.27	469.34	469.61	209.03	0.27	209.04	209.03	255.58	166.67
24	10	1000	449.12	469.34	0.27	468.78	469.06	209.04	0.27	209.04	209.04	255.02	166.67
25	10	1000	450.11	468.78	0.27	468.23	468.50	209.04	0.27	209.05	209.04	254.46	166.67
26	10	1000	451.12	468.23	0.27	467.66	467.94	209.05	0.27	209.05	209.05	253.89	166.67
27	10	1000	452.13	467.66	0.27	467.09	467.38	209.05	0.27	209.06	209.06	253.32	166.67
28	10	1000	453.16	467.09	0.27	466.52	466.81	209.06	0.27	209.06	209.06	252.75	166.67
29	10	1000	454.19	466.52	0.27	465.95	466.24	209.06	0.27	209.07	209.07	252.17	166.67
30	10	1000	455.25	465.95	0.27	465.37	465.66	209.07	0.27	209.07	209.07	251.59	166.67
31	10	1000	456.31	465.37	0.27	464.79	465.08	209.07	0.27	209.08	209.08	251.00	166.67
32	10	1000	457.39	464.79	0.27	464.20	464.49	209.08	0.27	209.08	209.08	250.41	166.67
33	3	1000	458.09	464.20	0.08	464.03	464.11	209.08	0.08	209.09	209.09	250.03	50.00
	323				8.58				8.58				**5383.33**

Operation Time	**5.38**	**Or 5 Hours 23 minutes**
Head Loss	**5**	
Generation mode efficiency	**0.89**	

Annexure - 6.2

Gandikota Pumped Storage Project (1000 MW)

Annexure-6.2

Pumping Operation Simulation Studies

Operating Levels and Storage available at Reservoirs

	Upper reservoir		Lower reservoir		
	Level	Storage		Level	Storage
	m	MCM		m	MCM
FRL	481	9.514	FRL	212	760.30
MDDL	464	0.922	MDDL	202.9	90.93
Live Storage		8.59	Average Level	208.97	456.82

Scenario: Operating Levels considered for Operation Simulation

	Upper reservoir		Lower reservoir	
	Level	Storage	Level	Storage
	m	MCM	m	(MCM)
FRL - PS Operation	481.19	9.615	208.97	456.82
MDDL- PS Operation	464	0.922	208.90	448.13
Pondage for PS Operation		8.75		8.75

Interval No	Time Interval (Minutes)	Station Output (MW)	Discharge (cumecs)	Upper Pond				Lower Pond				Average Net Head to be pumped (m)	Energy Utilisation (MWh)
				Initial Pond Level (m)	Inflow into Pond (MCM)	Final Pond Level (m)	Average Pond Level (m)	Initial Pond Level (m)	Outflow from Pond (MCum)	Final Pond Level (m)	Average Pond Level (m)		
1	10	1000	356.42	464.00	0.21	464.46	464.23	208.97	0.21	208.96	208.97	260.26	166.67
2	10	1000	355.79	464.46	0.21	464.91	464.68	208.96	0.21	208.96	208.96	260.72	166.67
3	10	1000	355.17	464.91	0.21	465.37	465.14	208.96	0.21	208.96	208.96	261.18	166.67
4	10	1000	354.55	465.37	0.21	465.82	465.59	208.96	0.21	208.96	208.96	261.63	166.67
5	10	1000	353.94	465.82	0.21	466.27	466.04	208.96	0.21	208.96	208.96	262.08	166.67
6	10	1000	353.34	466.27	0.21	466.71	466.49	208.96	0.21	208.96	208.96	262.53	166.67
7	10	1000	352.74	466.71	0.21	467.15	466.93	208.96	0.21	208.95	208.96	262.98	166.67
8	10	1000	352.15	467.15	0.21	467.60	467.38	208.95	0.21	208.95	208.95	263.42	166.67
9	10	1000	351.55	467.60	0.21	468.04	467.82	208.95	0.21	208.95	208.95	263.86	166.67
10	10	1000	350.97	468.04	0.21	468.47	468.25	208.95	0.21	208.95	208.95	264.30	166.67
11	10	1000	350.39	468.47	0.21	468.90	468.69	208.95	0.21	208.95	208.95	264.74	166.67
12	10	1000	349.82	468.90	0.21	469.34	469.12	208.95	0.21	208.95	208.95	265.17	166.67
13	10	1000	349.25	469.34	0.21	469.77	469.55	208.95	0.21	208.94	208.95	265.61	166.67
14	10	1000	348.68	469.77	0.21	470.19	469.98	208.94	0.21	208.94	208.94	266.04	166.67
15	10	1000	348.13	470.19	0.21	470.61	470.40	208.94	0.21	208.94	208.94	266.46	166.67
16	10	1000	347.58	470.61	0.21	471.03	470.82	208.94	0.21	208.94	208.94	266.88	166.67
17	10	1000	347.03	471.03	0.21	471.45	471.24	208.94	0.21	208.94	208.94	267.30	166.67
18	10	1000	346.49	471.45	0.21	471.87	471.66	208.94	0.21	208.94	208.94	267.72	166.67
19	10	1000	345.95	471.87	0.21	472.28	472.07	208.94	0.21	208.93	208.94	268.14	166.67
20	10	1000	345.43	472.28	0.21	472.68	472.48	208.93	0.21	208.93	208.93	268.55	166.67
21	10	1000	344.90	472.68	0.21	473.09	472.89	208.93	0.21	208.93	208.93	268.95	166.67
22	10	1000	344.38	473.09	0.21	473.49	473.29	208.93	0.21	208.93	208.93	269.36	166.67
23	10	1000	343.86	473.49	0.21	473.90	473.69	208.93	0.21	208.93	208.93	269.77	166.67
24	10	1000	343.35	473.90	0.21	474.29	474.10	208.93	0.21	208.93	208.93	270.17	166.67
25	10	1000	342.84	474.29	0.21	474.69	474.49	208.93	0.21	208.93	208.93	270.57	166.67
26	10	1000	342.34	474.69	0.21	475.09	474.89	208.93	0.21	208.92	208.92	270.96	166.67
27	10	1000	341.84	475.09	0.21	475.48	475.28	208.92	0.21	208.92	208.92	271.36	166.67
28	10	1000	341.34	475.48	0.20	475.88	475.68	208.92	0.20	208.92	208.92	271.76	166.67
29	10	1000	340.85	475.88	0.20	476.27	476.07	208.92	0.20	208.92	208.92	272.15	166.67
30	10	1000	340.36	476.27	0.20	476.65	476.46	208.92	0.20	208.92	208.92	272.54	166.67
31	10	1000	339.88	476.65	0.20	477.04	476.85	208.92	0.20	208.92	208.92	272.93	166.67
32	10	1000	339.39	477.04	0.20	477.42	477.23	208.92	0.20	208.91	208.91	273.32	166.67
33	10	1000	338.91	477.42	0.20	477.81	477.62	208.91	0.20	208.91	208.91	273.70	166.67
34	10	1000	338.44	477.81	0.20	478.19	478.00	208.91	0.20	208.91	208.91	274.09	166.67
35	10	1000	337.97	478.19	0.20	478.57	478.38	208.91	0.20	208.91	208.91	274.47	166.67
36	10	1000	337.50	478.57	0.20	478.95	478.76	208.91	0.20	208.91	208.91	274.85	166.67
37	10	1000	337.04	478.95	0.20	479.32	479.14	208.91	0.20	208.91	208.91	275.23	166.67
38	10	1000	336.57	479.32	0.20	479.70	479.51	208.91	0.20	208.90	208.90	275.61	166.67
39	10	1000	336.11	479.70	0.20	480.08	479.89	208.90	0.20	208.90	208.90	275.98	166.67
40	10	1000	335.66	480.08	0.20	480.45	480.26	208.90	0.20	208.90	208.90	276.36	166.67
41	10	1000	335.21	480.45	0.20	480.82	480.63	208.90	0.20	208.90	208.90	276.73	166.67
42	10	1000	334.76	480.82	0.20	481.19	481.00	208.90	0.20	208.90	208.90	277.10	166.67
43	3	1000	334.47	481.19	0.06	481.30	481.24	208.90	0.06	208.90	208.90	277.34	50.00
	423				**8.75**				**8.75**				**7050.00**

Operation Time 7.05 Or 7 Hours 3 minutes **Cycle Efficiency** 76.36%

Head Loss 5

Pumping mode efficiency 0.91

CHAPTER-7:

DESIGN OF CIVIL STRUCTURES

CHAPTER – 7

7. DESIGN OF CIVIL STRUCTURES

7.1 The Scheme

The Gandikota Reservoir project is located near Kondapuram Village in Kadapa district, Andhra Pradesh on the Pennar River. The purpose of this project is an irrigation and Kadapa district is benefitted.

The catchment area at the dam site is 19197 sq. km. The reservoir with Gross storage of 760.31 MCM and Dead storage 90.93 MCM. The Gandikota dam of having length 320.00m. The Max. Flood discharge is 8180 Cumec.

It is envisaged to utilise the existing Gandikota Reservoir as Lower pond for the proposed PSP scheme by locating upper pond at a suitable higher location in the vicinity.

7.2 Present Proposal

Accordingly, the existing Gandikota Reservoir has been proposed as lower reservoir for the Pumped storage scheme with Full Reservoir Level of El. 212.0 m and Minimum draw down level of El. 202.90 m. An artificial Reservoir is proposed as upper Reservoir which is constructed by composite bund & excavating Pit Type Reservoir at an El.-462.0m. The live storage capacity for pump storage scheme required is only 8.59 MCM. The proposed project will generate 1000 MW of power by utilizing net design head of 258.41m. The water from the upper reservoir will be diverted through Power House and TRT to the lower reservoir. The water will be pumped back to the upper reservoir through TRT-Reversible Turbines-pressure shaft-HRT to upper reservoir.

Generation capacity calculation is given in Annexure 7.9.

7.3 Selection of Layout – General

The concept of pumped storage Projects are broadly categorized in two types such as;

- Closed-loop pumped storage projects are not continuously connected to a naturally-flowing water feature.
- Open-loop pumped storage projects are continuously connected to a naturally-flowing water feature.

In Closed loop systems, the upper reservoir or Lower reservoir or both reservoirs have little or no natural drainage catchment basin. The upper basin is filled only using water pumped from the lower reservoir. Closed loop systems are often preferred because of the fewer environmental impacts associated with these developments.

A water source must still be identified, however, that is able to provide the initial water required as well as replenish any water losses, which can be challenging. Potential off-stream water sources can include groundwater, sea water, and treated wastewater. The upper basin may also fill only using water pumped from the lower reservoir, if natural flow is available.

The Proposed scheme is categorized as open loop Pump Storage type. The Lower reservoir is an existing reservoir namely Gandikota Reservoir which is connected to natural stream as well as tunnel from Owk reservoir. The Upper reservoir is proposed as an artificial reservoir at higher elevation to gain the available head. Based on the preliminary study of the topography of the area, a suitable locations for upper reservoirs which has been identified at this stage. However, it is proposed that a detailed study will be required during DPR stage to further examine with extensive investigation and data with regard to topography and geology etc.

Generally following key aspects make any PSP attractive from techno economic standpoint:

1. Topographical features: - If the topography offers high head makes scheme more viable with less cost.

2. Installed Capacity: It is a generally considered that higher installed capacity enhances overall economy of pumped storage project. PSP with installed capacity less than 200 MW is generally not considered very economical.

3. Design Head: it is one of the most important criteria for selection of PSP for the following reasons:

- Higher head results in lesser civil works like smaller height of dams, smaller size of water conductor system and smaller power house complex.
- Higher head results in smaller electro-mechanical components like smaller size of turbine, smaller size of stator and other associated E&M components.
- Higher head require lesser pondage thus results in smaller reservoirs.
- It reduces overall requirement of land for various components of project like size of HRT, TRT etc. together with reduction in quarry/borrow and dumping land requirements.
- However, very little technical know-how is available in the world for handling a project having head more than 800m. Therefore, range of head between 150m to 700m is preferable.

4. L/H Ratio: This aspect is very important in the evaluation of any PSP. Lesser L/H ration has inherent multiple advantages. It generally results in low initial capital cost, less head losses in WCS, reduction or absence of costly surge requirements and better performance of E&M components.

Generally, for heads in the range of 150m to 250m the L/H ration may be of the order of 4 to 6. For higher heads more than 250m to 450m it can be 6 to 10. For heads more than 450m to 700m it can be up to 10 to 14.

5. Geological/geotechnical Setup: A good geological setup enables construction of underground structures as well as for surface structures safely with less cost.

6. Transmission Networks: Easy access to electrical transmission networks and low-cost power for pumping also supports the PSP schemes significantly.

7. **Existing Reservoirs:** Use of an existing reservoir one or both greatly supports in reduction of the project cost with associated mitigation of adverse impact on environment.

7.4 Alternative Layout studies

Since the lower reservoir is existing in the present scheme various alternatives were examined to locate the upper reservoir and two possible options were identified at the nearby hilltop. Technically there are two possible methods to create an artificial upper reservoir either by constructing a bund of requisite height around the flat area available to create pondage for the required generation or excavating a pit to certain depth to create pondage.

The Topography of the project area suggests that, highest contour available in the vicinity of the project is of the order of 468m and 505m. Accordingly two possible location of the Upper Reservoirs namely Option-1 and Option-2 have been considered for optimizing the project layout. The detailed comparison between both the options is stated as under:

Option – 1

In this option, the upper reservoir is proposed on left bank at geographical co-ordinate N- 14˚ 49’ 47.78’’ and E- 78˚ 13’ 53.81’’ in NE direction of existing lower Reservoir. The highest possible elevation is at EL-468m on the hilltop. At this location the flat surface area is inadequate to create required capacity in reservoir. Therefore, it is proposed to create pondage through composite bund and pit type upto desired depth for optimum live storage. The length of water conductor is 1837m starting from upper Intake to lower intake. The General Layout Map for Option-I is presented below:

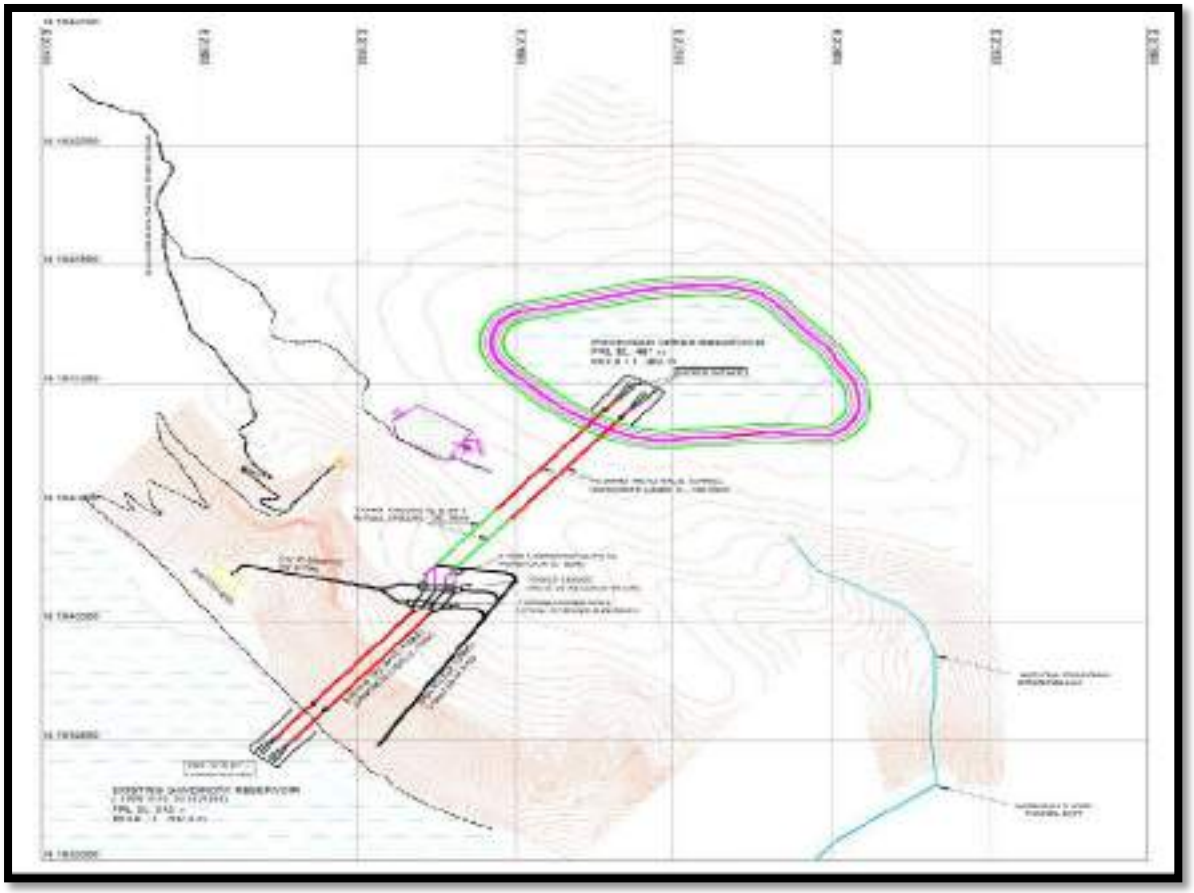


Fig. 7.1 General Layout Map- Option-1

The viability of the project has some technical aspects which have already been elaborated above. The gross head available in this type of reservoir is 263.41 m and similarly live storage is 8.59 MCM.

Option – 2

In this option, the upper reservoir is proposed on right bank at geographical co-ordinate N- 14° 46’ 28.93” E- 78° 17’ 6.77”. The highest possible elevation is at EL-505m on the hilltop. At this location the flat surface area is inadequate to create required capacity in reservoir. Therefore, it is proposed to create pondage through composite bund and pit type upto desired depth for optimum live storage. The length of water conductor is 2812m starting from upper Intake to lower intake. The General Layout Map for Option-2 is presented below:

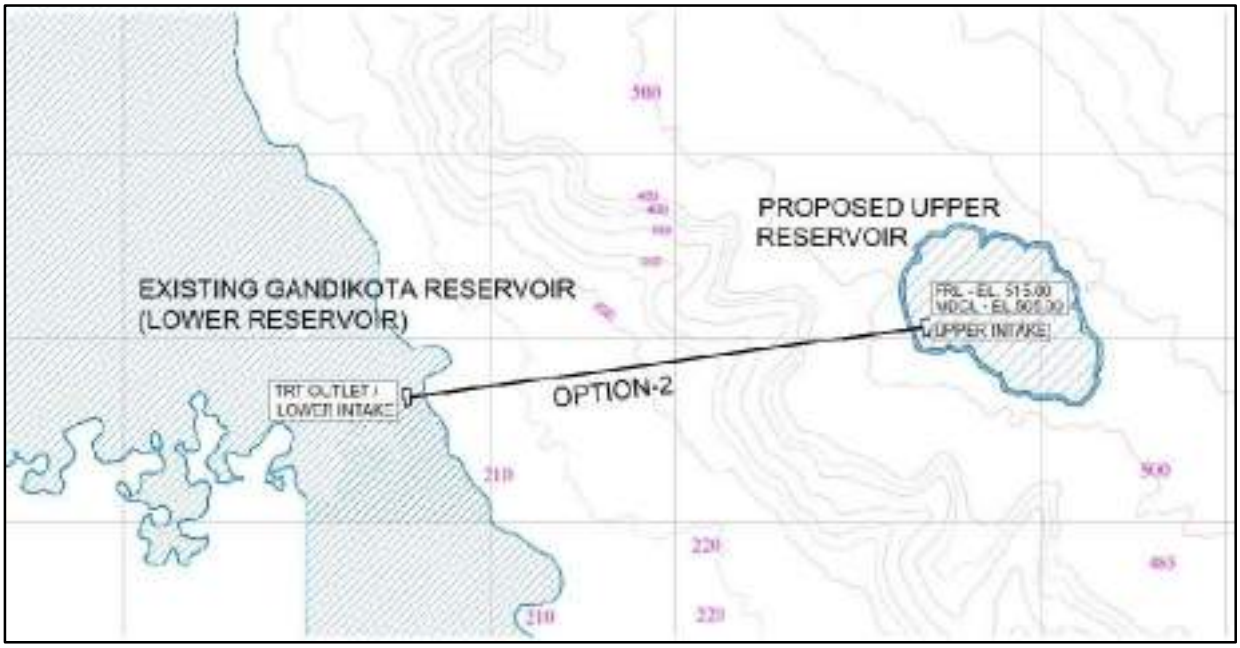


Fig. 7.2 General Layout Map- Option-2

A comparative preliminary analysis is presented below:

Table 7:1

Gandikota PSP			
Basic Data		**Basic Data**	
Lower Reservoir (Existing)		**Lower Reservoir (Existing)**	
FRL	El. 212 m	FRL(m)	El. 212 m
MDDL	El. 202.9 m	MDDL(m)	El. 202.9 m
Upper Reservoir (Option-1)		**Upper Reservoir (Option-2)**	
Reservoir Type – Bund & Pit Combined		**Reservoir Type – Bund & Pit Combined**	
FRL	El. 481m	FRL(m)	El. 515 m

MDDL	El. 464 m	MDDL(m)	El. 505 m
Gross Head(m)	263.41 m	Head(m)	302.55 m
Length(m)	1837 m	Length(m)	2812 m
L/H Ratio	6.98	L/H Ratio	9.29

As evident from above, L/H ratio in option-1 is much less than Option-2 which is a major criterion from techno economic standpoint. Moreover, during site visit, it was observed that in Option-2, the Gandikota Village and Wind mill are situated near proposed upper reservoir. Hence, Private Land acquisition will impose additional cost and may involve R&R issues. Therefore, Option-1 is more economical and is the preferred option and hence selected at this stage.

An exhibit showing locations of two options is at **Annexure--7.1.** The actual excavation quantity and nature of slope stabilization measures will depend upon the depth of bed rock and can be firmly assessed after carrying out sub surface explorations through drill holes and other associated investigations. The General Layout plan of the selected option i.e. Option-1 is shown in **Annexure--7.2**. The Longitudinal section along the alignment of the waterway from the intake to the tailrace outlet/Lower Intake is shown in **Annexure-7.3**.

7.5 Upper Reservoir

A composite bund and pit is proposed to store the required water in Upper Reservoir. Since upper reservoir is not on any nallah or stream, hence complete water required for generation will be pumped form Lower reservoir only. The maximum ground level available at the proposed location is of EL 468.0 m but the surface area is too small for constructing bund. Hence, excavation is needed upto a level where adequate surface area is available as well as the Rockfill material for bund can be availed from excavation too. Keeping this in mind, different options for upper reservoir were explored for every one meter of excavation to get a required live capacity which is

sufficient to provide peak generation of at least 5 hours and excavation material sufficient for construction of Rockfill Dam (subjected to suitability of the material).

Finally, excavation upto EL 462.0 m has been proposed which will provide surface area to construct bund for sufficient live storage for peaking. From EL 462.0 m, a Rockfill bund with top width of 8.0 m having a side slope of 1:1.5 (V : H) is designed. However, necessary check for stability for slope failure and adequate measures will be studied at DPR level. The area capacity elevation table of upper reservoir is presented **Table 7.2** below:

Table 7:2

AREA CAPACITY FOR UPPER RESERVOIR

S. No.	Contour Value (m)	Area (m2)	Area (ha)	Interval (m)	Capacity (m3)	Cum. Capacity (m3)	Cum. Capacity (MCM)
1	462	456961.44	45.70	0	0.00	0.00	0.000
2	464	465080.38	46.51	2	922029.90	922029.90	0.922
3	466	473255.99	47.33	2	938324.50	1860354.40	1.860
4	468	481488.27	48.15	2	954732.43	2815086.83	2.815
5	470	489777.22	48.98	2	971253.70	3786340.53	3.786
6	472	506525.15	50.65	2	996255.44	4782595.98	4.783
7	474	514984.12	51.50	2	1021497.60	5804093.57	5.804
8	476	523499.77	52.35	2	1038472.25	6842565.82	6.843
9	478	532072.09	53.21	2	1055560.26	7898126.08	7.898
10	480	540701.08	54.07	2	1072761.60	8970887.68	8.971
11	481	545036.83	54.50	1	542867.51	9513755.19	9.514
12	482	549386.75	54.94	1	547210.35	10060965.54	10.061
13	484	558129.09	55.81	2	1107504.34	11168469.88	11.168
14	486	566928.10	56.69	2	1125045.72	12293515.60	12.294

The MDDL of Upper reservoir is kept at EL 464.0 m which will have 0.922 MCM as dead storage. At EL 481.0 m. The gross capacity of upper reservoir will be 9.514 MCM.

A free board of 1 m. is proposed in present studies and the same will be reviewed at DPR stage. The top level of the bund has been kept at El 482.0 m. The Typical Cross Section and L-Section of Upper Rockfill dam and Upper reservoir is presented at **Annexure-7.4.**

Provision of spillway for emergency and overflowing condition and channel for passage of discharge in such conditions as well as seepage through dam body will be investigated at DPR stage.

7.6 Upper Reservoir Intake

Waterway of a pumped storage power plant is pressure one, so an inlet of a pumped storage power plant also comes to pressure type. Concerning vertical arrangement of an inlet for a pressure conduit, it is generally said that water depth from sill of an inlet to the minimum water level should be 1.5 to 2.0 times as high as internal diameter of the connecting pressure conduit in order to prevent air from flowing into the pressure conduit. Since the M.D.D.L of the upper reservoir and the internal diameter of the headrace tunnel are designed as EL.464.00 m and 8.90 m respectively, sill level of the inlet is set at EL.441.04 m.

Concerning hydraulic design, criteria on hydraulic design for intake of a Pumped Storage Power Station isn't specified in the Indian Standard even though "Criteria for hydraulic Design of Hydropower Intakes (IS 9761)" specifies criteria for a conventional hydraulic power station. As mentioned below, an intake of a pumped storage power station has the following characteristics in difference from a conventional hydraulic power station;

- Both an intake and a tailrace outlet are to function as an intake as well as an outlet since directions in generating and pumping modes are exact reverse even though hydraulic feature is quite different between water intake and discharge.
- There is a possibility that vortex easily comes into being for the reason that water depth between a surface to an intake comes to small near the maximum draw-down level.

- It is difficult that water flow discharged from an inlet or outlet evenly diffuses into a reservoir because flow velocity of a pumped storage power station is generally faster than that of a conventional hydraulic power station.

As mentioned above, it is found that hydraulic functions to be required for an intake are different between a pumped storage power station and a conventional hydraulic power station. Therefore, in order to design of an intake and an outlet of a pumped storage power station, the provisions of the above mentioned Indian standard which is specified for only a conventional hydraulic power station, was not applied.

On the other hand, concerning Purulia Pumped Storage Project (PPSP) which was commissioned in 2008, hydraulic design of the inlet and outlet was designed in accordance with a kind of guideline proposed by Central Research Institute of Electric Power Industry in Japan which has been mostly applied to design for intakes and outlets of a lot of pumped storage power station. In addition, any problem and trouble on the inlet and outlet haven't been reported in the PPSP since commissioning. Therefore, intake of Gandikota Pumped Storage Project is also designed in accordance with aforesaid kind of Japanese guideline.

As a result, the proposed inlet structure is designed and the plan and section drawing is provided in **Annexure 7.7 and 7.8**.

To prevent trash such as drifting wood, etc., from flowing into the waterway, trash rack is fixed at the entrance of the inlet. The calculation of invert level and velocity through trash rack is given in **Annexure 7.11 and 7.12.**

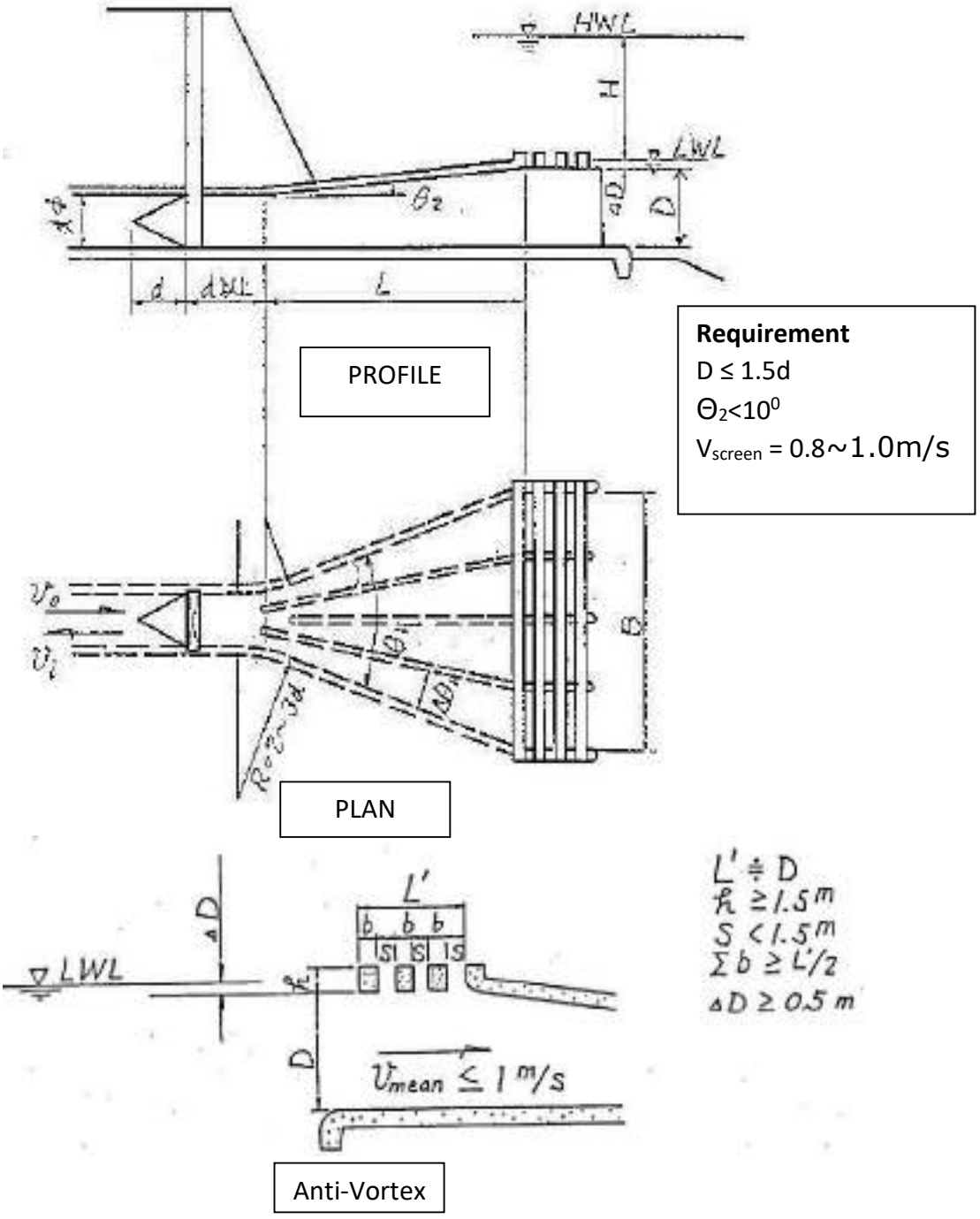


Figure 7.3 Guideline on Hydraulic Design for Inlet Structure of Pumped Storage Power Plant

Cut slope around the inlet is covered by 50cm-thick pitching concrete or 10cm-thick shotcrete with wire mesh depending on geological condition. The detailed design of intake will be carried out at DPR stage.

7.7 Upper Intake Gate Shaft

As for Intake gates, they are furnished between intake and to prevent water from inflowing into the waterway in the case of internal inspection under the condition that water inside the waterways is drained out. Intake gates are furnished in the vertical shaft like Purulia PSP. The location is selected in light of reduction of amount of open excavation. The gate shaft will be accessible through a railing from top of upper reservoir bund.

7.8 Water Conductor System

As in pump storage plant, pumping and generation both are proposed, there would be water hammer effect by shutting off/sudden starting of Pump Turbines in different modes leading to water hammer effect in water conductor system. In order to take this into account, upstream side of HRT shall be proposed with Surge Shaft and downstream side of Tail race tunnel with Surge chamber, if required. For downstream Tail race tunnel transient analysis should be carried out. As there is sufficient rock cover in major lengths of HRT and TRT, both are proposed to be concrete lined. In case some geological surprise in detailed investigations reveals less rock cover, the affected length can be provided with steel liner. The pressure shaft is proposed to have steel liner with concrete lining due to exposure to water hammer effects.

Alignment and profile of the waterway is also one of major elements to be optimized in the selection of optimum general layout, because it governs other layouts of structures such as switchyard, access tunnel etc.

Following aspects are considered while finalizing the alignment of the waterway from the intake to the tailrace outlet;

- Shortest possible Length of waterway.
- Bends are to be avoided as far as possible.
- Both intake and tailrace outlet are aligned in such a way that pumping and generation mode have favorable flow characteristics.

- The rock cover on the powerhouse cavern has been kept more than twice of height of the cavern for proper stability of the cavern.

The locations of power intake and tailrace outlet/Lower Intake are selected in the area where stable topographical and geological conditions are seen.

7.9 Head Race Tunnel (Concrete Lined) Cum Pressure Shaft (Steel Lined)

To carry a discharge of 443 cumec, one HRT of 12.7 m diameter is needed which is on higher side of size and has no flexibility when it comes to partial operation. Hence, Off taking from upper intake, Two nos. of 532 m long and 8.90 m dia. Head Race Tunnel (HRT) has been proposed to carry a discharge of 222 Cumec each. The cover of HRT varies between 18 m and 53 m. A butterfly valve has been proposed at transition of HRT into pressure shaft. 2 Nos. of steel lined pressure shaft with diameter of 7.00 m and length 383 m is provided at 50-degree angle with horizontal. These two-pressure shaft then bifurcates into 4.95 m diameter steel lined of 92 m length each. Actual support system will be decided after geological investigations and analysis at DPR stage. The Typical support details of HRT-Layout is presented at **Annexure-7.5.** The calculation of discharge and diameter consideration is given in **Annexure 7.10.**

Head loss through water conductor system is coming out to be 5.0 m. Head loss calculation for complete water conductor system is given in **Annexure 7.15.**

Pressure shaft and penstock thickness for steel liner and total weigh requirement is calculated and given in **Annexure 7.16, 7.17 & 7.18**. At FR stage, ASTM 537 Class 2 and ASTM 517 grade F has been used to calculate the thickness for steel liner.

7.10 Transient Analysis: Need for Surge tank

A surge tank serves two main functions in a hydropower system:

a. To absorb the pressure rise occurring during the load rejection condition.
b. To immediate fulfil the requirement of supply of water to the system during the load acceptance condition.

The need of surge tank is preliminary determined using following criteria:

a) According to a thumb rule, surge tank is usually necessary for following condition.

$$\frac{L}{H} > 5$$

Where,

L – Length of water conductor (HRT/TRT) (m)

H – Net head (m)

b) Another criterion pertains to the acceleration time of the hydraulic system. The acceleration time of a hydraulic system is given by the equation.

$$Ta = \frac{LXV}{gXH}$$

Where,

L – Length of water conductor (HRT/TRT) (m)

V – Velocity of flow in water conductor (m/s)

H – Net head (m)

g – Acceleration due to gravity (m/s2)

If the acceleration of a hydraulic system is less than 2 seconds, no surge tank is required in the hydraulic system. For acceleration time between 2 and 5 seconds. Surge tank may be provided for a stable operation of the system. For acceleration time greater than 5 sec, a surge tank is almost always required.

