

**GOVERNMENT OF ANDHRAPRADESH  
WATER RESOURCES DEPARTMENT**



**RALLAPADU PROJECT**



**OPERATION AND MAINTENANCE (O&M)  
MANUAL of RALLAPADU DAM**

**PROJECT ID CODE: AP01LH0013**

**PREPARED BY**

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**Government of Andhrapradesh  
Water Resources Department**

**Disclaimer**

*This Operation and Maintenance Manual for Rallapadu Dam* in no way restricts the dam owner in digressing from her/his responsibilities. The State Dam Safety Organization or the Central Water Commission cannot be held responsible for the efficacy of this Manual developed based on documents provided by the dam owner. The Dam Owner and her/his Operators must exercise appropriate discretion when implementing and using this Operation and Maintenance Manual for managing the O&M of Rallapadu Dam and appurtenant structures.

The Manual was developed for the purpose of organizing and managing the Operation, Inspection and Maintenance of Rallapadu Dam for reducing risk and optimizing performance of the dam.

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**Government of Andhrapradesh  
Water Resources Department  
State Dam Safety Organization**

**PREFACE**

This Operation and Maintenance (O&M) Manual for Rallapadu Dam, contains procedures for carrying out Reservoir and Gates operations, Inspections and Maintenance. It will assist in ensuring that the dam is functioning safely and is being properly operated and maintained. Timely inspection and maintenance is necessary for the safe functioning of the dam and continued productive use of the dam and reservoir. The term “O & M” as employed in this Manual includes operation, inspection, maintenance and repair of dam components, replacement of equipment and appurtenant structures, as required.

This Manual is provided to assist the dam owner in management of Rallapadu Dam in a safe and efficient manner.

This Manual was prepared following the “Guidelines for Preparing Operation and Maintenance Manual for Dams” (Doc. No. CDSO\_GUD\_DS\_O3\_v1.0) published by CWC in the year 2018 under DRIP.

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## CHAPTER 1: GENERAL INFORMATION

The operation and Maintenance (O&M) Manual contains procedures for carrying out Reservoir and Gates operations, Inspections and Maintenance for Rallapadu dam. It will assist in ensuring that the dam is functioning safely and to keep it in a good condition by periodic repairs/maintenance. Timely maintenance is important for the continued safe functioning of the dam and productive use of the dam and reservoir.

The term “O&M” as employed in this Manual includes operation, maintenance, general repairs of dam components including replacement, as necessary.

The Manual is prepared primarily for the dam operations staff and their supervisors who are assigned the responsibility for the physical operations and maintenance of the dam. It contains all information and instructions necessary for them to perform their allotted tasks. In addition to instructions for dam operations staff, the manual defines responsibilities of various dam officials and provides the systematic procedures, guidance and standard forms to ensure safe operation, extend the life and achieve the intended purpose of the dam.

If any unusual and emergency condition arises, then the procedures laid down in the Emergency Action Plan (EAP) are to be followed.

### **1.1 Purpose, Location, Description of Dam**

#### *1.1.1 Purpose*

The purpose of Rallapadu Dam is to store water for irrigation. The project provides irrigation facility to a registered ayacut of 6475 Ha. in Khariff season covered in Kondapuram, Lingasamudram and Gudlur mandals of SPSR Nellore district. Besides, it caters the drinking needs of 116 habitations in Kandukur revenue division.

#### *1.1.2 Location*

Rallapadu Irrigation project is situated at Rallapadu village in Lingasamudram mandal of SPSR Nellore district with global co-ordinates latitude of 15°02'30"N and longitude of 79°42'30"E. It is 35 km away from nearby town Kandukur and 35 kms away from the nearest railway station Kavali in Vijayawada-chennai railway line. Nearest airport is Tirupati Airport, Renigunta which is 190 kms away from the dam.

#### *1.1.3 Description of dam*

Rallapadu Reservoir is a Medium Irrigation Project, completed and commissioned in the year 1958. It was built across Manneru river with a total catchment area of 2202 Sq.Kms out of which intercepted catchment area is 782 Sq. kms. Manneru is one of the main Rivers in “East flowing rivers between Mahanadi and Pennar basin” (Basin code 16 as per CWC). The total length of dam is 2950 M and it comprises of an earthen embankment of rolled filled zoned earth type and two spillways. The main (old) spillway is provided with 10 nos of vertical gates of size 12.19m x 4.57m and two scour vent gates of size 6.10m x 3.05m and the additional spillway is provided with 5 nos of radial gates of size 12.19m x 7.62m. The spillways are located almost at centre of the dam and the maximum height of the dam is 16.46m from the deepest bed of the river. The additional spillway was constructed across the breach portion of the dam in 1999.

## **Salient features of Dam**

### **A. HYDROLOGY**

- |                            |   |                                       |
|----------------------------|---|---------------------------------------|
| a. Catchment area          | : | 2202 km <sup>2</sup>                  |
| b. Mean annual rainfall    | : | 700 mm                                |
| c. Maximum flood discharge | : | 10250.70 m <sup>3</sup> /s (observed) |

### **B. RESERVOIR**

- |                                  |   |               |
|----------------------------------|---|---------------|
| a. Gross storage capacity at FRL | : | 3133 ha-m.    |
| b. Dead storage at DSL           | : | 49.56 ha-m.   |
| c. Live storage capacity         | : | 3083.44 ha-m. |
| d. FRL                           | : | +41.15 m      |
| e. MWL                           | : | +43.89 m      |
| f. DSL                           | : | +34.44 m      |
| g. Area of submergence at F.R.L. | : | 7.0 sq.km     |
| h. Top level of Dam              | : | +45.415 m     |

### **C. MAIN DAM**

- |                          |   |   |
|--------------------------|---|---|
| a) Type                  | : | Rolled filled earth type  |
| b) Total length of dam   | : | 2950 m  |
| c) Maximum height of dam | : | 16.46 m   |
| d) Top width             | : | 7.00 m (from KM0.75 to KM2.95),<br>4.5m (from KM0.00 to KM0.75) |

### **D. OLD SPILLWAY**

- |                         |   |                                      |
|-------------------------|---|--------------------------------------|
| a. Location             | : | (From Ch Km. 1.282 to Ch Km. 1.450)  |
| b. Type                 | : | Glacis                               |
| c. Length of spillway   | : | 168 m                                |
| d. Number of bays       | : | 12 nos                               |
| e. Width of bay         | : | 12.19m(crest gate)/ 6.1m(scour vent) |
| f. Spillway Crest level | : | +35.05 m                             |

### **E. GLACIS VERTICAL GATES**

- |                          |   |                                  |
|--------------------------|---|----------------------------------|
| a. Regular Gates         | : | 10 no.                           |
| b. Regular Gates Size    | : | 12.19 m (W) x 4.57 m (H)         |
| c. Operating arrangement | : | Both manual & Electrical Motors  |
| d. Gate position         | : | Mechanical Dial Indicator        |
| e. Scour Gates           | : | 2 no.<br>6.10 m (W) x 3.05 m (H) |
| e. Scour Gates Size      | : |                                  |



## F. ADDITIONAL SPILLWAY

- |                         |   |                                     |
|-------------------------|---|-------------------------------------|
| a. Location             | : | (From Ch Km. 1.525 to Ch Km. 1.598) |
| b. Type                 | : | Ogee spillway                       |
| c. Length of spillway   | : | 73 m                                |
| d. Number of bays       | : | 5nos                                |
| e. Width of bay         | : | 12.19 m                             |
| f. Spillway Crest level | : | +33.53 m                            |

## G. RADIAL CREST GATES

- |                          |   |                                 |
|--------------------------|---|---------------------------------|
| a. Number                | : | 5 no.                           |
| b. Size                  | : | 12.19 m (W) x 7.62m (H)         |
| c. Operating arrangement | : | Both manual & Electrical Motors |
| d. Gate position         | : | Mechanical Dial Indicator       |

## H. OLD SPILLWAY HOISTS

- |                      |   |                |
|----------------------|---|----------------|
| a. Type              | : | Counter weight |
| b. Number            | : | 1no.           |
| c. Lifting Speed     | : | 0.469m/min     |
| d. Hoisting capacity | : | 10 tonnes      |

## I. ADDITIONAL SPILLWAY HOISTS

- |                      |   |                |
|----------------------|---|----------------|
| a. Type              | : | Rope Drum type |
| b. Number            | : | 1nos           |
| c. Lifting Speed     | : | 0.495m/min     |
| d. Hoisting capacity | : | 55 tonnes      |

## J. SPILLWAY STOP LOG GATES

No stop log gates provided for either spillways

## K. IRRIGATION OUTLET

### Rallapadu Right Distributary System:

- |                              |   |                           |
|------------------------------|---|---------------------------|
| a. Location                  | : | @ Ch. 1829m of earth bund |
| b. Size of Vent              | : | 1.52m x 1.83m             |
| c. Sill level of Head sluice | : | + 34.43m                  |
| d. Length of Canal           | : | 20.14Kms                  |
| e. Bed width                 | : | 7.32m                     |
| f. FSD                       | : | 1.22m                     |
| g. Ayacut under Canal        | : | 14,498Acres               |
| h. Designed Discharge        | : | 220Cusecs                 |
| i. Required Discharge        | : | 220Cusecs                 |