In the present scenario, the necessity of the surge tank is assessed using the empirical formulae given above.

HRT Branch

It is inferred that acceleration of a hydraulic system is less than 2 sec for the proposed scheme, so no surge tank is required in the hydraulic system. The same may be confirmed once the turbine pump parameters obtained from the manufacturer and after transient analysis at the time of DPR Stage.

TRT Branch

In case of TRT, the acceleration of a hydraulic system is less than 2 sec for the proposed scheme, so no surge tank is required in the hydraulic system. The same may be confirmed once the turbine pump parameters obtained from the manufacturer and after transient analysis using WHAMO at the time of DPR Stage.

7.11 Underground Power House Cavern and Underground Transformer Cavern

An underground Power House (UGPH) of size 160m (L) x 24m (W) x 55m (H) and a transformer cavern hall of 137m (L) x 18m (W) x 22.5m (H) have been proposed for this project. The power house will have four Francis type vertical shaft reversible units of 250 MW each. The design head for turbine mode as 258.41 m and pumping mode as 268.80 m has been assessed. Four horizontal unit tail race draft tube tunnel are proposed. The length of unit draft tube tunnel will be 75 m and 5.50m dia. The X-section of power house is shown in **Annexure-8.1.**

7.12 Machine Cavern

The machine hall cavern would be 160m in length, 24m in width and overall height of the power house cavity from the lowest excavation of the turbine pit would be 55m. The entrance to the Machine hall cavern shall be through Main Access Tunnel (MAT) of D-Shaped having size 8m x 8m. The auxiliary rooms shall be located at different floors provided on the services bay side of the machine hall cavern.

The penstock for each generating unit would enter the power house horizontally making an angle with the power house longitudinal direction and accommodate the main inlet valve in the machine hall. The penstock for each unit will terminate into a distributor feeding the turbine nozzles. The center line of the horizontal penstocks entering the power house cavity would be El. 160.50m in line with nozzles of the turbines. RCC columns are proposed for supporting the EOT crane beam. A clearance of about 500mm has been provided between the column edge and excavated rock surface to take care of the convergence of power house walls.

7.13 Transformer cavern

The transformer cavern would be 137 m long, its width and height being 18m and 22.5m respectively. It accommodates 4 sets of unit transformers at El. 176.50m. The roof arch of this cavity would be of circular arch shape with 5.0m rise of crown from the spring level. As in the machine hall cavity, the roof and walls of the transformer cavity are also supported by systematic rock bolting and shotcreting (SFRS), where the rock mass is of poor quality ('Q' value from 1.0 to 2.0), the roof is supported with the combination of shotcrete (SFRS), rock bolts and steel ribs. Provision of drainage holes in regular way has also been made for roof and walls for draining the seepage water adjoining the cavern.

7.14 Tail Race Tunnel (Concrete Lined)

Two nos. of 8.90 m dia. and 755 m long concrete lined TRT has been proposed. The rock cover along TRT will vary from 30m to 266m. TRT will be provided with suitable rock support system depending upon the geological strata. Actual support system will be decided after geological investigations and analysis at DPR stage. The Typical support details of HRT-Layout is presented at **Annexure-7.6.**

7.15 Lower reservoir Gate Shaft

Tailrace Gate Shaft is arranged at appropriate location upstream from the end of the Tailrace Tunnel for conduit in light of reduction of amount of open excavation around the gate shaft.

7.16 Tail Race Outlet/Lower Reservoir Intake

Tail race outlet/lower reservoir intake is provided on the same lines of upper reservoir intake.

Concerning vertical arrangement of an inlet for a pressure conduit, it is generally said that water depth from sill of an inlet to the minimum water level should be 1.5 to 2.0 times as high as internal diameter of the connecting pressure conduit in order to prevent air from flowing into the pressure conduit. Since the M.D.D.L of the lower

reservoir and the internal diameter of the headrace tunnel are designed as EL.202.9.00 m and 8.90 m respectively, sill level of the inlet is set at EL.179.94 m.

The Plan and Section of Lower outlet Structure-Intake is presented at **Annexure 7.7** and **Annexure 7.8** respectively.

To prevent trash such as drifting wood, etc., from flowing into the waterway, trash rack is fixed at the entrance of the inlet. The calculation of invert level and velocity through trash rack is given in **Annexure 7.13 and 7.14.**

Annexure - 7.1

ANNEXURE - 7.1

FR STAGE DRAWING

EXISTING MYLAVARAM RESERVOIR

PROPOSED UPPER RESERVOIR
FRL - EL. 481.00
MDDL - EL.464.00

OPTION-1

GANDIKOTA DAM (EXISTING)

PENNAR RIVER

EXISTING GANDIKOTA RESERVOIR
(LOWER RESERVOIR)
FRL - EL. 212.00
MDDL - EL. 202.90

PROPOSED UPPER RESERVOIR
FRL - EL. 515.00
MDDL - EL.505.00

OPTION-2

NOTES:-

1. ALL DIMENSIONS ARE IN METER AND ELEVATION IN METER UNLESS AND OTHERWISE SPECIFIED.
2. NO DIMENSION SHALL BE MEASURED FROM THE DRAWING.ONLY WRITTEN DIMENSION SHALL BE FOLLOWED.

LEGEND:-

Contour Line Major

EXISTING GANDIKOTA RESERVOIR (LOWER RESERVOIR)

FRL	212.00 M
MDDL	202.90 M
LATITUDE	14 ° 48' 28.54"
LONGITUDE	78° 15' 5.41"

OPTION-1 UPPER RESERVOIR

FRL	481.00 M
MDDL	464.00 M
LATITUDE	14°49'47.28"
LONGITUDE	78°13'53.23"

OPTION-2 UPPER RESERVOIR

FRL	515.00 M
MDDL	505.00 M
LATITUDE	14°46'28.93"
LONGITUDE	78°17'6.77"

NEW & RENEWABLE ENERGY DEVELOPMENT CORPORATION OF ANDHRA PRADESH

CONSULTANTS
WAPCOS LIMITED
(A GOVERNMENT OF INDIA UNDERTAKING)
MINISTRY OF JAL SHAKTI

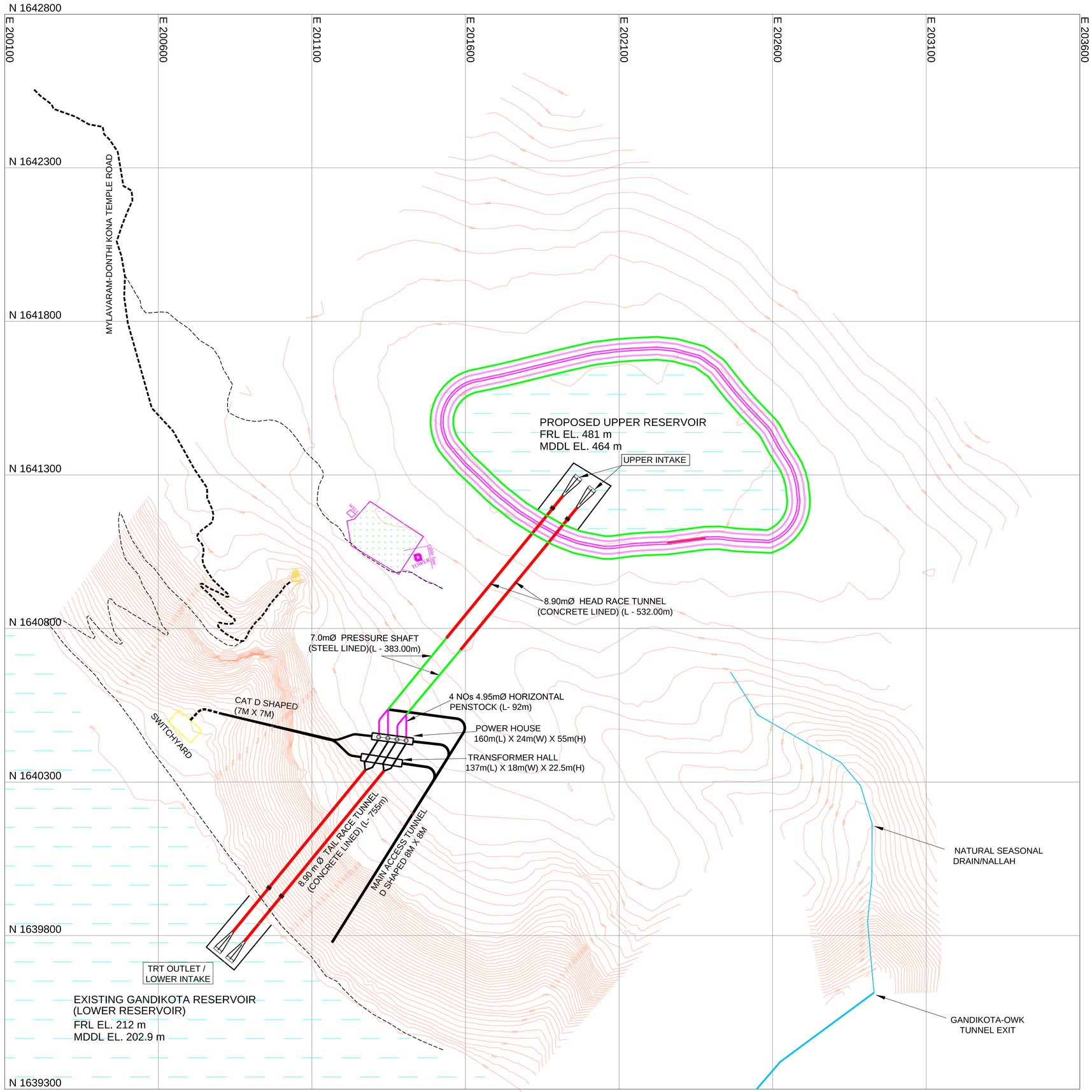
GANDIKOTA PUMPED STORAGE PROJECT (1000 MW)

ALTERNATIVE LAYOUT PLAN

SURVD. BHUPAL ROY	DRAWN RAJESH K. CHAUHAN	CHKD. VINAY SHANKAR
	REV. NO. 0	APPRD. RAJEEV SINGH
DATE:- JUNE-2021	DRG. NO.: WAP/D&RE/GANDIKOTA/FR-7.1	

Annexure - 7.2

ANNEXURE - 7.2



NOTES:-

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METER UNLESS OTHERWISE SPECIFIED.

2. NO DIMENSION SHALL BE MEASURED FROM THE DRAWING AND ONLY WRITTEN DIMENSION SHALL BE FOLLOW.

3. THE ELEVATION/LEVEL OF PROJECT COMPONENTS MENTIONED IN THE DRAWING IS TENTATIVE (FR LEVEL)

LEGENDS:

SL. NO	NAMES	SYMBOLS
1	CONTOUR	
2	APPROACH	
3	EX. RESERVOIR	
4	AGRICULTURE	
5	TEMPLE	

Scale:

-200m 0 200 400 600m

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MINISTRY OF JAL SHAKTI

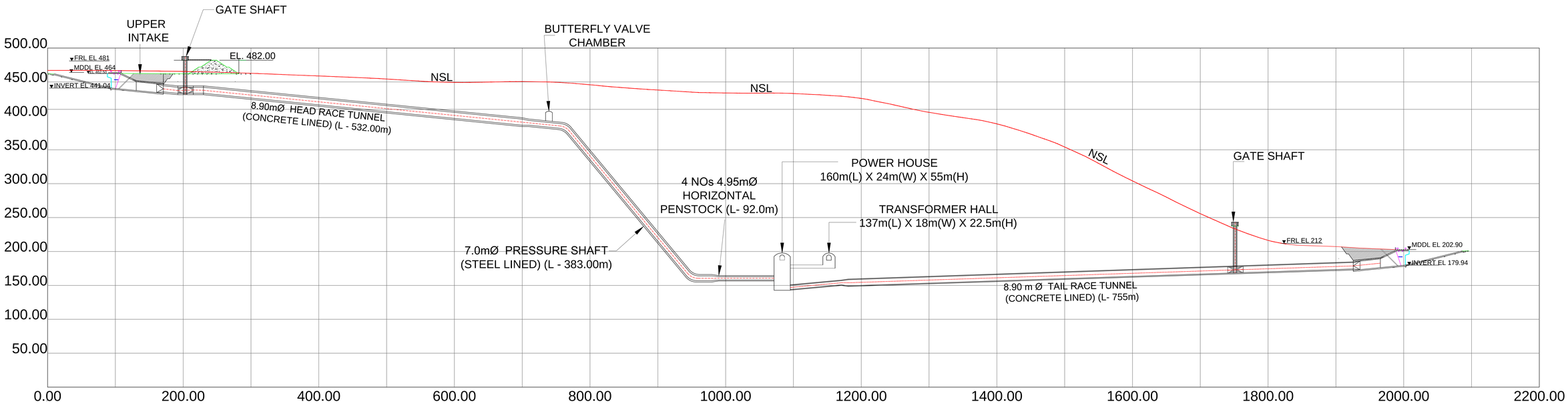
GANDIKOTA PUMPED STORAGE PROJECT (1000 MW)

GENERAL LAYOUT PLAN (5 M CONTOUR INTERVAL)

SURVD. BHUPAL ROY	DRAWN R.K.CHAUHAN	CHKD. VINAY SHANKAR
	REV. NO. 0	APPRD. RAJEEV SINGH
DATE: JUNE-2021	DRG. NO.: WAP/D&RE/GANDIKOTA/PFR-7.2	

Annexure - 7.3

ANNEXURE - 7.3



NEW & RENEWABLE ENERGY DEVELOPMENT CORPORATION OF ANDHRA PRADESH

CONSULTANTS

WAPCOS LIMITED

(A GOVERNMENT OF INDIA UNDERTAKING)

MINISTRY OF JAL SHAKTI

GANDIKOTA PUMPED STORAGE PROJECT (1000 MW)

L–SECTION OF WATER CONDUCTOR SYSTEM

SURVD. BHUPAL ROY	DRAWN RAJESH K. CHAUHAN	CHKD. VINAY SHANKAR
	REV. NO. 0	APPRD. RAJEEV SINGH
DATE: JUNE-2021	DRG. NO. WAP/D&RE/GANDIKOTA/FR-7.3	

Annexure - 7.9

Annexure- 7.9

GANDIKOTA PUMPED STORAGE PROJECT

(REF : CBIP Publication no. 265)

PRELIMINARY COMPUTATIONS FOR GENERATION CAPACITY

UPPER RESERVOIR				
	FRL	=	481	m
	MDDL	=	464	m
gross storage capacity		=	9.514	MCM
live storage capacity		=	8.592	MCM
water spread area of Lower Res.				
at full reservoir level		=	107.74	Sq.Km
Hrt design discharge		=	440.00	cumec
assumed head loss of WCS		=	5	m
LOWER RESERVOIR		=		
MDDL	Min.WL	=	202.9	m
FRL	Max.WL	=	212	m
Average Gross head		=	266.37	m
Average Net Head		=	261.37	m
		=		

§ Gen capacity (MW) = 9.81*Q*H*ηt*ηg*1/1000

efficiency of the generator 'ηg'		=	*0.98*	Assumed
efficiency of the turbine 'ηt'		=	*0.91*	Assumed
Combined efficiency of generation 'η'			*0.89*	
Generation capacity		=	1006.1	MW
No. of Units provided			4	
each unit Gen. cap		=	252	MW
	Say	=	**250**	MW

Annexure - 7.10

Annexure - 7.10

	(REF : CBIP Publication no. 265)	**GANDIKOTA PSP**			
		Unit Size	=	250	MW
		No. of Units	=	4	Nos.
A	**RATED DISCHARGE**				
		losses in WCS	=	5	m
		average gross head	=	266.37	m
		average net head	=	261.37	m
	Rated discharge (Generation mode)				
		P=9.81*Q*H*ηg*ηt.			
		Generation efficiency	=	0.89	
		for generation of power 'P'	=	1000	
		TOTAL DISCHARGE 'Q' (Gen) reqd.	=	437.33	cumec
		Adding for overloading (10%) etc	=	**481.07**	cumec
		say	=	**482**	cumec
	Rated discharge (Pumping mode)				
		Head in Pumping Mode H=Gross head +losses	=	271.37	m
		Assuming efficiency of pumping 'ηp' as	=	0.91	
		P=(9.81*Q*H)/(ηp)			
		Q(pump)	=	341.834	cumec
		say	=	**345**	cumec
B	**Preliminary estimation of size of tunnels / Pressure Shaft**				
		V=Q/A			
	HRT	No. of HRT Proposed	=	2	Nos.
		Discharge 'Q' through each HRT (with 10% overload)	=	241	cumec
		dia .of HRT proposed	=	**8.90**	m
		area	=	62.180	m^2
	permitted vel.= <4m/sec (incl. 10% overloading)	velocity	=	3.88	m/sec
				OK	
	Inclined steel liner PS	No of Pressure Shaft	=	2	Nos.
		Discharge 'Q' witheach (with 10% overload)	=	241	cumec
		dia .of PS proposed	=	**7.00**	m
		area	=	38.47	m^2
	permitted vel.= <6.5 m/sec (incl. 10% overloading)	velocity	=	6.27	m/sec
				OK	
	Penstock after bye furcation				
		Discharge 'Q' each (with 10% overload)	=	120.5	cumec
		area of UNIT PS reqd.	=	19.23	m^2
		dia of unit PS	=	**4.95**	m
		velocity adopting from PS before bifurcation	=	6.27	m/sec
				OK	

Annexure - 7.11 & 7.12

PROJECT	**GANDIKOTA PUMPED STORAGE PROJECT (AP)** **Pre- Feasibilty Report**
NAME OF WORK	**UPPER RESERVOIR - Hydraulic Design of INTAKE**

HYDRAULIC DESIGN OF INTAKE

Straight Type Intake Structure

Design Data

i	Design Discharge (for HRT), Q	=	437.33	m3/sec	
ii	Nos. of Intake structure	=	2		
iii	Discharge(per Intake str.) , q	=	218.67	m3/sec	
iv	Min.draw down level , (MDDL)	=	464	m	
v	Full reservoir level , FRL	=	481	m	
vi	HRT diameter (Circular)	=	8.90	m	

A Opening Area required

Area required

Area, A = Penstock Area / (Cc Cos∅)

As per the Cl 5.1.3 IS

Area of HRT	=	62.180	m2	
Cofficient of Contrction, Cc	=	0.6		As per the Cl 5.1.3 IS
Angle of inclination of HRT	=	0	deg	
opening area at Intake, A	=	103.63	m2	

Conduit before transition

Shape	=	Rectangular		
Height	=	13	m	
Width	=	11	m	Assume

B **Check for Intake center line**

i) As per Cl 5.2.2 Is 9761:1995

5.2.2 To prevent vortices, the centre line of intake should be so located as to ensure submergence requirements given in Fig. 18 which has been developed by an evaluation of minimum design submergence at prototypes operating satisfactorily.

For large size intakes at power plants:

$$\left(F_r = \frac{V}{\sqrt{gD}} \leq 1/3 \right)$$

especially at pumped storage system, a submergence depth,

$h = 1$ to $1{\cdot}5$ times the intake height or diameter is recommended.

For medium and small size installations ($F_r \geq 1/3$), especially at pump sumps, submergence requirements may be calculated using the formula:

$$\frac{h}{D} = 0{\cdot}5 + 2F_r$$

	Froude No of flow at Intake, Fr	=	V/√gD		
	Area of Flow (rectangular section)	=	143	m^2	
	Velocity of flow through Rect.section	=	1.53	m/s	
	Entry Froude No. Fr	=	0.135		
		≤	1/3		Ok

The Intake shall be classified as Small Size Intake *(As per Cl 5.2.2, IS 9761:1995)*

	Ratio h/d	=	2.0 Fr +0.5		
		=	0.771		
	Submergence, h	=	10.02	m	
	Invert Elevation required	=	447.48	m	
	Invert Elevation provided	=	441.0	m	Ok

ii) As per USBR guidelines

	Intake center line depth from MDDL	=	0.8he		
		=	16.464	m	
	Invert Elevation required	=	441.04	m	
	Invert Elevation provided	=	441.04	m	Ok

iii) As per Gordon Formula

	Ratio S/d	=	2.3 Fr +0.5		
		=	0.811		
	Submergence, S	=	10.549	m	
	Invert Elevation required	=	446.96	m	
	Invert Elevation provided	=	441.04	m	Ok

iv) As per Amphlett Equation

	Ratio S/d	=	3.3 Fr - 0.5		
		=	-0.053		
	Submergence, S	=	-0.691	m	
	Invert Elevation required	=	458.20	m	
	Invert Elevation provided	=	441.04	m	Ok

	Minimum invert elevation	=	441.04		
			445.20		**2XD + 1 Criteria**

Now, as per above all it is recommended to fix the centre line of intake at El. 441.04 m

Annexure - 7.12

PROJECT	**GANDIKOTA PUMPED STORAGE PROJECT (AP)** **Pre- Feasibilty Report**
NAME OF WORK	**LOWER RESERVOIR - Trash Rack System**

HYDRAULIC DESIGN OF TRASH RACK

Straight Type Intake Structure

Design Data

i	Design Discharge (for HRT), Q	=	437.33	m3/sec	
ii	Nos. of Intake structure	=	2		
iii	Discharge(per Intake str.) , q	=	218.67	m3/sec	
iv	Min.draw down level , (MDDL)	=	464	m	
v	Full reservoir level , FRL	=	481	m	
vi	HRT diameter (Circular)	=	8.9	m	
vii	Bottom of Trash Rack	=	441.04	m	(Assume)
viii	Top of trash rack	=	464.00	m	
ix	Intake sill level				
	U/s of transition	=	441.04	m	

Design of Trash Rack

a Trash rack with mechanical Cleaning

Angle of Inclination	=	70	deg, (with horz)	
Permissible Velocity	=	1.5	m/s	**(Cl 5.3.6, IS 9761:1995)**

5.3.6 The normal velocity of flow through the rack structure is indicated below:

For units with hand raking,

$V = 0.75$ m/s

For units with mechanical raking

$V = 1.5$ m/s

Flow depth through trash rack	=	22.96	m	
Effective flow depth	=	20.83	m	
Area Required	=	Discharge/velocity		
	=	145.78	m^2	
Width of Trash rack required	=	7.00	m	
Providing 2.0 bays of 7.25 m width				
Width Provided	=	14.5	m	
Gross area of flow	=	302.09	m^2	

Flow Velocity through Trash Rack

Area of Trash rack excluding steel flats	=	25% of the Gross area		
Clear area	=	226.565	m^2	
Velocity	=	0.965	m/s	< 1.0 m/sec
			Ok	
Area of Trash rack (including clogging)	=	25% of the clear area		
Clear area	=	169.923	m^2	
Velocity	=	1.287	m/s	< 1.5 m/sec
			Ok	(Cl 5.3.6, IS 9761:1995)

Annexure - 7.13 & 7.14

PROJECT	**GANDIKOTA PUMPED STORAGE PROJECT (AP)** **Pre- Feasibilty Report**
NAME OF WORK	**LOWER RESERVOIR - Hydraulic Design of PUMP INTAKE**

HYDRAULIC DESIGN OF INTAKE

Straight Type Intake Structure

Design Data

i	Design Discharge (for HRT), Q	=	437.33	m3/sec	
ii	Nos. of Intake structure	=	2		
iii	Discharge(per Intake str.) , q	=	218.67	m3/sec	
iv	Min.draw down level , (MDDL)	=	202.9	m	
v	Full reservoir level , FRL	=	212	m	
vi	TRT diameter (Circular)	=	8.90	m	

A Opening Area required

Area required

$$\text{Area, A} = \frac{\text{Penstock Area}}{\text{Cc Cos}\varnothing}$$

As per the Cl 5.1.3 IS

Area of HRT	=	62.180	m2	
Cofficient of Contrction, Cc	=	0.6		As per the Cl 5.1.3 IS
Angle of inclination of HRT	=	0	deg	
opening area at Intake, A	=	103.63	m2	

Conduit before transition

Shape	=	Rectangular		
Height	=	13	m	
Width	=	11	m	Assume

B **Check for Intake center line**

i) As per Cl 5.2.2 Is 9761:1995

5.2.2 To prevent vortices, the centre line of intake should be so located as to ensure submergence requirements given in Fig. 18 which has been developed by an evaluation of minimum design submergence at prototypes operating satisfactorily.

For large size intakes at power plants:

$$\left(F_r = \frac{v}{\sqrt{gD}} < 1/3 \right)$$

especially at pumped storage system, a submergence depth,

$h = 1$ to $1{\cdot}3$ times the intake height or diameter is recommended.

For medium and small size installations ($F_r \geq 1/3$), especially at pump sumps, submergence requirements may be calculated using the formula:

$$\frac{h}{D} = 0{\cdot}5 + 2F_r$$

	Froude No of flow at Intake, Fr	=	V/ΓgD		
	Area of Flow (rectangular section)	=	143	m^2	
	Velocity of flow through Rect.section	=	1.53	m/s	
	Entry Froude No. Fr	=	0.135		
		≤	1/3		Ok

The Intake shall be classified as Small Size Intake *(As per Cl 5.2.2, IS 9761:1995)*

	Ratio h/d	=	2.0 Fr +0.5		
		=	0.771		
	Submergence, h	=	10.02	m	
	Invert Elevation required	=	186.38	m	
	Invert Elevation provided	=	179.9	m	Ok
ii)	**As per USBR guidelines**				
	Intake center line depth from MDDL	=	0.8he		
		=	16.464	m	
	Invert Elevation required	=	179.94	m	
	Invert Elevation provided	=	179.94	m	Ok
iii)	**As per Gordon Formula**				
	Ratio S/d	=	2.3 Fr +0.5		
		=	0.811		
	Submergence, S	=	10.549	m	
	Invert Elevation required	=	185.86	m	
	Invert Elevation provided	=	179.94	m	Ok
iv)	**As per Amphlett Equation**				
	Ratio S/d	=	3.3 Fr - 0.5		
		=	-0.053		
	Submergence, S	=	-0.691	m	
	Invert Elevation required	=	197.10	m	
	Invert Elevation provided	=	179.94	m	Ok
	Minimum invert elevation	=	179.94		
			184.10		**2XD + 1 Criteria**

Now, as per above all it is recommended to fix the centre line of intake at El. 179.94 m

Annexure - 7.14

PROJECT	**GANDIKOTA PUMPED STORAGE PROJECT (AP)** **Pre- Feasibilty Report**
NAME OF WORK	**LOWER RESERVOIR - Trash Rack System**

HYDRAULIC DESIGN OF TRASH RACK

Straight Type Intake Structure

Design Data

i	Design Discharge (for HRT), Q	=	437.33	m3/sec	
ii	Nos. of Intake structure	=	2		
iii	Discharge(per Intake str.) , q	=	218.67	m3/sec	
iv	Min.draw down level , (MDDL)	=	202.9	m	
v	Full reservoir level , FRL	=	212	m	
vi	TRT diameter (Circular)	=	8.9	m	
vii	Bottom of Trash Rack	=	179.94	m	(Assume)
viii	Top of trash rack	=	202.90	m	
ix	Intake sill level				
	U/s of transition	=	179.94	m	

Design of Trash Rack

a Trash rack with mechanical Cleaning

Angle of Inclination	=	70	deg, (with horz)	
Permissible Velocity	=	1.5	m/s	**(Cl 5.3.6, IS 9761:1995)**

5.3.6 The normal velocity of flow through the rack structure is indicated below:

For units with hand raking,

$V = 0.75$ m/s

For units with mechanical raking

$V = 1.5$ m/s

Flow depth through trash rack	=	22.96	m	
Effective flow depth	=	20.83	m	
Area Required	=	Discharge/velocity		
	=	145.78	m^2	
Width of Trash rack required	=	7.00	m	
Providing 2.0 bays of 7.25 m width				
Width Provided	=	14.5	m	
Gross area of flow	=	302.09	m^2	

Flow Velocity through Trash Rack

Area of Trash rack excluding steel flats	=	25% of the Gross area		
Clear area	=	226.565	m^2	
Velocity	=	0.965	m/s	< 1.0 m/sec
			Ok	
Area of Trash rack (including clogging)	=	25% of the clear area		
Clear area	=	169.923	m^2	
Velocity	=	1.287	m/s	< 1.5 m/sec
			Ok	(Cl 5.3.6, IS 9761:1995)

Annexure - 7.15

Annexure - 7.15

TITLE:	**PRELIMINARY WATER CONDUCTER SYSTEM - HEAD LOSS CALCULATION**

Head loss for the Generation mode are estimated as below for the water conducter system						
Project Parameters:						
Upper reservoir FRL				m	=	**481**
Upper reservoir MDDL				m	=	**464**
Lower reservoir FRL				m	=	**212**
Lower reservoir MDDL				m	=	**202.9**
Turbine Center Line				m	=	**160.5**
Design Discharge (taking 10% overload condition)				cumec	=	**482.0**
Installed capacity in MW				MW	=	**1000**
No of units					=	**4**
Gross Head				m	=	**266.37**
Design Head		**Gross head - losses**		**m**	**=**	**261.37**

Major Component Parameters						
HRT Intake						
Height of bellmouth entrance				m	=	**20.58**
Width of bellmouth entrance				m	=	**5.04**
Head Race Tunnel Concrete Lined (circular)						
Diameter				m	=	**8.90**
Length of HRT				m	=	**650**
Manning's 'n'					=	**0.012**
Absolute roughness 'e'		Concrete		mm	=	**1.65**
Pressure shaft Tunnel Steel Lined (circular)						
Diameter				m	=	**7.00**
Length of pressure shaft before bifurcation				m	=	**410**
Manning's 'n'					=	**0.01**
Absolute roughness 'e'		Steel		mm	=	**0.0675**
Penstock Steel Lined (Circular)						
Diameter of unit pressure shaft				m	=	**4.95**
Length of unit pressure shaft				m	=	**60**
Manning's 'n'					=	**0.01**
Acc. Due to gravity				m/s^2	=	**9.81**
Tail Race Tunnel Concrete Lined (circular)						
Diameter				m	=	**8.90**
Length of HRT				m	=	**585**
Manning's 'n'					=	**0.012**
Absolute roughness 'e'		Concrete		mm	=	**1.65**

COMPONENT WISE HEAD LOSS ESTIMATION

1	**Head loss due to trash racks of HRT Power Intake**					
	the trash rack is provided before the intake bell mouth to restrict the entry of debris					
	Velocity through Trash Rack - Select Type of cleaning	**Mannual**		m/s	=	0.75
	Minimum Head loss					
	Net area to Gross area ratio, R				=	0.75
	Loss cofficient				=	1.45-0.45*0.75-0.75^2
					=	0.55
	Head loss				=	0.55*0.75^2/19.62
			head loss	m	=	**0.016**
	Maximum Head loss					
	Considering 50% clogging					
	Net area to Gross area ratio, R				=	0.75*0.50
					=	0.375
	Loss cofficient				=	1.45-0.45*0.375-0.375^2
					=	1.14
	Head loss	$h_f = \frac{k_1 V^2}{2g}$			=	1.14*0.75^2/19.62
	head loss due to Tash rack			m	=	**0.033**

50% clogging may not be possible as it is an Pumped Storage Project

2	**Head loss through Bellmouth entrance- HRT power Intake**						
	The water has to pass through the bellmouth entrance of Intake.-2 nos bellmouth openings						
	The size of the openings			20.580	Height	x	5.04
	Discharge through each bellmouth			(= 482 /2)	m^3/s	=	**241.00**
	Area of entrance			20.58*5.04	m^2		
					m^2	=	103.72
	Velocity of flow					=	241/103.7232
					m/s	=	2.32
	Head loss through each bellmouth entrance					=	$K_e*V^2/2g$
	Corresponding to Square bellmouth Entrance			(Ref Tab IS 4880 (P-3)-1976)	**K_e**	=	0.16
	Head loss					=	0.16*(2.3^2)/(2*9.81)
		head loss one bell mouth			m	=	0.044
	Total head loss - bell mouth entry for one power intake - HRT		**head loss due to bell mouth entra**		m	=	**0.044**

3	**Transition loss at HRT entry-power intake (rectangular to Circular)**						
	A transition from Rectangular Shape Intake to circular HRT is provided.						
	Design discharge through transition Discharge of 2 unit has been taken				m^3/s	=	241.00
	Length of transition				m	=	14.3
	Width before transition				m	=	5.04
	Depth before transition				m	=	20.58
	Depth /Dia. after transition				m	=	8.9
	Total Area before transition				m^2	=	103.7232
	Velocity before transition					=	241 / 103.7232
				V1	m/s	=	2.32
	Area after transition					=	3.142 x 8.9^2
					m^2	=	62.58
	Velocity after transition			V2		=	241 / 62.58
					m/s	=	3.9
		5.040	α				8.9
	Transition angle						
					α/2	=	7.69
					k_{t1}	=	3.5 * TAN((7.69*3.14/180))^1.22
		(Reference: cl.2.4, IS2951(p-ii) -1965			**K_{t1}**	=	**0.304**
	Loss due toTransition					=	$K_{t1}*(V_1-V_2)^2/2g$
	head loss due to transition					=	**0.036**

4.1	**Head loss due to Emergency gate at HRT Intake**					
	Number of gates				=	1
	Height of the gate				=	8.90
	Width of gate				=	6.675
	Discharge through the gate				=	241
	Loss co-efficient			**K_g**	=	0.1
	Area of entrance				=	8.9 x 6.675
					=	59.4075
	Velocity through the gate slot				=	241/59.4075
					=	4.06
	Head loss				=	$K_gV^2/2g$
					=	0.1 x (4.06^2) / (2*9.81)
					=	0.084
	Total Head loss due to two nos.emergency gates slots				=	**0.084**

4.2	**Head loss due to Service Gate at HRT Intake**						
	Water is conveyed into the system through gates						
	Number of gate					=	1
	Height of gate					=	8.90
	Width of gate					=	6.675
	Discharge through the gate					=	**241.00**
	Loss co-efficient				K_g	=	0.1
	Area of gate entrance					=	8.9 x 6.675
						=	59.4075
	Velocity through gate slot					=	241 / 59.4075
						=	4.06
	Head loss					=	$K_g V^2/2g$
						=	0.1 x (4.06^2)/2*9.81
						=	0.084
	Total Head loss due to TWO nos service gates slots					=	**0.084**

5	**Head loss due to friction in Head Race Tunnel (HRT)**						
	A Head Race Tunnel of circular Shape with 8.9 m diameter and 650m length,is provided after the intake						
	Design Discharge				m^3/s	=	**241.00**
	Length of HRT				m	=	**650**
	Diameter of tunnel				m	=	**8.9**
	Area of cross section of tunnel			A	m2	=	62.18
	Dyn. Viscosity value at 25 °C				Pa.S	=	**0.00089**
	Density of water				kg/m^3	=	**997**
	Velocity				m/s	=	**3.88**
	Reynolds number (Re)					=	3.864E+07
	Relative Roughness e/D					=	1.854E-04
	Friction factor (from Moodys Diagram)			f		=	**0.015**
	Head loss in HRT			Hf	m		**0.839**

$$h_f = f\frac{L}{d}\frac{v^2}{2g}$$

6	**Transition loss due to contraction at Pr.Shaft Entry**						
	Design discharge through transition				m^3/s	=	241.00
	Length of transition				m	=	30.00
	Diameter before transition				m	=	8.90
	Diameter after transition				m	=	7.00
	Area before transition				m^2	=	62.1799
	Velocity before transition					=	3.876
				V1	m/s	=	3.88
	Area after transition				m^2	=	38.465
	Velocity after transition			V2	m/s	=	6.265
	Transition angle						
					$\alpha/2$	=	1.81
				k_{t1}		=	3.5 * TAN((1.81*3.14/180))^1.22
				K_{t1}		=	0.052
	Loss due to CONTRACTION AT SS - PS ENTRY					=	$K_{t1}*(V_1-V_2)^2/2g$
	Head loss due to contraction				**m**	**=**	**0.015**

7	**Friction loss in Pressure Shaft**						
	Design Discharge one PS				m^3/s	=	241.00
	Diameter of Pressure shaft				m	=	7.00
	Length of the Pressure shaft				m	=	**410**
	Area of Pressure shaft				m2	=	38.47
	Dyn. Viscosity value at 25 °C				Pa.S	=	**0.00089**
	Density of water				kg/m^3	=	**997**
	Velocity				m/s	=	**6.27**
	Reynolds number (Re)					=	4.913E+07
	Relative Roughness e/D					=	9.643E-06
	Friction factor (from Moodys Diagram)			f		=	**0.009**
	Head loss due to Pressure Shaft			Hf	m		**1.055**

8	**Head loss due to bends in Pressure shaft**						
	Design Discharge				m^3/s	=	**241.00**
	Diameter				m	=	7
	Area				m2	=	38.47
	Velocity					=	241/38.47
					m/s	=	6.27
	First 50 degree Bend in PS						
	Deflection angle				degree	=	50
	Radius of curve				m	=	15
	Considering R/D ratio					=	2.14
	Loss coefficient					=	0.1
	Head loss due to bend				m	=	$K_b*V^2/2g$
					m		0.200
	Second 50 Degree Bend in PS						
	Deflection angle				degree	=	50
	Radius of curve				m	=	15
	Considering R/D ratio					=	2.14
	Loss coefficient					=	0.1
	Head loss due to bend					=	$K_b*V^2/2g$
					m	=	0.2004
	Total head loss due to 2. bends in PS				**m**	=	**0.4007**
	Hor. Bend no 1 in PS near Power House						
	Deflection angle				degree	=	45
	Radius of curve				m	=	15
	Considering R/D ratio					=	2.14
	Loss coefficient					=	0.1
	Head loss due to Hor. bend					=	$K_b*V^2/2g$
					m	**=**	**0.2004**
	TOTAL HEAD LOSS DUE TO BENDS				**m**	**=**	**0.6011**
9	**Head Loss in PS due to bifurcation- wye piece**						
	each PS bifurcates into 2 nos.						
	Design Discharge				m^3/s	=	120.50
	Diameter				m	=	4.95
	Area				m^2	=	19.23
	Velocity				m/s	=	6.27
		k=0.03 to 0.05 for 45 to 60 degree bifurcation angle as per Japanese Manual					
	Head loss due to bifurcation					=	$k*V^2/2g$
	Head loss due to bifucation				m	=	**0.100**

10	**Friction loss in Penstock after bifucation**						
	Design Discharge one PS				m^3/s	=	120.50
	Diameter of Penstock				m	=	4.95
	Length of the Penstock				m	=	**60**
	Area of Penstock				m2	=	19.23
	Dyn. Viscosity value at 25 °C				Pa.S	=	**0.00089**
	Density of water				kg/m^3	=	**997**
	Velocity				m/s	=	**6.27**
	Reynolds number (Re)					=	3.474E+07
	Relative Roughness e/D					=	1.364E-05
	Friction factor (from Moodys Diagram)			f		=	**0.007**
	Head loss in Penstock			Hf	m		**0.170**

11	**Friction Loss (draft tube from turbine upto bonetted gate)**						
	Design Discharge				m^3/s	=	120.50
	Diameter of DT (assumed)				m	=	5.00
	Length of the DT				m	=	**75**
	Area of DT				m2	=	19.63
	Dyn. Viscosity value at 25 °C				Pa.S	=	**0.00089**
	Density of water				kg/m^3	=	**997**
	Velocity				m/s	=	**6.14**
	Reynolds number (Re)					=	3.439E+07
	Relative Roughness e/D					=	1.350E-05
	Friction factor (from Moodys Diagram)			f		=	**0.007**
	Head loss in Penstock			Hf	m		**0.202**

TAIL RACE TUNNEL

12	**Head Loss due to Transition of DT. To TRT**						
	Design discharge through transition				m^3/s	=	**122.00**
	Length of Transition				m	=	30
	Width/Dia. before transition				m	=	5.00
	Area before transition				m^2	=	19.643
	Velocity before transition					=	6.211
				V1	m/sec	=	6.211
	Dia. after transition				m		9
	Area after transition				m^2	=	63.643
	discharge after transition					=	244
	Velocity after Expansion			V2	m/s	=	3.834
		5.000					9.00
	Transition angle				**α**/2	=	3.81
					k_{t1}	=	3.5*TAN(3.81*3.14/180)^1.22
	Loss due to transition				k_{t1}	=	0.128
						=	$k_{t1}*(V_1-V_2)^2/2g$
					m	=	**0.03696**
						=	1
	Total loss at transitions of TRT					**=**	**0.03696**

13	**Head loss due to friction in Tail Race Tunnel (TRT)**						
	Design Discharge				m^3/s	=	**241.00**
	Length of HRT				m	=	**585**
	Diameter of tunnel				m	=	**8.90**
	Area of cross section of tunnel			A	m2	=	62.18
	Dyn. Viscosity value at 25 °C				Pa.S	=	**0.00089**
	Density of water				kg/m^3	=	**997**
	Velocity				m/s	=	**3.88**
	Reynolds number (Re)					=	3.864E+07
	Relative Roughness e/D					=	1.854E-04
	Friction factor (from Moodys Diagram)			f		=	**0.015**
	Head loss in HRT			Hf	m		**0.755**

$$h_f = f\frac{L}{d}\frac{v^2}{2g}$$

14	**Loss due to service & emergency Gate SLOTS in the pump intake**				
	The Sizing & outflow discharge of pump intake is similar to power intake				
	Total Head loss inLower Gate shaft	**m**	**=**		**0.168**

15	**Transition (during Expansion in TRT) [same as power intake HRT)**		m	**0.036**

16	**PUMP INTAKE & Trash Rack loss (same as power intake at HRT)**	**Exit Loss**	m		**0.077**

S.No		summary of head loss			
		Component			**Head Loss (m)**
1		head loss due to Tash rack		=	0.033
2		Head loss through Bellmouth entrance- HRT power Intake		=	0.044
3		Transition loss at HRT entry-power intake (rectangular to Circular)		=	0.036
4		Head loss due to Emergency gate at HRT Intake		=	0.168
5		Head loss due to friction in Head Race Tunnel (HRT)		=	0.839
6		Transition loss due to contraction at Pr.Shaft Entry		=	0.015
7		Friction loss in Pressure Shaft		=	1.055
8		Head loss due to bends in Pressure shaft		=	0.601
9		Head Loss in PS due to bifurcation- wye piece		=	0.100
10		Friction loss in Penstock after bifucation		=	0.170
11		Friction Loss (draft tube from turbine upto bonetted gate)		=	0.202
12		Head Loss due to Transition of DT. To TRT		=	0.037
13		Head loss due to friction in Tail Race Tunnel (TRT)		=	0.755
14		Loss due to service & emergency Gate SLOTS in the pump intake		=	0.168
15		Transition (during Expansion in TRT) [same as power intake HRT)		=	0.036
16		PUMP INTAKE & Trash Rack loss (same as power intake at HRT)		=	0.077
		Grand total of all losses		=	**4.335**
		Taking 10% Extra and rounding off	**SAY (m)**		**5.0**

Annexure - 7.16, 7.17 & 7.18

ANNEXURE 7.16

Preliminary estimation of PS liner thickness

Using BIS method			
Minimum Handling thickness of Preesure Shaft			
Dia. of Steel liner	=	7.00	m
Radius of liner	=	3.5	m
Thickness	$Thk = \frac{R + 0.25}{200}$	0.01875	m
Add Corrosion Allowance of 1.5mm	=	20.25	mm
PROVIDE MIN. THICKNESS for HRT PS	=	**21**	**mm**
Minimum Handling thickness of Unit Penstock			
Dia. of Steel liner Unit Penstock	=	4.95	m
Radius of liner	=	2.475	m
Thickness	$Thk = \frac{R + 0.25}{200}$	0.01362	m
Add Corrosion Allowance of 1.5mm	=	15.124	mm
PROVIDE MIN. THICKNESS for Unit PS	=	**16**	**mm**
Upper Reservoir FRL	=	481	m
Upper Reservoir MDDL	=	464	m
C/L of Turbine	=	160.5	m
Invert of start of Steel liner Pressure shaft	=	376.58	m
Allowable stress in Steel(ASTM-A537)	=	1868	kg/cm2
Internal Dia pf Pressure Shaft/HRT	=	7.00	m
Unit Pressure Shaft dia	=	4.95	m

Materials proposed for steel liner

ASTM 537,Class 2		
YS	415	Mpa
UTS	550	Mpa
Allowable Hoop stress =minimum of 1/3 of UTS and 0.6 of YP	183.33	Mpa
(upto mid of inclined Pressure shaft)	1869.5	Kg/cm2

ASTM 517,Grade F		
YS	690	Mpa
UTS	795	Mpa
Allowable Hoop stress =minimum of 1/3 of UTS and 0.6 of YP	265	Mpa
From mid of inclined pressure shaft to Power House	2702.2	Kg/cm2

PS >Economic Diameter analysis of PS shall be detailed in DPR.

> Rock participation shall be considered in the design of liner based on the rock mass qaulity

> Design for external pressure shall be carried out at the detailed design stage in DPR

> This design is for preliminary cost estimate

> This design is for internal pressure considering 10% water hammer

ANNEXURE 7.17

Preliminary estimation of PS liner thickness For Internal Pressure

Thickness of liner against internel pressure

$$Thk, t = \frac{PD}{2x0.9x\sigma}$$

Allowable stresses in steel σ in kg/cm2
Internal Diameter of Steel liner D in cm
Net Pressure head without rock participation in Kg/cm2
Thickness of Steel liner t in cm

Min Thickness as per BIS in 7 m dia. 21 mm
Min Thickness as per BIS in 4.95 m dia 16 mm

Reach EL in m upto which THK provided		Water Head	Net Pressure head considering 10% water hammer	Allowaable stress in steel	Diameter of liner	Thickness Thk	Add 1.5mm Allowance for Corrosion allowance	Adoted THK	Length
From	To	m	Kg/cm2	Kg/cm2	m	mm	mm	mm	m
Start of Transition from HRT	Upto 50 Degree bend	104.42	11.4862	1869.45	7.00	23.89	25.39	26	64
373.23	348.23	132.77	14.6047	1869.45	7.00	30.38	31.88	32	32.64
348.23	323.23	157.77	17.3547	1869.45	7.00	36.10	37.60	38	32.64
323.23	298.23	182.77	20.1047	1869.45	7.00	41.82	43.32	44	32.64
298.23	273.23	207.77	22.8547	1869.45	7.00	47.54	49.04	50	32.64
273.23	248.23	232.77	25.6047	1869.45	7.00	53.26	54.76	54	32.64
248.23	223.23	257.77	28.3547	2702.21	7.00	40.81	42.31	42	32.64
223.23	198.23	282.77	31.1047	2702.21	7.00	44.76	46.26	46	32.64
198.23	173.23	307.77	33.8547	2702.21	7.00	48.72	50.22	50	32.64
173.23	160.50	320.50	35.255	2702.21	7.00	50.74	52.24	52	16.62
Lower PS bend	Penstock Bifurcation	320.50	35.255	2702.21	7.00	50.74	52.24	52	41.00
Penstock Bifurcation	Power House	320.5	35.255	2702.21	4.95	35.88	37.38	38	92

*The steel liner shall also be checked for external pressure at the detailed design stage in DPR.
**Rock participation shall be considered at the DPR stage based on the rock mass properties and use of stiffners for reducing the liner

***The Wye piece bifurcation design shall carried out at the detailed design stage in DPR. (weight added in gross weight)

ANNEXURE 7.18

Preliminary estimation of PS liner Weight

Sr.No.	Reach		Type of Liner	Inner dia. of penstock	Radius	Length	Liner thickness	Radius to C/L of liner	Perimeter	Volume	weight of steel	Weight of unit
	in meter			in meter	in meter	in meter	in m	in meter	in meter	m3	Kg/m3	Kg
1	Start of Tra	Upto 50 Degree be	ASTM 537 Cl. 2	7.00	3.5	64	0.026	3.513	22.1	36.7	7850	288324.13
2	373.23	348.23	ASTM 537 Cl. 2	7.00	3.5	32.6352	0.032	3.516	22.1	23.1	7850	181106.66
3	348.23	323.23	ASTM 537 Cl. 2	7.00	3.5	32.6352	0.038	3.519	22.1	27.4	7850	215247.66
4	323.23	298.23	ASTM 537 Cl. 2	7.00	3.5	32.6352	0.044	3.522	22.1	31.8	7850	249446.60
5	298.23	273.23	ASTM 537 Cl. 2	7.00	3.5	32.6352	0.05	3.525	22.1	36.1	7850	283703.50
6	273.23	248.23	ASTM 537 Cl. 2	7.00	3.5	32.6352	0.054	3.527	22.2	39.1	7850	306573.62
7	248.23	223.23	ASTM 517 Gr. F	7.00	3.5	32.6352	0.042	3.521	22.1	30.3	7850	238040.52
8	223.23	198.23	ASTM 517 Gr. F	7.00	3.5	32.6352	0.046	3.523	22.1	33.2	7850	260859.13
9	198.23	173.23	ASTM 517 Gr. F	7.00	3.5	32.6352	0.05	3.525	22.1	36.1	7850	283703.50
10	173.23	160.5	ASTM 517 Gr. F	7.00	3.5	16.6178	0.052	3.526	22.2	19.1	7850	150282.92
11	Lower PS b	Penstock Bifurcati	ASTM 517 Gr. F	7.00	3.5	41	0.052	3.526	22.2	47.2	7850	370782.33
12	Penstock B	Power House	ASTM 517 Gr. F	4.95	2.475	92	0.038	2.494	15.7	54.8	7850	430048.46
	Total length of one HRT/PS					383		Total Wt of one HRT/PS for			ASTM 537 Cl. 2	1524402.17
	Total length of one Unit Penstock					92		Total Wt of one HRT/PS for			ASTM 517 Gr. F	1303668.40
								Total Wt of one Unit Penstock			ASTM 517 Gr. F	430048.46

		ASTM 537 Cl. 2	ASTM 517 Gr. F
Total wt of 2 Nos. HRT/PS in Tonns	=	3048.8	2607.3
Total wt of 4 Nos. Unit PS in Tonns	=	0.0	1720.2
Gross Wt	=	3048.8	4327.5
Y piece and other accessories		0.0	100.0
Say (in Tonnes)		**3049**	**4430**

CHAPTER-8:

DESIGN OF E&M EQUIPMENT'S

CHAPTER – 8

8. DESIGN OF ELECTRO-MECHANICAL EQUIPMENTS

8.1 General

The pumped storage scheme consist of an upper and lower reservoir connected with a water conductor system through an underground power house complex equipped with desired numbers of Generator-Motor and Pump-Turbine units. The Underground power house of Gandikota Pumped Storage scheme will have four (04) nos. Pump-Turbine units of 250 MW each along with all the auxiliary system such as cooling water system, compressed air system, potable water supply system, fire protection system, ventilation and air conditioning system, illumination system, HT&LT AC and DC systems etc.

In the Scheme each main unit consists of one (01) 250 MW Turbine-Generator/285 MW Pump-Motor and one (01) Main transformer (three phase bank transformer of 110 MVA x 3 = 330 MVA). The main power transformer will be installed and connected to each generator/motor. The generator-motor set will be connected to the LV side (18 kV) of main power transformer, located in the transformer cavern, by isolated phase metal enclosed bus (IPB). A generator circuit breaker will be installed in the IPB for parallel operation of the Generators / Motors. A phase reversal switch will also be installed in the IPB for changing the mode of operation of the units i.e. Generation mode / Motor mode. The HV side (400 kV) of main power transformer located in the transformer cavern will be connected to the 400 kV double Bus located at the 420 kV Gas Insulated Switchgear (GIS) Substation through 400 kV XLPE (Cross-linked polyethylene) cables of appropriate size. A 400 kV Gas Insulated Switchgear (GIS) sub-station is proposed to be installed in the scheme for evacuation and receiving of power. Two nos. of 400 kV Double circuits or One no. of double circuit and two nos of single circuit Transmission lines are required to be constructed from Gandikota PSP to nearest 400 kV substation for evacuation of generated power or receiving of power for pumping purpose. However Power evacuation system will be finalized after load

flow study and system stability analysis concerning this project at the Detailed Project Report (DPR) Stage.

Two (02) Nos. of 18 kV line will be branched from the IPB of both Units and to be connected with Station Auxiliary Step down Transformer having secondary at 11kV to be connected at 11kv Switch Gear for Station Auxiliary Power. For static excitation system, Excitation transformer will be branched from IPB of each generator-motor unit.

One (01) static frequency converter (SFC) for starting of the units in pumping mode will required to be installed for four generator-motor whose power also be fed from IPB. Back to back pump starting system will also be equipped for three of four generator-motor units.

Station service power at 11 kV will be supplied by means of three sources: Station Auxiliary Switch Gear – 1, Station Auxiliary Switch Gear – 2 and Emergency Diesel generator set. The 11 kV power will be stepped down to 415 V / 230 V for use in Auxiliary equipment, Illuminating loads etc.

Consideration have been made that the power plant will be controlled by remote control system from the main control room in the power house with the provision for local control to be utilized during test and emergency cases.

A main supervisory computer system supporting necessary man-machine interface will be located at the main control room and separate local plant controllers will be provided for each main unit, station service circuit and 400 kV switchyard equipment. The computer system and controllers will be linked by high-speed data transmission system.

Following options for configuration of the main units have been considered for the basic design of electromechanical equipment at present.

- 4 Variable Speed Units of 250 MW each. (Depending upon further investigation and comparison of cost vs efficiency of variable turbines at later stage, a configuration of 2 variable + 2 Fix speed turbines or all 4 units of fix speed turbines can be opted)

- The entrance to the Machine hall cavern will be through Main Access Tunnel (MAT). The Main Transformer hall cavern will be placed on the downstream of main power house cavern.
- The approximate size of the machine hall cavern at EL 176.50 m will be 160 m length (including service bay and control block), 24 m width and 55m height.
- The auxiliary rooms shall be located at different floors with the main control room / block placed on the Unit – 1 side of the machine hall cavern. Control room, Model / Conference room, Engineers room, room for 220 V DC system, HVAC equipment, mechanical workshop etc. shall be located in these auxiliary rooms.
- Approximate size of Transformer hall Cavern at EL 176.50 m will be 137 m length, 18 m width and 22.5 m height (Including secondary GIS).

The floor wise equipment layout plan is as stated below:

Machine Hall Floor at EL 176.50 m

- Phase Reversal Switches along with Generator Circuit Breakers (GCB) which will be installed and connected through Isolated Phase Bus Duct (IPBD)
- Main Transformers will be installed at the Transformer cavern

Generator-Motor Floor at EL 171.00 m

- Unit Control Boards (UCBs)
- Unit Auxiliary Boards (UABs)
- LT Distribution board with Dry Type Transformers
- Neutral Grounding Cubicles
- Excitation Transformers and Panels
- Lubrication system etc.

Pump-Turbine Floor at EL 165.50 m

- Compressed Air System
- Oil Pressure Units for Governors
- Other Pump-Turbine Auxiliaries

Main Inlet Valve (MIV) Floor at EL 158.00 m

- Cooling Water Pumps
- Dewatering & Drainage Pumps
- Flood Water Pumps.
- Dewatering, Drainage and Flood Water Control Blocks

Drainage & Dewatering Gallery Floor at EL 144.00 m

- Dewatering Sump – Draft tubes will be connected with this sump through a network of valves & pipes.
- Drainage Sump – Seepage and drainage from various floors of power house will be collected to this sump.

24 kV Isolated Phase Bus Ducts (IPBD) interconnecting machine hall Floor with the Transformer cavern will be laid in individual bus duct tunnel of respective units. LAVT cubicles, Station Service (Auxiliary) connections with IPB shall also be installed in these tunnels. Beside these four Bus Duct Tunnels, two (02) additional tunnels (One at the extended part of MAT on Service bay side and other on Unit–4 side) will be provided for inter-connecting Machine Hall cavern with Transformer Hall.

One cable tunnel of adequate size will be provided to accommodate 400 kV XLPE cables for transmitting power between Pothead Yard (Main Transformer HV side) and 400 kV GIS. Various other HT cables and LT control, protection, signal cables to be provided between various panels in the underground Power House and Transformer Hall & Pothead yard shall be laid in cable trench / cable tunnel / duct, as required.

The access to turbine pit will be from pump-turbine Floor. Necessary hatches for erection and removal of MIV will be provided at various floors in the machine hall cavern.

The Main Access Tunnel (MAT) and Construction Adit Tunnel for the power house cavern shall be utilized as ventilation tunnel afterward. Suitable ventilation and air conditioning ducts, as required, shall be installed at various locations and floors.

Two nos. of 250/80/10 Ton EOT Cranes (250 ton EOT crane considered for variable speed machine, shall be installed in the power house cavern for tandem operation. One no. of 10 Tones EOT Crane shall be installed in the GIS hall for handling the GIS equipment. One no. 80T EOT crane shall be installed in Transformer cavern for handling of Draft tube gates).

The Crosse section of Power House is presented at **Annexure-8.1**

8.2 Brief Particulars of Pump-Turbine Equipment

8.2.1 Pump-Turbine

The Pump-turbine shall be of vertical shaft reversible Francis type coupled to Generator-Motor. 4 nos. of the Francis pump-turbine set each of 285 MW output rating while operating under rated head shall be installed.

The details of the hydraulic system of the generating units are as given below:

i) Upper Reservoir Levels

a) Full Reservoir Level (FRL) El. 481.00 m
b) Minimum Drawdown Level (MDDL) El. 464.00 m

ii) Lower Reservoir Levels

a) Full Reservoir Level (FRL) El. 212.00 m
b) Minimum Drawdown Level (MDDL) El. 202.90 m

iii)Head Loss

a)	Turbine mode	5.0 m
b)	Pump mode	5.0 m

iv) Operating Head range as Turbine

a)	Maximum net Head	266.800 m
b)	Rated Net Head	258.410 m
c)	Minimum design head	250.030 m

v) Operating Head range as Pump

a)	Maximum Head	277.34 m
b)	Minimum Head	260.26 m

vi)Turbine Basic Data

a)	Rated Output at rated head	255.886 MW
b)	Turbine Output at 10% overload operation	281.475 MW
c)	Specific Speed	122.670 m-kW
d)	Rated Speed	250 rpm
e)	Max. Discharge at rated head:	110.75 m3/sec
f)	Turbine center	Level 160.50 m

vii) Pump Basic Data

a)	Specific speed at maximum pump head	39.42 m- m3/sec
b)	Specific speed at minimum pump head	42.75 m- m3/sec
c)	Rated speed	250 rpm
d)	Minimum discharge at maximum pump head	98.45 m3/sec
e)	Maximum discharge at minimum pump head	104.94 m3/sec

The Pump-Turbine shall be designed to have output of 0 to 100% rated output at the head ranges as specified above. And a stable pumping mode shall be obtainable within the design pump head specified above without pressure fluctuation and/or other faults. A design of highest efficiency for both turbine and pump shall be made.

The fall in turbine efficiency when the generator is operated with minimum head or partial output shall be kept to a minimum.

The fall in pump efficiency and water discharge while operating at the higher pump head from the best efficiency point head shall be kept to a minimum.

In both operation modes, pumping and generating, the cavitation pitting, vibrations and noises shall be kept to a minimum.

The unit shall also be capable of operating in Spinning Reserve or Synchronous Condenser mode. To facilitate the same, necessary water supply system for runner gaps shall be provided.

The machine shall be capable of Line Charging operation including charging of one Transmission line during total grid failure, towards restoration of grid power.

For variable speed machine Turbine center will be lower than fixed speed machine, necessary civil constructions will have to be taken accordingly.

However, setting of pump turbine units (selection of center line elevation level) will be fixed at Detailed Project Report (DPR) stage considering the type of machines

The main components of the Pump-Turbine set will be as follows:

- Spiral Casing
- Stay Ring
- Runner
- Bottom Ring
- Guide Vanes
- Main Shaft Sealing Devices

- Water Supply Devices for runner gaps
- Spiral Casing Pressurizing System
- Draft Tube etc.

8.2.2 Speed Governor

Quantity: Four (4) sets

In pumping operation, the pump speed is governed by the motor, as the speed regulator circuit is not used. The speed governor shall continuously actuate and adjust the opening of guide vanes, initiated by the gate opening control device and water level measuring devices installed in the sequence control equipment, to obtain the best pumping efficiency corresponded with the pump head.

In generating operation, the speed governor shall be capable of automatic frequency control devices, deflective line control and guide vanes setting operation.

The electro-hydraulic governor shall have stable and accurate operation characteristics with Proportional-Integral-Derivative (PID) function. It shall be designed to have high sensitivity and high response characteristics. The governor shall be constructed for easy operation and its inspection can be carried out under running condition. Control system shall be so designed that both remote control and local control of speed and load limiting from the control board or at regulator cubical can be carried out by the operation handle.

Necessary protective devices including relays and contacts for control and alarm to lock the actuator and for quick stop of pump-turbine shall be provided in case of drop of hydraulic oil pressure for actuator, speed signal generator failure, DC power source failure or governor trouble. Whenever detecting the speed rise, the governor shall immediately send a closing signal of guide vane to make the speed stable regardless of the position of generator / motor circuit breaker and other control signals to the governor.

8.2.3 Pressure Oil Supply System For Speed Governor

The oil pressure supply system shall be used for operation of the pump-turbine controlled by the speed governor.

Each system shall consists of two (02) nos. of oil pumps (one for regular use and other for stand-by), one (01) no. of oil sump tank, one (01) no. of oil pressure tank, one (01) no. of leakage oil tank with pump, control device and other necessary accessories. Continuous running system by an unloader shall be applied for each pump.

The start and stop of the oil pressure unit shall be controlled automatically by the pressure relay in the pump-turbine control board. Each pump shall also have the provision to be started and stopped manually by the switch mounted on the Motor Control Centre (MCC).

8.2.4 Draft Tube Gates

Individual hoisting mechanism shall be provided for draft tube gate of each unit for quick closing, under the unbalanced condition of water pressure.

8.2.5 Draft Tube Gates

Individual hoisting mechanism shall be provided for draft tube gate of each unit for quick closing, under the unbalanced condition of water pressure.

8.3 Brief Particulars of Generator-Motor Equipment

8.3.1 Generator-Motor

The Generator-Motor will be three phase alternating current synchronous generator motor of rotating field, vertical shaft type. Each of the four Generator-Motors shall have the following characteristics:

(a) Generator

Table 8:1

i)	Rated capacity	250.00 MW
ii)	Power factor	0.9 lagging
iii)	Rated terminal voltage between phases	18 kV ± 10%
iv)	Frequency	50 Hz
v)	Phase	3
vi)	Speed	250 rpm
vii)	Range of frequency	50 Hz ± 3%
viii)	Type of Generator-Motor	Semi Umbrella Type
ix)	Over load capacity (10%)	306 MVA

(b) Motor

Table 8:2

i)	Motor Capacity	285 MW / 300 MVA
ii)	Power factor	0.95 leading
iii)	Rated terminal voltage between phases	18 kV
iv)	Frequency	50 Hz
v)	Phase	3
vi)	Speed	250 rpm

The voltage rating shall be optimized during preparation of bidding document / detailed project report stage.

Class F insulation will be provided for the armature winding and the field winding of the generator-motor.

The generator-motor will be provided with a conventional type of cooling system, i.e., air coolers. The air coolers shall have sufficient cooling capacity to maintain the air temperature.

8.3.2 Excitation System and AVR

The excitation equipment shall be static type potential-source, rectifier-type excitation system complete with digital type Automatic Voltage Regulator (AVR).

Static excitation system shall be used for generating, motoring and synchronous condenser operation in the generating and motoring direction, back-to-back synchronous starting operation and static frequency converter (SFC) starting for pumping.

The excitation system shall be complete with:

- Exciter transformer
- Rectifiers
- Current transformer
- Buses
- Transducers
- Field circuit breaker
- Automatic voltage regulator
- Exciter cubical and all necessary devices for indication, protection and control of the equipment

The AVR will regulate automatically and rapidly the generator-motor voltage to a setting value by detecting the three-phase terminal voltage at both generating and pumping operations.

The AVR will be capable of covering 80% to 110% of the rated voltage of the generator at no-load operation. It will be also suitable for synchronous condenser operation.

When full load rejection occurs at generating mode due to external fault, the excitation system will be capable of depressing the terminal voltage rise of the generator-motor within 30% of the rated voltage under the conditions that the field breaker is in closed position and the speed rise of the generator-motor is within 45% of the rated revolving speed

8.3.3 Neutral Grounding Device for Generator-Motor

Neutral Grounding Resistor (NGR) system and Neutral Grounding Transformer (NGT) system are available for the neutral point grounding of the generator- motor.

Neutral Grounding Resistor (NGR) system would be suitable from the view point of cost and varying resistance characteristics with frequency during starting operation by back to back system. Hence, Neutral Grounding Resistor (NGR) system shall be used for grounding the neutral point of the generator-motor windings.

The Neutral Grounding Device shall consist of:

- Neutral Grounding Resistor (NGR)
- Disconnecting Switch
- Current Transformer

8.3.4 LAVT System

LAVT Cubicles shall include Surge Capacitors, Lightning Arrestors, Voltage Transformers and associated accessories.

8.3.5 Motor Starting Method

A. **Static Frequency Converter (SFC)**

One (01) set of Static Frequency Converter (SFC) with digital control type shall be used in common for four units of the generator / motor simultaneously and shall be connected to each generator / motor through the selective Disconnecting Switch, Circuit Breakers etc. to accelerate the machine in reverse direction for “pumping operation” up to rated speed by grid power. After synchronizing the machine with the grid SFC gets cut off.

The Static Frequency Converter (SFC) consists of:

- Starting Transformer
- Static Converter

- Inverter
- AC reactor
- DC reactor
- Circuit breakers
- Other accessories for control and protection etc.

B. Back to Back Starting Method

Beside SFC as main starting method of the motor (pumping mode), back-to-back (BTB) starting method as back-up option is recommended for the project.

8.4 Main Inlet Valve

Quantity: Four (04) Sets

The Main Inlet Valve is located between the Spiral Casing and the Penstock. Spherical type valve is generally recommended for a pumped storage plant because of its low loss, but considering the large size of the spherical valve due to high discharge volume, through-flow valve may be acceptable for this project considering the diameter of penstock.

The flow capacity of the inlet valve will have sufficient to allow maximum flow of the pump-turbine discharge.

The inlet valve will be designed to safely withstand the stress due to the maximum hydraulic pressure obtainable including water thrust in the penstock and will be free from vibration and any abnormalities under the whole operating range of the pump-turbine including any transient conditions of operation.

The inlet valve will be designed to be capable of closing from fully opened position under the condition of maximum flow at every head.

A bypass valve of needle valve type will be furnished to the main inlet valve in order to balance the water pressure of both the penstock side and the pump-turbine side when the inlet valve is opened.

All the main inlet valve and the bypass valve will be operated by pressure oil and the operating mechanism will consist of pressure-oil supply system, servomotor, rod and lever. Each component will be constructed to have sufficient strength and to ensure smooth operation under all operating conditions of the pump-turbine. Pressure of the oil system will be approximately 25 kg/cm2. The bearing shall of the self-lubricated type.

Manually operated mechanical locking device shall be provided to firm locking of the operating mechanism at fully closed position. The locking device shall also be provided with the by-pass valve.

8.4.1 Pressure Oil Supply System for Main Inlet Valve

The pressure oil supply system shall be used for operation of the inlet valve and the bypass valve. Each system shall consists of two (02) nos. of oil pump (one for regular use and other for stand-by), one (01) no. of oil sump tank, one (01) no. of oil pressure tank and other necessary accessories.

The start and stop of the oil pressure unit shall be controlled automatically by the pressure relay in the pump-turbine control board. Each pump shall also have the provision to be started and stopped manually by the switch mounted on the Motor Control Centre (MCC).

8.5 Oil Treatment and Storage Equipment

The Oil Treatment and Storage Equipment of adequate capacity shall be used for storage and purifying the lubrication oil of the pump / turbine, generator / motor and pressure oil of the pressure oil supply system. The oil treatment and storage equipment shall consist of oil filter presses, oil purifiers, oil storage tank and other required accessories.

Oil handling system

Oil handling system for transformer oil and lubricating oil for generating units will be provided with suitable piping, valves, tanks, purifiers etc. and shall be located such as to conform the requirements of underground power house.

8.6 Compressed Air Supply System

A HP and LP Compressed air system shall consists of the following:-

- Air Tanks
- Compressors
- Air receivers complete with all accessories
- Air Dryers complete with all accessories
- Pressure Reducer
- Complete air distribution system including valves, piping, fittings, automatic moisture traps, filters etc.
- Protection system including pressure gauges, pressure switches, transducers, temperature switches, temperature indicators, moisture indicator, flow indicators, control panel etc.

The compressed air supply system shall be applied for following purpose:

i) Draft tube water depressing for pump starting
ii) Compressed air supply for the speed governor oil pressure tank and main inlet valve oil pressure tank.
iii) Compressed air supply for generator / motor break
iv) Fire protection system, various instrumentation systems and station service system etc.

8.7 Cooling Water System

It is proposed to provide individual cooling water system for each unit to remove heat from generators and bearing oils through heat exchangers.

The main water supply system shall be applied for following purposes:

i) Cooling water supply for generator-motor air cooler, thrust bearing oil heat exchanger and guide bearings
ii) Cooling water supply system for pump-turbine main guide bearing and shaft seal water supply for the sealing box of pump-turbine.
iii) Cooling water supply for the gap of runner
iv) Cooling water supply for main transformer at On-Load operation
v) The water supply system shall be provided for cooling of main transformer, on load tap changer and transformer fire extinguisher.
vi) The water supply system shall also be provided for cooling of the static frequency converter (SFC) and static frequency converter transformer.

The water supply system shall be provided for replenishing the leakage water from the spiral case at depressing water level in draft tube at pump starting.

The cooling water for each main unit is supplied from the corresponding draft tube by an individual motor driven pump set. There is one regular use pump set for each main unit and one stand-by use pump set is provided for all main units. The stand-by use pump and regular use pumps are isolated by automatic operated valves.