### Rallapadu Left Distributary System:

- |             |   |                          |
|-------------|---|--------------------------|
| a. Location | : | @ Ch. 850m of earth bund |
|-------------|---|--------------------------|

b. Size of Vent	:	0.91m x 1.52m
c. Sill level of Head sluice	:	+35.88m
d. Length of Canal	:	3.00Kms
e. Bed width	:	3.66m
f. FSD	:	0.76m
g. Ayacut under Canal	:	1500Acres
h. Designed Discharge	:	30Cusecs
i. Required Discharge	:	30Cusecs

**L. GATES& HOISTS OF IRRIGATIONOUTLET**

**Emergency Gate (Left Main Canal)** Size: 0.91 m x 1.52 m

1. Level : +35.88m
2. Operation arrangement : Through screw rod with help of gearbox fitted with nut (screw hoist)

**Emergency Gate (Right Main Canal)** Size: 1.52 m x 1.83 m

1. Level : +34.43m
2. Operation arrangement : Through screw rod with help of gearbox fitted with nut (screw hoist)

**1.2 Assignment of Responsibility:****TABLE -1**

Sl. No.	Function	Officers having responsibility
1.	Officer-in-Charge	Executive Engineer, RPR Division, Kandukur.
2.	Operations of equipment at the dam	Deputy Executive Engineer, RPR Subdivision No-2, Rallapadu.
3.	Estimating Inflows in the reservoir and flood forecasting	Executive Engineer, RPR Division, Kandukur.
4.	Authorizing spillway releases	Chief Engineer, Projects, Ongole.
5.	Authorizing releases for irrigation	Chief Engineer, Projects, Ongole.
6.	Recording reservoir data	Assistant Executive Engineer, RPR Subdivision No2, Rallapadu
7.	Routine inspection	Executive Engineer, RPR Division, Kandukur & Deputy Executive Engineer

		RPR Subdivision No-2, Rallapadu.
8.	Maintenance	Executive Engineer, RPR Division, Kandukur &  Deputy Executive Engineer RPR Subdivision No-2 Rallapadu.
9.	Dam safety surveillance including instrumentation.	Executive Engineer, RPR Division, Kandukur & Deputy Executive Engineer RPR RPR Subdivision No-2, Rallapadu.

### **1.3 Collection & Reporting of Dam and Reservoir Data:**

Routine data for the following is to be recorded

- Reservoir water surface elevation.
- Reservoir inflow.
- Spillway outflow.
- Irrigation and water supply releases
- Rain gauge station at Dam site
- Surveillance and monitoring

Records of the following operations in a dam need to be maintained in a chronological manner for reference. These records would be helpful in identifying development of any unusual conditions in the dam.

- Attendance statement during normal operations both during monsoon and non-monsoon period.
- Operations of the spillway gates and outlet works.
- Operating hours of mechanical equipment's.
- Testing/Operation of spillway gates, stop-logs and associated controls.
- Testing/operation of Outlet gates, valves and associated controls,
- Maintenance activities carried out.
- Reservoir and dam inspections.
- Unusual conditions or occurrences including acts of vandalism.
- Attendance statement at the dam during emergency operations.
- Changes to normal operating procedures.
- Communication network checks.
- Safety and special instructions.

- Names and addresses of official visitors (e.g. staff carrying out inspection)
- Any other item pertaining to the operation and maintenance of the dam.

#### **1.4 Public Utilities and Safety:**

The nearest medical assistance available is Lingasamudram health center. And the Rallapadu dam comes under the jurisdiction of Lingasamudram police station which is 5 kms away from dam.

The following are the safety equipment's available at dam site:

- Helmets
- Life Jackets
- Safety belts
- Gum shoes
- Torch lights
- Ropes

#### **1.5 Restricted Area**

Since, there is no alternative road/bridge nearby available for commuters to cross Manneru River, public are being allowed to enter the dam crest road & spillway bridge to utilise it as major district road.

#### **1.6 Staff position, Communication & Warning system:**

##### **1.6.1 Communication System**

The Assistant Executive Engineer of the project has been entrusted with the effective transmission of hydro-metrological and stream flow data through different means which include Short Message Service (SMS), mobile phone/ mobile app (apwr unified mobile app), social media groups and e-mail to the Flood Cell of the A.P.state.

The Superintending Engineer ensures appropriate mechanism to keep local administration informed about extreme inflows, sudden release of water and other exigency conditions.

Contact numbers of key persons of Civil Administration, Police, Ambulance, Fire Station etc. should be listed in communication directory of dam. Regular revision / updating of the Directory shall be carried out from time to time. Necessary information shall be given to the key personals concerned in emergency.

The proper accessibility with jeepable roads has been ensured to all the vulnerable points for constant monitoring during emergency situations.

##### **1.6.2 Warning System:**

At the time of release of water from dam, the district administration and press/media are being intimated. Public residing in downstream areas are informed through mike announcement / social media/ local news channels prior to release of water through crest gates in monsoon period.

Two hours prior to the opening of gates, the siren is blown at every 0.5 hr. interval.

### **1.7 Distribution of Operation & Maintenance Manual**

The list of unit offices to whom the O&M Manual is required to be distributed, are mentioned below:

1. Chief Engineer Projects, Ongole.
2. Superintending Engineer, Irrigation Circle, Ongole.
3. Executive Engineer, RPR Division, Kandukur.
4. Deputy Executive Engineer, Rallapadu Subdivision No-2, Rallapadu.
5. Assistant Executive Engineer, Rallapadu Subdivision No-2, Rallapadu.

### **1.8 List of Supporting Documents & Reference Material**

The list of supporting documents for the O&M manual of Rallapadu project are as under:

1. Operating criteria for the reservoir, spillway & outlets.
2. Flood forecasting and operating criteria.
3. Maintenance procedures.
4. Maintenance schedules.
5. Manufacturer's Manuals & drawings.
6. Regional communications directory for dams.

### **1.9 Schedule of duties for operating personnel**

The duty schedules for operating personnel are given below. All activities should be recorded in dam log book /site registers.

Sl. No.	Component	Frequency	Personnel
1	Visual inspection of crest of the dam (dam top) and visible portions of dam (upstream and downstream faces), foundation, abutment contacts, Spillway and Energy Dissipation Arrangements, Spill channel structures and Outlet structures.	Daily	Assistant Executive Engineer
2	Record water surface elevation	Hourly during monsoon and daily during non-monsoon	Assistant Executive Engineer.
3	Record estimated reservoir inflow and spillway discharge	Hourly during monsoon and daily during non-monsoon	Assistant Executive Engineer.
4	Record releases from outlets /sluices.	Daily	Assistant Executive Engineer.

5	Record seepage from Toe drains, notches of baffle wall on d/s of old spillway & etc.	Daily	Assistant Executive Engineer.
6	Record meteorological data.	Daily	Assistant Executive Engineer.
7	Check security and safety devices.	Daily	Assistant Executive Engineer.
8	Standby generator (DG Sets)	Weekly	Assistant Executive Engineer
9	Drainage systems - Toe drains etc	Weekly	Deputy Executive Engineer
10	Inspection of crest of dam top	Monthly	Deputy Executive Engineer
11	Critical landslides area of Dam & Reservoir	Monthly during monsoon	Executive Engineer
12	Reservoir Periphery	Monthly during monsoon	Executive Engineer
13	Drainage systems - Toe Drains etc.	Monthly	Executive Engineer
14	Measuring devices/Instruments	Monthly	Deputy Executive Engineer
15	Communication Devices	Monthly	Deputy Executive Engineer
16	Status of Vegetation growth	Monthly	Deputy Executive Engineer
17	Check Sign/ Warning display boards near vulnerable locations	Monthly	Deputy Executive Engineer
18	Replace fuse light bulbs	Monthly	Assistant Executive Engineer.
20	Crest of the dam (dam top), Spillway and Energy Dissipation Arrangements, guide walls and Outlet structures	Monthly	Deputy Executive Engineer
21	Abutment contacts	Monthly	Deputy Executive Engineer
22	Rodent problems	Monthly	Deputy Executive Engineer
23	Availability of updated operating instruction of outlet works.	Quarterly	Executive Engineer
24	Check gate air vents of outlet works	Quarterly	Executive Engineer
25	Operation of outlet gates	Before and after crop seasons	Deputy Executive Engineer
26	Visual inspection of crest of the dam (dam top) and visible portions of dam (upstream and downstream faces), foundation, abutment contacts	Quarterly	Executive Engineer
27	Grease gate hanger/ dogging of outlet works	Quarterly	Executive Engineer
28	Check condition of Outlet works & its Energy	Quarterly	Executive Engineer