The cooling water system shall consist of:

- Pump Sets
- Motor driven strainers
- Additional strainer for supplying the main shaft packing box cooling water and for runner seal cooling water
- All required fitting, piping and accessories.

8.8 Dewatering and Water Drainage System

Dewatering system shall be provided in the power house for dewatering of unit for access to underwater parts.

The system shall comprise of:

- Dewatering Sump
- Two (02) nos. of submersible pumps of sufficient capacity (One as main and one as standby) installed in the dewatering sump
- Necessary valves, piping, control, annunciation.
- Water drainage system shall be provided for water drainage of the leaked water from pump-turbine and other apparatuses, leaked water of power-house, equipment drain and others.

The Drainage System shall comprise of:

- Drainage Sump
- Two (02) nos. submersible drainage pumps (One as main and one as standby) installed in the sump.
- Requisite piping, control panels etc.

8.9 Generator-Motor Main Circuit

Generator-Motor main circuit will consist of:

Generator Circuit Breaker

24 kV, Indoor type, metal-enclosed, SF_6 circuit breaker will be installed between each Generator and respective Main Step-up Transformer for protection and synchronization (for remote closing and remote tripping or automatic tripping due to fault)

Each generator-motor circuit breaker is required to have enough current carrying capacity to withstand line charging current at the rated voltage in case of Line Charging (Black Start) by the relevant generator according to CEA's guideline.

Phase Reversal Disconnecting Switch

Rotational directions of pumping mode and generating mode of the unit are opposite. Therefore, a 24 kV Phase Reverse Disconnecting Switch Set of required current rating will be installed to change any 2 phases of 3 phases of main circuit in order to change

the phase rotational direction at the generator-motor terminal to assure the desired direction of rotation for both generation mode and pumping mode.

Pump Starting Disconnecting Switch

For each unit, 24 kV Disconnecting Switch for pump-starting by SFC will be provided between the generator-motor circuit breaker and the generator-motor. Furthermore, 24 kV Disconnecting Switch for pump-starting by BTB will also be provided at the starting generator side (will be decided at the later stage)

Insulating phase Bus (IPB)

Metal Enclosed Isolated Phase Bus (IPB) will be provided as the main bus (21 kV) between the terminals of generator-motor and the primary terminals of main step-up transformer.

Braking System of the units

Both Electrical and Mechanical Braking System will be provided with each unit in order to reduce the time of stop operation. The electrical brake will begin to work at around 40% of the rated revolving speed. Below 10% of the rated revolving speed, the electrical brake will be released and the mechanical brake will begin to operate.

Instrument Transformer

For protection and measuring of the main units, necessary current transformers and potential transformers will be installed.

8.10 Transformer Main Step-Up

8.10.1 Type and Rating

Quantity: Four (04) sets

Rated Capacity: 330 MVA

Rated Voltage: Primary 18 kV, Secondary 400 kV ± 5%

Indoor type, oil-immersed, single phase bank or special three phase, forced oil forced water (OFWF) cooled, with on-load tap-changer (OLTC).

Each transformer cooling system shall consist of oil pump and cooler (heat exchanger) to form a unit cooling facility.

The cooling water shall be supplied from the main water supply system when the generator-motor is in operation.

The water fire extinguisher equipment shall be provided for each main transformer..

8.10.2 Surge Arrester for main Step-Up Transformer

GIS type Surge Arresters will be installed at the HV side of the step-up transformer.

8.10.3 Neutral Earthing of Main Step-Up Transformer

The neutral point of the secondary winding (HV Side) of each main step-up transformer will be solidly grounded.

8.11 Cables and Accessories

8.11.1 High Voltage Power Cable (400 kV XLPE Cable)

Single core 400 kV high voltage XLPE cables will be installed and connected from the underground secondary GIS to the outside switchyard through the cable tunnel for power evacuation between the main step-up transformers and the GIS / outdoor switchyard.

400 kV XLPE cable will be laid in snake shape on the racks in the cable tunnel from the secondary GIS to the GIS / outdoor switchyard and fixed by cleats. The cable sheath of cable head yard side shall be solidly grounded and the cable sheath of main transformer side shall be grounded through the grounding device, for example gap-less lightning arrester.

8.11.2 Power, Control & Instrumentation Cables and Cable Trays Etc.

11 kV XLPE cables shall be used for connection from and to the 11 kV switchboards to be installed at different load centers in power house and switchyard.

1.1 kV Grade PVC insulated Copper / Aluminium power cables shall be used in the power house, transformer cavern, switchyard, Lower Dam, Upper Dam areas for supplying power to various auxiliaries, while for control cables 1.1 kV Grade PVC insulated copper cables will be employed.

The instrumentation cables used including Optical Fiber Cables (OFC) will be immune to electromagnetic interference. The number of pairs / cores required will be as per the requirement of the system.

All the accessories like Cable Glands, Ferrules, Cable Trays with Cable Racks & Supporting Structures, Conduits etc. of adequate sizes as required for the installation of cables will be included. Al cables will be FRLS type.

8.12 400 KV GIS/Outdoor Switch Yard

400 kV GIS (Gas Insulated Switchgear) or Outdoor type switchyard will be installed with proposed four (4) nos. of 400 kV Bays for connection of following feeder circuits:

- Four (04) circuits of 400 kV power cables incoming from units connecting four (04) units of the Power House
- Four (04) circuits (Two nos. Double circuit or two nos. single circuit and one no. of double circuit) of outgoing transmission lines
- One bus tie circuit breaker

Double bus bar arrangement is proposed for this project which will provide flexibility and reliability in the operation of the plant. The line terminal equipment will consist of Wave Traps and Coupling Capacitor Potential Devices with Carrier Current Accessories.

Eight (8) sets of surge arrester will be provided for the protective purpose of switchyard equipment and 400 kV power cables. Out of which, Four (04) sets of surge arrester to be installed at outgoing transmission line terminals will be of conventional porcelain type and four (04) sets of surge arrester to be installed at main power transformer feeders will be of GIS type.

The GIS Switchyard shall consist of:

- Circuit Breakers
- Disconnecting Switches (with and without earth switches)
- Instrument transformers
- Protective Relays, Meters and other necessary equipment

The conducting parts will be housed in grounded metal enclosures filled with SF_6 gas and the parts will be insulated and supported from enclosures by means of spacers and supporting insulators.

8.13 Control and Protection System

The system shall be applied for automatic control such as start, stop and protection of the pump-turbine combined with the control and protection system during all modes of operation such as turbine and pumping. All necessary components required for performing the automatic sequential control of the pump-turbine, and their main parts shall be accommodated inside the pump-turbine control board.

Beside the Local automatic control, remote control system which will be done through the Supervisory Control Monitoring and Data Acquisition System (SCADA) will also be employed in this project The Single Line Diagram for Gandikota Project is presented at **Annexure-8.2**

8.13.1 Control System

A supervisory control and data acquisition (SCADA) system will be provided for an efficient and economic plant operation. The control and monitoring system will be built up of distributed control technique with independent control module in hierarchical

control levels and standard open protocol for communication network. The control system of the project will be provided with distinguished operating characteristics, high reliability and responsibility.

The power house will be designed to be operated with three levels of control:

- From the control room
- From the Unit control board located on the machine hall floor.
- From local control cubicles of each element located adjacent to the unit.

A main supervisory computer system supporting necessary man-machine interface will be located at the Main Control Room and separate local plant controllers will be provided for each main unit, station service circuit and 400 kV switchyard. The computer system and controllers will be linked by high-speed data transmission system.

8.13.2 Protection System

The protective relays will be provided for each units including its excitation transformer, station auxiliary system, main transformers, 400 kV XLPE cables, 400kV switchgear etc.

The design of the protection scheme will be based on the general philosophy that all the protection equipment has a primary and back-up protection supplementing each other. The Protection System will have two level of response according to seriousness of the fault.

- When a serious trouble occurs, relevant equipment shall be stopped or tripped the breaker automatically by operating the protective system.
- On the other hand, when a slight trouble occurs, fault indication lamps as well as audible alarms will only be provided for control & protection and the operators will be requested to dispose the fault properly by their own judgment.

8.13.3 Main Functions Of SCADA System

A. Control Function

- Main Unit Control
- Main Transformer Control
- Station Service Circuit Control
- Switchyard Control

B. Supervising and Monitoring Function

C. Display Presentation

D. Recording Function

- Daily operation log
- Monthly operation log
- Fault and operation record
- Auxiliary system operation log

E. Calculating Functions etc.

8.14 D.C. Supply System

For control, protection, metering, annunciation, emergency lighting and other DC load requirements in the Power House and Switchyard, 220V DC system shall be installed.

The 220V DC System for Power House shall consist of 2 sets of 220V, 1800 Ah Lead Acid Battery Bank, 2 sets of Battery Charger, Uninterruptible Power Supply (UPS) System, Inverter (to supply AC Auxiliary Power using DC Power source) and other switching equipment.

The 220V DC System for GIS Switchyard shall consist of 2 sets of 220V, 250 Ah Lead Acid Battery Bank, 2 sets of Battery Charger, Uninterruptible Power Supply (UPS) System, Inverter (to supply AC Auxiliary Power using DC Power source) and other switching equipment.

In addition to the above, two (02) sets of UPS / Battery System will be provided for gate control of Dams (upper & lower) and 48V DC System will be provided for PLCC purpose.

8.15 AC Electrical Auxiliaries Supply System

8.15.1 Station Service Power

The station service auxiliary power for use in the power plant and GIS/ Switchyard and Dam areas shall be supplied with 11kV/415/230 volt Distribution Transformers consisting of 3-phase, 4-wire, 50 Hz, AC power source which will receive power from two nos. station service circuits of 7 MVA, 18/11 kV Transformer from IPB. All electrical equipment and apparatus shall withstand voltage & frequency fluctuation of ±10% and ±5% respectively, in the same direction simultaneously. The main AC supply system will be arranged from the 400 kV grid through the station service transformer to the LV (11 kV) side of Main Transformer or from generator (during generation) through 2 nos. of Station Service Switch Gears.

Station Service Auxiliaries will be fed from nine (9) sets of Distribution Transformers as mentioned below.

- 2 Nos. of 11/0.415 kV, 1000 KVA Unit Auxiliary Transformers (UAT) for 2 Nos. Generator-Motor Sets.
- 1 No. of 11/0.415 kV, 2000 KVA Station Service Transformers (SST) for Power House
- 2 Nos. of 11/0.415 kV, 250 kVA Station Service Transformers (SST) for GIS / Switchyard
- 2 Nos. of 11/0.415 kV, 250 kVA Station Service Transformers (SST) for Upper Dam
- 2 Nos. of 11/0.415 kV, 200 kVA Station Service Transformers (SST) for Lower Dam

8.15.2 Emergency Power

For emergency power supply, 2 nos. of 11 kV, 1 MVA Diesel Generator Set will be installed at the Power house. The DG Sets will be connected with the 11 kV Bus through VCB.

8.15.3 Motor Control Centre (MCC)

From 11 kV Bus, 4 nos. of 11/ 0.415 kV (Two nos. of 1 MVA and two nos. 1.5 MVA) Dry type Distribution transformers will supply auxiliary power to Power House Motor Control Centre (MCC), Unit auxiliary equipment control center, Air compressor control center, drainage and dewatering pump control center, Oil supply system control system. 6 nos. of 11/0.415 kV Upper Dam and lower Dam auxiliary power and GIS/Switch Yard. Each pump of various systems shall have the provision to be started and stopped manually by the respective switch mounted on the Motor Control Centre (MCC)

8.16 Grounding System

The grounding mat of copper or MS flat or steel rods, or combination thereof, having suitable cross sectional area would be provided in the power house complex comprising following grounding meshes:

- Powerhouse cavern
- Transformer cavern
- Isolated phase bus tunnels
- Cable tunnel
- Access tunnel
- Tailrace tunnels
- Switchyard
- Headrace
- Penstock
- Power Intake etc.

Suitable number of grounding risers would be provided in the machine hall & transformer hall caverns for connection to machinery equipment / panels / boards in various auxiliary bay floors, bus duct tunnels, cable tunnels, interconnecting tunnels, main access tunnel, GIS etc. for earthing of various electrical equipment. Separate provision would be made for earthing various electronic equipment in the power house. All non-current carrying equipment shall be grounded by using at least two earthing

conductors of adequate sizes which shall finally be connected to the grounding grid. The grounding system would be designed to minimize the touch and step potential within acceptable safe limit.

All ground meshes are to be connected together to make a low grounding resistance

8.17 EOT Crane

The Electrical Overhead Traveling Cranes are installed in the underground powerhouse for unloading, assembly, erection and future maintenance of the turbines, generators, and other mechanical and electrical equipment.

The heaviest equipment part to be handled by the main hoist will be the generator rotor. It is proposed to provide Two (02) nos. EOT cranes of 250 / 80 / 10 ton capacity EOT Crane with tandem operation. The auxiliary hoists are to be provided for the convenience of handling small parts. The capacity of crane however would need to be further examined in consultation with manufacturer of generating equipment.

One (01) no. EOT Crane of 10 Ton capacity shall be installed at GIS hall.

One (01) no. EOT Crane of 80 Ton capacity shall be installed in Transformer Room for Draft Tube Gate.

8.18 Fire protection System

The Fire Protection System in the underground power house, main access tunnel, isolated phase bus duct tunnels, GIS / switchyard etc. shall be designed to timely detect the occurrence & quick extinguishing of fire break outs and prevention of spread of fire so as to minimize the extent of damage.

Water spray type Fire Extinguishing System shall be provided for all the generator-motor sets, main transformer, Station service system & SFC transformer. The fire extinguisher system shall detect fire inside the generator-motor barrel and transformer rooms instantaneously and accurately, and shall discharge water automatically by actuation both of the fire detector and protection relay, and also, by manual operation at the extinguisher panel.

8.19 Air Conditioning & Ventilation System

The machine and transformer halls shall be provided with ventilation and air conditioning system as required to maintain the control room, conference room and other work areas at the required level of temperature, humidity and comfort.

Adequate number of exhaust fans shall be installed at suitable locations to provide the air changes per hour as mentioned in Indian standards.

8.20 Illumination System

Illumination system design shall be based on the principle of achievement of the desired illumination levels with minimum glare. The design shall result in the most energy-efficient and presentable illumination as per the latest international trends in underground power plants.

The illumination system shall provide lighting and electric power supply to all plant areas, dam, access road to various locations of the project and switchyard. In addition, it shall provide lighting for selected area during plant emergency conditions.

Suitable scheme / arrangement will be provided for emergency lighting during AC supply failure.

8.21 PLCC Equipment

PLCC system shall provide efficient sources and reliable information links to meet the communication need of protection, voice and data including SCADA system. It shall provide for distance protection and direct tripping for remote end breaker, signal transmission & speech communication between the power house/ GIS / sub-station and data communication to remote places through various frequency channels etc.

8.22 Communication System & Surveillance System

A suitable communication and surveillance system shall be installed in the power house complex to facilitate the communication and desired security in the power house

area. Communication system comprises of the public address system and EPBAX equipment.

The surveillance system would comprise of access control system and CCTV system equipment including all spaces of power house.

8.23 Electrical Equipment Testing Laboratory

Portable Electrical Testing Equipment will be provided to carry out normal testing of power house equipment. Separate room is proposed in the power house for Electrical Testing Laboratory for storage of portable equipment and to serve as a base for testing personnel. All the testing equipment should be PC compatible and of latest design.

8.24 Mechanical Workshop

A Mechanical Workshop will be provided in control block in machine hall cavern for routine maintenance as required for all works & will be equipped with drilling, welding, milling & lathe machines & other required machine tools.

8.25 Lift

One number electrically operated lifts shall be in the control block for easy movement. The lift shall be designed for approximately a load of 10 persons.

8.26 Power Evacuation Arrangement

Following power evacuation schemes are proposed at this stage for 1000 MW Gandikota Pumped Storage Project.

a) Two nos. of 400 kV Double Circuit Transmission Line from Gandikota Hydro power station to nearest two different 400 kV Substation (One double circuit for one 400 kV substation) or one double circuit to one 400 kV substation and another two single Circuit Transmission Line from Gandikota Hydro power station to nearest two different 400 kV Substation may be used for power transmission or for power drawl purpose.

b) The power evacuation scheme will be finalized at the Detailed Project Report (DPR) Stage.

However, a comprehensive load flow study is necessary during DPR stage under peak / night load scenario encompassing the all power stations and load centers and thereby setting up Substation & Transmission system effectively.

Single line diagram for 400 kv switchyard is given in **Annexure-8.2.**

8.27 Advantage and Disadvantage Of Variable Speed Machine

Advantages:

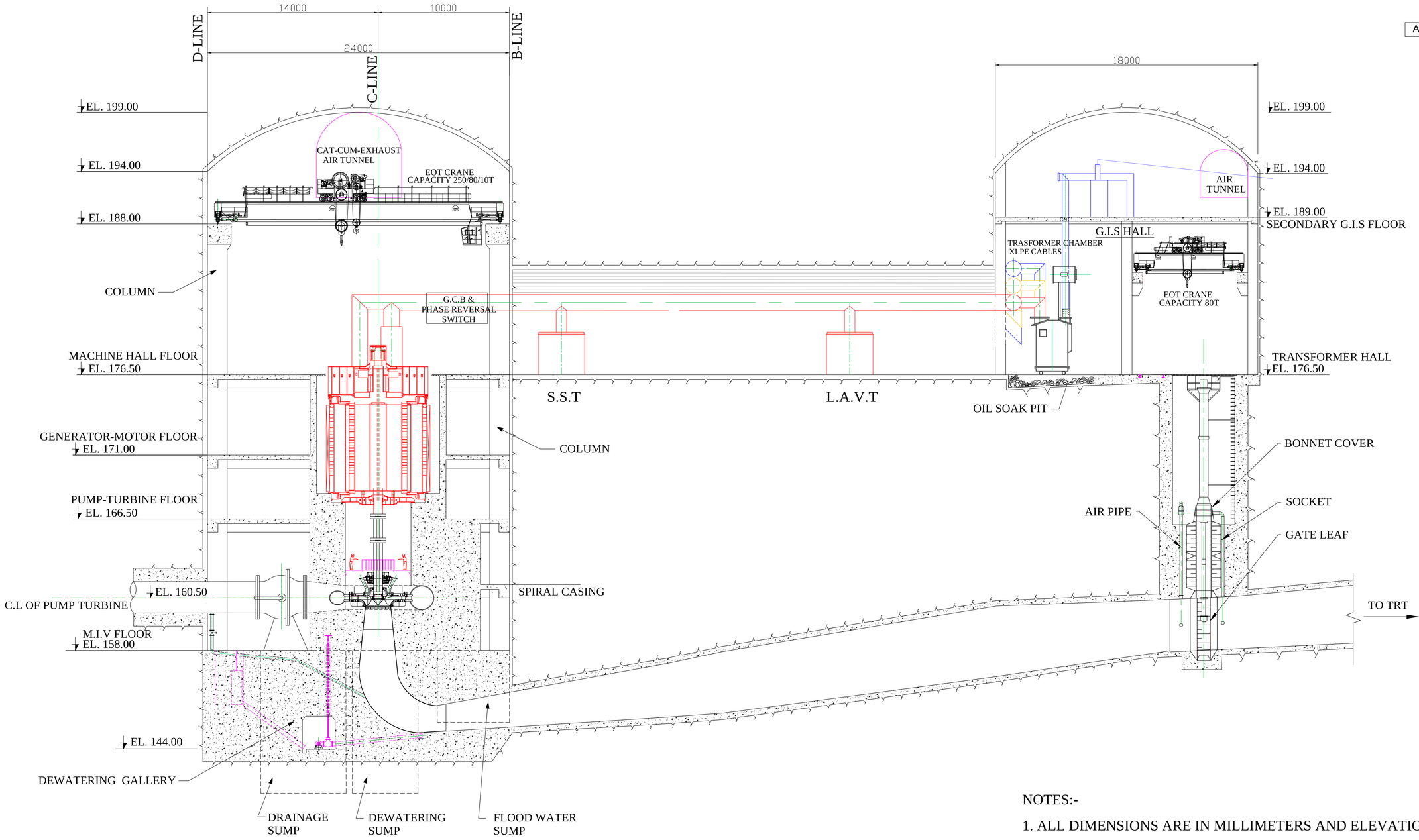
- Speed of the pump can vary as well as consumption of power for pumping is variable
- Improvement of Turbine efficiency in generation mode
- Expansion of operational range at generation mode
- Improvement of power system stability

Disadvantages:

- Larger space required for AC excitation system
- Cost is higher

Annexure 8.1:

ANNEXURE - 8.1



NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATIOMS IN METERS.

CROSS SECTION OF POWER HOUSE

NEW & RENEWABLE ENERGY DEVELOPMENT CORPORATION OF ANDHRA PRADESH LTD. (NREDCAP)

CONSULTANTS

WAPCOS LIMITED

(A GOVT. OF INDIA UNDERTAKING)

GANDIKOTA PUMPED STORAGE PROJECT (1000 MW)

CROSS SECTION OF POWER HOUSE

DEGN.- RIDDHIMAN DEY	CHKD.- B. N. SARKAR	
DRAWN- R. K. CHAUHAN	REV.NO.- 0	
DATE- JUNE. 2021	DRG.NO.-WAP/D&RE/GANDIKOTA/FR-8.1	

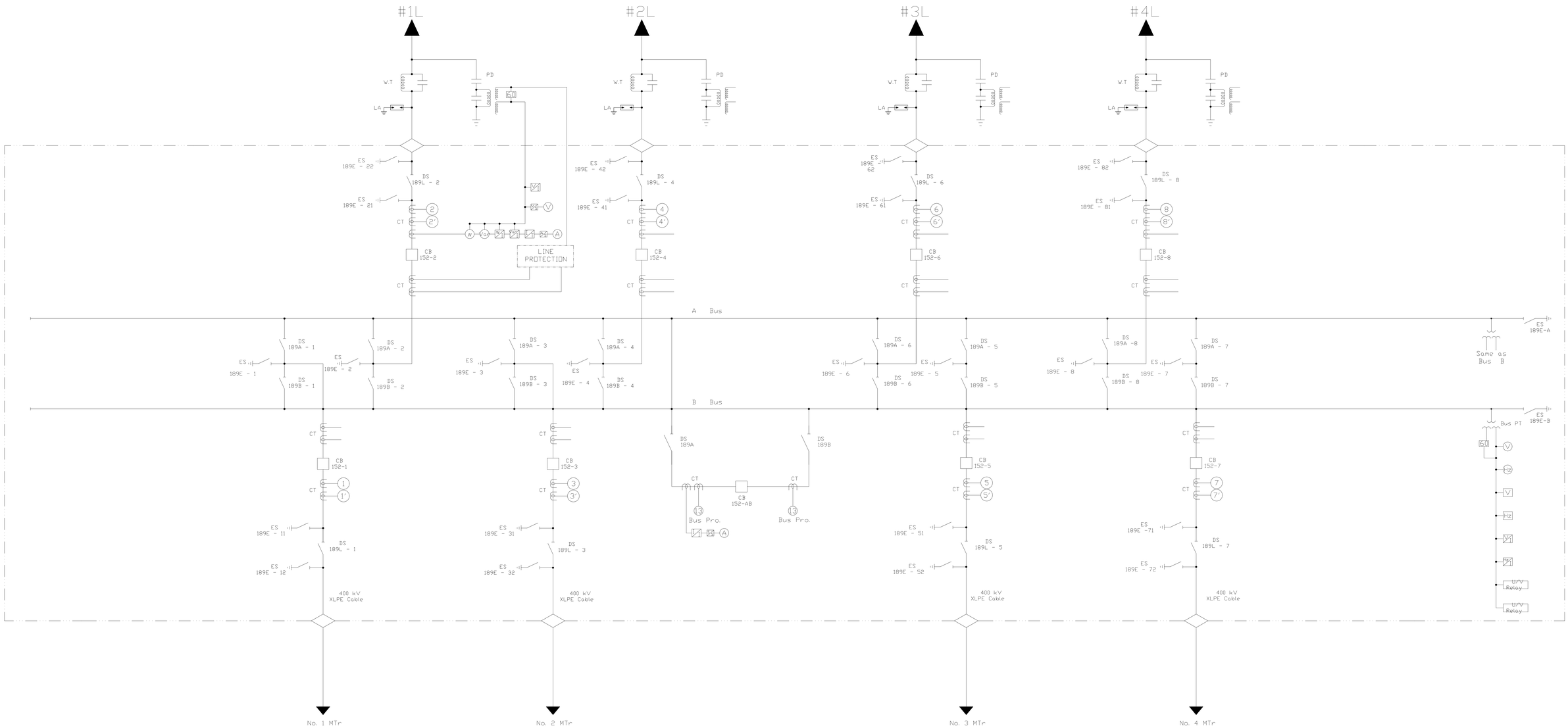
Annexure 8.2:

ANNEXURE - 8.2

To & From NEAREST
400kV Sub-Station

To & From NEAREST
400kV Sub-Station

To & From NEAREST
400kV Sub-Station



LEGENDS:-

SL. NO.	DESCRIPTION	SYMBOL
1.	DISCONNECTING SWITCH (DS)/ISOLATOR	
2.	LIGHTENING ARRESTOR (LA)	
3.	SURGE CAPACITOR(SC)	
4.	EARTH SWITCH (ES)	
5.	CIRCUIT BREAKER WITHOUT CLOSING RESISTOR OR CONTROL SWITCHING DEVICES	
6.	WAVE TRAP	
7.	CURRENT TRANSFORMER (CT)	
8.	POTENTIAL TRANSFORMER (PT)	

400 kV GAS INSULATED SWITCHYARD (GIS)

NEW & RENEWABLE ENERGY DEVELOPMENT CORPORATION OF ANDHRA PRADESH LTD. (NREDCAP)

CONSULTANTS
WAPCOS LIMITED
(A GOVT. OF INDIA UNDERTAKING)

GANDIKOTA PUMPED STORAGE PROJECT (1000 MW)

SINGLE LINE DIAGRAM FOR 400 kV SWITCHYARD

DEGN.- RIDDHIMAN DEY	CHKD.- B. N. SARKAR	
DRAWN- R. K. CHAUHAN	REV.NO.- 0	
DATE- JUNE. 2021	DRG.NO.-WAP/D&RE/GANDIKOTA/FR-8.2	

CHAPTER-9:

CONSTRUCTION PLANNING & SCHEDULE

CHAPTER – 9

9. CONSTRUCTION PROGRAMME AND SCHEDULE

9.1 General

Construction of proposed Gandikota Pumped Storage Scheme including erection of the four generating units is planned to be completed in a period of Five years including Pre-construction works of eight months for creation of infrastructure facilities viz. additional Investigations, improvement of Road network and colonies.

Two shift working is considered economical for surface works. For underground works which do not follow normal pattern of shift working because of cyclic operations, three shifts working with minimum 15 hrs. or upto completion of cycle operations/day has been considered. Opting 25 working days in a month, shift wise scheduled working hours annually are adopted as follows

Single Shift Work= 25 x 10 x 6 hrs. = 1500 hrs
Two Shift Work =25 x 10x 11hrs = 2750 hrs } for Surface Works
Three Shift Work = 25x10 x 15 hrs = 3750 hrs
Three Shift Works = 25x10 x 18 hrs = 4500 hrs for Underground.

9.2 Main Components of the Project

9.2.1 Main Structure/ Components

The construction schedule has been detailed for major items of the following main structures/ components.

i. Civil Works

- Upper Reservoir/ Excavated Pit
- Upper intake
- Coffer Dam
- Headrace tunnel cum pressure shaft

- Tailrace outlet structures
- MAT and construction Adits
- Draft Tube and Tailrace tunnel.
- Switch yard and Cable Tunnel
- Underground powerhouse and transformer cavern.

ii. Electrical Works

- E.O.T. cranes
- Supply and erection of T.G./Pumps sets 4 nos. 250 MW each
- 400 kv G.I.S. and bays equipment
- Main power transformers
- Other auxiliary electro-mechanical equipment

iii. Hydraulic equipment

- Intake gates
- Tailrace Outlet gates
- Draft Tube gates

9.2.2 Target Schedule

The total construction period is scheduled as follows.

Pre-construction Period	: 8 Months
Construction Period (Main Works)	: 52 Months (4 years 4 Months)
Total construction period	: 60 Months (5 years)

The Programme is also exhibited in the form of a bar chart and is enclosed as **Annexure 9**

9.3 Infrastructure Facilities

The proposed Gandikota Pumped Storage Project is located in Kondapur village of Kadapa district of Andhra Pradesh, India and belongs to Rayalaseema region. The

project falls in the Lat. N 14° 48' 38" and Long. E 78° 15' 30". It is located 80 KM towards west from District headquarters Kadapa. The altitude of the project area varies between 465m and 195m. The Upper reservoir is proposed by excavating a pit and constructing a bund at hilltop.

The Upper reservoir at present is not accessible but the Lower is accessible to nearest road network which is at about 26 km from NH-67. For power house approach tunnel, a new road is to be developed. Upper dam falls in forest area and there is no habitation. Lower dam is utilized for Irrigation, Drinking water and fisheries purpose. The Upper reservoir is not accessible by road network. However for lower intake, a road network is available at about 26 km from National highway. The rail head is Yerraguntala which is about 70 km approx. from project site. The nearest airport is Kadapa which is 100 km approx. from the project site.

Construction of infrastructure works will be taken up in first years. Construction power may be obtained from the existing grid, but a new sub-station needs to be developed. Construction/ improvement of project road and upgrading of existing road will be taken up immediately. The construction of office and residential buildings will be started in first year and be completed by second year. Construction of Project road shall be taken up first priority to complete within a year due to short length.

Following provision is being kept for construction of offices and residential building at various sites:

- Permanent Office Buildings
- Temporary Office Buildings
- Temporary Site Offices
- Permanent Residential Buildings
- Temporary Residential Buildings

The construction of project colony, residential and other Non-residential building will be taken up from first months and completed all within eight months.

9.4 Upper Reservoir/ Excavated Pit

As the upper dam is proposed on hilltop by excavating and constructing a bund of required storage. The excavation for the Upper dam is proposed to be started in the 10th months i.e. 6 months of 2nd year. Construction of dam embankment will be started in the 7th month of 2nd year and in continuation upto 9th month of 4th year.

9.5 HRT & pressure shaft

Excavation of HRT from intake face will be taken up in the 4th month of second year after partial completing the open excavation of upper reservoir on upper intake side. The same will be completed in the 1st month of third year. The concreting/backfilling/ grouting/ rock bolting will be taken up simultaneously and completed in the 4th month of third year.

The excavation of horizontal pressure shaft will be taken up in the 2nd month of second year after completing the adit excavation which will start in 9th month of 1st year and spread over five months. The steel liners will be erected from 2nd month of third year and completed in the 1st month of fifth year.

9.6 Coffer Dam

As the proposed lower reservoir is existing, during construction stage, diversion method is being followed for lower reservoir, so that foundation excavation and embankment will be treated sequentially.

The construction of coffer dam is proposed to be started in the 9th month of first year and will be spread over six months upto 2nd month of 2nd Year.

9.7 Tailrace Tunnel/ Lower Intake/ TRT Outlet

Open Excavation of tailrace will start from 1st month of second year which will be completed in 3rd month of 3rd year and construction of Tailrace tunnel will be started in the 1st month of 3rd year which will be completed in 8th month of 3rd year. TRT outlet will be completed by 2nd month of 4th year.

9.8 Underground Powerhouse/ Transformer Caverns

Main Access tunnel to power house will be done by 6th month of second year and then the excavation of the power house cavern will be taken up in the 7th month of the second year and will be completed by 3rd month of fourth year. The concreting will be completed by the 9th month of the fourth year and will take 10months for completion.

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9.9 Electro-Mechanical Works

Action for procurement of EOT cranes is proposed to be initiated in the 1st year itself. The entire process of inviting the tender, placing orders, manufacture, supply, erection and testing is planned to be carried out and completed upto 3rd year.

All the E&M equipments installation period for each pump/ turbine and generator/ motor has been considered as fifteen months

9.10 Impounding Schedule

Filling of reservoirs will be based on the following considerations: -

- As upper reservoir is not on any nallah or stream so, Filling would be started after the construction of upper reservoir.
- Filling elevation would not be permitted to exceed the height of embankment anytime.
- In case of exceeding the above clearance, extra water (including flood) would be flown to downstream by pumping or other ways.
- **Filling Time:** As stated in Hydrology chapter, there are sufficient water available in the lower reservoir and the quantity of water required to fill the upper reservoir for the first time is only 9.514 MCM which is just 1.42% of live storage of lower reservoir.

Annexure - 9

Gandikota Pumped Storage Project (1000 MW), Andhra Pradesh — **Annexure- 9**

Proposed Construction Schedule'

Sl. No.	Activities	Time (in months)	Ist Year												2nd Year												3rd Year												4th Year												5th Year											
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1	**Pre- Construction planning & Infrastructural Development**																																																												
i)	Preliminary	4																																																											
ii)	Land Acquisition	8																																																									
iii)	Procurement	8																																																									
iv)	Project Roads	8																																																									
v)	Project Colony/Office Buildings/ Construction Facilities	8																																																									
2	**Construction Phase**																																																											
i)	**Upper reservoir (Excavated pit type) and spillway**																																																											
	Excavation	10																																																										
	Construction of dam embankment	27																																																									
	Reservoir linning	12																																																									
ii)	**Intake Structures**																																																										
	Excavation	4																																																									
	Concreting	3																																																								
	Upper Intake gate Shaft	4																																																							
iii)	**HRT**																																																										
	Exacavation of HRT	10																																																								
	Grouting / Rock bolting	10																																																							
	Concrete Lining / backfilling	8																																																						
iv)	**Pressure Shaft**																																																									
	Adit to Pressure shaft (upper)	5																																																						
	Adit to Pressure shaft (lower)	5																																																					
	Excavation	12																																																						
	Erection of Steel Liners	24																																																						
v)	**Tailrace Tunnel & Outlet**																																																									
	Construction of Coffer Dam	6																																																						
	Excavation TRT	15																																																						
	Concreting TRT	8																																																						
	TRT Outlet	6																																																						
	Outlet Gate Shaft	3																																																					
vi)	**Power House Complex & Transformer Cavern**																																																									
	Main Access Tunnel to Powerhouse	10																																																							
	Cavern Excavation	21																																																							
	Cavern Concreting	10																																																						
vii)	**Electro-mechanical Equip.**																																																									
	E&M installation including commissioning	15																																																						
viii)	**Hydro-mechanical Equip.**																																																									
	HM Work including testing etc.	15																																																						

CHAPTER-10: ENVIRONMENTAL ASPECT

CHAPTER – 10

10. ENVIRONMENTAL ASPECT

10.1 General

The commissioning of any hydro power project or pumped storage projects leads to significant impacts on environmental resources of the project area and its surroundings. However, by proper planning at the inception stage and incorporating appropriate migratory measures in the planning, design, construction and operation phases, adverse impacts can be minimized to a large extent, whereas beneficial impacts can be maximized. The Chapter covers the impacts likely to accrue as a result during construction and operation phases of the proposed Gandikota Pumped Storage project located in Kadapa district, Andhra Pradesh. A broad framework of Environmental Management Plan for amelioration of adverse impacts on account of various phases of implementation of Gandikota PSP along with the outline of the Environmental Monitoring Programme too has also been covered as a part of the present Chapter.

10.2 Study Area

The Study Area considered for the Environmental Assessment study shall comprise of the following:

- Area to be acquired for various project appurtenances
- Submergence area for Upper and Lower reservoirs
- Area within 10 km periphery of Upper and Lower reservoir sites on upstream and downstream sides

10.3 Environmental Baseline Status

The assessment of pre-project environmental status is essential to determine the environmental parameters which could be significantly affected due to the proposed Gandikota Pumped Storage Project. The baseline status has been assessed mainly

based on review of secondary data and site visits. The existing project related documents too have been reviewed to assess the baseline environmental status.

10.3.1 Climate

The District experiences its minimum temperature varies in 28-30° C range in November to January and its hottest temperature varies in 40-45° C range during April-May. Based on the Agro-climatic conditions the District falls both in Southern and scarce rainfall zone. In southern zone rainfall ranges from 700 to 800 mm while it is 500 to 700 mm rainfall in scarce rainfall zone. The District's normal rainfall is 700 mm and its actual rainfall varies from 400+ to 800+ mm. The District gets its major portion of rainfall (around 60%) during June-September period through South-West Monsoon. More than 30% of its average rainfall comes from North-East Monsoon during October-December. It gets its remaining 10-15% of its rainfall during Winter Period (January & February) and in Hot Weather Period (March-May). Among the 51 Mandals of this district, Rajupalem, Duvvur, Kalasapadu & Porumailla Mandals get maximum rainfall from South-West Monsoons, while Chitvel, Kodur & Obulavaripalle Mandals gets from North-East Monsoons.

10.3.2 River System

Penna (also known as Pennar, Penner, Penneru, and Uttara Pinakini) rises in the Nandi Hills in Chikkaballapur District of Karnataka state, and runs north and east through the states of Karnataka and Andhra Pradesh to empty into the Bay of Bengal. It traverses over a length of 597 km with a basin area of 55,213 km2. The basin area in Karnataka and Andhra Pradesh are 6,937 km2 and 48,276 km2 respectively.The river basin lies in the rain shadow region of Eastern Ghats

The entire Kadapa District lies in Pennar river Basin. The major quantum of rainfall is received under the s due to South-West Monsoons. The important rivers in the District are Penna, Chitravathi, Kundu, Sagileru, Papagni, Bahuda and Cheyyeru.

10.3.3 Geology

The project area lies in the south-western part of the Kadapa district of Andhra Pradesh. Different types of landforms like structural hills, pediment-pediplain, plateau etc. are found in and around the project area. Quartzite belonging to Gandikota Quartzite Formation, shale and tuff of Tedpatri Formation, both under Chitravati Group are present in and around the project site. The general strike of the rocks is N40°W-S40°E and dip 5°-15° towards N50°E.

The proposed project envisages construction of an artificial reservoir in the upper reaches where the water is passing through a HRT-Pressure shaft- penstock to an Underground powerhouse- TRT to the lower reservoir located at the lower reaches

10.3.4 Seismicity

As per Seismic Zonation Map of India (IS 1893 – 1984) the district Kadapa falls in Zone II (least active seismic zone) and Zone III (moderate seismic zone). 91% of the total area and 95% of the total population of the district falls in Zone II; while 9% of the total area and 5% of the total population falls in Zone III.

10.3.5 Soils

Kadapa district is endowed mainly with red and black soils ranging from poor to fertile soils. The soil of the district has been classified into red ferruginous soil and black spoil. These two classes can be sub divided into clay, loam sand with finer distinctions. Red soils occupy 53% of the cultivated area and are mostly situated in L. R. Palli, Rayachoty, Rajampet, Pulivendla and Kodur Mandals. These soils have a low nutrient status. Black corson soil lands are 24%, black soil 19%, sandy soil lands 4%, red soil lands 25%..

10.3.6 Water Quality

Water Quality of Pennar river has been monitored by CPCB and the results are summarized in Table-10.1.

Table 10:1

Parameter	Value (mg/l)
Alkalinity	0.1-4
hardness	7-48
Chlorides	0.499-8.79
Nitrates	0.121-0.8
Fluorides	0.002-0.06
Phosphates	0.002-0.399

Alkalinity of water lies between 0.4-1 mg/l. Alkalinity is higher in the Post monsoon period in all sites except Populated area which is higher during monsoon. Though there is seasonal variation it is within the permissible limit.

Hardness in water is due to the natural accumulation of salts from contact with the soil and geological formations or it may enter from the direct pollution by human activities. In the present study hardness ranges from 10-48 mg/l. The hardness levels are well within the permissible limit of 200 mg/l.

The chloride level ranged from 0.499-8.79 mg/l, which is well within the permissible limit of 250 mg/l. It is within the permissible limit. The nitrate level ranged from 0.121-0.8 mg/l, which well within the permissible limit of 20 mg/l.

Fluoride concentration was observed to be between 0.002-0.06mg/l. The phosphate concentrations in different site areas lies between 0.002-0.399 mg/l.

10.3.7 Flora

The Kadapa district has rich and varied flora, the major contributing factors to this variety being differences in rainfall and topography within the district. As per the revised classification of forest types of India by Champion and Seth (1968), the forest types are reported in Kadapa district are briefly described in the following paragraphs.

Moist Deciduous Forests (3/3B): Moist deciduous forests are the mixture of trees and grasses. These forests are found in areas of moderate rainfall of 100 to 200 cm per annum, mean annual temperature of about 27°C and the average annual relative humidity of 60 to 75 per cent. Open grass patches are found in this forest. The trees have broad trunks, are tall and have branching trunks and roots to hold them firmly to the ground. Some of the taller trees shed their leaves in the dry season. There is a layer of shorter trees and evergreen shrubs in the undergrowth. The dominant trees found in this forest are- Madhuca indica, Pterocarpus Ficus auriculata, Bombax ceiba Shorea robusta, Phyllanthus emblica Lannea coromandelica, Diospyros melanoxylon, Terminalia bellirica, Buchanania lanzan, and Syzygium cumini. The dominant shrubs are- Ananas comosus, Ricinus communis, Datura metal, Bixa orellana, Callicarpa tomentosa, Clerodendrum infortunatum and Holarrhena antidysenterica. Common herbs are- Rumex hastatus, Plumbago zeylanica etc and many other herbs found in this forest.

Tropical Dry Deciduous Forests (5/C2): There is a considerable intermixture of rather smaller trees which in this type form part of the main canopy layer. These types of forests are mostly found in those areas having 70 to 100 cm rainfall. Seasonality is the prime feature of these forests as trees shed their leaves in the dry season and grow back leaf in rainy seasons these forests are comparatively less dense than evergreen forests. The general height of trees found in this forest is around 8 meters to 20 meters. A feature of the forest is the contrast between the hot weather condition when it is entirely leafless and the soil fully exposed, and the monsoon condition when it takes on almost luxuriant appearance from the growth of ephemeral herbaceous vegetation occupied with the leafing out of the trees and shrubs. The dominant tress species found in this forest are- Acacia catechu, Mangifera indica, Terminalia bellirica, Terminalia chebula,Cassia fistula, Ziziphus xylopyrus, and Ziziphus jujube. The dominant shrub species found in this forest are- -Acacia concinna, Carissa spinarum, Clerodendrum infortunatum, Lantana camara and Ziziphus nummularia. The dominant herbs are- Argemone Mexicana, Cynodon dactylon, Eclipta prostrate Mimosa pudica. Euphorbia hirta and other herb species are found in this type of forest.

Bamboo Gregarious Forest (2/2S1): In shady slopes of lower hills, Sal is ousted by the growth of bamboo, either Dendrocalamus strictus resulting in almost pure formations of bamboo, which gives bright to mixed pink tone in green season and no particular trace in dry season.

The list of floral species reported in Study Area are given in Table-10.2.

Table 10:2: List of floral species in Study Area

Botanical name	Local name	Family	Habit
Abutilon hirtum (Lam.) sweet	Kanghai	Malvaceae	Herb
Acacia catechu (L.f.) Willd.	Khair	Mimosaceae	Tree
Acacia concinna DC.	Shikakai	Fabaceae	Shrub
Acacia leucophloea (Roxb.) Willd	Reonja	Fabeaceae	Tree
Acorus calamus L.	Bach	Arecaceae	Herb
Ailanthus excelsa Roxb.	Mahanimb	Simarobaceae	Tree
Alangium salvifolium (L.f.) Wang.	Ankol	Cornaceae	Tree
Albizia lebbeck (L.) Benth.	Sirish	Fabeaceae	Tree
Albizia procera (Roxb.) Benth.	Safed Siris	Fabeaceae	Tree
Alocasia fornicata (Roxb.) Schott	Mankanda	Araceae	Herb
Aloe vera (L.) Burm.f.	Gheekumari	Asphodelaceace	Herb
Alstonia scholaris (L.)	Chitvan	Apocyanaceae	Tree
Anagallis arvensis L.	Billi booti	Primulaceae	Herb
Anogeissus latifolia (Roxb. ex Dc.) Wall.	Dhainra	Combretaceae	Tree
Anthocephalus chinensis (Lam.) A.	Kadam	Rubiaceae	Tree
Antidesma acidum Retz.	Aamari	Fabaceae	Tree
Argemone mexicana L.	Prickly poppy	Papaveraceae	Herb
Arisaema tortuosum (wall.) Schott	Bagh Jandhra	Araceae	Herb
Asparagus racemosus Willd	Satawari	Liliaceae	Herb
Atalantia monophylla (L.) Corr.	Adavi nimbe	Rutaceae	Tree
Azadirachta indica A. Juss	Neem	Meliaceae	Tree
Bacopa monnieri (L) Wettst	Jalbirahmi	Scrophulariaceae	Herb
Bauhinia malabarica Roxb.	Amli	Caesalpiniaceae	Tree

Bauhinia variegata L.	Koiral	Caesalpiniaceae	Tree
Begonia picta Sm	Makarkanchi	Begoniaceae	Herb
Bidens bipinnata L.	Kuru	Asteraceae	Herb
Bixa orellana L.	Latkan	Bixaceae	Shrub
Boehmeria rugulosa Wedd.	Gethi	Urticaceae	Tree
Boerhavia diffusa Kuntze	Punarnava	Nyctaginaceae	Herb
Bombax ceiba L.	Semul	Bombacaceae	Tree
Boswellia serrata Roxb. ex Colebr.	Salai	Burseraceae	Tree
Bridelia retusa (L.) Spreng.	Kasai	Phyllanthaceae	Tree
Buchanania lanzan Spreng.	Chironji	Anacardiaceae	Tree
Butea monosperma (Lam.) Taub.	Palasha	Fabaceae	Tree
Butea parviflora Roxb	Palash	Fabaceae	Shrub
Callicarpa tomentosa (L.) Murr.	Priyangu	Lamiaceae	Shrub
Callistemon lanceolatus (Sm.) Sweet	Cheel	Myrtaceae	Tree
Calotropis procera (Aiton) Dryand	Mudar	Apocynaceae	Shrub
Cannabis sativa L.	Bhang	Cannabaceae	Herb
Capparis zeylanica L.	Jhiris	Capparidaceae	Shrub
Cardamine impatiens L.	Ban laiyya	Brassicaceae	Herb
Cardiospermum halicacabum L.	kanphuta	Sapindaceae	Herb
Careya arborea Roxb	Kumbhi	Lecythidaceae	Tree
Carissa spinarum L.	Karonada	Apocynaceae	Shrub
Caryota urens L.	Mari	Arecaceae	Tree
Cassia absus Sesse & Moc.	Cheaksu	Caesalpiniaceae	Herb
Cassia fistula L.	Amaltas	Caesalpiniaceae	Tree
Chromolaena odorata (L.) R.M.King & H.Rob.	Triva gandha	Asteraceae	Herb
Cinnamomum tamala (Buch.-Ham.) T.Nees & Eberm.	Tejpata	Lauraceae	Tree
Cissampelos pareira L.	Mus bel	Menispermaceae	Climber
Clerodendrum indieum (L.) Kuntze	Chhoti arani	Acanthaceae	shrub
Clerodendrum infortunatum L.	Aranyo	Lamiaceae	Shrub

Cocos nucifera L.	Nariyal	Arecaceae	Tree
Corymbia citriodora (Hook.) K.D.Hill & L.A.S.Johnson	Safeda	Myrtaceae	Tree
Cuminum cyminum L.	Jira	Apiaceae	Herb
Cymbopogon flexuosus (Nees exsteud) Wats	Gavati Chaha	Poaceae	Herb
Cynodon arcuatus J.S. Presl	-	Poaceae	Herb
Cynodon dactylon L.	Dhub	Poaceae	Herb
Cyperus compressus L.	Jhusuna	Cyperaceae	Herb
Cyperus distans L.f.	Flatsedge	Cyperaceae	Herb
Cyperus exaltatus Retz.	Ghodachio Dungaro	Cyperaceae	Herb
Cyrtococcum oxyphyllum (Steud.) stapf	-	Poaceae	Grass
Dalbergia sissoo DC.	Sheesham	Papilionaceae	Tree
Datura metal L.	Dhatura	Solanaceae	Shrub
Delonix regia(Hook.) Raf.	Gulmohar	Caesalpiniaceae	Tree
Dendrocalamus strictus (Roxb.) Nees	Nigal	Gramineae	Bombo o
Desmostachya bipinnata (L.) stapf	Kusha	Poaceae	Grass
Digitaria longifolia (Retz.) Pers.	-	Poaceae	Grass
Diospyros melanoxylon Roxb.	Abnus	Ebenaceae	Tree
Diploknema butyracea (Roxb.) H.J.Lam	Chewra	Sapotaceae	Tree
Echinops echinatus Roxb.	Gokhru	Compositae	Herb
Eclipta prostrata (L.) L.	Bhringraja	Asteraceae	Herb
Elephantopus scaber L	Tutamuli	Asteraceae	Herb
Embelia ribes Burm.f.	Vidanga	Myrsinaceae	Shrub
Eryngium foetidum L.	Ban dhania	Apiaceae	Herb
Erythrina suberosa Roxb.	Pangra	Fabaceae	Tree
Euphorbia hirta L.	Dudhi	Euphorbiaceae	Herb
Evolvulus alsinoides (L.) L.	Sankhpuspi	Convolulaceae	Herb
Ficus benghalensis L.	Barh	Moraceae	Tree

Ficus hispida L	Baidimiri	Moraceae	Tree
Ficus racemosa L.	Goolar	Moraceae	Tree
Ficus religiosa L.	Pipal	Moraceae	Tree
Ficus auriculata Lour.	Phagoora	Moraceae	Tree
Ficus mollis Vahl.	Kathpeepal	Moraceae	Tree
Ficus palmata Forrsk.	Jangli-anjir	Moraceae	Tree
Firmiana colorata (Roxb.) R.Br.	Samari	Moraceae	Tree
Fumaria indica (Haussk.)Pugsley	Pit papra	Fumariaceae	Herb
Galinsoga parviflora Cav.	Marchya	Asteraceae	Herb
Gardenia latifolia Ait.	Papra	Rubiaceae	Tree
Gmelina arborea Roxb.	Gamhar	Lamiaceae	Tree
Grewia tiliaefolia Vahl.	Dhamani	Tiliaceae	Tree
Gymnema sylvestre R.Br.	Chhota-dudhilata	Asclepiadaceae	Climber
Haplanthodes verticillatus (Roxb.)Nees.	Kastula	Acanthaceae	Herb
Hemidesmus indicus (L.) R.Br.	Nannari	Periploaceae	Tree
Holarrhena antidysenterica Wall. ex A.DC.	Kurchi	Apocyanaceae	Shrub
Holarrhena pubescens (Buch.-Ham.) Wall	Kutaja	Apocyanaceae	Tree
Hygrophila heinei Sreemadh	Talimakhana	Acanthaceae	Herb
Ichnocarpus frutescens (L.) R.Br.	Kali-dudhi	Apocyanaceae	Shrub
Impatiens minor (DC.) Bennet	Ban gulmendi	Balsminaceae	Herb
Jasminum abyssinicum Hochst. ex DC.	Chameli	Oleaceae	Herb
Jasminum humile L.	Shunjai	Oleaceae	Shrub
Justicia adhatoda L.	Vasaka	Acanthaceae	Shrub
Lannea coromandelica (Houtt.) Merr.	Jinghini	Anacardiaceae	Tree
Lantana camara L.	Raimuniya	Verbenaceae	Shrub
Lasia spinosa (L.) Thw. Enum.	Kohila	Araceac	Herb
Launaea acaulis (Roxb.) Babc.	Jangi gobi	Asteraceae	Herb
Lavandula bipinnata Kuntze.	Jungali Lavende	Lamiaceae	Herb

Lawsonia inermis L.	Mehandi	Lythraceae	Shrub
Leptadenia reticulata (Retz.) Wight & Arn.	Duri	Asclepiadaceae	Shrub
Leptochloa chinensis (L.) Nees	-	Poaceae	Grass
Leptodermis lanceolata Wall.	Padera	Rubiaceae	Shrub
Leucas aspera (Willd.) Link	Chhota halkusa	Lamiaceae	Herb
Madhuca longifolia (Koenig) Macbr.	Mahuwa	Sapotaceae	Tree
Mallotus philippensis (Lam.) Müll.Arg.	Ruina	Euphorbiaceae	Tree
Malvastrum coromandelianum (L.) Garcke	Kharenti	Malvaceae	Climber
Mangifera indica L.	Aam	Anacardiaceae	Tree
Melilotus officinalis subsp. alba (Medik.) H.Ohashi & Tateishi	Banmethi	Fabaceae	Herb
Mentha arvensis L. L	Podina	Lamiaceae	Herb
Mentha spiata L	Pahari pudina	Mimosaceae	Herb
Michelia champaca L.	Champak	Magnoliaceae	Tree
Mimosa pudica L.	Lajjalu	Mimosaceae	Herb
Morinda pubescens Sm.	Aal	Rubiaceae	Shrub
Moringa pterygosperma Gaertn	Shigru	Morignaceae	Tree
Morus australis Poir.	-	Moraceae	Shrub
Murraya koenigii (L.) Spreng.	Kari patta	Rutaceae	Tree
Nepeta ciliaris Benth.	Lute	Lamiaceae	Herb
Nyctanthes arbor-tristis L.	Shefali	Oleaceae	Shrub
Operculina turpethum (L.) S. Manso	Nishoth	Convolvulaceae	Climber
Oplismenus compositus (L.) P. Beauv	Basketgrass	Poaceae	Herb
Opuntia monacantha Haw.	Nagphani	Cactaceae	Shrub
Oroxylum indicum (L.) Vent.	Bhut-vriksha	Bignoniaceae	Tree
Oxalis corniculata L.	Chilmoda	Oxalidaceae	Herb
Parabaena sagittata Miers.	Kurdadra	Menispermaceae	Climber
Parthenium hysterophoru L.	Congress grass	Fabaceae	Herb

Phoenix humilis (L.) Cav.	Khajoor	Palmae	Tree
Phyllanthus emblica L.	Amla	Euphorbiaceae	Tree
Plantago major L.	Vrantank	Plantaginaceae	Herb
Plumbago zeylanica L.	Chitrak	Plumbaginaceae	Shrub
Polygonatum verticillatum (L) All.	Kantula	Liliaceae	Herb
Polygonum chinense L.	Jangli palak	Polygonaceae	Herb
Pongamia pinnata (L.) Pierre	Karanjua	Fabaceae	Tree
Pterospermum xylocarpum (Gaertn) Sant & Wagh	Kanaka champaka	Sterculiaceae	Tree
Rauvolfia serpentina (L.) Benth. ex kurz	Sarpagandha	Apocynaceae	Herb
Rauvolfia tetraphylla L.	Barachandrika	Apocyanaceae	Shrub
Reinwardtia indica Dumort.	Basanti	Linaceae	Shrub
Rhamnus virgata Roxb.	Chaitula	Rhamnaceae	Tree
Ricinus communis L.	Inde	Euphorbiaceae	Shrub
Rorippa indica (L.) Hiern	Chamsuru	Brassicaceae	Herb
Rubus ellipticus Sm.	Lalanchu	Rosaceae	Shrub
Rumex hastatus D.Don	Chalmore	Polygonaceae	Herb
Saccharum spontaneum L.	Kans	Gramineae	Grass
Sarcococca saligna (D. Don) Muell-Arg	Piruli	Buxaceae	Shrub
Semecarpus anacardium L.f.	Bhilawan	Anacardiaceae	Tree
Senna occidentalis (L.) Link	Kasondi	Caesalpiniaceae)	Tree
Setaria palmifolia (Koenig) stapf	Baanspaate	Poaceae	Herb
Shorea robusta Gaertn.f.	Sal	Dipterocarpaceae	Tree
Sida cordifolia L.	Balu	Malvaceae	Herb
Smilax ovalifolia Roxb. ex D.Don	Jangli aushbah	Smilacaceae	Climber
Solanum anguivi Lam.	Kandyari	Solanaceae	Shrub
Solanum violaceum Ortega	Brahati	Solanaceae	Shrub
Sonchus asper (L.) Hill	Dudhi	Asteraceae	Herb
Sonchus oleraceus (L.) L.	Dudhi, Pathari	Asteraceae	Herb
Stachytarpheta jamaicensis (L.) Vahl	Kari uttaraani	Verbenaceae	Herb
Symplocos racemosa Roxb.	Lodh	Symplocaceae	Shrub

Syzygium cumini (L.) Skeels.	Jamun	Myrtaceae	Tree
Tagetes minuta L.	Jangali genda	Asteraceae	Herb
Tamarindus indica L.	Imli	Fabaceae	Tree
Tamarix dioica Roxb.	Lal-jhar	Tamaricaceae	Shrub
Tecomella undulata (Sm.) Seem.	Rohitaka	Bignoniaceae	Tree
Tectaria cicutaria (L.) copel	-	Tectariaceae	Herb
Tectona grandis L.	Sagun	Verbenaceae	Tree
Terminalia arjuna (Roxb.ex DC.) Wight.	Arjun	Combretaceae	Tree
Terminalia bellirica (Gaertn.) Roxb.	bahera	Combretaceae	Tree
Terminalia chebula Retz.	Harra	Combretaceae	Tree
Thalictrum foliolosum DC.	Chaitra	Ranunculaceae	Herb
Trewia nudiflora L.	Gamari	Euphorbiaceae	Tree
Urena lobata L	Aramina	Malvaceae	Shrub
Urtica dioica L.	Siyoon	Urticaceae	Shrub
Vernonia cinerea (L.) Less.	Sahdebi	Asteraceae	Herb
Vitex negundo L.	Siwain	Verbenaceae	Shrub
Vitex peduncularis Wall. ex Schauer	Goda	Lamiaceae	Tree
Wattakaka volubilis (L.f.) Stapf	Kurincha	Apocynaceae	Climber
Woodfordia fruticosa (L.) Kurz.	Dhawai	Lythraceae	Tree
Wrightia arborea (Dennst.) Mabb.	Dudhi	Apocyanaceae	Tree
Zanthoxylum armatum DC.	Tejphal	Rutaceae	Tree
Ziziphus rugosa Lam.	Churna	Rhamnaceae	Shrub
Ziziphus xylopyrus (Retz.) Willd.	Kakora	Rhamnaceae	Tree
Ziziphus jujuba Mill.	Ber	Rhamnaceae	Tree
Ziziphus nummularia (Burm.f.) Wight & Arn.	Jhar Beri	Rhamnaceae	shrub
Ziziphus oenoplea Mill.	Makora	Rhamnaceae	Shrub

10.4 Prediction of Impacts

Prediction is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur because of the implementation of the project. Based on the project details and the baseline environmental status, potential impacts as a result of the construction and operation of the proposed project have been identified. The impacts on various aspects of environment are briefly described in the following sections.

10.4.1 Impacts on Land Environment

a) Construction Phase

Environmental degradation due to immigration of labour population

The number of maximum personnel requirement for the employer and contractor has been estimated to be of the order of 500 and 100 respectively. Thus, the peak aggregation of labour and technical staff including their families will be 1500. The immigration of labour population during construction phase will also induce secondary migration in the area to cater to the various requirements of the project construction staff. These will include persons to manage shops of various types, transportation, workshops, etc.

Separate accommodation and related facilities for workers, service providers and technical staff are to be provided as a part of the project. The congregation of labour force is likely to create problems of sewage disposal, solid waste management and felling of trees for meeting fuel requirements, etc.

Operation of construction equipment

During construction phase, various types of equipment will be brought to the site. These include crushers, batching plant, drillers, earth movers, etc. The siting of these construction equipment would require significant amount of space. In addition, land will be required for storage of various construction material as well. However, land for

this purpose will be temporarily acquired, i.e. for the duration of project construction phase.

Soil erosion

The runoff from various construction sites, will have a natural tendency to flow towards along with the natural drainage. Thus, the disposal of drainage effluent with such high turbidity levels is bound to affect the water quality, especially in the lean season. The drains/nallahs close to various construction sites are seasonal in nature. Normally in such rivers biological productivity is not high. Hence, the increase in turbidity levels are not expected to be significant in nature.

b) Operation Phase

Acquisition of land

The total land to be acquired for the project is 190 ha (469.5 acre). The details are given in Table-10.3.

Table 10:3 **Landl Requirement for Gandikota Pumped Storage Project**

S. No.	Project Component	Area	
		Ha	Acre
1.	Project Component	130	321.2
2.	Roads	20	49.4
3.	Muck Disposal/ Quarry Site	30	74.1
4.	Contractor's facility	10	24.7
	Total	**190**	**469.5**

As a part of CEIA study, detailed studies to assess the ownership status of the land to be acquired for various project appurtenances shall be conducted. Suitable compensatory measures as per the ownership status of the land to be acquired for the project shall be formulated.

10.4.2 Impacts on Water Environment

a) Construction phase

i. Sewage from labour camps

The project construction is likely to last for a period of 5 years (60 months). The peak labour strength likely to be employed during project construction phase is about 500 workers and 100 technical staff. Based on experience of similar projects, the increase in the population as a result of migration of labour population during construction phase is expected to be of the order of 1500.

The construction phase, also leads to mushrooming of various allied activities to meet the demands of the immigrant labour population in the project area. The domestic water requirement has been estimated as 70 lpcd. Thus, total water requirements work out to 0.11 mld. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, total quantum of sewage generated is expected to be of the order of 0.08 mld. The BOD load contributed by domestic sources will be about 68 kg/day. It is recommended to commission Sewage Treatment Plant (STP), for treatment of sewage generated from labour camps prior to disposal.

ii. Effluent from crushers

During construction phase, at least one crusher will be commissioned at site by the contractor involved in construction activities. It is proposed only crushed material would be brought at construction site are likely. Water is required to wash the boulders and to lower the temperature of the crushing edge. About 0.1 m3 of water is required per ton of material crushed. The effluent from the crusher would contain high suspended solids. It is proposed to treat the effluent from crushers in settling tank prior to disposal, so as to ameliorate even the marginal impacts likely to accrue on this account.

b) Operation phase

The major sources of water pollution during project operation phase include:

- Effluent from project colony.
- Impacts on reservoir water quality.
- Effluent from project colony

Effluent from project colony.

During project operation phase, due to absence of any large scale construction activities, the cause and source of water pollution will be much different. Since, only a small number of O&M staff will reside in the area in a well designed colony which will have a Sewage Treatment Plant (STP) and other infrastructure facilities, the problems of water pollution due to disposal of sewage are not anticipated.

Impacts on reservoir water quality

Stratification can limit the mixing of the water body, leading to depletion of D.O. levels. This can lead to reducing conditions in waters. Since, the depth in the proposed reservoir is not very high, the diurnal variations would prevent formation of any significant temperature stratification. Thus, no problems related to reservoir stratification are anticipated.

The flooding of previously forest and agricultural land in the submergence area will increase the availability of nutrients resulting from decomposition of vegetative matter. Phytoplankton productivity can supersaturate the euphotic zone with oxygen before contributing to the accommodation of organic matter in the sediments. Enrichment of impounded water with organic and inorganic nutrients will be the main water quality problem immediately on commencement of the operation. However, this phenomenon is likely to last for a short duration of few years from the filling up of the reservoir. Also, the vegetation likely to come under reservoir submergence will be cleared before reservoir filling. Thus, any significant impact on reservoir water quality is not anticipated.

Eutrophication risks

The fertilizer use in the project area is negligible, hence, runoff at present does not contain significant amount of nutrients. During post-project phase too, use of fertilizers

in the project catchment area is not expected to rise significantly. Hence, eutrophication risks, which are primarily caused by enrichment of nutrients in water is not anticipated in the proposed project.

10.4.3 Impacts on Air Environment

In a water resources project, air pollution occurs mainly during project construction phase. The major sources of air pollution during construction phase are:

- Pollution due to fuel combustion in various equipment
- Emission from various crushers
- Dust emission from muck disposal

Pollution due to fuel combustion in various equipment

The operation of various construction equipment requires combustion of fuel. Normally, diesel is used in such equipment. The major pollutant which gets emitted as a result of combustion of diesel is SO2. The SPM emissions are minimal due to low ash content in diesel. The short-term increase in SO2, even assuming that all the equipment are operating at a common point, is quite low, i.e. of the order of less than 1□g/m3. Hence, no major impact is anticipated on this account on ambient air quality.

Emissions from crushers

The operation of the crusher during the construction phase is likely to generate fugitive emissions, which can move even up to 1 km in predominant wind direction. During construction phase, one crusher each is likely to be commissioned near proposed dam and proposed power house sites. During crushing operations, fugitive emissions comprising mainly the suspended particulate will be generated. Since, there are no major settlements close to proposed project site, hence, no major adverse impacts on this account are anticipated. However, during layout design, care should be taken to ensure that the labour camps, colonies, etc. are located on the leeward side and outside the impact zone (say about 2 km on the wind direction) of the crushers.

Dust emissions from muck disposal

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

10.4.4 Impacts on Noise Environment

a) Construction phase

In a water resource projects, the impacts on ambient noise levels are expected only during the project construction phase, due to earth moving machinery, etc. Likewise, noise due to quarrying, blasting, vehicular movement will have some adverse impacts on the ambient noise levels in the area.

i. Impacts due to operation of construction equipment

The noise level due to operation of various construction equipment is given in Table-10.4.

Table 10:4 : Noise level due to operation of various construction equipment

Equipment	Noise level dB(A)
Earth moving	
Compactors	70-72
Loaders and Excavator	72-82
Dumper	72-92
Tractors	76-92
Scrappers, graders	82-92
Pavers	86-88
Truck	84-94
Material handling	
Concrete mixers	75-85
Movable cranes	82-84
Stationary	
Pumps	68-70
Generators	72-82
Compressors	75-85

Under the worst-case scenario, considered for prediction of noise levels during construction phase, it has been assumed that all these equipment generate noise from a common point. The increase in noise levels due to operation of various construction equipment is given in Table-10.5.

Table 10:5; Increase in noise levels due to operation of various construction equipment

Distance (m)	Ambient noise levels dB(A)	Increase in noise level due to construction activities dB(A)	Increased noise level due to construction activities dB(A)	Increase in ambient noise level due to construction activities dB(A)
100	36	45	45	34
200	36	39	39	29
500	36	31	31	25
1000	36	25	25	25
1500	36	21	21	24
2000	36	19	19	24
2500	36	17	17	24
3000	36	15	15	24

It would be worthwhile to mention here that in absence of the data on actual location of various construction equipment, all the equipment have been assumed to operate at a common point. This assumption leads to over-estimation of the increase in noise levels. Also, it is a known fact that there is a reduction in noise level as the sound wave passes through a barrier. The transmission loss values for common construction materials are given in Table-10.6.

Table 10:6: Transmission loss for common construction materials

Material	Thickness of construction material (inches)	Decrease in noise level dB(A)
Light concrete	4	38
	6	39
Dense concrete	4	40
Concrete block	4	32
	6	36
Brick	4	33
Granite	4	40

The walls of various houses will attenuate at least 30 dB (A) of noise. In addition there are attenuation due to the following factors.

- Air absorption
- Rain
- Atmospheric inhomogeneties.
- Vegetal cover

Thus, no increase in noise levels is anticipated as a result of various activities, during the project construction phase.

Impacts on labour

The effect of high noise levels on the operating personnel, has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB (A) affects the hearing acuity of the workers/operators and hence, should be avoided. To prevent these effects, it has been recommended by Occupational Safety and Health Administration (OSHA) that the exposure period of affected persons be limited as per the maximum exposure period specified in Table-10.7.

Table 10:7: Maximum Exposure Periods specified by OSHA

Maximum equivalent continuous Noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	8
95	4
100	2
105	1
110	½
115	¼
120	No exposure permitted at or above this level

10.4.5 Impacts on Land Environment

a) Construction phase

The major impacts anticipated on land environment during construction are as follows:

- Operation of construction equipment
- Quarrying operations
- Muck disposal
- Acquisition of land

i) Operation of construction equipment

During construction phase, various types of equipment will be brought to the site. These include crushers, batching plant, drillers, earthmovers, rock bolters, etc. The siting of this construction equipment would require significant amount of space. Similarly, space will be required for storing of various other construction equipment. In addition, land will also be temporarily acquired, i.e. for the duration of project construction for storage of quarried material before crushing, crushed material, cement, rubble, etc. The contractor's facilities and storage sites for construction material shall be located outside Gandikota Wildlife Sanctuary.

Various criteria for selection of these sites would be:

- Proximity to the site of use
- Sensitivity of forests in the nearby areas
- Proximity from habitations
- Proximity to drinking water source

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

ii) Quarrying operations

A number of mafic rocks of volcanic origin are present in and around the project. Fresh mafic rocks can be used as coarse aggregate of concrete. Again, hard, competent quartzite outcrops are also present in the vicinity of project site which can also be used. However, determination of engineering properties and quantity assessment will be undertaken during FSR/DPR stage to know their suitability for wearing and non-wearing surfaces as well as availability of sufficient quantities.

The sand deposit of Chitravati River may be utilized as fine aggregates. However, suitable quarry sites will be selected in FSR/DPR stage. The required tests will be done to know their suitability. In addition, the material from crushing of fresh rock (mafic rocks & quartzite) may also be used as fine aggregate, if found suitable

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

Muck disposal

A significant quantity of muck is expected to be generated as a result of various construction activities. A part of the much is proposed to be utilized as a construction material. The balance muck needs to be properly disposed otherwise it can lead to significant adverse impacts on environment. Normally muck is disposed along the river bank which ultimately finds it way into the water body, leading to adverse impacts on riverine ecology. The other option is to dispose muck over low lying areas, preferably over non-forest land. Efforts need to be made so that the site selected for muck disposal has minimum vegetation. After disposal of muck, the site needs to be stabilized using bio-engineering measures. This aspect needs to be covered in great detail as a part of EIA Studies.