	Dissipation Arrangement		
29	Operation of crest gates of spillway	Quarterly	Executive Engineer
30	Damage in spillway glacis, energy dissipation arrangement, d/s area etc. of spillway	Quarterly	Executive Engineer
31	Clear bridge drainage spouts of spillway	Quarterly	Deputy Executive Engineer
32	Checking condition of V-notch/other see page measuring devices	Quarterly	Deputy Executive Engineer
33	Checking paint on gates of spillway and outlet works	Half yearly	Deputy Executive Engineer (Mech.)
34	Checking lubrication of wire ropes and application of cardium compound.	Half yearly	Deputy Executive Engineer (Mech.)
35	Checking mechanical hoist bearings and flexible coupling bearings	Half yearly	Deputy Executive Engineer (Mech.)
36	Checking gear systems	Half yearly	Deputy Executive Engineer (Mech.)
37	Exercise of spillway gates	Half yearly	Deputy Executive Engineer (Mech.)
38	Checking rubber seals and seal clamp bar	Half yearly	Deputy Executive Engineer (Mech.)
39	Lubricate gate rollers	Half yearly	Deputy Executive Engineer (Mech.)
40	Top up of Engine oil in Generator	Half yearly	Deputy Executive Engineer
41	Check exposed electrical wiring, Gate limit Switches and adjust.	Half yearly	Deputy Executive Engineer
42	Check condition of painting of metalwork, Gate, Hoists and all exposed metal parts of spillway & outlet works	Half yearly	Deputy Executive Engineer (Mech.)
43	Inspect stilling basin / energy dissipation arrangement after dewatering	Every 5 years	Deputy Executive Engineer
44	Review Dam operation procedures and EAP	Every 5 years	Superintending Engineer, IC, Ongole.
45	Checking of metal welds for damages/ cracks (in gate structure, hoist bridge, tie flats, trunions girder/ supports etc.	Annually	Deputy Executive Engineer (Mech.)
46	Check Electrical Conduits, Pull-out boxes and Switches in Gates/Hoists, Outlet works etc.	Annually	Deputy Executive Engineer (Mech.)

## **CHAPTER 2: PROJECT OPERATION**

The operation of a dam will involve regulation of its reservoir as per project specific requirements, keeping records and ensuring public safety. Proper operation procedures are crucial for maintaining a safe structure.

*Data of historical floods:*

<b>DATE</b>	<b>Maximum flood Dis-charge m<sup>3</sup>/s</b>
01.11.1994	4955
19.10.1996	10250

*Latest Design Inflow Flood and Flood Routing Studies:*

The total maximum design flood of Rallapadu dam was earlier fixed at 3029 cumecs. The spillway was designed with ten number of vertical gates of size 12.19M X 4.57M and two scour vents of size 6.10M X 3.05M. Later, the project experienced unprecedented flood of 4955 and 10250 cumecs in the years 1994 and 1996 respectively and caused heavy damages to the dam and downstream area. After conducting flood routing studies, the Chief Engineer, Investigation, Hyderabad had suggested that a discharge arrangement of 7391 cumecs (2,61,000 cusecs) is to be provided against the inflow design flood of 10,250 cumecs (3,62,000 cusecs) by rising the MWL from +135Ft (+41.15M) to +144Ft (+43.89M) vide their Lr No.Rc.(H&S)/Rallapadu/C4/97, Dt:05-09-1997. Hence, after due approval of Government vide minutes of meeting held on 30-08-1997 in the chambers of principal secretary, I&CAD department, Government of Andhrapradesh, Hyderabad, an additional spillway with five vents of radial gates of size 12.19M X 7.62M was constructed for a discharge capacity of 4298 cumecs in addition to the original spillway and resulted in rise of MWL to +144 Ft (+43.89M), which is 2.74M above the original MWL/FRL +135Ft (+41.15M).

A design flood review study for Rallapadu Project was done by the Central Water Commission in the year 2021 and in its draft report communicated to the RPR Division through Chief Engineer, Central Designs Organisation, Vijayawada, estimated the SPF of Rallapadu Project as 8531 cumecs.

### **2.1 Operation Plan**

The operation of the dam includes maintaining reservoir levels as per the rule curve, regulation of the spillway radial gates and irrigation outlet gates as per the



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reservoir operation schedule/irrigation requirements, safe disposal of the surplus flood waters during monsoon consistent with dam safety, keeping records and ensuring public safety. This Manual covers the normal operation procedures to be followed during both monsoon and non-monsoon.

Special operational procedures are to be followed during emergency situations (out-lined in Para 4.2.1 under Immediate maintenance) and the Emergency Action Plan is to be invoked. Mock drill in respect of operation of gates and all hydro mechanical equipment's are organized prior to the onset of monsoon and the observations are transmitted to State DSO Exercising of all the radial gates of the spillway and service gates of the head regulator is carried out at least twice in a year. Before operation all the gates and hoists are inspected and their parts lubricated and repaired as necessary.

The O&M Manuals of the Gates Manufacturer's would however govern the overall maintenance of Gates & Hoists whenever there is any contradiction with the instructions given in the Manual.

### **2.2 NORMAL OPERATION:**

Rule curve for the dam has not been prepared for this dam. However, in general, during the 3<sup>rd</sup> week of November the dam reaches to its maximum capacity (3133 ha-m) i.e. at FRL.

#### **2.2.1 Instructions for operating control mechanisms:**

The operation of the spillway radial gates shall be done as per the reservoir operating criteria & prevailing practices.

The DOL starter is provided with three buttons namely 'Forward', 'Reverse', 'Stop'. When the forward push button is pressed the gate is raised similarly when the reverse push button is pressed the gate is lowered. With the stop push button, the gate movement is stopped.

In case of power failure the gate operation is done by using a stand by DG set. When DG set is not available the gates are lowered or raised manually by operating the hand drive unit. Only trained authorized persons are allowed to operate the gates.

All the spillway and outlet gates should be tested on a regular schedule along with testing of alarms and associated indicators. The test should include use of both the primary and auxiliary power systems. The maintenance instructions are strictly followed to ensure smooth trouble free operation of the gates.

#### **2.2.2 Operation of the Reservoir:**

When the ensuing inflows from the catchment are sufficient and the Rallapadu reservoir level is rising close to FRL, it shall be ensured that the supplementation from

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Somasila reservoir (inflows from the GKN canal) stopped by pursuing with the Somasila Project field staff for dam safety.

Gate operation sequence including tables giving discharges for different gate openings, monitoring and regulation of inflows and outflows are explained in 2.2.4 and 2.2.6.

### *i) Reservoir Capacities*

The various important reservoir levels and corresponding capacities are given below:

Particulars	RL. In meters (Feet)	Capacity in M. Cum
Minimum draw down level	+34.43 (+112.96)	0.49
Crest level of old spillway/additional spillway	+35.05/+33.53 (+115/+110)	0.84/0.28
Full Reservoir level	+41.15 (+135)	31.33
Maximum water level	+43.89 (+144)	63.30

### *ii) Monsoon Yields*

Inflow data in monsoon months for Rallapadu Dam site is calculated on monthly basis from the actual observed data at Rallapadu Dam and the same expressed as percentage of gross reservoir capacity is given below:

Month	Average yield in M. Cum	Average monthly yield as percentage (%) of reservoir capacity
September	2.05	6.54
October	3.38	10.79
November	26.63	85
December	22.64	72.26
January	2.83	9.04
February to August	--	--

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### iii) Proposed Reservoir Levels during Monsoon Months

The reservoir levels to be maintained should be such that the reservoir receives the average monsoon yields during the particular month so that it is at FRL by 15th December every year. The yield during 2<sup>nd</sup> fortnight of December and the month of January is very meagre and cannot be relied upon for filling of reservoir.

The Executive Engineer located at dam site should use his discretion and judgement to alter the outflows from the reservoir keeping in view of flood releases from upstream projects such as Gandipalem, Mopadu and Nakkalagandi projects apart from the inflows of self-catchment to safe guard the Rallapadu project. The self-catchment has the potential to yield inflows, if significant rainfall occurs, that causes the Rallapadu reservoir surplus in few hours.

### iv) Release of Surplus Water

If reservoir level increases beyond the alarming level, based on the inflows received to the project, the crest gates shall be cautiously opened by issuing warning by sirens and wireless messages to all concerned authorities as prescribed.

The field Engineers shall cautiously observe the trend of the inflow flood where it changes from rising limb to recession limb. In the early hours of flood period i.e., when the flood is in rising trend, the outflow of spillway shall be maintained such that the spillway discharge is slightly higher than the inflow flood. Similarly when the flood falls in to recession limb of hydrograph, the outflow of spillway shall be maintained such that the spillway discharge is slightly lower than the inflow flood for dam safety.