Construction of roads

The project construction would entail significant vehicular movement for transportation of large construction material, heavy construction equipment. Some of the roads in the project area, would require widening. As a part of the project, of new roads shall be constructed and existing roads shall be upgraded. The topography of the project area has steep to precipitous slopes which descends rapidly into narrow valleys. Construction of roads in such area can give rise to erosion hazards due to net downhill movement of soil aggregates, if adequate protection measures are not undertaken. Construction of new roads may lead to removal of trees on slopes and re-working of the slopes in the immediate vicinity of road, which may lead to landslides, soil erosion, gully formation, etc. Adequate management measures shall be implemented to ameliorate such impacts.

10.4.6 Impacts on Biological Environment

a) Construction phase

i) Impacts on Terrestrial Flora

Impacts due to Vehicular movement and blasting

Dust is expected to be generated during blasting, vehicle movement for transportation of construction material or construction waste. The dust particles shall settle on the

foliage of trees and plants, thereby reduction in amount of sunlight falling on tree foliage. This will reduce the photosynthetic activity. Based on experience in similar settings, the impact is expected to be localized upto a maximum of 50 to 100 m from the source. In addition, the area experiences rainfall for almost 6 to 7 months in a year. Thus, minimal deposition of dust is expected on flora. Thus, no significant impact is expected on this account.

Acquisition of forest land

During project construction phase, land will be required for location of muck disposal quarrying centralization facilities widening of existing roads and construction of new project roads. The total land requirement for the project is 190 ha or 469.50 acre, most part of which is forest land.

ii) Impacts on Terrestrial fauna

a) Construction phase

Disturbance to wildlife

During the construction period, machinery and construction workers are mobilized, which can disturbed the wildlife population in the vicinity of project area.

During construction phase, accessibility to area will lead to influx of workers and the people associated with the allied activities from outside will also increase. The other major impact could be the blasting to be carried out during construction phase, This impact needs to be mitigated by adopting controlled blasting and strict surveillance regime and the same is proposed to be used in the project. This will reduce the noise level and vibrations due to blasting to a great extent.

Siting of construction equipment, godowns, stores, labour camps, etc. may generally disturb the fauna in the area. The project site is located about 3.4 km from Gandikota Wildlife Sanctuary. To minimize any adverse inputs due to poaching activities from immigrant labour population, strict anti-poaching surveillance measures need to be

implemented, especially during project construction phase. The same shall be covered in detail as a part of the Environmental Management Plan (EMP).

b) Operation phase

Impacts due to increased accessibility

Both Upper Reservoir and Lower (Gandikota) Reservoir are already constructed and under operation. Only water conductor system to convey water from Upper Reservoir to power house and from power house to Lower Reservoir and back to Upper Reservoir will be commissioned. The entire water conductor system and power house to be constructed shall be underground. Thus, during operation phase, no adverse impacts on terrestrial ecology is anticipated.

During project operation phase, accessibility to the area will improve due to operation of the project, which in turn may increase human interferences leading to marginal adverse impacts on the terrestrial ecosystem. Since significant increase in human population is not anticipated during project operation phase, adverse impacts of such interferences are likely to be marginal.

10.4.7 Aquatic Flora

a) Construction phase

Impacts due to excavation of construction material from river bed

The areas from where construction material is excavated, benthic fauna gets destroyed. In due course of time, however, the area gets recolonized, with benthic fauna. The density and diversity of benthic fauna, is however, much lesser as compared to the pre-dredging levels.

Impacts due to discharge of sewage from labour camp/colony

The proposed hydro-power project would envisage temporary and permanent residential areas to accommodate labour and staff engaged in the project. This would

result in emergence of domestic waste water which is usually discharged into the river. It is proposed to treat the sewage prior to disposal.

During construction of a river valley project, huge quantity of muck is generated at various construction sites, which if not properly disposed, invariably would flow down the river during heavy precipitation. Such condition can lead to adverse impacts on the development of aquatic life, which needs to be avoided.

Impacts due to discharge to increased human interferences

The increased labour population during construction phase, could lead to increased pressure on fish fauna, as a result of indiscriminate fishing by them. Adequate protection measures at sensitive locations, identified on the basis of fisheries survey in the EIA study shall be implemented.

b) Operation phase

Gandikota Pumped Structure project is not expected to result in significant changes in the riverine ecology, as both the upper and lower reservoirs are already constructed and are under operation. Thus, no adverse impacts on existing riverine ecology is expected due to the proposed pumped storage project.

10.4.8 Impacts on Socio-Economic Environment

The proposed project is likely to entail both positive as well as negative impacts on the socio-cultural aspects of the area. During construction and operation phases, significant allied activities will mushroom in the project area.

(i) Impacts due to influx of labour force

During the construction phase a large labour force, including skilled, semi-skilled and un-skilled labour force of the order of about 1500 persons, is expected to immigrate into the project area. It is felt that most of the labour force would come from other parts of the country. However, some of the locals would also be employed to work in the project. The labour force would stay near to the project construction sites.

The project will also lead to certain negative impacts. The most important negative impact would be during the construction phase. The labour force that would work in the construction site would settle around the site. They would temporarily reside there. This may lead to solid waste generation, sewage generation, etc. which can lead to harmful impacts if proper mitigatory measures are not undertaken.

The employment opportunities in the area are limited. Thus, during project construction phase, some of the locals may get employment. It has been observed during construction phase of many of the projects; the major works are contracted out, who bring their own skilled labour. However, it is only in the unskilled category, that locals get employment.

(ii) Economic impacts of the project

Apart from direct employment, the opportunities for indirect employment will also be generated which would provide great impetus to the economy of the local area. Various types of business like shops, food-stall, tea stalls, etc. besides a variety of suppliers, traders, transporters will concentrate here and benefit immensely as demand will increase significantly for almost all types of goods and services. The business community as a whole will be benefited. The locals will avail these opportunities arising from the project and increase their income levels. With the increase in income levels, there will be an improvement in the infrastructure facilities in the area.

(iii) Impacts due to land acquisition

The key impact during construction phase will be that, pertaining to land acquisition. About 469.50 acre of land is proposed to be acquired for the proposed Gandikota Pumped Storage project. Based on the present level of investigations, ownership status of land to be acquired for the project is not known.

As a part of CEIA study, the quantum of private and forest land to be acquired needs to be identified. Based on the ownership status, appropriate, compensatory measures, Resettlement and Rehabilitation Plan will be formulated.

10.5 Environmental Management Plan

Based on the environmental baseline conditions and project inputs, the adverse impacts will be identified and a set of measures will be suggested as a part of Environmental Management Plan (EMP) for their amelioration. An outline of various measures suggested as a part of Environmental Management Plan is briefly described in the following sections.

10.5.1 Environmental Measures For Labour Camps

(i) Facilities in labour camps

It is recommended that project authorities can compulsorily ask the contractor to make semi-permanent structures for their workers. These structures could be tin sheds. These sheds can have internal compartments allotted to each worker family. The sheds will have electricity and ventilation system, water supply and community latrines.

The water for meeting domestic requirements may be collected from the rivers or streams flowing upstream of the labour camps.

(ii) Sanitation facilities

One community toilet can be provided per 20 persons. The sewage from the community latrines can be treated in a sewage treatment plant before disposal.

(iii) Solid waste management from labour camps

For solid waste collection, suitable number of masonry storage vats, each of 2 m^3 capacity should be constructed at appropriate locations in various labour camps. These vats should be emptied at regular intervals and shall be disposed at identified landfill sites. Suitable solid waste collection and disposal arrangement shall be provided. A suitable landfill site should be identified and designed to contain municipal waste from various Project Township, labour colonies, etc. The landfill site shall be finalized

(iv) Provision of free fuel

During the construction period of the project, there would be around 600 labour and technical staff would be involved in the project construction work. Many families may prefer cooking on their own instead of using community kitchen. In the absence of fuel for cooking, they would resort to tree cutting and using wood as fuel. To avoid such a situation, the project authority shall make LPG and or kerosene available to the labour population involved in construction activities. The supply of LPG and kerosene can be ensured on regular basis. A local depot can be established through LPG/ kerosene suppliers for supply of the same.

10.5.2 Muck Disposal

A part of the muck generated, is proposed to be utilized for construction works after crushing it into the coarse and fine aggregates. The balance quantum of muck would have to be disposed. The site shall then be stabilized by implementing bioengineering treatment measures.

Muck disposal is done after creating terraces thus usable terraces are developed. The overall idea is to enhance/maintain aesthetic view in the surrounding area of the project in post-construction period and avoid contamination of any land or water resource due to muck disposal.

Suitable retaining walls shall be constructed to develop terraces so as to support the muck on vertical slope and for optimum space utilization. Loose muck would be compacted layer wise. The muck disposal area will be developed in a series of terraces of boulder crate wall and masonry wall to protect the area/muck from flood water during monsoons. In-between the terraces, catch water drain will be provided.

The terraces of the muck disposal area will be ultimately covered with fertile soil and suitable plants will be planted adopting suitable bio-technological measures.

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

- Land acquisition for muck dumping sites

- Civil works (construction of retaining walls, boulder crate walls etc.)
- Dumping of muck
- Levelling of the area, terracing and implementation of various engineering control measures e.g., boulder, crate wall, masonry wall, catch water drain.
- Spreading of soil
- Application of fertilizers to facilitate vegetation growth over disposal sites.

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

Engineering Measures

- Wire crate wall
- Boulder crate wall
- Retaining wall
- Catch water Drain

Biological Measures

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

10.5.3 Restoration Plan for Quarry Sites

The following biological and engineering measures are suggested for the restoration of quarry sites:

- Garland drains around quarry site to capture the runoff and divert the same to the nearest natural drain.
- Construction of concrete guards check the soil erosion of the area.
- The pit formed after excavation be filled with small rocks, sand and farmyard manure.

- Grass slabs will be placed to stabilized and to check the surface runoff of water and loose soil.
- Bench terracing of quarry sites once extraction of construction material is completed.

10.5.4 Restoration and Landscaping of Project Sites

The working area of power house complex colony area have been selected for beautification of the project area after construction is over. The upper and lower reservoirs can become tourist attractions. Thus, there is a need to develop parks, restaurants, benches for sitting, development of resting sheds, walking trails, etc. The beautification would be carried out by developing plantations ornamental plants and flower gardens.

There would be sufficient open space in power house complex and colony area. Forested area in the power house complex would provide aesthetic view and add to natural seismic beauty. The beautification in the colony area would be carried out by development of flowering beds for plantation of ornamental plant, creepers, flower garden and a small park, construction of benches for sitting, resting sheds, walk way and fountain.

10.5.5 Compensation for Acquisition of Forest Land

Based on the ownership status of land to be acquired, it is proposed to afforest twice the forest area being acquired for the project. The species for afforestation shall be selected in consultation with local forest department. In addition to compensatory afforestation, cost of trees and numbers will also be paid by the project proponent.

10.5.6 Anti-poaching measures

It is recommended to commission check posts at various sites, i.e. labour camps, construction material storage site, alignment of water conductor system, etc. during project construction phase. Each check post will have 4 guards. One Range Officer would be employed to supervise the operation of these check-posts and ensure that poaching does not become a common phenomenon in the area. These check posts

also will also be provided with appropriate communication facilities and other infrastructure as well.

10.5.7 Bio-diversity Conservation Plan

As a part of the EIA study a detailed Bio diversity plan shall be formulated. The plan shall cover measures for conservation of floral and faunal species including awareness programme infrastructure development etc.

10.5.8 Greenbelt Development

Although the forest loss due to various project appurtenances structure compensated as a part of compensatory afforestation, it is proposed to develop greenbelt around the periphery of various project appurtenances, selected stretches along periphery of Upper and Lower Reservoirs.

10.5.9 Sustenance of Riverine Fisheries

As a part of the CEIA study, it is proposed to study the presence of various fish species in river Pennar, upper and lower reservoirs and other locations of the study Area. Based on the type of fish species available in the Study Area, appropriate management measures will be implemented.

Based on present level of information, it is proposed to implement supplementary stocking programmes for sustenance of endemic fisheries. It is proposed to stock upper and lower reservoir, river Pennar upstream and of the upper region downstream. The stocking can be done annually by the Fisheries Department, State Government of Andhra Pradesh.

10.5.10 Public Health Delivery System

The suggested measures are given in following paragraphs:

- Site selected for habitation of workers shall not be in the path of natural drainage.

- Adequate drainage system to dispose storm water drainage from the labour colonies shall be provided.
- Adequate vaccination and immunization facilities shall be provided for workers at the construction site.
- Labour camps and resettlement sites shall be at least 2 km away from a main water body or quarry areas.

As a part of Health Delivery System, following measures shall be implemented:

- Clearing of shoreline, mats and floating debris, etc. to reduce the proliferation of mosquitoes.
- Development of medical facilities in the project area and near labour camps
- Implementation of mosquito control activities in the area.

Infrastructure

Dispensary: Considering the number of rooms, staff quarters and open space etc., it is estimated that 10,000 sq.feet of plot will be required for dispensary, out of which about 8000 sq. Feet will be the built-up land which includes staff quarters, etc.

First Aid Posts: Temporary first aid posts shall be provided at major construction sites. These will be constructed with asbestos sheets, bamboo, etc.

10.5.11 Maintenance of Water Quality

The sewage generated from the labour camps, as mentioned earlier, is proposed to be treated in sewage treatment plant prior to disposal. In addition, it is proposed to treat the effluent generated from batching plant, concrete mixer, workshop, etc. prior to disposal.

In the project operation phase, a plant colony with about 50 quarters is likely to be set up. The sewage so generated would be treated through a sewage treatment plant, equipped with secondary treatment units.

10.5.12 Control of Noise

The suggested measures are given in following paragraphs:

- Contractors will be required to maintain properly functioning equipment and comply with occupational safety and health standards.
- Construction equipment will be required to use available noise suppression devices and properly maintained mufflers.
- Vehicles to be equipped with mufflers recommended by the vehicle manufacturer.
- Staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- Use of temporary sound fences or barriers to be evaluated.
- Monitoring of noise levels will be conducted during the construction phase of the project. In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing construction.

10.5.13 Control of Air Pollution

Minor air quality impacts will be caused by emissions from construction vehicles, equipment and DG sets, and emissions from transportation traffic. Frequent truck trips will be required during the construction period for removal of excavated material and delivery of select concrete and other equipment and materials. The following measures are recommended to control air pollution:

- Contractor will be responsible for maintaining properly functioning construction equipment to minimize exhaust.
- Construction equipment and vehicles will be turned off when not used for extended periods of time.
- Unnecessary idling of construction vehicles to be prohibited.

- Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.

Dust Control

To minimize issues related to the generation of dust during the construction phase of the project, the following measures have been identified:

- Identification of construction limits (minimal area required for construction activities).
- When practical, excavated spoils will be removed as the contractor proceeds along the length of the activity.
- When necessary, stockpiling of excavated material will be covered or staged offsite location with muck being delivered as needed during the course of construction.
- Excessive soil on paved areas will be sprayed (wet) and/or swept and unpaved areas will be sprayed and/or mulched. The use of petroleum products or similar products for such activities will be strictly prohibited.
- Contractors will be required to cover stockpiled soils and trucks hauling soil, sand, and other loose materials (or require trucks to maintain at least two feet of freeboard).
- Contractor shall ensure that there is effective traffic management at site. The number of trucks/vehicles to move at various construction sites to be fixed.
- Dust sweeping - The construction area and vicinity (access roads, and working areas) shall be swept with water sweepers on a daily basis or as necessary to ensure there is no visible dust.

10.6 Resettlement and Rehabilitation Plan

Based on the present level of investigations, quantum of private land to be acquired, number of project affected families is not available. The information of families losing land, houses and other private properties shall also be ascertained. Socio-economic survey for the Project Affected Families (PAFs) will be conducted as a part of the site. Based on the findings of the survey an appropriate Resettlement and Rehabilitation Plan will be formulated as per the norms and guidelines of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.

10.7 Catchment Area Treatment

The following aspects are proposed as a part of the Catchment Area Treatment Plan to be prepared as a part of the CEIA study:

- Delineation of micro-watersheds in the river catchment and mapping of critically degraded areas requiring various biological and engineering treatment measures.
- Identification of area for treatment based upon Remote Sensing & GIS methodology and Silt Yield Index (SYI) method of AISLUS coupled with ground survey.
- Prioritization of watershed for treatment based upon SYI.
- Spatial Information in each micro watershed to be earmarked on maps.
- CAT plan would be prepared with year-wise Physical and financial details.

10.8 Infrastructure Development Under Local Area Development Plan (LADP)

A lump-sum budget of the Project Cost is generally earmarked for construction of Infrastructure and Local Area Development Plan works. The activities envisaged are given as below:

- Up gradation of Education Facilities
- Strengthening of existing PHSCs/ Health Care Facilities

- Construction of community toilets
- Approach Roads and Widening of Existing Roads
- Up gradation of Drinking Water Supply
- Miscellaneous activities

10.9 Environmental Monitoring Programme

The Environmental Impact Assessment is basically an evaluation of future events. It is necessary to continue monitoring certain parameters identified as critical by relevant authorities under an Environmental Monitoring Programme. This would anticipate any environmental problem so as to take effective mitigation measures. An Environmental Monitoring Programme will be formulated for implementation during project construction and operation phases. The cost estimates and equipment necessary for the implementation of this programme shall also be covered as a part of the Comprehensive EIA study.

The Environmental Monitoring Programme for implementation during construction and operation phases is given in Tables-10.8 and 10.9 respectively.

Table 10:8: Summary of Environmental Monitoring Programme during Project Construction Phase

S. No.	Item	Parameters	Frequency	Location
1.	Effluent from STP	pH, BOD, COD, TSS, TDS	Once every month	Before and after treatment from Sewage Treatment plant
2.	Water-related diseases	Identification of water related diseases, adequacy of local vector control and curative measure, etc.	Three times a year	Labour camps and colonies

S. No.	Item	Parameters	Frequency	Location
3.	Noise	Equivalent noise level (L_{eq})	Once in three months	At major construction sites.
4.	Air quality	PM_{10} SO_2 and NO_2	Once every season	At major construction sites

Table 10:9: Summary of Environmental Monitoring Programme during Project Operation Phase

S. No.	Items	Parameters	Frequency	Location
1.	Water	pH, Temperature, EC, Turbidity, Total Dissolved Solids, Calcium, Magnesium, Total Hardness, Chlorides, Sulphates, Nitrates, DO. COD, BOD, Iron, Zinc, Manganese	Thrice a year	• Upper and Lower Reservoir • 1 and 5 km upstream of upper reservoir dam site • 1, 5 and 10 km downstream of Lower Reservoir
2.	Effluent from Sewage Treatment Plant (STP)	pH, BOD, COD, TSS, TDS	Once every week	• Before and after treatment from Sewage Treatment Plant (STP)
3.	Erosion & Siltation	Soil erosion rates, stability of bank embankment, etc.	Twice a year	-

S. No.	Items	Parameters	Frequency	Location
4.	Afforestation program	Status of afforestation programmes of green belt development	Once in 2 years	-
5.	Bio-diversities	Presence of floral faunal species, threats to flora and fauna, efficacy of mitigation measures, etc.	Three times a year	Sites for implementation of Bio diversity conservation Plan.
6.	Water-related diseases	Identification of water-related diseases, sites, adequacy of local vector control measures, etc.	Three times a year	• Villages adjacent to project sites
7.	Aquatic ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Once a year	• Upper and Lower Reservoir • 1 and 5 km upstream of upper reservoir dam site • 1, 5 and 10 km downstream of Lower Reservoir
8.	Landuse	Landuse pattern using satellite data	Once in a year	Catchment area of Upper and Lower Reservoirs
9.	Soils	pH, EC, texture, organic matter	Once in a year	Catchment area of Upper and Lower Reservoirs

10.10 Conclusions

Based on the preliminary assessment of environmental issues considered in the present Chapter, it can be concluded that the project is likely to entail certain adverse environmental impacts. However, these can be ameliorated to a large extent by implementing appropriate mitigation measures. It is recommended that a detailed Comprehensive EIA Study be conducted with an objective to assess various impacts likely to accrue as a result of construction and operation of the proposed project. Appropriate management measures too can be delineated as a part of Environmental Management Plan (EMP), which will be covered as a part of the Comprehensive EIA Study.

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CHAPTER-11: CONSTRUCTION MATERIAL

CHAPTER – 11

11. CONSTRUCTION MATERIAL

11.1 Introduction

The proposed Gandikota Pumped Storage Project is located in Cuddapah district, Andhra Pradesh, India. Cuddapah falls in toposheet no. 57J and the project area is bounded by Lat. N 14°46’ to 14° 50’ and Long. E 77° 10’ to 78° 16’In the vicinity of the project area Kurnool Group of Upper Proterozoic age which unconformably overlie over the Cuddapah Supergroup which consists of quartzite, limestone and shale.

11.2 Coarse Aggregate

The district has been classified into six different zones based on geotechnical characteristics (Fig.11.1 & 11.2). A number of mafic rocks of volcanic origin are present in and around the project (Plate-5.I) area. Fresh mafic rocks can be used as coarse aggregate of concrete. Quartzite belonging to Gandikota Quartzite Formation is present in and around the project site (Plate-5.I regional geological map) of project site which can also be used. Hard, competent quartzite having high bearing capacity is the major rock type in upper reservoir area. However, determination of engineering properties and quantity assessment will be undertaken during DPR stage through geological mapping & survey including lab bases tests to know their suitability for wearing and non-wearing surfaces as well as availability in sufficient quantities.

Following test are required to know the suitability of the coarse aggregates for wearing & non wearing surfaces as per IS: 383:2016 which will be carried out during DPR stage.

- Sp. Gravity
- Aggregate Impact Value (%)
- Aggregate Crushing Value (%)
- Aggregate Abrasion Value (%)
- Soundness (loss of weight 5 Cycles of Na2SO4) (%)

- Alkali – Aggregate reactivity (Accelerated Mortar bar) test
- Water Absorption (%)
- Petrographic Study

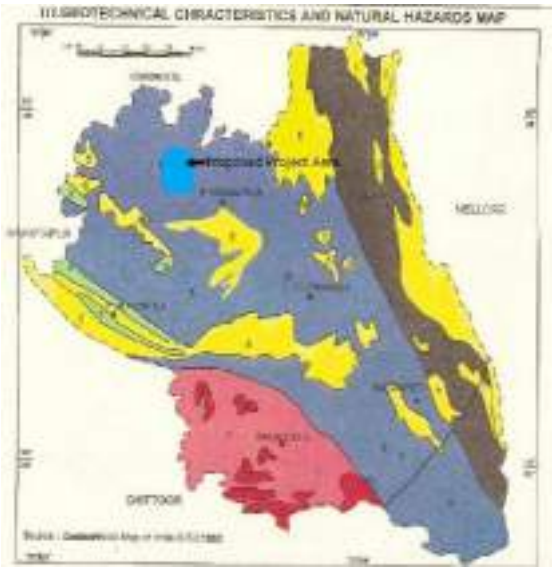

Fig.11.1 & 11.2: Figure showing the distribution of the rock types & geotechnical characteristics (Source: GSI, District Resource Map)

11.3 Fine Aggregate

The sand deposit of Chitravathi River may be utilized as fine aggregates. However, suitable quarry sites will be selected in DPR stage investigations. In addition, the material from crushing of fresh rock (mafic rocks & quartzite) may also be used as fine aggregate, if found suitable. The tests are required as per IS: 383:2016 and will be done to know their suitability are given below.

- Sp. Gravity
- Fineness modulus
- Grading zone
- Organic Impurities
- Soundness (loss of weight 5 cycles of Na2SO4) %
- Materials finer than 75-microns %

In addition, the material from crushing of fresh rock (mafic rocks & quartzite) may also be used as fine aggregate, if found suitable.

11.4 Water Samples

Samples of water are to be collected from Chitravathi River is tested for their suitability for use in construction purposes as well as to know the probabilities to react with the concrete and to take remedial measures. All the under mentioned tests on water samples are to be conducted during pre-monsoon, monsoon and post-monsoon periods.

- pH
- Conductivity
- Temperature
- pH – calcium carbonate saturated
- Ammonium ions
- Deleterious sulphate
- Calcium
- Magnesium
- Sodium — Cat-ions
- Potassium
- Hydroxide
- Carbonate
- Bi-carbonate — An-ions
- Chloride
- Sulphate
- Acidity as CaCo3
- Alkalinity as CaCo3
- Dissolved salts – in organic, organic and total soluble salts
- Suspended solids

The above mentioned tests will be carried out during DPR stage investigations to find out suitability of the construction materials.

CHAPTER-12: COST ESTIMATE

CHAPTER – 12

12. COST ESTIMATE

12.1 Project Cost

A summary of the cost estimate, including direct and indirect charges for the Civil & Electro-mechanical works at January, 2021 Price Level has been worked out as given below:

Item	Estimated Cost (₹. Crores)
Civil Works	1878.02
Electro-mechanical Works	1820.00
Total	**3698.02**

The estimate has been prepared to arrive at the capital cost of Pumped Storage Project, Andhra Pradesh. The estimate is of Pre-feasibility level and has been prepared on the basis of "Guide Lines for preparation of cost estimates for River Valley Projects" published by Central Water Commission, Govt. of India, New Delhi. The Abstract of Cost is enclosed at in the relevant chapter of this report. The detailed estimate is presented at **Annexure – 12.**

12.2 Basis of Estimate

The estimate for Civil & Hydro-mechanical civil works have been prepared based on:

1. On the basis of Schedule of Rates of Andhra Pradesh for the year 2020-21.
2. The rates which were not available in the Schedule of Rates have been adopted by updation to current price level from the recently approved H.E. Projects having similar parameters and working conditions. Moreover, items having SOR rates very less which are practical non-workable have also been revised.
3. The rates of materials are exclusive of GST, hence 12% GST has been considered, as applicable.

4. Escalation during construction period not considered.

Quantity estimate have been carried out by calculating the quantities of different work items involved. Unit rate corresponding to major item of works have been worked out by analysis of rate based on SoR and prevailing market rates. Some rates of major item of works, lump sum provision have been made based on the other similar projects. The following guidelines have been referred for the preparation of this cost estimate:

- "Guidelines for Formulation of Detailed Project Reports for Hydro Electric Schemes, their Acceptance and Examination for Concurrence" dated January 2015 by Central Electricity Authority, Govt. of India.
- "Guide Lines for preparation of Detailed Project Report of Irrigation and Multipurpose projects" 2010 by Central Water Commission, Govt. of India.

12.3 Classification of Civil Works into Minor Head/Sub Heads

The cost has been classified into direct and indirect charges and covered under the following minor heads:

Direct Charges

I. Works
II. Establishment
III. Tools and Plants
IV. Receipts and Recoveries on Capital Account

Indirect Charges

I. Capitalized Value of Abatement of Land Revenue
II. Audit and Account Charges

12.3.1 Direct Charges

I –Works

Current Cost = ₹. 1745.49 Crores

The minor head I-Works has been subdivided in to the following detailed subheads:

A-Preliminary

Current Cost: ₹ 28.25 Crores

Under this head provision has been made for surveys and investigations to be conducted at DPR stage and later to arrive at the optimum of the project components. Provision for in-house Design & Engineering and consultancy charges has been kept under this head as 2% of cost of C & J Works.

B-Land

Current Cost: ₹ 30.00 Crores

This covers the provision for acquisition of land/lease charges for construction of the project, structures, colonies, offices etc. and the provision for Rehabilitation and Resettlement (R&R) of Project Affected Persons.

C- Works

Current Cost: ₹ 371.20 Crores

This sub-head covers the cost of Upper Dam & Lower Dam and associated Hydro-mechanical equipments.

J- Power Plant Civil Works

Current Cost ₹ 1041.41 Crores

This covers the cost of Civil Works of Power Tunnel Intake structures, Head Race Tunnel, Surge shaft/chamber, Pressure Shaft, Power House, Transformer Cavern & Tail Race Tunnel etc. along with associated Hydro-mechanical equipment.

K- Buildings

Current Cost: ₹ 56.50 Crores

A provision @ 4% of C-J Works has been made towards temporary and permanent buildings (both residential and non-residential) proposed to be built in colonies for various locations of the project area. The buildings included under the permanent category are all those buildings, which will be subsequently utilized during the state of running and maintenance of the project.

M- Plantation

Current Cost: ₹ 1.50 Crores

The provision under this head includes cost of plantation in colonies, along approach roads, landscaping and improvements of area around powerhouse.

O- Miscellaneous

Current Cost: ₹ 28.25 Crores

Under this head provision is generally made to cover the cost of the following miscellaneous works:

a) Capital cost of electrification, water supply, sewage disposal, firefighting equipment etc.
b) Repair and maintenance of electrification water supply, sewage disposal, medical assistance, recreation, post office telephone office security arrangements, firefighting, inspection vehicles, schools, transport of labour etc.
c) Other services such as laboratory testing, R&M of Guest House and transit camps, Community center and photographic instruments as well as R&M charges etc.

As the estimate is of Pre-feasibility level, percentage provision @ 2% of C-J works has been considered towards head O- Miscellaneous.

P- Maintenance

Current Cost: ₹.14.69 Crores

For maintenance of buildings, roads and other structures during construction period, provision @ 1% of C-works, J-Power Plant civil works, K- buildings have been kept.

Q- Special T&P

Current Cost: ₹ 10.00 Crores

It is assumed that the work will be carried through Contracts and accordingly nominal provision for procurement of necessary equipment for taking up the work at the earliest by the contractor have been made. The total expenditure towards this will be recovered from the contractors and the same is credited under receipt and recoveries.

Adequate provision is made for inspection vehicles and cost for resale of vehicles is accounted for under receipt and recoveries.

R-Communication

Current Cost: ₹. 60.00 Crores

Provision under this head covers the cost of construction of roads and bridges for project works. The provision is Lump sum only at this stage based on preliminary assessments as detailing shall be done later on.

X-Environment and Ecology

Current Cost: ₹. 100.00 Crores

Provision under this head covers Bio-diversity Conservation, Creation of green belt, Restoration of Construction Area, Catchment Area Treatment and Compensatory Afforestation etc.

Y-Losses on Stock

Current Cost: ₹ 3.67 Crores

The provision under this head have been made @ 0.25% of the cost of C, J & K.

II-Establishment

Current Cost: ₹ 98.61 Crores

Provision for establishment including establishment of cost control cell at the project and Head Quarter Level has been made as per "Guidelines for Formulation of Detailed Project Reports for Hydro Electric Schemes, their Acceptance and Examination for Concurrence" dated January 2015 by Central Electricity Authority @ 60 Cr.+ 4% of I-Works less B Land exceeding 750 cr.

III- Tools &Plants

Current Cost: ₹.17.45 Crores

The provision is distinct from that under Q-Special T&P and is meant to cover cost of survey instruments, camp equipment and other small tools & plants. A provision of 1% of I-works has been kept under this head.

IV-Receipt &Recoveries

Current Cost's. (-) ₹ 2.50 Crores

The provision under this head cover the estimated recoveries by way of resale of temporary buildings, transfer of construction equipment, inspection vehicles, generators etc. Provision @ 25% of Q- Special T&P has been considered towards IV=Receipt & Recoveries.

12.3.2 Indirect Charges

Current Cost: ₹. 18.95 Crores

Provisions under this head have been made for capitalized value of abatement of land revenue. Besides, provision for Audit & Account Charges has been made at 1% of the cost of I-Works.

12.4 Electro-Mechanical Works

Current Cost: ₹ 1820.00 Crores

The total cost of Electro-Mechanical works at Jan, 2021 level works out to be: ₹ 1820.00 Crores, which includes, the cost of main Electro-Mechanical equipment such as turbines, generators, transformers etc. based on the prevailing market prices in India and abroad. Suitable provision for transportation, erection and commissioning charges, freight and insurance etc. have been adequately made as per general guidelines issued by CEA. Provision for establishment and Audit and Account charges for the electro-mechanical works have also been made under this cost separately.