### v) Discretion of Field Engineers

The above recommendations shall be treated as guide lines for average monsoon and run-off conditions. The field Engineer should be extremely vigilant and shall closely watch the rainfall pattern in catchment, storms and resulting yields and floods during the months of October, November and December and take decisions accordingly so that excessive releases are not made nor water is stored more than required, necessitating heavy peak flood releases in panic.

The knowledge, experience and ingenuity of the officer in charge of the reservoir operation blended with fast processing of rainfall and G.D. data of catchment area would provide the best solution for the operation of reservoir.

### **2.2.3 Safety Aspects:**

The information to downstream areas regarding release of flood outflows from spillway should be communicated to our department higher authorities, revenue authorities and police department authorities. As a prelude, a siren shall be blown before releasing of water to the downstream of Manneru river through spillway crest gates to alert the people who are in proximity of downstream riverine area. Adequate prior information shall be disseminated to the downstream villagers through electronic media regarding release of water through crest gates.

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Sign boards of speed limits and caution boards shall be fixed at appropriate places on dam. Public is restricted to access spillway parts like walkway bridge, control rooms, chutes and stilling basins.

### 2.2.4 Flood Release Procedure:

#### 2.2.4.1 Sequence of Spillway Gates operation

The additional spillway is operated first as it is convenient to release high discharges with meagre gate openings due to its advantage of lower crest level compared to old spillway.

Total length of old spillway is 168 m and additional spillway is 73 m.

The regulation of the gates is based on inflow food and past experience. First of all, the central radial gate no.3 shall be opened by 0.3m, thereafter, the other radial gates shall be opened in a sequence with 0.30m opening starting from the gate no.2/4 to end gate i.e., gate no.5/1. Similarly the old spillway gates also to be operated starting from the centre gate to end gate with gate opening 0.3m in the sequence shown below.

In this manner the spillway gates shall be opened in a symmetrical manner starting from the centre towards the end through gradual increase in openings to avoid cross/return flows due to downstream topography. Also care is to be taken to maintain such a gate opening at which there are no vibrations.

While closing the gates, the gate that is opened last should be closed first. The procedure to be followed for closing the gates shall be reverse of the procedure followed for opening of the gates.

Sequence of gate operation of additional spillway shall be as under:

Gate No.	1	2	3	4	5
----------	---	---	---	---	---

Opening Sequence

			3		
		2	3		
		2	3	4	
1	2	3	4		
1	2	3	4	5	

Closing Sequence

1	2	3	4	5	
1	2	3	4		
	2	3	4		
	2	3			
		3			

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Sequence of gate operation of old spillway shall be as under:

Gate No.      1        2        3        4        5        6        7        8        9        10

Opening Sequence

```

                    5
                    5   6
                      4   5   6
                      4   5   6   7
                        3   4   5   6   7
                        3   4   5   6   7   8
                          2   3   4   5   6   7   8
                          2   3   4   5   6   7   8   9
                            1   2   3   4   5   6   7   8   9
                            1   2   3   4   5   6   7   8   9   10
    
```

Closing Sequence

```

    1   2   3   4   5   6   7   8   9   10
    1   2   3   4   5   6   7   8   9
        2   3   4   5   6   7   8   9
        2   3   4   5   6   7   8
            3   4   5   6   7   8
            3   4   5   6   7
                4   5   6   7
                4   5   6
                    5   6
                    5
    
```

Complete closure of the gates shall be accomplished by gradual lowering of the gates by 0.3m to 0.5m in the sequence mentioned above. Gate operation should also be aimed at avoiding flooding of inhabitants on downstream.

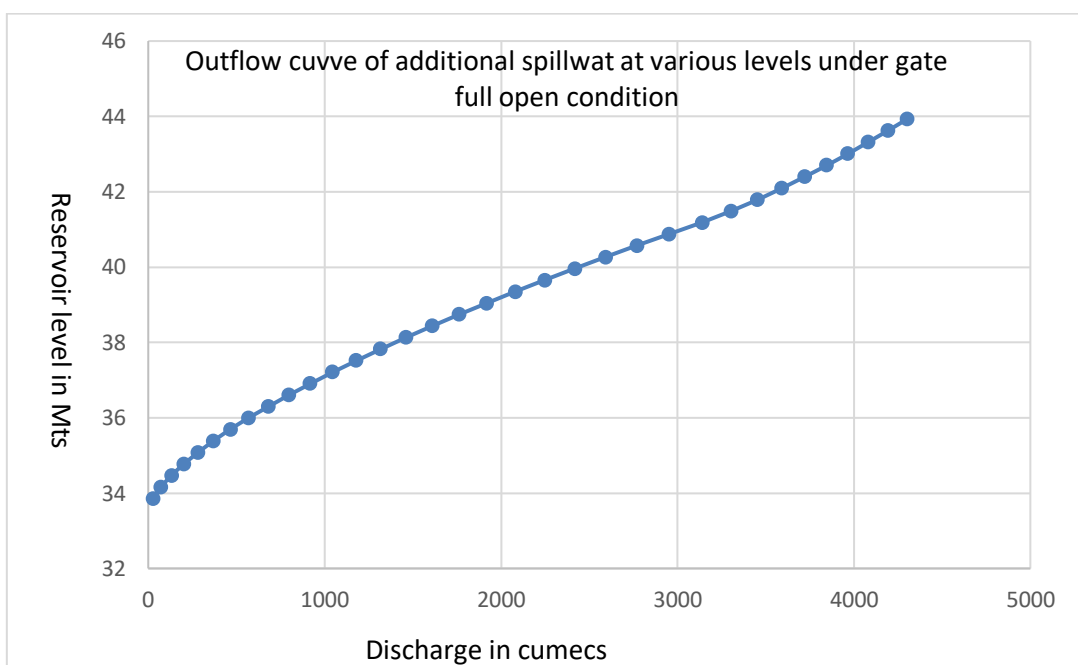
### 2.2.4.2 Discharge through spillway for different reservoir levels with different gate openings

Spillway discharge (free flow) for Rallapadu dam through its 5 Nos additional spillway gates for different reservoir levels under full gate open condition has given in tabular and graphical format below.

Sl. No.	Reservoir Elevation (m)	Reservoir Elevation (Ft)	Outflow m <sup>3</sup> /s
1	+33.83	+111	25.1
2	+34.44	+113	130.45
3	+35.05	+115	280.65

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4	+35.66	+117	464.85
5	+36.27	+119	677.7
6	+36.88	+121	915.7
7	+37.49	+123	1176.5
8	+38.10	+125	1458.15
9	+38.71	+127	1759.3
10	+39.32	+129	2078.75
11	+39.93	+131	2415.45
12	+40.54	+133	2768.6
13	+41.15	+135	<b>3137.5</b>
14	+41.76	+137	3450.4
15	+42.37	+139	3719.05
16	+42.98	+141	3963.35
17	+43.59	+143	4190.25

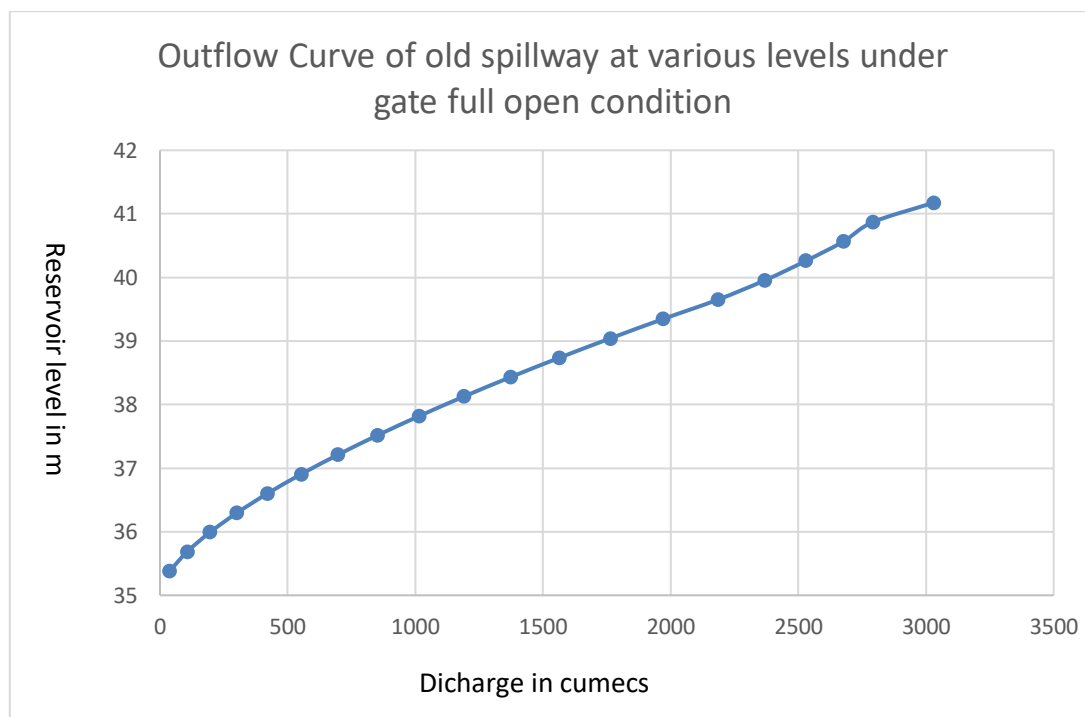


Spillway discharge (free flow) for Rallapadu dam through its 10 Nos old spillway gates for different reservoir levels under full gate open condition has given in tabular and graphical format below.

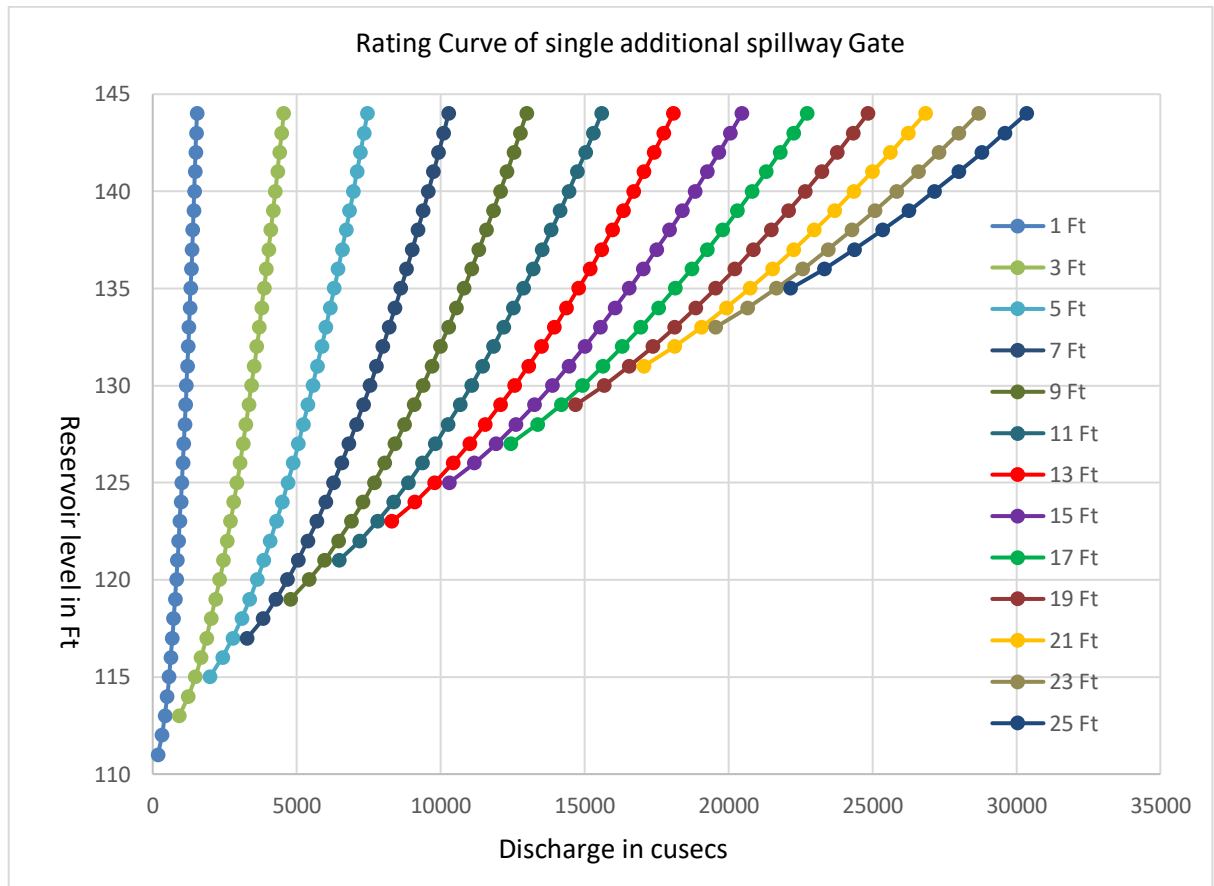
Sl. No.	Reservoir Elevation (m)	Reservoir Elevation (Ft)	Outflow m <sup>3</sup> /s
1	+35.36	+116	37.6
2	+35.66	+117	106.4
3	+35.97	+118	195.4
4	+36.27	+119	300.8

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5	+36.58	+120	420.4
6	+36.88	+121	552.7
7	+37.19	+122	696.4
8	+37.49	+123	850.9
9	+37.80	+124	1015.3
10	+38.10	+125	1189.2
11	+38.41	+126	1371.9
12	+38.71	+127	1563.2
13	+39.01	+128	1762.6
14	+39.32	+129	1969.8
15	+39.62	+130	2184.6
16	+39.93	+131	2369.1
17	+40.23	+132	2529.4
18	+40.54	+133	2676.4
19	+40.84	+134	2792
20	+41.15	+135	3029.6



Further the spillway discharge from a single additional spillway bay for different reservoir levels with partial gate openings has given in tabular and graphical format below.