Annexure - 12

GANDIKOTA PUMPED STORAGE PROJECT (1000 MW)		
GENERAL ABSTRACT OF COST		
Sl. No.	**DETAILED HEAD OF WORKS**	**Amount (Rs. Lacs)**
A	**CIVIL WORKS**	
1	**DIRECT CHARGES**	
	I-WORKS	
	A-Preliminary	2825.24
	B-Land	3000.00
	C-Works including HM Works	37120.59
	J-Power Plant Civil Works	104141.48
	K-Building (4% of C-J Works)	5650.48
	M-Plantation LS	150.00
	O-Miscellaneous	2825.24
	P-Maintenance during construction @1% of C, J & K	1469.13
	Q-Special T&P	1000.00
	R-Communication	6000.00
	X-Environment & Ecology	10000.00
	Y-Losses on Stock @0.25% of C,J & K	367.28
	Total of I-Works	**174549.44**
	II-ESTABLISHMENT	**9861.98**
	III-TOOLS & PLANTS(1% of I-Works)	**1745.49**
	IV-SUSPENSE	**0.00**
	V-RECEIPT & RECOVERIES (-)	**-250.00**
	Total of Direct Charges	**185906.91**
2	**Indirect Charges**	
	(a) Capitalised value of abatement of land revenue @ 5% of cost of culturable land	**150.00**
	(b) Audit & Account Charges (@ 1% of I-Works)	**1745.49**
	Total of Indirect Charges	**1895.49**
	Total Cost (Direct charges + Indirect Charges)	**187802.41**
	Total Cost Civil Works	**187802.41**
A	**Civil Works**	**187802.41**
B	**Electo-Mechanical Works**	**182000.00**
	Total Cost	**369802.41**

Abstract of Rates for Principal Construction Materials			
Sl.No	**Description of item**	**Unit**	**Rate a in Rs.**
1	Loose or unconsidolated excavation other than trenches	cum	**176**
2	Material excavated from rocky ground through blasting	cum	**462**
3	Removal of Material arising from overbreak	cum	**400**
4	Concrete- M15	cum	**4525**
5	Concrete- M 20	cum	**4627**
6	Concrete- M25	cum	**4933**
7	Concrete-M30	cum	**5724**
8	Concrete- M35	cum	**6079**
9	Shotcrete Plain	cum	**6707**
10	Shotcrete with Steel Fibre	cum	**16725**
11	Fill material Rockfill (Backfill)	cum	**486**
12	Filter material (Gravel)	cum	**1125**
13	Impervious Core Material (Clay)	cum	**1045**
14	Stone Pitching	cum	**1068**
15	Rock Bolting-25mm dia 1 to 6m long	m	**1136**
18	Drilling grout holes upto 5 m depth	m	**452**
20	Drainage hole	m	**393**
21	Reinforcement for steel tunnel	MT	**70339**
22	ASTM-537 Gr. II Steel Liner for Penstock	MT	**136711**
23	ASTM-517 Gr. F Steel Liner for Penstock	MT	**207631**
24	Rock Excavation- in tunnel (8.5 m dia or above)	cum	**2102**
25	Rock Excavation in Shafts (Vertical Pressure Shaft)	cum	**2784**
26	Contact Grouting	MT	**10403**
27	Consolidation Grouting	MT	**9098**
28	PVC Rubber Water Stop	m	**2281**
29	Wire Mesh 2"	sq.m	**235**
30	Fabrication & Erection - Steel supports	MT	**96204**
31	Shaft Excavation	cum	**2784**
32	Precast lagging	cum	**13549**
33	Crushed sand	cum	**721**
34	Fabrication and Erection of Trash Rack	MT	**150168**
35	100 mm dia MS pipe	m	**1248**
36	Cement	MT	**7497**
37	HDPE Membrane	Sqm	**163**
38	Concrete- M10	cum	**4354**
39	Cable Anchor	RM	**20000**
40	ISMB 250 Steel Ribs	MT	**103240**
41	Reinforcement in DAM & ALLIED WORK (dia <36mm)	MT	**54174**
42	Reinforcement in DAM & ALLIED WORK (dia >36mm)	MT	**56335**
43	Bentonite	MT	**6420**
44	MOVING GANTRY CRANE-CLASS II	tonne capacity	**228447**
45	HM WORKS		
46	RAIL TRACK FOR GANTRY CRANE	Rm	**7604**
47	vertical lift gates and stop log gate elements (SLIDING GATES)	tonnes	**154322**
48	VERTICAL LIFT GATES-EM PARTS	tonnes	**186190**
49	VERTICAL LIFT GATES-ROPE DRUM HOIST UPTO 30 TON CAP. POWER OPERATED	tonne capacity	**67209**
50	Rock bolt 32 m dia	m	**1436**

A-PRELIMINARY					
Sl. No.	**Item**	**Quantity**	**Unit**	**Rate Rs.**	**Amount**
1	Cost of surveys and investigation including geological investigation, hydrological investigation, preliminary construction materials surveys, access paths and roads etc. at PFR stage	LS @ 2% of the cost of C-J Works			2825.24
2	Topographical & other surveys for HRT, TRT & Powerhouse etc.				
3	Geological Investigation				
4	Drilling & Drifting				
5	Construction Material Survey				
6	Hydrologcal and meteorological observations				
7	Geophysical survey, seimological study				
8	Hydraulic model studies				
9	Charges for prelimanary consultancy & specialists				
10	Training of Engineers during Investigation				
11	Instuments and equipments for S & I works				
12	Stationary, writing of completion report & history of project				
					2825.24

DAM AND APPURTENANT WORKS
I-WORKS

C-WORKS & HM WORKS

ABSTRACT OF COST

Sr. No.	Item	Amount (Rs. Lacs)
1	Upper Reservoir	34561
2	HM Works	2560
	Total for Civil & HM Works	**37121**
	Say	**37121**

J-WORKS

ABSTRACT OF COST

Sr. No.	Item	Amount (Rs. Lacs)
1	Upper Intake	3131
2	Upper Intake Gate Shaft	1392
3	Intake Tunnel and HRT	9622
4	Pressure Shaft (7.0 m dia.)	16349
5	Penstock (4.95 m dia.)	6174
6	Main Access Tunnel	5476
7	Power House	25741
8	Transformer hall	10738
9	Draft Tube	2030
10	Adit to PS, CAT and Switchyard	4969
11	Tail race tunnel	13641
12	Tail Race Gate Shaft	1739
13	Outlet	3140
	Total Cost of J-Works	**104141**
	Say	**104141**

DAM AND APPURTENANT WORKS					
UPPER RESERVOIR					
Sl. No.	**Items Details**	**Quantity**	**Unit**	**Rate Rs.**	**Amount (Rs. Lacs)**
1	**Site Clearance**		LS		50.00
2	**Open Excavation (Soil)**	739471	cum	176	1301.47
3	**Open Excavation (Rock)**	1725433	cum	462	7971.50
4	**Filling Material**				
	Clay Core	447701	cum	1045	4679.37
	Fine Filter (Sand)	425880	cum	721	3069.40
	Coarse Filter (Crushed Stone/Garvel)	371504	cum	563	2089.71
	RipRap	228092	cum	1068	2435.56
	Compacted Rockfill Material Placing	939744	cum	486	4569.04
5	**Drilling holes for consolidation grouting**	249256	RM	452	1126.14
6	**Cement for consolidation grouting**	6231	MT	9098	566.95
7	**Reservoir Linning - M15 concrete 0.3m for levelling**	28958	cum	6707	1942.17
8	**Reservoir Linning - HDPE Membrane**	96525	Sqm	163	157.61
9	**Instrumentation @ 3% of Sub-Total**		LS		899
10	**GST @12%**				3703
				Total	34560.59
				Say	**34561**

Upper Reservoir Inlet					
Sl No.	**Item Details**	**Quantity**	**Unit**	**Rate Rs.**	**Amount (Rs. Lacs)**
1	Cleaning, Grubbing & Stripping	18000.00	m2	11.00	1.98
2	Excavation- soil	10878.00	cum	176.00	19.15
3	Excavation - Rock	108780.00	cum	462	502.56
4	Outlet Structural Concrete (M25)	19322.89	cum	4933	953.18
5	Precast Lagging	0.00	cum	13549	0.00
6	Reinforcement	1516.85	MT	70339	1066.93
7	Stone Pitching	3522.20	cum	1068	37.61
8	Rock Bolt and Anchor Bolt	746.67	m	1136	8.48
9	Shortcrete (t=10cm, Wiremesh)	140.00	cum	16725	23.42
10	Trashrack (MT)	55.90	MT	150168	83.95
11	other works		LS		25.00
12	Dewatering @ 3%				81.67
13	GST @ 12%				326.67
	Total				3130.59
	G. Total			**Say**	**3131**

INTAKE (UPPER) GATE SHAFT					
Sl No.	**Item Details**	**Quantity**	**Unit**	**Rate Rs.**	**Amount (Lakh)**
1	Open Excavation- soil	0	cum	176	0.00
2	Open Excavation- Rock	1143	cum	462	5.28
3	Shaft Excavation- Rock	11432	cum	2784	318.24
4	Non-Core Drilling for Consolidation Grouting	1545	m	452	6.98
5	Grouting Material (Cement)	19	MT	9098	1.76
6	Lining Concrete (M20)	4510	cum	4627	208.67
7	Backfill Concrete M-15	1136	cum	4525	51.41
8	Reinforcing Steel	354	MT	70339	249.02
9	Waterstop	283	m	2281	6.46
10	SFRS	549	cum	16725	91.81
11	Rockbolt (L=3.0m)	21638	m	1136	245.73
12	Drilling for Drainage Holes	225	m	393	0.88
13	Precast Lagging	304	cum	13549	41.23
14	Other Works	LS			15.00
15	GSt @12%				149.10
				Total	1391.57
	Say				1392

2 Nos. x HRT (8.90 m Dia., Length- 532 m)					
Sl No.	**Item Details**	**Quantity**	**Unit**	**Rate Rs.**	**Amount (Rs. Lacs)**
1	Excavation	88352	cum	2102	1856.99
2	Overbreak in Underground Excavation	8835	cum	462	40.82
3	Steel Ribs	498	MT	103240	514.27
4	Rock bolt				
	32 mm dia	86556	m	1436	1242.95
	25 mm dia	123588	m	1136	1403.47
5	SFRS	4682	cum	16725	783.10
6	Drilling Drain holes	2660	m	393	10.44
7	Consolidation & Contact Grouting Holes	18265	m	452	82.52
8	Pressure Grouting with Cement	228	MT	10403	23.75
9	Concrete of grade M-15 in backfill	9645	cum	4525	436.48
10	Lining Concrete(M-25)	16700	cum	4933	823.81
11	Steel Reinforcement	1311	MT	70339	922.13
12	Precast Lagging	1477	cum	13549	200.11
13	Dewatering @ 3%				250.23
14	GST (12%) Total				1030.93
				Total	9621.99
				G. Total	**9622**

Circular Pressure Shaft 2 Nos. (7.00 m Dia., Length- 370 m)					
Sl No.	**Item Details**	**Quantity**	**Unit**	**Rate Rs.**	**Amount (Rs. Lacs)**
1	Excavation	42332	cum	2102	889.74
2	Overbreak in Underground Excavation	4233	cum	462	19.56
3	Steel Ribs	255	MT	103240	263.05
4	Rock bolt				
	32 mm dia	44401	m	1436	637.59
	25 mm dia	132472	m	1136	1504.35
5	SFRS	2526	cum	16725	422.50
6	Drilling Drain holes	1915	m	393	7.52
7	Consolidation & Contact Grouting Holes	13150	m	452	59.41
8	Pressure Grouting with Cement	164	MT	10403	17.10
9	Concrete of grade M-15 in backfill	14575	cum	4525	659.55
10	Lining Concrete(M-25)	0	cum	4933	0.00
11	Steel Reinforcement	0	MT	70339	0.00
12	Precast Lagging	1140	cum	13549	154.47
13	ASTM 517 Grade F Liner	2607	MT	207631	5413.64
14	ASTM 537 Class 2 Liner	3049	MT	136711	4168.05
15	Dewatering @3%				426.50
16	GST @ 12%				1705.98
	Total				16349.01
	G. Total				**16349**

Circular Penstock 4 Nos. (4.9 m Dia., Length- 70 m)					
Sl No.	**Item Details**	**Quantity**	**Unit**	**Rate Rs.**	**Amount (Rs. Lacs)**
1	Excavation	11614	cum	2102	244.10
2	Overbreak in Underground Excavation	1161	cum	462	5.37
3	Steel Ribs	93	MT	103240	95.97
4	Rock bolt				
	32 mm dia	16198	m	1436	232.61
	25 mm dia	48014	m	1136	545.25
5	SFRS	917	cum	16725	153.45
6	Drilling Drain holes	920	m	393	3.61
7	Consolidation & Contact Grouting Holes	6317	m	452	28.54
8	Pressure Grouting with Cement	79	MT	10403	8.21
9	Concrete of grade M-15 in backfill	4780	cum	4525	216.29
10	Lining Concrete(M-25)	0	cum	4933	0.00
11	Steel Reinforcement	0	MT	70339	0.00
12	Precast Lagging	414	cum	13549	56.16
13	ASTM 517 Class F Liner	1820	MT	207631	3779.29
14	ASTM 537 Class 2 Liner	0	MT	136711	0.00
15	Dewatering @3%				161.07
16	GST @ 12%				644.26
	Total				6174.17
	G. Total Say				**6174**

MAIN ACCESS TUNNEL (Circular Section with Base 8 m) Length- 746m					
Sl No.	**Item Details**	**Quantity**	**Unit**	**Rate Rs.**	**Amount (Rs. Lacs)**
1	Excavation	62005	cum	2102	1303.23
2	Overbreak in Underground Excavation	6201	cum	462	28.65
3	Steel Ribs	770	MT	103240	794.56
4	Rock bolt				
	32 mm dia	36522	m	1436	524.45
	25 mm dia	57817	m	1136	656.57
5	SFRS	3034	cum	16725	507.46
6	Drilling Drain holes	1865	m	393	7.32
7	Consolidation & Contact Grouting Holes	12806	m	452	57.86
8	Pressure Grouting with Cement	160	MT	10403	16.65
9	Concrete of grade M-15 in backfill	0	cum	4525	0.00
10	Lining Concrete(M-25)	7238	cum	4933	357.05
11	Steel Reinforcement	568	MT	70339	399.66
12	Precast Lagging	1238	cum	13549	167.73
13	Misc	LS			25.00
14	Dewatering (1%)				48.46
15	GST(12%) Total				581.54
				Total	5476.20
				G. Total	**5476**

Adits & Cable Tunnels and switch yard					
Sl No.	**Item Details**	**Quantity**	**Unit**	**Rate Rs.**	**Amount (Rs. Lacs)**
1	Excavation	42167	cum	2102	886.27
2	Overbreak in Underground Excavation	4217	cum	462	19.48
3	Steel Ribs	453	MT	103240	467.36
4	Rock bolt				
	32 mm dia	39967	m	1436	573.92
	25 mm dia	64350	m	1136	730.75
5	SFRS	1699	cum	16725	284.09
6	Drilling Drain holes	1375	m	393	5.40
7	Consolidation & Contact Grouting Holes	9442	m	452	42.66
8	Pressure Grouting with Cement	118	MT	10403	12.28
9	Concrete of grade M-15 in backfill	5463	cum	4525	247.22
10	Lining Concrete(M-25)	0	cum	4933	0.00
11	Steel Reinforcement	0	MT	70339	0.00
12	Precast Lagging	910	cum	13549	123.33
13	switch yard cost for civil works	LS			1000.00
14	Dewatering @1%				43.93
15	GST @ 12%				532.40
				Total	4969.09
				G. Total	**4969**

Power House					
Sr. No.	**DESCRIPTION OF ITEMS**	**QUANTITY**	**UNIT**	**Rate Rs.**	**Amount (Rs. Lacs)**
1	Excavation	316800	cum	2784	8819.08
2	Overbreak	31680	cum	400	126.66
3	Concrete				
	M10	5081	cum	4354	221.22
	M15	12510	cum	4525	566.11
	M25	16187	cum	4933	798.48
	M30	40605	cum	5724	2324.32
4	Rock bolt				
	32 mm dia	134933	m	1436	1937.64
5	SFRS	0	cum	16725	0.00
	Normal Shotcrete	9108	cum	6707	610.87
6	Drilling Drain holes	75638	m	393	296.96
7	Rock Fill	22918	cum	486	111.43
8	Wire Mesh	0	Sq. m	235	0.00
9	Lenngth of cable anchor 30m long	4769	RM	20000	953.85
10	Strucutral Steel for Truss	1516	MT	96204	1458.53
11	Steel Reinforcement	5839	MT	70339	4107.13
12	Misc.	L.S			25
13	Other Works	L.S			30
14	Dewatering @3%				670.72
15	GST @ 12%				2682.87
	Total				25740.87
				Say	**25741**

Transformer Cavern					
Sr. No.	**DESCRIPTION OF ITEMS**	**QUANTITY**	**UNIT**	**Rate Rs.**	**Amount (Rs. Lacs)**
1	Excavation	83228	cum	2784	2316.89
2	Overbreak	8323	cum	400	33.27
3	Concrete				
	M10	2167	cum	4354	94.34
	M15	5335	cum	4525	241.43
	M25	13806	cum	4933	681.05
	M30	17317	cum	5724	991.25
4	Rock bolt				
	32 mm dia	46500	m	1136	528.05
5	SFRS	0	cum	16725	0.00
	Normal Shotcrete	3139	cum	6707	210.51
6	Drilling Drain holes	32257	m	393	126.64
7	Rock Fill	6021	cum	486	29.27
8	Wire Mesh	0	Sq. m	235	0.00
9	Lenngth of cable anchor 30m long	4084	RM	20000	816.73
10	Strucutral Steel for Truss	1137	MT	96204	1093.90
11	Steel Reinforcement	3032	MT	70339	2132.73
12	Misc.	L.S			15
13	Other Works	L.S			30
14	Dewatering @3%				279.33
15	GST @ 12%				1117.33
	Total				10737.74
				Say	**10738**

Draft Tube 4 Nos. (5.5m, 75m)					
Sl No.	**Item Details**	**Quantity**	**Unit**	**Rate Rs.**	**Amount (Rs.Lacs)**
1	Underground excavation	10102	cum	2102	212.33
2	ASTM537 class-2 Liner	981	MT	136711	1340.94
3	Rock bolting 25-mm dia, 2.5m long	603	m	1136	6.85
4	SFRS	428	cum	16725	71.65
5	Drainage holes	180	m	393	0.71
6	Drilling holes for (consolidation + contact) grouting	4200	m	452	18.98
7	Cement for (consolidation + contact) grouting	130	MT	10403	13.52
8	Backfill Concrete(M-20)	2043	cum	4627	94.55
9	Dewatering (3%)				52.79
10	GST(12%) Total				217.48
	Total				2029.79
				G.Total	**2030**

2 Nos. x TRT (8.9 m Dia., Length- 755 m)					
Sl No.	**Item Details**	**Quantity**	**Unit**	**Rate Rs.**	**Amount (Rs. Lacs)**
1	Excavation	125387	cum	2102	2635.38
2	Overbreak in Underground Excavation	12539	cum	462	57.93
3	Steel Ribs	707	MT	103240	729.84
4	Rock bolt				
	32 mm dia	122838	m	1436	1763.96
	25 mm dia	175393	m	1136	1991.76
5	SFRS	6645	cum	16725	1111.36
6	Drilling Drain holes	3775	m	393	14.82
7	Consolidation & Contact Grouting Holes	25922	m	452	117.11
8	Pressure Grouting with Cement	324	MT	10403	33.71
9	Concrete of grade M-15 in backfill	13689	cum	4525	619.43
10	Lining Concrete(M-25)	23701	cum	4933	1169.14
11	Steel Reinforcement	1861	MT	70339	1308.66
12	Precast Lagging	2096	cum	13549	284.00
13	Misc	LS			25.00
14	Dewatering @3%				355.86
15	GST @ 12%				1423.45
				Total	13641.41
				G. Total	**13641**

TAIL RACE (LOWER) GATE SHAFT					
Sl No.	**Item Details**	**Quantity**	**Unit**	**Rate Rs.**	**Amount (Lakh)**
1	Open Excavation- soil	0	cum	176	0.00
2	Open Excavation- Rock	1448	cum	462	6.69
3	Shaft Excavation- Rock	14480	cum	2784	403.10
4	Non-Core Drilling for Consolidation Grouting	1957	m	452	8.84
5	Grouting Material (Cement)	24	MT	9098	2.23
6	Lining Concrete (M20)	5014	cum	4627	231.99
7	Backfill Concrete M-15	1439	cum	4525	65.11
8	Reinforcing Steel	394	MT	70339	276.85
9	Waterstop	283	m	2281	6.46
10	SFRS	695	cum	16725	116.30
11	Rockbolt (L=3.0m)	27409	m	1136	311.25
12	Drilling for Drainage Holes	285	m	393	1.12
13	Precast Lagging	385	cum	13549	52.22
14	Other Works	LS			25.00
15	Dewatering (3%)				45.22
16	GST(12%) Total				186.29
				Total	1738.67
				Say	1739

Lower Intake/TRT Outlet					
Sl No.	**Item Details**	**Quantity**	**Unit**	**Rate Rs.**	**Amount (Rs. Lacs)**
1	Cleaning, Grubbing & Stripping	18000.00	m2	11.00	1.98
2	Excavation- soil	10878.00	cum	176.00	19.15
3	Excavation - Rock	108780.00	cum	462	502.56
4	Outlet Structural Concrete (M25)	19322.89	cum	4933	953.18
5	Precast Lagging	0.00	cum	13549	0.00
6	Reinforcement	1516.85	MT	70339	1066.93
7	Stone Pitching	3522.20	cum	1068	37.61
8	Rock Bolt and Anchor Bolt	746.67	m	1136	8.48
9	Shortcrete (t=10cm, Wiremesh)	140.00	cum	16725	23.42
10	Trashrack (MT)	55.90	MT	150168	83.95
11	other works		LS		25.00
12	Dewatering (3%)				81.67
13	GST(12%) Total				336.47
	Total				3140.39
				G. Total	**3140**

Gandikota Pumped Storage Project (4 x 250 MW) Andhra Pradesh

Cost Estimate of HM works

	Description	Nos	Width (m)	Height (m)	Design head (m)	Unit Wt. MT	Total wt. MT	Rate /t. (Rs)	Amount (Rs. In Lakh.)
1	**Power Intake (Upper Reservoir)**								
i.	**Upper Intake gates**								
	Gate leaf	2	6.67	8.50	28.50	60.0	120	**195000**	**234**
	Embedded parts	2				16.0	32	**195000**	**62.4**
	Hoist machinary	2				18.0	36	**215000**	**77.4**
	Hoist Support structure	2				17.0	34	**170000**	**57.8**
ii.	**Upper Intake Emergency gates**								
	Gate leaf	2	6.67	8.50	28.50	70.0	140	**195000**	**273**
	Embedded parts	2				12.0	24	**195000**	**46.8**
	Hoist machinary	2				14.0	28	**215000**	**60.2**
	Hoist Support structure	2				17.0	34	**170000**	**57.8**
iii.	Liner for Intake gates	2				20	40	**170000**	**68**
2	**Draft Tube gates**								
	Gate leaf	4	5.00	3.93	60.00	22.0	88	**195000**	**171.6**
	Embedded parts incl. Bonnet	4				30.0	120	**195000**	**234**
	Hydraulic Hoist 35t cap, 4.5m st	4				**L.S.***		**4000000**	**160**
	Liner for gates	4				10	40	**170000**	**68**
3	**Lower Intake gates (Lower Reservoir)**								
i	**Lower Intake Service gates**								
	Gate leaf	2	7.30	9.30	26.15	55.00	110	**195000**	**214.5**
	Embedded parts	2				15.00	30	**195000**	**58.5**
	Hoist machinary (Cap. 100t)	2				15.00	30	**215000**	**64.5**
	Hoist Support structure	2				18.00	36	**170000**	**61.2**
ii	**Lower Intake Emergency gates**								
	Gate leaf	2	7.30	9.30	26.15	60.00	120	**195000**	**234**
	Embedded parts	2				11.00	22	**195000**	**42.9**
	Hoist machinary (Cap. 80t)	2				12.00	24	**215000**	**51.6**
	Hoist Support structure	2				18.00	36	**170000**	**61.2**
iii	Liner for gates	2				13	26	**170000**	**44.2**
6	**MISCELLANEOUS**								
i)	Instrumentation and remote control with complete automation				**1**	**LS***		**10000000**	**100**
ii)	D.G Set				**2**	**LS***		**2000000**	**40**
iii)	Model studies for groove shape, lip shape,air requirement etc. for gates				**1**	**LS***		**1000000**	**10**
		Total Quantity in MT =					**1170**		**2553.6**
		say				**MT**	**1170**		**2560**

Total estimated cost for gates = Rs. 25.60 Cr (inclusive of GST)

For items marked(*) provision shall be made in cost estimates. Weights are not estimated being bought out items. Provision towards the cost has to be made as per norms of cost appraisal in such cases.

Note : Rates(inclusive of GST) in the above estimate have been taken as per the prevalent rates of such items considered in HM estimates of other projects. The rates of major items are available in AP schedule of rates 2020-20 . Rates of such major items are comparable with the AP schedule of rates after taking cost of design, painting & 12% of GST which are otherwise not

CHAPTER-13: ECONOMIC EVALUATION

CHAPTER – 13

13. ECONOMIC EVALUATION

13.1 General

The economic and financial evaluation of the Gandikota Pumped Storage Project, Andhra Pradesh has been considered as per the standard guidelines issued by Central Electricity Authority and the norms laid down by the Central Electricity Regulatory Commission (CERC) for Hydro projects have been kept in view in this regard.

13.2 Project Benefits

The scheme would afford on annual peaking period energy generation of 1964.92 GWh annually. For assessing the tariff, design energy generation of 1866.67 GWh, calculated with 95% capacity availability in a normal dependable year, has been adopted. The project would provide 1000 MW of 5 hours 23 minutes, daily peaking capacity benefits.

13.3 Capital Cost

The project cost has been estimated at ₹ **3432.87 Crores** without IDC as given below:

1.	Cost of civil works	=	₹. 1878.02 Crores
2.	Cost of Electrical/Mechanical works	=	₹. 1820.00 Crores
	Total	=	₹. **3698.02 Crores**

13.4 Mode of Financing

The project is proposed to be financed with a debt equity ratio of 70:30. An interest rate of 10.0% per annum on the loan component has been considered for the financial analysis of the project. The interest on the working capital is taken as 10.50% (as on Jan 2021).

13.5 Phasing of Expenditure

The project is scheduled to be completed in 5 years from the financial closure in all respects. The phasing of the expenditure worked out on the basis of proposed construction programme is summarized in Table 13.1.

Table 13:1: Phasing of Expenditure

Year	Capital Expenditure (₹. Crores)
1st Half Year	188.14
2nd Half Year	288.79
3rd Half Year	392.97
4th Half Year	594.86
5th Half Year	803.81
6th Half Year	643.81
7th Half Year	666.34
8th Half Year	313.39
9th Half Year	324.36
10th Half Year	241.65
Total	**4458.12**

13.6 Financial Analysis

13.6.1 Basic and Normative Parameters

The following normative parameters have been adopted for working out the financial analysis of the project.

i. The estimated capital cost of ₹. 4458.12 Crores including the Interest During Construction as ₹. 760.09 Crores

ii. Annual gross energy generation of 1964.92 GWh considering 365 days generation in a year.

iii. Operation & maintenance expenses (including insurance) @ 3.5% of the project cost in the first year with 4.77% escalation every year.

iv. Depreciation allowed @ 5.28 % of the project cost excluding land cost for first 14 years and remaining depreciation is spread over the balance life i.e. 26 years on an average basis keeping 10% salvage value of the assets.

v. Auxiliary consumption i.e. quantum of energy consumed by auxiliary equipments of the generating station and transformer loss @ 1.20 % of the energy generated.

vi. Interest on working capital @ 10.50%. per annum as on Jan 2021 based on MCLR values of SBI as per CERC Guidelines.

vii. Interest during construction has been worked out based upon the interest rates @ 10.0 % per Annum as on Jan 2021. The computations are given in **Annexure-13.1** for present day capital cost.

viii. Return on equity @ 15.50%.

ix. Pump-Generation Cycle efficiency @ 76.36%

x. Pumping Energy Required 2444.59. Gwh considering 95% time operation as taken during generation.

xi. Off-peak Energy has been considered for three possibilities (₹/kWh) @ ₹. 1.00, 2.00, 2.50 & 3.00 /- respectively.

xii. MAT @ 21.55 %

xiii. Corporate Tax – 25.17% (Base tax of 22%, Surcharge of 10% and Cess of 4%)

xiv. Tax Holiday – 10 Years

13.6.2 Assessment of Tariff

Based upon the parameters given above, the sale rate of energy at bus bar has been computed in **Annexure-13.2** for project life of 40, 50 and 60 years. As per CERC guideline, for hydropower 40 year project life is to be considered for tariff calculation.

The sale rate applicable in the first year and levelised tariff is indicated below.

Table 13:2

Sl. No.	Off Peak Energy Rate (₹/kWh)	First Tariff (₹/kWh)	40 Year Levelized Tariff (₹/kWh)	Conversion cost of the project (excluding pumping cost) (₹/kWh)
1	3.00	9.15	8.49	4.47
2	2.50	8.48	7.82	4.47
3	2.00	7.81	7.15	4.47
4	1.00	6.47	5.81	4.47

However, Levelized tariff has also been calculated considering the project life 50 & 60 years as well and tabulated below:

Table 13:3

Sl. No.	Off Peak Energy Rate (₹/kWh)	First Tariff (₹/kWh)	50 Year Levelized Tariff (₹/kWh)	Conversion cost of the project (excluding pumping cost) (₹/kWh)
1	3.00	9.15	8.54	4.51
2	2.50	8.48	7.87	4.51
3	2.00	7.81	7.20	4.51
4	1.00	6.47	5.85	4.51

Table 13:4

Sl. No.	Off Peak Energy Rate (₹/kWh)	First Tariff (₹/kWh)	60 Year Levelized Tariff (₹/kWh)	Conversion cost of the project (excluding pumping cost) (₹/kWh)
1	3.00	9.15	8.58	4.55
2	2.50	8.48	7.91	4.55
3	2.00	7.81	7.23	4.55
4	1.00	6.47	5.89	4.55

Annexure - 13.1

Annexure-14.1

GANDIKOTA PSP (4x250=1000 MW)
INTEREST DURING CONSTRUCTION (IDC)

1	**Cost of Civil Works**	**INR**	**1878.02**	Cr.	
2	**Cost of E&M Works**	**INR**	**1820.00**	Cr.	
3	**Total Cost of the Projec**	**INR**	**3698.02**	Cr.	
4	**Interst Rate on Loan**		**10.00**	%	per annum as on Jan 2021
5	**Equity**		**30.0**	%	
6	**Loan**		**70.0**	%	
7	**CERC Gudelines followed**		**2019-24**		

Period	Phasing of expendtiure	Hard Cost	Equity	Loan	IDC	Loan for IDC	Equity for IDC	Outstanding Loan
Half Year	%	INR Cr.	INR Cr.	INR Cr.	INR Cr.	INR Cr.	INR Cr.	INR Cr.
1	5	184.90	55.47	129.43	3.24	2.27	0.97	131.70
2	7.5	277.35	83.21	194.15	11.44	8.01	3.43	333.85
3	10	369.80	110.94	258.86	23.16	16.21	6.95	608.93
4	15	554.70	166.41	388.29	40.15	28.11	12.05	1025.33
5	20	739.60	221.88	517.72	64.21	44.95	19.26	1588.00
6	15	554.70	166.41	388.29	89.11	62.37	26.73	2038.66
7	15	554.70	166.41	388.29	111.64	78.15	33.49	2505.10
8	5	184.90	55.47	129.43	128.49	89.94	38.55	2724.48
9	5	184.90	55.47	129.43	139.46	97.62	41.84	2951.53
10	2.5	92.45	27.74	64.72	149.19	104.44	44.76	3120.68
		3698.02	**1109.41**	**2588.62**	**760.09**	**532.07**	**228.03**	

Hard Cost	**INR**	**3698.02**	**Cr.**	**Equity**	**INR**	**1337.44**	**Cr.**
IDC	**INR**	**760.09**	**Cr.**	**Loan**	**INR**	**3120.68**	**Cr.**
Total Capital Cost	**INR**	**4458.12**	**Cr.**	**Total Capital Cost**	**INR**	**4458.12**	**Cr.**

Annexure - 13.2

GANDIKOTA PSP (4x250=1000 MW)

S.No	Parameters	Unit	Value		S.No	Parameters	Unit	Value		S.No	Parameters	Unit	Value	S.No	Parameters	Unit	Value
1	Installed Capacity	MW	1000.00		11	ROE	%	15.50		14	Interest rate on W.C	%	10.50	22	Equity	INR in Crs	1337.44
2	Normative availability	%	95.00		12	Working capital				15	O&M Expenses	%	3.50	23	Loan	INR in Crs	3120.68
3	Annual Energy Generation	GWh	1964.92														
4	Annual Energy Generation @ 95% availability	GWh	1866.67			i) Spares(% of O&M)	%	15.00		16	O&M Escalation rate	%	4.77	24	interest on Loan	%	10.00
5	Secondary Energy	GWh	0.00			ii) O&M expenses	Months	1.00		17	Discount Rate	%	9.89	25	Repay P	Yrs	14.00
6	Transformation losses	%	0.50			iii) Receivables	days	45		18	Depreciation Rate	%	5.28	26	Total cost	INR in Crs	4458.12
7	Auxiliary Consumption	%	0.70		13	i) MAT		21.55%		19	Max Dep Allowed	INR Cr.	4012.31	27	Project Life	Years	**40**
8	Transmission losses	%	0.00			II) Tax		25.17%		20	Energy Required for pumping	MU	2444.59				
9	Free Power	%	0.00			III) Tax holiday	years	10.00		21	Rate for off peak energy	INR	**1.00**				
10	Net Saleble energy	MU	1844.34										per unit				

Year	ROE	O&M	Depreciation	Outstanding Principal	Intt on Loan	Loan Principle Paid	Loan Installment	W.C				Intt on W.C	Charges for Pumping	Annual Expenses	Energy		Tarrif	Discount Factor	Discounted Tariff
								O&M	Spares	Recievables	Total				Free	Sold			
	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	GWh	GWh	INR/KWh		INR/KWh
1	264.25	129.43	235.39	3120.68	300.30	235.39	535.69	10.79	19.41	147.01	177.21	18.61	244.46	1192.43	0.00	1844.34	6.47	1.00	6.47
2	264.25	135.60	235.39	2885.29	276.76	235.39	512.15	11.30	20.34	144.86	176.50	18.53	244.46	1174.99	0.00	1844.34	6.37	0.91	5.80
3	264.25	142.07	235.39	2649.91	253.22	235.39	488.61	11.84	21.31	142.75	175.90	18.47	244.46	1157.86	0.00	1844.34	6.28	0.83	5.20
4	264.25	148.85	235.39	2414.52	229.68	235.39	465.07	12.40	22.33	140.68	175.41	18.42	244.46	1141.05	0.00	1844.34	6.19	0.75	4.66
5	264.25	155.95	235.39	2179.13	206.14	235.39	441.53	13.00	23.39	138.65	175.03	18.38	244.46	1124.57	0.00	1844.34	6.10	0.69	4.18
6	264.25	163.39	235.39	1943.74	182.60	235.39	417.99	13.62	24.51	136.66	174.78	18.35	244.46	1108.44	0.00	1844.34	6.01	0.62	3.75
7	264.25	171.18	235.39	1708.35	159.07	235.39	394.45	14.27	25.68	134.71	174.66	18.34	244.46	1092.68	0.00	1844.34	5.92	0.57	3.36
8	264.25	179.35	235.39	1472.96	135.53	235.39	370.92	14.95	26.90	132.82	174.67	18.34	244.46	1077.31	0.00	1844.34	5.84	0.52	3.02
9	264.25	187.90	235.39	1237.57	111.99	235.39	347.38	15.66	28.19	130.97	174.82	18.36	244.46	1062.34	0.00	1844.34	5.76	0.47	2.71
10	264.25	196.87	235.39	1002.18	88.45	235.39	323.84	16.41	29.53	129.18	175.12	18.39	244.46	1047.80	0.00	1844.34	5.68	0.43	2.43
11	277.02	206.26	235.39	766.80	64.91	235.39	300.30	17.19	30.94	129.04	177.16	18.60	244.46	1046.64	0.00	1844.34	5.67	0.39	2.21
12	277.02	216.09	235.39	531.41	41.37	235.39	276.76	18.01	32.41	127.36	177.78	18.67	244.46	1033.00	0.00	1844.34	5.60	0.35	1.99
13	277.02	226.40	235.39	296.02	17.83	235.39	253.22	18.87	33.96	125.74	178.56	18.75	244.46	1019.86	0.00	1844.34	5.53	0.32	1.78
14	277.02	237.20	235.39	60.63	3.03	60.63	63.66	19.77	35.58	125.27	180.62	18.96	244.46	1016.07	0.00	1844.34	5.51	0.29	1.62
15	277.02	248.52	27.57	0.00	0.00	0.00	0.00	20.71	37.28	100.38	158.37	16.63	244.46	814.20	0.00	1844.34	4.41	0.27	1.18
16	277.02	260.37	27.57	0.00	0.00	0.00	0.00	21.70	39.06	101.90	162.65	17.08	244.46	826.50	0.00	1844.34	4.48	0.24	1.09
17	277.02	272.79	27.57	0.00	0.00	0.00	0.00	22.73	40.92	103.49	167.14	17.55	244.46	839.39	0.00	1844.34	4.55	0.22	1.01
18	277.02	285.80	27.57	0.00	0.00	0.00	0.00	23.82	42.87	105.15	171.84	18.04	244.46	852.90	0.00	1844.34	4.62	0.20	0.93
19	277.02	299.44	27.57	0.00	0.00	0.00	0.00	24.95	44.92	106.90	176.76	18.56	244.46	867.05	0.00	1844.34	4.70	0.18	0.86
20	277.02	313.72	27.57	0.00	0.00	0.00	0.00	26.14	47.06	108.72	181.93	19.10	244.46	881.87	0.00	1844.34	4.78	0.17	0.80
21	277.02	328.68	27.57	0.00	0.00	0.00	0.00	27.39	49.30	110.64	187.33	19.67	244.46	897.41	0.00	1844.34	4.87	0.15	0.74
22	277.02	344.36	27.57	0.00	0.00	0.00	0.00	28.70	51.65	112.65	193.00	20.26	244.46	913.68	0.00	1844.34	4.95	0.14	0.68
23	277.02	360.79	27.57	0.00	0.00	0.00	0.00	30.07	54.12	114.75	198.93	20.89	244.46	930.73	0.00	1844.34	5.05	0.13	0.63
24	277.02	378.00	27.57	0.00	0.00	0.00	0.00	31.50	56.70	116.95	205.15	21.54	244.46	948.59	0.00	1844.34	5.14	0.11	0.59
25	277.02	396.03	27.57	0.00	0.00	0.00	0.00	33.00	59.40	119.26	211.66	22.22	244.46	967.31	0.00	1844.34	5.24	0.10	0.55
26	277.02	414.92	27.57	0.00	0.00	0.00	0.00	34.58	62.24	121.67	218.49	22.94	244.46	986.91	0.00	1844.34	5.35	0.09	0.51
27	277.02	434.71	27.57	0.00	0.00	0.00	0.00	36.23	65.21	124.21	225.64	23.69	244.46	1007.46	0.00	1844.34	5.46	0.09	0.47
28	277.02	455.44	27.57	0.00	0.00	0.00	0.00	37.95	68.32	126.86	233.13	24.48	244.46	1028.98	0.00	1844.34	5.58	0.08	0.44
29	277.02	477.17	27.57	0.00	0.00	0.00	0.00	39.76	71.58	129.64	240.98	25.30	244.46	1051.53	0.00	1844.34	5.70	0.07	0.41
30	277.02	499.93	27.57	0.00	0.00	0.00	0.00	41.66	74.99	132.55	249.20	26.17	244.46	1075.15	0.00	1844.34	5.83	0.06	0.38
31	277.02	523.78	27.57	0.00	0.00	0.00	0.00	43.65	78.57	135.60	257.82	27.07	244.46	1099.90	0.00	1844.34	5.96	0.06	0.35
32	277.02	548.76	27.57	0.00	0.00	0.00	0.00	45.73	82.31	138.80	266.85	28.02	244.46	1125.83	0.00	1844.34	6.10	0.05	0.33
33	277.02	574.94	27.57	0.00	0.00	0.00	0.00	47.91	86.24	142.15	276.30	29.01	244.46	1153.00	0.00	1844.34	6.25	0.05	0.31
34	277.02	602.36	27.57	0.00	0.00	0.00	0.00	50.20	90.35	145.66	286.21	30.05	244.46	1181.47	0.00	1844.34	6.41	0.04	0.29
35	277.02	631.09	27.57	0.00	0.00	0.00	0.00	52.59	94.66	149.34	296.59	31.14	244.46	1211.29	0.00	1844.34	6.57	0.04	0.27
36	277.02	661.20	27.57	0.00	0.00	0.00	0.00	55.10	99.18	153.19	307.47	32.28	244.46	1242.54	0.00	1844.34	6.74	0.04	0.25
37	277.02	692.74	27.57	0.00	0.00	0.00	0.00	57.73	103.91	157.23	318.86	33.48	244.46	1275.27	0.00	1844.34	6.91	0.03	0.23
38	277.02	725.78	27.57	0.00	0.00	0.00	0.00	60.48	108.87	161.45	330.80	34.73	244.46	1309.57	0.00	1844.34	7.10	0.03	0.22
39	277.02	760.40	27.57	0.00	0.00	0.00	0.00	63.37	114.06	165.88	343.31	36.05	244.46	1345.50	0.00	1844.34	7.30	0.03	0.20
40	277.02	796.67	27.57	0.00	0.00	0.00	0.00	66.39	119.50	170.53	356.41	37.42	244.46	1383.15	0.00	1844.34	7.50	0.03	0.19
			4012.31			**3120.68**												**10.86**	63.06
	L. T(INR/Kwh)=	**5.81**																	