## RALLAPADU PROJECT GATE OPERATION SCHEDULE OF ADDITIONAL SPILLWAY

## DISCHARGE IN CUSECS AT VARIOUS LEVELS FOR 1 FOOT RISE OF GATE

formula  $Q = 4.432 L \{ H_1^{(3/2)} - H_2^{(3/2)} \}$ ,

H2 = H1 - Gate opening

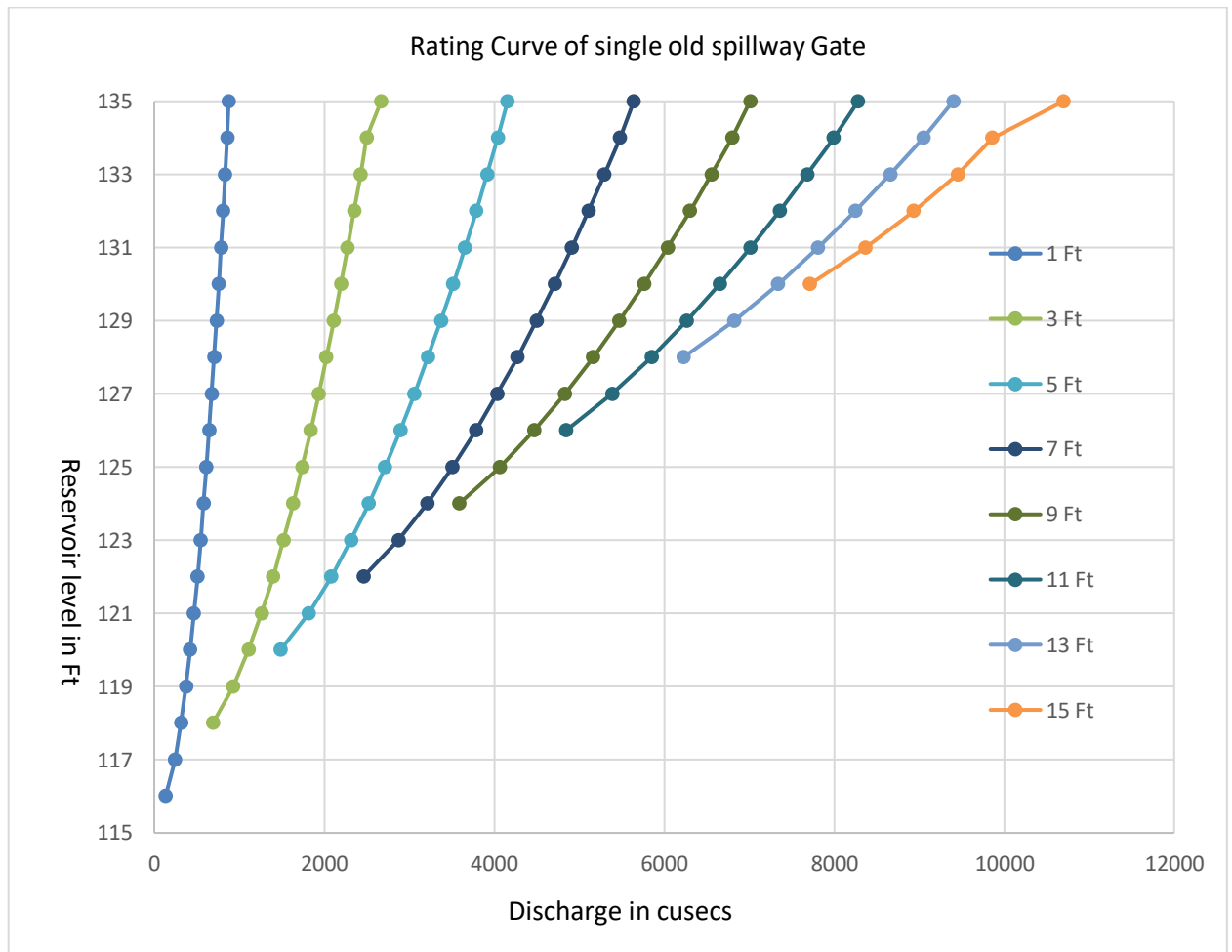
Crest Level ..... +110.00Ft,

F.R.L .....+135.00 Ft,

M.W.L .....+144.00Ft, Size of vent .....40Ft X 25Ft, No. of vents ..... 5

Head over sill in ft (H1)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Water level in ft	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
Gate opening in ft																																		
1	177	324	420	497	564	623	678	728	775	820	862	902	940	977	1013	1047	1080	1112	1144	1174	1204	1233	1261	1289	1316	1343	1369	1395	1420	1444	1469	1493	1516	1539
2		501	744	917	1061	1187	1301	1406	1503	1595	1681	1763	1842	1917	1990	2059	2127	2193	2256	2318	2378	2437	2494	2550	2605	2659	2712	2763	2814	2864	2913	2961	3008	3055
3			921	1241	1481	1684	1865	2029	2181	2323	2456	2583	2703	2819	2930	3036	3140	3239	3336	3430	3522	3611	3698	3783	3867	3948	4028	4106	4183	4258	4333	4405	4477	4548
4				1418	1805	2104	2362	2593	2805	3001	3184	3358	3523	3680	3831	3977	4117	4252	4383	4511	4634	4755	4873	4987	5100	5209	5317	5422	5526	5627	5727	5825	5921	6016
5					1982	2428	2782	3090	3368	3624	3862	4086	4298	4500	4693	4878	5057	5229	5396	5557	5715	5867	6016	6162	6304	6442	6578	6712	6842	6970	7096	7219	7341	7460
6						2606	3106	3510	3865	4188	4486	4764	5026	5275	5513	5740	5958	6169	6373	6570	6761	6948	7129	7305	7478	7646	7811	7973	8131	8286	8439	8588	8735	8880
7							3283	3834	4285	4685	5049	5387	5704	6003	6288	6559	6820	7071	7313	7547	7774	7994	8209	8418	8622	8821	9015	9206	9392	9575	9755	9931	10104	10275
8								4011	4609	5105	5547	5951	6327	6681	7016	7335	7640	7932	8215	8487	8751	9007	9256	9498	9734	9964	10190	10410	10625	10837	11044	11247	11447	11643
9									4787	5429	5966	6448	6891	7304	7694	8063	8415	8752	9076	9389	9691	9984	10268	10545	10814	11077	11333	11584	11829	12070	12305	12536	12763	12986
10										5606	6290	6868	7388	7868	8317	8740	9143	9527	9896	10250	10593	10924	11245	11557	11861	12157	12446	12728	13004	13274	13538	13798	14052	14302
11											6468	7192	7808	8365	8881	9364	9821	10255	10671	11070	11454	11826	12185	12534	12874	13204	13526	13840	14147	14448	14742	15031	15314	15592
12												7369	8132	8785	9378	9928	10444	10933	11399	11845	12274	12687	13087	13474	13851	14216	14573	14920	15260	15592	15917	16235	16547	16853
13													8310	9109	9798	10425	11008	11556	12077	12573	13049	13507	13949	14376	14791	15193	15585	15967	16340	16704	17060	17409	17751	18086
14														9287	10122	10845	11505	12120	12700	13251	13777	14282	14768	15238	15692	16133	16562	16980	17387	17784	18173	18553	18925	19290
15															10299	11169	11925	12617	13264	13874	14455	15010	15543	16057	16554	17035	17502	17957	18399	18831	19253	19665	20069	20464
16																11346	12249	13037	13761	14438	15078	15688	16271	16832	17373	17897	18404	18897	19376	19844	20300	20745	21181	21608
17																	12426	13361	14181	14935	15642	16311	16949	17561	18149	18716	19266	19799	20316	20821	21312	21792	22261	22720
18																		13538	14505	15355	16139	16875	17573	18238	18877	19491	20085	20660	21218	21761	22289	22805	23308	23800
19																			14682	15679	16559	17372	18137	18862	19555	20220	20860	21480	22080	22662	23229	23782	24321	24847
20																				15856	16883	17792	18634	19426	20178	20897	21588	22255	22899	23524	24131	24722	25298	25860
21																					17060	18116	19053	19923	20742	21521	22266	22983	23674	24344	24993	25623	26238	26837
22																						18293	19377	20342	21239	22085	22890	23661	24403	25119	25812	26485	27139	27777
23																							19555	20667	21659	22582	23454	24284	25080	25847	26587	27305	28001	28679
24																								20844	21983	23001	23951	24848	25704	26525	27315	28080	28821	29540
25																									22160	23326	24370	25345	26268	27148	27993	28808	29596	30360

Further the spillway discharge from a single old spillway bay for different reservoir levels with partial gate openings has given in tabular and graphical format below.



**RALLAPADU PROJECT GATE OPERATION SCHEDULE OF OLD SPILLWAY****DISCHARGE IN CUSECS AT VARIOUS LEVELS FOR 1 FOOT RISE OF GATE**

formula  $Q = 3.32 L \{ H_1^{(3/2)} - H_2^{(3/2)} \}$ ,  $H_2 = H_1 - \text{Gate opening}$       Crest Level ..... +115.00Ft, F.R.L .....+135.00 Ft, M.W.L .....+144.00Ft,  
Size of vent ...40Ft X 15Ft, No. of vents .... 10

Head over sill in ft	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Water level in ft	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
Gate opening																				
1	133	243	314	372	422	467	508	545	581	614	645	676	704	732	759	784	809	833	857	876
2		376	557	687	795	889	975	1053	1126	1195	1259	1321	1380	1436	1490	1543	1593	1642	1690	1732
3			690	930	1109	1262	1397	1520	1634	1740	1840	1935	2025	2112	2195	2275	2352	2427	2499	2668
4				1062	1352	1576	1769	1943	2101	2248	2385	2516	2639	2757	2870	2979	3084	3185	3283	3373
5					1485	1819	2084	2315	2523	2715	2893	3061	3220	3371	3516	3654	3788	3917	4042	4157
6						1952	2327	2629	2896	3137	3360	3569	3765	3952	4129	4300	4463	4621	4774	4910
7							2460	2872	3210	3510	3783	4036	4273	4497	4710	4914	5109	5297	5478	5641
8								3005	3453	3824	4155	4458	4740	5005	5256	5494	5723	5942	6153	6340
9									3586	4067	4469	4830	5162	5472	5763	6040	6303	6556	6799	7010
10										4200	4712	5145	5535	5894	6230	6547	6849	7137	7413	7600
11											4845	5388	5849	6266	6653	7015	7357	7682	7994	8281
12												5520	6092	6581	7025	7437	7824	8190	8539	8860
13													6225	6824	7339	7809	8246	8657	9047	9400
14														6957	7582	8124	8618	9079	9514	9900
15															7715	8366	8933	9452	9860	10699

### **2.2.5 Reservoir Capacities:**

#### *Elevation Capacity Curve*

A drawing showing Elevation – Capacity curve of Rallapadu dam is in the drawing section.

In tabular format it is given as under:

<b>Reservoir Level in m</b>	<b>Reservoir Level in Ft</b>	<b>Capacity in Million m<sup>3</sup></b>
+33.53	+110	0.283
+34.44	+113	0.496
+35.36	+116	1.444
+36.27	+119	3.650
+37.19	+122	6.880
+38.10	+125	10.534
+39.01	+128	15.857
+39.93	+131	21.747
+40.84	+134	28.911
+41.15	+135	31.329

### **2.2.6 Inflow forecasting:**

The inflow has to be assessed based on daily rainfall occurred in free catchment area observed from the following rain gauge stations and communication of flood releases from upstream projects viz., Gandipalem Project, Nakkalagandi Reservoir and Mopadu Reservoir. It will be helpful for prediction of probable floods in the river.

<b>Free Catchment Area Rain Gauge Stations of Rallapadu Project</b>		
<b>S.No</b>	<b>Station Name</b>	<b>Mandal</b>
1	Chakala konda	Vinjamur
2	Janarthanapuram	Vinjamur
3	Iskadamerla	Kondapuram
4	Varikuntapadu	Varikuntapadu
5	Iskapalli	Varikuntapadu
6	Udayagiri	Udayagiri

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7	Thirumalapuram	Udayagiri
8	Narravada	Duttalur
9	Pabulavaripalli	Pamur
10	Botla Gudur	Pamur
11	Pamur	Pamur

If 10cm rainfall occurs in isolated area, it won't be much effective or may not have considerable inflows. If the same amount of rainfall occurs in widespread area, it may amount to considerable inflows to the reservoir. Since no gauge point is available in the free catchment area of Rallapadu Project, the field engineers have to assess the inflows meticulously duly monitoring the amount of rainfall occurred in catchment, duration and its pattern i.e, isolated or widespread. Cumulative/hourly real time rainfall data recorded in catchment can be obtained by following the website <http://apsdps.ap.gov.in/Realtime/Rainfall.jsp>.