GANDIKOTA PSP (4x250=1000 MW)

S.No	Parameters	Unit	Value		S.No	Parameters	Unit	Value		S.No	Parameters	Unit	Value	S.No	Parameters	Unit	Value
1	Installed Capacity	MW	1000.00		11	ROE	%	15.50		14	Interest rate on W.C	%	10.50	22	Equity	INR in Crs	1337.44
2	Normative availability	%	95.00		12	Working capital				15	O&M Expenses	%	3.50	23	Loan	INR in Crs	3120.68
3	Annual Energy Generation	GWh	1964.92														
4	Annual Energy Generation @ 95% availability	GWh	1866.67			i) Spares(% of O&M)	%	15.00		16	O&M Escalation rate	%	4.77	24	interest on Loan	%	10.00
5	Secondary Energy	GWh	0.00			ii) O&M expenses	Months	1.00		17	Discount Rate	%	9.89	25	Repay P	Yrs	14.00
6	Transformation losses	%	0.50			iii) Receivables	days	45		18	Depreciation Rate	%	5.28	26	Total cost	INR in Crs	4458.12
7	Auxiliary Consumption	%	0.70		13	i) MAT		21.55%		19	Max Dep Allowed	INR Cr.	4012.31	27	Project Life	Years	**40**
8	Transmission losses	%	0.00			II) Tax		25.17%		20	Energy Required for pumping	MU	2444.59				
9	Free Power	%	0.00			III) Tax holiday	years	10.00		21	Rate for off peak energy	INR	**2.00**				
10	Net Saleble energy	MU	1844.34										per unit				

Year	ROE	O&M	Depreciation	Outstanding Principal	Intt on Loan	Loan Principle Paid	Loan Installment	W.C				Intt on	Charges for Pumping	Annual	Energy		Tarrif	Discount	Discounted
								O&M	Spares	Recievables	Total	W.C		Expenses	Free	Sold		Factor	Tariff
	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	GWh	GWh	INR/KWh		INR/KWh
1	264.25	129.43	235.39	3120.68	300.30	235.39	535.69	10.79	19.41	177.55	207.75	21.81	488.92	1440.10	0.00	1844.34	7.81	1.00	7.81
2	264.25	135.60	235.39	2885.29	276.76	235.39	512.15	11.30	20.34	175.40	207.04	21.74	488.92	1422.66	0.00	1844.34	7.71	0.91	7.02
3	264.25	142.07	235.39	2649.91	253.22	235.39	488.61	11.84	21.31	173.28	206.43	21.68	488.92	1405.52	0.00	1844.34	7.62	0.83	6.31
4	264.25	148.85	235.39	2414.52	229.68	235.39	465.07	12.40	22.33	171.21	205.94	21.62	488.92	1388.71	0.00	1844.34	7.53	0.75	5.67
5	264.25	155.95	235.39	2179.13	206.14	235.39	441.53	13.00	23.39	169.18	205.57	21.58	488.92	1372.23	0.00	1844.34	7.44	0.69	5.10
6	264.25	163.39	235.39	1943.74	182.60	235.39	417.99	13.62	24.51	167.19	205.32	21.56	488.92	1356.11	0.00	1844.34	7.35	0.62	4.59
7	264.25	171.18	235.39	1708.35	159.07	235.39	394.45	14.27	25.68	165.25	205.19	21.55	488.92	1340.35	0.00	1844.34	7.27	0.57	4.13
8	264.25	179.35	235.39	1472.96	135.53	235.39	370.92	14.95	26.90	163.35	205.20	21.55	488.92	1324.97	0.00	1844.34	7.18	0.52	3.71
9	264.25	187.90	235.39	1237.57	111.99	235.39	347.38	15.66	28.19	161.51	205.35	21.56	488.92	1310.01	0.00	1844.34	7.10	0.47	3.34
10	264.25	196.87	235.39	1002.18	88.45	235.39	323.84	16.41	29.53	159.71	205.65	21.59	488.92	1295.46	0.00	1844.34	7.02	0.43	3.01
11	277.02	206.26	235.39	766.80	64.91	235.39	300.30	17.19	30.94	159.57	207.70	21.81	488.92	1294.30	0.00	1844.34	7.02	0.39	2.73
12	277.02	216.09	235.39	531.41	41.37	235.39	276.76	18.01	32.41	157.89	208.31	21.87	488.92	1280.67	0.00	1844.34	6.94	0.35	2.46
13	277.02	226.40	235.39	296.02	17.83	235.39	253.22	18.87	33.96	156.27	209.10	21.96	488.92	1267.52	0.00	1844.34	6.87	0.32	2.22
14	277.02	237.20	235.39	60.63	3.03	60.63	63.66	19.77	35.58	155.80	211.15	22.17	488.92	1263.73	0.00	1844.34	6.85	0.29	2.01
15	277.02	248.52	27.57	0.00	0.00	0.00	0.00	20.71	37.28	130.91	188.90	19.83	488.92	1061.86	0.00	1844.34	5.76	0.27	1.54
16	277.02	260.37	27.57	0.00	0.00	0.00	0.00	21.70	39.06	132.43	193.18	20.28	488.92	1074.17	0.00	1844.34	5.82	0.24	1.42
17	277.02	272.79	27.57	0.00	0.00	0.00	0.00	22.73	40.92	134.02	197.67	20.76	488.92	1087.06	0.00	1844.34	5.89	0.22	1.30
18	277.02	285.80	27.57	0.00	0.00	0.00	0.00	23.82	42.87	135.69	202.37	21.25	488.92	1100.56	0.00	1844.34	5.97	0.20	1.20
19	277.02	299.44	27.57	0.00	0.00	0.00	0.00	24.95	44.92	137.43	207.30	21.77	488.92	1114.71	0.00	1844.34	6.04	0.18	1.11
20	277.02	313.72	27.57	0.00	0.00	0.00	0.00	26.14	47.06	139.26	212.46	22.31	488.92	1129.54	0.00	1844.34	6.12	0.17	1.02
21	277.02	328.68	27.57	0.00	0.00	0.00	0.00	27.39	49.30	141.17	217.87	22.88	488.92	1145.07	0.00	1844.34	6.21	0.15	0.94
22	277.02	344.36	27.57	0.00	0.00	0.00	0.00	28.70	51.65	143.18	223.53	23.47	488.92	1161.34	0.00	1844.34	6.30	0.14	0.87
23	277.02	360.79	27.57	0.00	0.00	0.00	0.00	30.07	54.12	145.28	229.46	24.09	488.92	1178.39	0.00	1844.34	6.39	0.13	0.80
24	277.02	378.00	27.57	0.00	0.00	0.00	0.00	31.50	56.70	147.48	235.68	24.75	488.92	1196.26	0.00	1844.34	6.49	0.11	0.74
25	277.02	396.03	27.57	0.00	0.00	0.00	0.00	33.00	59.40	149.79	242.20	25.43	488.92	1214.97	0.00	1844.34	6.59	0.10	0.69
26	277.02	414.92	27.57	0.00	0.00	0.00	0.00	34.58	62.24	152.21	249.02	26.15	488.92	1234.58	0.00	1844.34	6.69	0.09	0.63
27	277.02	434.71	27.57	0.00	0.00	0.00	0.00	36.23	65.21	154.74	256.17	26.90	488.92	1255.12	0.00	1844.34	6.81	0.09	0.59
28	277.02	455.44	27.57	0.00	0.00	0.00	0.00	37.95	68.32	157.39	263.66	27.68	488.92	1276.64	0.00	1844.34	6.92	0.08	0.54
29	277.02	477.17	27.57	0.00	0.00	0.00	0.00	39.76	71.58	160.17	271.51	28.51	488.92	1299.19	0.00	1844.34	7.04	0.07	0.50
30	277.02	499.93	27.57	0.00	0.00	0.00	0.00	41.66	74.99	163.09	279.74	29.37	488.92	1322.82	0.00	1844.34	7.17	0.06	0.47
31	277.02	523.78	27.57	0.00	0.00	0.00	0.00	43.65	78.57	166.14	288.35	30.28	488.92	1347.57	0.00	1844.34	7.31	0.06	0.43
32	277.02	548.76	27.57	0.00	0.00	0.00	0.00	45.73	82.31	169.34	297.38	31.22	488.92	1373.50	0.00	1844.34	7.45	0.05	0.40
33	277.02	574.94	27.57	0.00	0.00	0.00	0.00	47.91	86.24	172.69	306.84	32.22	488.92	1400.67	0.00	1844.34	7.59	0.05	0.37
34	277.02	602.36	27.57	0.00	0.00	0.00	0.00	50.20	90.35	176.19	316.75	33.26	488.92	1429.13	0.00	1844.34	7.75	0.04	0.35
35	277.02	631.09	27.57	0.00	0.00	0.00	0.00	52.59	94.66	179.87	327.13	34.35	488.92	1458.96	0.00	1844.34	7.91	0.04	0.32
36	277.02	661.20	27.57	0.00	0.00	0.00	0.00	55.10	99.18	183.72	338.00	35.49	488.92	1490.20	0.00	1844.34	8.08	0.04	0.30
37	277.02	692.74	27.57	0.00	0.00	0.00	0.00	57.73	103.91	187.76	349.40	36.69	488.92	1522.94	0.00	1844.34	8.26	0.03	0.28
38	277.02	725.78	27.57	0.00	0.00	0.00	0.00	60.48	108.87	191.99	361.34	37.94	488.92	1557.23	0.00	1844.34	8.44	0.03	0.26
39	277.02	760.40	27.57	0.00	0.00	0.00	0.00	63.37	114.06	196.42	373.84	39.25	488.92	1593.17	0.00	1844.34	8.64	0.03	0.24
40	277.02	796.67	27.57	0.00	0.00	0.00	0.00	66.39	119.50	201.06	386.95	40.63	488.92	1630.81	0.00	1844.34	8.84	0.03	0.22
			4012.31			**3120.68**												**10.86**	77.64
	L. T(INR/Kwh)=	**7.15**																	

Annexure-14.2

GANDIKOTA PSP (4x250=1000 MW)

S.No	Parameters	Unit	Value		S.No	Parameters	Unit	Value		S.No	Parameters	Unit	Value	S.No	Parameters	Unit	Value
1	Installed Capacity	MW	1000.00		11	ROE	%	15.50		14	Interest rate on W.C	%	10.50	22	Equity	INR in Crs	1337.44
2	Normative availability	%	95.00		12	Working capital				15	O&M Expenses	%	3.50	23	Loan	INR in Crs	3120.68
3	Annual Energy Generation	GWh	1964.92														
4	Annual Energy Generation @ 95% availability	GWh	1866.67			i) Spares(% of O&M)	%	15.00		16	O&M Escalation rate	%	4.77	24	interest on Loan	%	10.00
5	Secondary Energy	GWh	0.00			ii) O&M expenses	Months	1.00		17	Discount Rate	%	9.89	25	Repay P	Yrs	14.00
6	Transformation losses	%	0.50			iii) Receivables	days	45		18	Depreciation Rate	%	5.28	26	Total cost	INR in Crs	4458.12
7	Auxiliary Consumption	%	0.70		13	i) MAT		21.55%		19	Max Dep Allowed	INR Cr.	4012.31	27	Project Life	Years	**40**
8	Transmission losses	%	0.00			II) Tax		25.17%		20	Energy Required for pumping	MU	2444.59				
9	Free Power	%	0.00			III) Tax holiday	years	10.00		21	Rate for off peak energy	INR	**2.50**				
10	Net Saleble energy	MU	1844.34										per unit				

Year	ROE	O&M	Depreciation	Outstanding Principal	Intt on Loan	Loan Principle Paid	Loan Installment	W.C				Intt on	Charges for Pumping	Annual	Energy		Tarrif	Discount	Discounted
								O&M	Spares	Recievables	Total	W.C		Expenses	Free	Sold		Factor	Tariff
	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	GWh	GWh	INR/KWh		INR/KWh
1	264.25	129.43	235.39	3120.68	300.30	235.39	535.69	10.79	19.41	192.81	223.01	23.42	611.15	1563.93	0.00	1844.34	8.48	1.00	8.48
2	264.25	135.60	235.39	2885.29	276.76	235.39	512.15	11.30	20.34	190.66	222.30	23.34	611.15	1546.49	0.00	1844.34	8.39	0.91	7.63
3	264.25	142.07	235.39	2649.91	253.22	235.39	488.61	11.84	21.31	188.55	221.70	23.28	611.15	1529.36	0.00	1844.34	8.29	0.83	6.87
4	264.25	148.85	235.39	2414.52	229.68	235.39	465.07	12.40	22.33	186.48	221.21	23.23	611.15	1512.54	0.00	1844.34	8.20	0.75	6.18
5	264.25	155.95	235.39	2179.13	206.14	235.39	441.53	13.00	23.39	184.45	220.83	23.19	611.15	1496.06	0.00	1844.34	8.11	0.69	5.56
6	264.25	163.39	235.39	1943.74	182.60	235.39	417.99	13.62	24.51	182.46	220.58	23.16	611.15	1479.94	0.00	1844.34	8.02	0.62	5.01
7	264.25	171.18	235.39	1708.35	159.07	235.39	394.45	14.27	25.68	180.52	220.46	23.15	611.15	1464.18	0.00	1844.34	7.94	0.57	4.51
8	264.25	179.35	235.39	1472.96	135.53	235.39	370.92	14.95	26.90	178.62	220.47	23.15	611.15	1448.81	0.00	1844.34	7.86	0.52	4.06
9	264.25	187.90	235.39	1237.57	111.99	235.39	347.38	15.66	28.19	176.77	220.62	23.16	611.15	1433.84	0.00	1844.34	7.77	0.47	3.66
10	264.25	196.87	235.39	1002.18	88.45	235.39	323.84	16.41	29.53	174.98	220.92	23.20	611.15	1419.29	0.00	1844.34	7.70	0.43	3.29
11	277.02	206.26	235.39	766.80	64.91	235.39	300.30	17.19	30.94	174.84	222.97	23.41	611.15	1418.14	0.00	1844.34	7.69	0.39	2.99
12	277.02	216.09	235.39	531.41	41.37	235.39	276.76	18.01	32.41	173.16	223.58	23.48	611.15	1404.50	0.00	1844.34	7.62	0.35	2.70
13	277.02	226.40	235.39	296.02	17.83	235.39	253.22	18.87	33.96	171.54	224.36	23.56	611.15	1391.35	0.00	1844.34	7.54	0.32	2.43
14	277.02	237.20	235.39	60.63	3.03	60.63	63.66	19.77	35.58	171.07	226.42	23.77	611.15	1387.57	0.00	1844.34	7.52	0.29	2.21
15	277.02	248.52	27.57	0.00	0.00	0.00	0.00	20.71	37.28	146.18	204.17	21.44	611.15	1185.70	0.00	1844.34	6.43	0.27	1.72
16	277.02	260.37	27.57	0.00	0.00	0.00	0.00	21.70	39.06	147.70	208.45	21.89	611.15	1198.00	0.00	1844.34	6.50	0.24	1.58
17	277.02	272.79	27.57	0.00	0.00	0.00	0.00	22.73	40.92	149.29	212.94	22.36	611.15	1210.89	0.00	1844.34	6.57	0.22	1.45
18	277.02	285.80	27.57	0.00	0.00	0.00	0.00	23.82	42.87	150.95	217.64	22.85	611.15	1224.40	0.00	1844.34	6.64	0.20	1.34
19	277.02	299.44	27.57	0.00	0.00	0.00	0.00	24.95	44.92	152.70	222.57	23.37	611.15	1238.55	0.00	1844.34	6.72	0.18	1.23
20	277.02	313.72	27.57	0.00	0.00	0.00	0.00	26.14	47.06	154.53	227.73	23.91	611.15	1253.37	0.00	1844.34	6.80	0.17	1.13
21	277.02	328.68	27.57	0.00	0.00	0.00	0.00	27.39	49.30	156.44	233.13	24.48	611.15	1268.90	0.00	1844.34	6.88	0.15	1.04
22	277.02	344.36	27.57	0.00	0.00	0.00	0.00	28.70	51.65	158.45	238.80	25.07	611.15	1285.18	0.00	1844.34	6.97	0.14	0.96
23	277.02	360.79	27.57	0.00	0.00	0.00	0.00	30.07	54.12	160.55	244.73	25.70	611.15	1302.23	0.00	1844.34	7.06	0.13	0.89
24	277.02	378.00	27.57	0.00	0.00	0.00	0.00	31.50	56.70	162.75	250.95	26.35	611.15	1320.09	0.00	1844.34	7.16	0.11	0.82
25	277.02	396.03	27.57	0.00	0.00	0.00	0.00	33.00	59.40	165.06	257.46	27.03	611.15	1338.80	0.00	1844.34	7.26	0.10	0.76
26	277.02	414.92	27.57	0.00	0.00	0.00	0.00	34.58	62.24	167.48	264.29	27.75	611.15	1358.41	0.00	1844.34	7.37	0.09	0.70
27	277.02	434.71	27.57	0.00	0.00	0.00	0.00	36.23	65.21	170.01	271.44	28.50	611.15	1378.95	0.00	1844.34	7.48	0.09	0.64
28	277.02	455.44	27.57	0.00	0.00	0.00	0.00	37.95	68.32	172.66	278.93	29.29	611.15	1400.47	0.00	1844.34	7.59	0.08	0.60
29	277.02	477.17	27.57	0.00	0.00	0.00	0.00	39.76	71.58	175.44	286.78	30.11	611.15	1423.02	0.00	1844.34	7.72	0.07	0.55
30	277.02	499.93	27.57	0.00	0.00	0.00	0.00	41.66	74.99	178.35	295.00	30.98	611.15	1446.65	0.00	1844.34	7.84	0.06	0.51
31	277.02	523.78	27.57	0.00	0.00	0.00	0.00	43.65	78.57	181.41	303.62	31.88	611.15	1471.40	0.00	1844.34	7.98	0.06	0.47
32	277.02	548.76	27.57	0.00	0.00	0.00	0.00	45.73	82.31	184.60	312.65	32.83	611.15	1497.33	0.00	1844.34	8.12	0.05	0.44
33	277.02	574.94	27.57	0.00	0.00	0.00	0.00	47.91	86.24	187.95	322.10	33.82	611.15	1524.50	0.00	1844.34	8.27	0.05	0.40
34	277.02	602.36	27.57	0.00	0.00	0.00	0.00	50.20	90.35	191.46	332.01	34.86	611.15	1552.96	0.00	1844.34	8.42	0.04	0.37
35	277.02	631.09	27.57	0.00	0.00	0.00	0.00	52.59	94.66	195.14	342.39	35.95	611.15	1582.79	0.00	1844.34	8.58	0.04	0.35
36	277.02	661.20	27.57	0.00	0.00	0.00	0.00	55.10	99.18	198.99	353.27	37.09	611.15	1614.03	0.00	1844.34	8.75	0.04	0.32
37	277.02	692.74	27.57	0.00	0.00	0.00	0.00	57.73	103.91	203.03	364.66	38.29	611.15	1646.77	0.00	1844.34	8.93	0.03	0.30
38	277.02	725.78	27.57	0.00	0.00	0.00	0.00	60.48	108.87	207.25	376.60	39.54	611.15	1681.07	0.00	1844.34	9.11	0.03	0.28
39	277.02	760.40	27.57	0.00	0.00	0.00	0.00	63.37	114.06	211.68	389.11	40.86	611.15	1717.00	0.00	1844.34	9.31	0.03	0.26
40	277.02	796.67	27.57	0.00	0.00	0.00	0.00	66.39	119.50	216.33	402.22	42.23	611.15	1754.65	0.00	1844.34	9.51	0.03	0.24
			4012.31			**3120.68**												**10.86**	84.93
	L. T(INR/Kwh)=	**7.82**																	

GANDIKOTA PSP (4x250=1000 MW)

S.No	Parameters	Unit	Value		S.No	Parameters	Unit	Value		S.No	Parameters	Unit	Value	S.No	Parameters	Unit	Value
1	Installed Capacity	MW	1000.00		11	ROE	%	15.50		14	Interest rate on W.C	%	10.50	22	Equity	INR in Crs	1337.44
2	Normative availability	%	95.00		12	Working capital				15	O&M Expenses	%	3.50	23	Loan	INR in Crs	3120.68
3	Annual Energy Generation	GWh	1964.92														
4	Annual Energy Generation @ 95% availability	GWh	1866.67			i) Spares(% of O&M)	%	15.00		16	O&M Escalation rate	%	4.77	24	interest on Loan	%	10.00
5	Secondary Energy	GWh	0.00			ii) O&M expenses	Months	1.00		17	Discount Rate	%	9.89	25	Repay P	Yrs	14.00
6	Transformation losses	%	0.50			iii) Receivables	days	45		18	Depreciation Rate	%	5.28	26	Total cost	INR in Crs	4458.12
7	Auxiliary Consumption	%	0.70		13	i) MAT		21.55%		19	Max Dep Allowed	INR Cr.	4012.31	27	Project Life	Years	**40**
8	Transmission losses	%	0.00			II) Tax		25.17%		20	Energy Required for pumping	MU	2444.59				
9	Free Power	%	0.00			III) Tax holiday	years	10.00		21	Rate for off peak energy	INR	**3.00**				
10	Net Saleble energy	MU	1844.34										per unit				

Year	ROE	O&M	Depreciation	Outstanding Principal	Intt on Loan	Loan Principle Paid	Loan Installment	W.C				Intt on W.C	Charges for Pumping	Annual Expenses	Energy		Tarrif	Discount Factor	Discounted Tariff
								O&M	Spares	Recievables	Total				Free	Sold			
	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	INR in Cr.	GWh	GWh	INR/KWh		INR/KWh
1	264.25	129.43	235.39	3120.68	300.30	235.39	535.69	10.79	19.41	208.08	238.28	25.02	733.38	1687.76	0.00	1844.34	9.15	1.00	9.15
2	264.25	135.60	235.39	2885.29	276.76	235.39	512.15	11.30	20.34	205.93	237.57	24.94	733.38	1670.32	0.00	1844.34	9.06	0.91	8.24
3	264.25	142.07	235.39	2649.91	253.22	235.39	488.61	11.84	21.31	203.82	236.97	24.88	733.38	1653.19	0.00	1844.34	8.96	0.83	7.42
4	264.25	148.85	235.39	2414.52	229.68	235.39	465.07	12.40	22.33	201.74	236.48	24.83	733.38	1636.37	0.00	1844.34	8.87	0.75	6.69
5	264.25	155.95	235.39	2179.13	206.14	235.39	441.53	13.00	23.39	199.71	236.10	24.79	733.38	1619.90	0.00	1844.34	8.78	0.69	6.02
6	264.25	163.39	235.39	1943.74	182.60	235.39	417.99	13.62	24.51	197.73	235.85	24.76	733.38	1603.77	0.00	1844.34	8.70	0.62	5.43
7	264.25	171.18	235.39	1708.35	159.07	235.39	394.45	14.27	25.68	195.78	235.72	24.75	733.38	1588.01	0.00	1844.34	8.61	0.57	4.89
8	264.25	179.35	235.39	1472.96	135.53	235.39	370.92	14.95	26.90	193.89	235.73	24.75	733.38	1572.64	0.00	1844.34	8.53	0.52	4.41
9	264.25	187.90	235.39	1237.57	111.99	235.39	347.38	15.66	28.19	192.04	235.89	24.77	733.38	1557.67	0.00	1844.34	8.45	0.47	3.97
10	264.25	196.87	235.39	1002.18	88.45	235.39	323.84	16.41	29.53	190.25	236.18	24.80	733.38	1543.13	0.00	1844.34	8.37	0.43	3.58
11	277.02	206.26	235.39	766.80	64.91	235.39	300.30	17.19	30.94	190.11	238.23	25.01	733.38	1541.97	0.00	1844.34	8.36	0.39	3.26
12	277.02	216.09	235.39	531.41	41.37	235.39	276.76	18.01	32.41	188.42	238.85	25.08	733.38	1528.33	0.00	1844.34	8.29	0.35	2.94
13	277.02	226.40	235.39	296.02	17.83	235.39	253.22	18.87	33.96	186.80	239.63	25.16	733.38	1515.18	0.00	1844.34	8.22	0.32	2.65
14	277.02	237.20	235.39	60.63	3.03	60.63	63.66	19.77	35.58	186.34	241.68	25.38	733.38	1511.40	0.00	1844.34	8.19	0.29	2.41
15	277.02	248.52	27.57	0.00	0.00	0.00	0.00	20.71	37.28	161.45	219.44	23.04	733.38	1309.53	0.00	1844.34	7.10	0.27	1.90
16	277.02	260.37	27.57	0.00	0.00	0.00	0.00	21.70	39.06	162.97	223.72	23.49	733.38	1321.83	0.00	1844.34	7.17	0.24	1.74
17	277.02	272.79	27.57	0.00	0.00	0.00	0.00	22.73	40.92	164.55	228.21	23.96	733.38	1334.72	0.00	1844.34	7.24	0.22	1.60
18	277.02	285.80	27.57	0.00	0.00	0.00	0.00	23.82	42.87	166.22	232.91	24.46	733.38	1348.23	0.00	1844.34	7.31	0.20	1.47
19	277.02	299.44	27.57	0.00	0.00	0.00	0.00	24.95	44.92	167.96	237.83	24.97	733.38	1362.38	0.00	1844.34	7.39	0.18	1.35
20	277.02	313.72	27.57	0.00	0.00	0.00	0.00	26.14	47.06	169.79	242.99	25.51	733.38	1377.20	0.00	1844.34	7.47	0.17	1.24
21	277.02	328.68	27.57	0.00	0.00	0.00	0.00	27.39	49.30	171.71	248.40	26.08	733.38	1392.74	0.00	1844.34	7.55	0.15	1.15
22	277.02	344.36	27.57	0.00	0.00	0.00	0.00	28.70	51.65	173.71	254.06	26.68	733.38	1409.01	0.00	1844.34	7.64	0.14	1.05
23	277.02	360.79	27.57	0.00	0.00	0.00	0.00	30.07	54.12	175.82	260.00	27.30	733.38	1426.06	0.00	1844.34	7.73	0.13	0.97
24	277.02	378.00	27.57	0.00	0.00	0.00	0.00	31.50	56.70	178.02	266.22	27.95	733.38	1443.92	0.00	1844.34	7.83	0.11	0.90
25	277.02	396.03	27.57	0.00	0.00	0.00	0.00	33.00	59.40	180.32	272.73	28.64	733.38	1462.64	0.00	1844.34	7.93	0.10	0.83
26	277.02	414.92	27.57	0.00	0.00	0.00	0.00	34.58	62.24	182.74	279.56	29.35	733.38	1482.24	0.00	1844.34	8.04	0.09	0.76
27	277.02	434.71	27.57	0.00	0.00	0.00	0.00	36.23	65.21	185.27	286.71	30.10	733.38	1502.78	0.00	1844.34	8.15	0.09	0.70
28	277.02	455.44	27.57	0.00	0.00	0.00	0.00	37.95	68.32	187.93	294.20	30.89	733.38	1524.31	0.00	1844.34	8.26	0.08	0.65
29	277.02	477.17	27.57	0.00	0.00	0.00	0.00	39.76	71.58	190.71	302.05	31.72	733.38	1546.86	0.00	1844.34	8.39	0.07	0.60
30	277.02	499.93	27.57	0.00	0.00	0.00	0.00	41.66	74.99	193.62	310.27	32.58	733.38	1570.48	0.00	1844.34	8.52	0.06	0.55
31	277.02	523.78	27.57	0.00	0.00	0.00	0.00	43.65	78.57	196.67	318.89	33.48	733.38	1595.23	0.00	1844.34	8.65	0.06	0.51
32	277.02	548.76	27.57	0.00	0.00	0.00	0.00	45.73	82.31	199.87	327.91	34.43	733.38	1621.16	0.00	1844.34	8.79	0.05	0.47
33	277.02	574.94	27.57	0.00	0.00	0.00	0.00	47.91	86.24	203.22	337.37	35.42	733.38	1648.33	0.00	1844.34	8.94	0.05	0.44
34	277.02	602.36	27.57	0.00	0.00	0.00	0.00	50.20	90.35	206.73	347.28	36.46	733.38	1676.80	0.00	1844.34	9.09	0.04	0.40
35	277.02	631.09	27.57	0.00	0.00	0.00	0.00	52.59	94.66	210.41	357.66	37.55	733.38	1706.62	0.00	1844.34	9.25	0.04	0.37
36	277.02	661.20	27.57	0.00	0.00	0.00	0.00	55.10	99.18	214.26	368.54	38.70	733.38	1737.87	0.00	1844.34	9.42	0.04	0.35
37	277.02	692.74	27.57	0.00	0.00	0.00	0.00	57.73	103.91	218.29	379.93	39.89	733.38	1770.60	0.00	1844.34	9.60	0.03	0.32
38	277.02	725.78	27.57	0.00	0.00	0.00	0.00	60.48	108.87	222.52	391.87	41.15	733.38	1804.90	0.00	1844.34	9.79	0.03	0.30
39	277.02	760.40	27.57	0.00	0.00	0.00	0.00	63.37	114.06	226.95	404.38	42.46	733.38	1840.83	0.00	1844.34	9.98	0.03	0.28
40	277.02	796.67	27.57	0.00	0.00	0.00	0.00	66.39	119.50	231.59	417.48	43.84	733.38	1878.48	0.00	1844.34	10.19	0.03	0.26
			4012.31			**3120.68**												**10.86**	92.22
	L. T(INR/Kwh)=	**8.49**																	

CHAPTER-14:

CONCLUSION & RECOMMENDATION

CHAPTER – 14

14. CONCLUSION AND RECOMMENDATION

Present report is prepared based on the limited available data which was collected and subsequently analysis and studies were carried out by WAPCOS.

Following conclusions are drawn and recommended for further consideration by the competent authority:

14.1 Technical Merits of the Project:

- The Gandikota PSP upper dam site have been selected after due diligence and based on the available digital data using latest software and techniques.
- Based on the preliminary geological studies it can be concluded that No geological surprise is envisaged. Geological setup is conducive for underground works.
- No interference is envisaged with hydrological regime of the Pennar River due to the fact that project being close loop Pumped storage project.
- Land requirement of 190 Ha. is on lower side considering the size of the project of 1000 MW.
- Based on preliminary stage studies, it is envisaged that the majority of land is forest and minimum private land is expected.
- Based on the present level of studies no R&R issues seems to be involved.
- The per MW cost is approx. ₹ 3.69 Cr. Only which is very attractive.

14.2 Need of Gandikota Pumped Storage Project

- In view of mandatory large injection of Renewables in to the grid in near future, AP needs advance planning to integrate it and Gandikota PSP can be useful in this regard.
- Pumped Storage is the natural Battery with longer useful life and environmentally friendly proposition of Energy Storage.
- It is learnt that in view of large envisaged injection of renewable various support measures are in active consideration of the Government and likely to be implemented such as differential tariff for peak and off peak, incentive for ancillary services for the operation of grid, black start facility etc.
- There is a precedence and current trend in favour of Pumped Storage projects. West Bengal has already constructed Purulia PSP (900 MW) and Turga PSP (1000 MW) is now under pre-construction. Other states are also going for PSP in an accelerated manner.
- Based on the available data it can be said that in view of overall trend of generation planning and demand, AP would be needing source to generate peak power to improve Hydro: Thermal Mix and provide much needed balance to renewable in year 2025-26 .

Gandikota Pumped Storage Project involves minimum and simple civil works and could be completed in 5 years. The project would afford an annual design energy generation of 1964.92 GWh per year. The cost per MW installed works out as approx. ₹ 3.69 crore / MW.