During monsoon, daily water releases from the Dam at 8 hrs & 16 hrs in normal situation and hourly data exchange during heavy floods is necessary. In this regard, the data is required to be established. The data regarding exchange floods is made available to the Revenue authorities and public by broadcasting in TV, social media and publication in newspapers.

Details of concerned officers of upstream projects for flood coordination of Rallapadu Dam are as listed below.

### ***Gandipalem Project:***

1. Assistant Executive Engineer, Gandipalem Project Section, Udayagiri of GP Subdivision, Udayagiri, SPSR Nellore District, phone number: 9849613175.
2. Deputy Executive Engineer, GP Subdivision, Udayagiri, SPSR Nellore District, phone number: 9491455144.
3. Executive Engineer, Irrigation Division, Atmakur, SPSR Nellore District, phone number: 9848267669.

### ***Nakkalagandi Reservoir:***

1. Assistant Executive Engineer, Vaikuntapadu Section of Special Subdivision, Vinjamur, SPSR Nellore District, phone number: 6303677041, 9642700525.
2. Deputy Executive Engineer, Special subdivision, Vinjamur, SPSR Nellore District, Phone No: 9347664223.
3. Executive Engineer, Nellore North Division, Kavali, SPSR Nellore District, phone number: 9704287658.

### ***Mopadu Reservoir:***

1. Assistant Executive Engineer, Mopadu Reservoir Section, of Kanigiri Subdivision, Prakasam District, phone number: 9000952557.
2. Deputy Executive Engineer, Irrigation Subdivision, Kanigiri, Prakasam District, phone number: 9959694429.

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3. Executive Engineer, Irrigation Division, Ongole, Prakasam District, phone number: 9440903555.

### **2.2.6.1 Inflow Computation**

Inflow into reservoirs is normally estimated by the reservoir gauging method (also called the rise and fall method or inflow-outflow method). All the outflows are added together and to it, difference of capacities with respect to the reservoir levels at certain time intervals will be added or subtracted as case may be (raise or fall).

### **2.2.6.2 Examples of Inflow Computation**

#### Procedure for calculation of reservoir capacity and inflow

Step 1:-Considering the previous day's reservoir level and capacity as base material.

Step 2:-Taking the reservoir level from dam site.

Step 3:-Calculation of reservoir capacity for observed level by using Elevation - capacity table by interpolation method.

Step 4:-Comparing the present day reservoir area and capacity with the previous day values.

Step 5:- Calculation of total outflows from the reservoir in the previous 24 hours.

Step 6:- Calculation of inflows by the addition of total outflows and difference of capacity which arrived in step 4 (i.e., total outflows  $\pm$  reservoir capacity).

Example:- For date of 28-10-2022.

Date	Reservoir level in Ft	Capacity (in Mcft)	Diff in Capacity (in Mcft)
28-10-2022	+127.27	515.52	518.06-515.52=2.54
29-10-2022	+127.31	518.06	

Total outflows in the previous 24 hours: 18 cusecs

Total- 18 cusecs  $\times$  0.0864=1.55 Mcft

Inflows=Total outflows  $\pm$  diff. in capacity from table

$1.55 + 2.54 = 4.09$  Mcft /0.0864 = 47 cusecs.

### **2.3 Emergency operation:**

The emergency operation will be carried out following the Emergency Action Plan (EAP to be prepared). The emergency conditions are outlined in chapter 4 under clause 4.2.1 on Immediate Maintenance. The EAP together with this Manual will be present at site at all times.

**2.4 Record Keeping**

Following records shall be kept for reservoir operations:

1. Reservoir levels – on daily basis during non-monsoon and on hourly basis during monsoon.
2. Rainfall data – on daily basis.
3. Releases through the irrigation outlet on daily basis.
4. Outflow through spillway during monsoon on hourly basis.

## CHAPTER 3: PROJECT INSPECTION

An effective inspection programme is essential for identifying problems and to keep a dam in good and healthy condition. Detailed description on project inspections is available in the Guideline for Safety Inspection of dams: (Doc.No: CDSO\_GUD\_DS\_07\_v1.0),CWC 2018) [https://damsafety.in/ecmincludes/PDFs/Guidelines for Safety Inspection of Dams .pdf](https://damsafety.in/ecmincludes/PDFs/Guidelines%20for%20Safety%20Inspection%20of%20Dams.pdf).

### **3.1 Types of inspections:**

The type of inspection to be conducted will depend on the purpose of the inspection. Dam safety inspections are conducted to determine the health status of the dam and its permanent structures.

Four types of dam safety inspections are to be carried out. They are:

- 1) Informal inspections
- 2) Scheduled inspections
- 3) Special (unscheduled) inspections
- 4) Comprehensive Evaluation inspections.

### **3.2 Informal inspections:**

The informal inspections are performed by the Engineer-in-charge of the dam and his staff while carrying out their regular duties. Informal inspections assist in a continuous surveillance of the dam which is critical to proper operation and maintenance of the dam. They consist of frequent inspections for observing the general issues/problems and functioning of the dam and appurtenant structures. The informal inspections are important and performed at every available opportunity. The informal inspections are not as detailed as comprehensive, scheduled, and special inspections. They require that a formal report be submitted to the dam authorities only if a condition is detected that might endanger the dam.

### **3.3 Scheduled inspections:**

Scheduled inspections are performed to gather information on the current condition of the dam and its appurtenant works. The scheduled inspections consist of pre monsoon and post monsoon inspections and other scheduled inspections. The Pre & Post monsoon inspections are conducted by field engineers every year as per the inspection schedule below mentioned in Chief Engineer, Central Design Organisation, Vijayawada Letter No.CE/CDO/EE-VII/Pre&Post Monsoon/132/2018, Dt: 04/05/2018. The clause 31(1) of the dam safety act, 2021 also asserts these pre and post monsoon inspections undertake every year. The deficiencies noticed shall be endorsed to State Dam Safety Organization for scrutiny and suggestion for possible remedial measures.



**Inspection Schedules**

S.No	Type of Inspection	Last Date for Sending inspection reports to SDSO
1	Pre monsoon	30 <sup>th</sup> June
2	Post monsoon	30 <sup>th</sup> December

NOTE: These inspections are to be carried out by the Executive Engineer, Rallapadu Project Reconstruction Division, Kandukur and the reports are to be uploaded in DHARMA portal “<https://dharma.cwc.gov.in/dharma/login>”.

Other scheduled inspections are conducted at least once in every 5 years by the engineers of State Dam Safety Organisation along with Geologist and representative of Mechanical Wing. All scheduled inspections are to be carried out as per the Guideline for Safety Inspection of dams (Doc. No. CDSO-GUD-DS-07 v 1.0, CWC 2018. [https://damsafety.in/ecmincludes/PDFs/Guidelines for Safety Inspection of Dams.pdf](https://damsafety.in/ecmincludes/PDFs/Guidelines%20for%20Safety%20Inspection%20of%20Dams.pdf))

These inspections will include the following components as a minimum:

1. Review of the past inspection reports, monitoring data and photographs, maintenance records and other pertinent data.
2. Inspection of the dam and its appurtenant works.
3. Preparation of a report with relevant documentation, photographs and uploading them in DHARMA portal.

***3.4 Special (Un Scheduled) inspections:***

Special inspections are performed to resolve specific problems of the dam. This is performed by an independent Expert Panel or Dam Authorities. Special inspections are not regularly scheduled activities but are usually made before or immediately after the dam or appurtenant works have been subjected to unusual events or conditions, such as an unusually high flood or a significant earthquake.

Japan Water Agency (JWA) has developed an excellent system of carrying out inspections after an earthquake event for Ichari Dam, Uttarakhand. For details refer “Inspection Manual for Dam Field Engineers after Seismic Events, Ichari Dam, Uttarakhand (CDSO\_MAN\_DS\_01\_v1.0), January 2018”. The Manual is available at the following link: [https://damsafety.in/ecmincludes/PDFs/Inspection Manual for Dam Field Engineers After Seismic Events.pdf](https://damsafety.in/ecmincludes/PDFs/Inspection%20Manual%20for%20Dam%20Field%20Engineers%20After%20Seismic%20Events.pdf).

### **3.5 Comprehensive Evaluation inspections:**

#### **3.5.1 General:**

For comprehensive dam safety evaluation an independent panel of experts known as Dam Safety Review Panel (DSRP), is to be set up by the Andhra Pradesh, WRD which shall consist of experts from the fields of Geology, Hydrology, Designs, and Construction for determining the condition of dam and appurtenant works. The main objective of the DSRP is to carry out an independent expert review of the overall health status of the dam and to propose remedial measures. The panel would undertake the evaluation of the dam once in 10 years or after occurrence of any extreme events, if required. The State Dam Safety Organization arranges the meetings and site visits of DSRP.

Terms of Reference (TOR) of comprehensive dam safety evaluation shall include but will not to be limited to:

- a) General assessment of hydrologic and hydraulic conditions, review of design flood, flood routing for revised design flood and mitigation measures.
- b) Review and analysis of available data of dam design, construction, operation maintenance and performance of dam structure and appurtenant works.
- c) A visual inspection or field examination of the dam, its appurtenant works, and the surrounding areas.
- d) Review of the instrumentation records and structural behaviour reports, if any.
- e) Evaluation of procedures for operation, maintenance and inspection of dam and to suggest improvements / modifications.
- f) Evaluation of any possible hazardous threat to the dam structure such as dam abutment slope stability failure or slope failures along the reservoir periphery.

#### **3.5.2 Details to be provided to DSRP before inspection:**

All relevant details / data / drawings for the dam project to be examined by the DSRP shall be provided at least 3 months in advance of the proposed visit. This will include:-

##### **a) General Information**

- 1. Scope of project.
- 2. Basic data and salient features.
- 3. Issues related to safety of dam including any earlier dam safety related incidents.
- 4. Emergency preparedness – Communications, Auxiliary power, Downstream Warning system and security at site.

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### ***b) Hydrology***

1. Description of drainage basin.
2. Original inflow design flood, MWL and routed outflow.
3. Revised design flood and flood routing study carried out by the project authorities and approved by CWC.
4. Area – Capacity curves.

### ***c) Geology***

1. Dam site Geology including Geological reports.
2. Any Special problems and their treatment.
3. Reservoir competency as per geological report.
4. Slope stability issues along reservoir rim.

### ***d) Drawings of the dam and HM works***

1. Layout plan.
2. Upstream & Downstream Elevation.
3. Cross Sections of the Dam and Spillway.
4. Foundation treatment details.
5. Junction between Earthen embankment & Concrete /Masonry spillway.
6. Irrigation Outlet details.
7. Layout details of gates and hoists of spillway and irrigation outlet.
8. Instrumentation details.

### ***e) Dam and Spillway***

1. Geological reports.
2. Special problems encountered, if any.
3. Foundation treatment including treatment of faults / shear zones / weak zones, curtain / consolidation grouting, drainage provisions, any other special treatment, cut-off trench, etc.
4. Design criteria and result of stability analysis.
5. Adequacy of design from dam safety considerations.
6. Hydraulic design of Spillway.
7. Pre-construction material testing reports including adequacy of field and laboratory investigations, appropriateness of materials selected etc.

8. Post-construction testing reports, if any.

**3.5.3 Field Inspection – Observation & Recommendations regarding Remedial Measures:**

Each component of the project is inspected, evaluated and specific problems are to be brought out. Recommendations for necessary remedial measures need to be included in the panel's report.

Various project components to be inspected include:

**a) Dam**

1. Upstream face
2. Downstream face
3. Top of dam
4. Structural behaviour as observed visually and as per evaluation of instrumentation data (any visible cracking, deflections etc.)
5. Seepage assessment
6. Condition of natural / excavated slopes in the abutments, both on u/s and d/s of the dam.
7. Any specific problems / deficiencies.

**b) Spillway**

1. Civil structure
2. Spill channel, drop structures etc.
3. Downstream safe carrying capacity of river / channel

**c) River / Canal Outlets**

1. Civil structures
2. Conduits / outlets through Embankment dam.

**d) Review of Sedimentation of the Reservoir**

1. Assessment of sedimentation and its effect on flood routing, operation / life of reservoir.

**e) Flood Hydrology**

1. Extent & Sufficiency of data available
2. Method used for estimating the design flood.

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3. Design flood review study.
4. Flood routing studies with the revised flood.
5. Adequacy of free board available.

### ***f) Miscellaneous services / facilities***

1. Access Roads
2. Communication facilities (Telephone, Mobile etc.)

### ***g) Photographs of dam project showing problem areas***

#### **3.5.4 Components Involved:**

A comprehensive evaluation inspection of a dam typically consists of five components:

1. Project records review (i.e., study of all design / construction records / drawings, history of the dam's performance, past inspection notes / reports, notes on distress observed etc.).
2. Inspection of the dam and its appurtenant works.
3. Preparation of a detailed report of the inspection.
4. Education and training of the dam engineers on the issues observed during dam inspection, identification of potential dam failure modes & to carryout additional field investigations & laboratory testing as required. Dam engineers should be made part of the inspection process so that they take ownership and are committed to implementing the recommended remedial measures.
5. Design studies e.g. review of design flood, checking of the adequacy of spillway capacity, freeboard requirements, dam stability, any special study as required & submission of the report.

## **CHAPTER 4: PROJECT MAINTENANCE**

A good maintenance program will protect a dam against deterioration, prolong its life, and greatly reduce the chance of failure. The dam authorities and operating and maintenance personnel must be knowledgeable of the potential problems which can lead to failure of a dam. Nearly all the components of a dam and its materials are susceptible to damage and deterioration if not well maintained.

This Manual is to be referred to mainly for routine maintenance works.

For most of the rehabilitation works in respect of Condition based and immediate maintenance works, the designs, drawings and technical specifications will need to be provided by the State DSO/Designs offices.

Guidance of experienced engineers/panel of experts will need to be taken.

### **4.1 Maintenance Plan**

Timely maintenance assures that a dam and reservoir would remain in a good working condition and prevents more harmful conditions from developing.

### **4.2 Maintenance Priorities**

Maintenance activities need to be prioritized.

#### **4.2.1 Immediate Maintenance**

The following conditions are critical and require immediate action by Dam authorities.

- Evidence of excessive seepage through the Earth dam, exiting on its downstream face or anywhere on the downstream of the dam and increasing in volume.
- Earth Dam showing signs of piping or internal erosion indicated by increasingly cloudy seepage or other symptoms.
- An increase in the reservoir level to near the top of the dam.
- Water overtopping the earthen dam.
- An Earth dam about to be breached by erosion, slope failure etc.
- A spillway being blocked or with some inoperable gates.

An EAP should be activated when any of the above conditions are noted.

#### **4.2.2.1 Condition based maintenance**

The following maintenance should be completed as soon as possible after the defective condition is noted.

- Removal of all vegetation and bushes from the dam and restoring any eroded areas and to establish good grass cover.
- Fill animal burrows.
- Repair livestock trails and fences to keep livestock off dam.
- Restore and reseed eroded areas and gullies on embankment dams.
- Repairs of any cracks in earth dam.
- Repair of defective gates, valves, and other hydro-mechanical equipment.
- Repair any concrete or metal components that have deteriorated.
- Cleaning/Reaming of choked drainage holes in the dam body/ foundations in concrete / masonry dams / spillways.
- Repair any damages on spillway glacis, piers, energy dissipaters, training/divide walls, downstream areas etc.
- Controlling any heavy seepage in the foundation/ inspection galleries in Masonry/Concrete dam.
- Repairs of any cracks/cavities/joints in masonry/concrete dam/spillway.

#### **4.2.2.2 Routine Maintenance**

- Routine mowing, restore and reseed eroded areas and gullies on downstream face of the embankment section and general maintenance including repairs/cleaning of surface drains on downstream face & in the downstream areas.
- Observation of any springs or seepage areas, comparing quantity and quality (clarity) with prior observations in the embankment section.
- Monitoring of development in the upstream watershed which would materially increase runoff and sediment from storms.
- Monitoring of downstream development which could have an impact on the dam and its hazard category.
- Maintenance of Electrical & Hydro-Mechanical equipment and systems, e.g. servicing of spillway gates, hoisting arrangements, irrigation outlet gates and hoists, and stand by generator.
- Proper lighting at dam top.
- Monitoring of seepage in the earth Dam.
- Maintenance of all dam roads & access roads.
- Operation of electrical and mechanical equipment and systems including gates.

- To keep the gate slots clear of silt/debris.
- Maintenance/testing of monitoring equipment (instruments) and safety alarms.
- Testing of security equipment.
- Testing of communication equipment.
- Any other maintenance considered necessary.

### **4.3 Maintenance Items**

#### **4.3.1 Earth work in earthen dam**

The surfaces of an earthen dam may deteriorate due to several reasons. For example, wave action may cut into the upstream slope, vehicles may cause ruts in the crest or slopes, trails left by live-stock can result in erosion, or runoff waters may leave erosion gullies on the downstream slope. Other special problems, such as shrinkage cracks or rodent damage, may also occur. Damage of this nature must be repaired constantly.

Conditions such as embankment slides, structural cracking, and sinkholes threaten the safety of a dam and require immediate repair under the directions of experienced engineers/experts.

The material selected for repairing embankments should be free from vegetation, organic materials, trash, and large boulders/rocks.

If flow resistant portions (core) of an embankment are being repaired, materials that are high in clay or silt content should be used. If the area is to be free draining or highly permeable (such as pervious shell of an embankment dam) the material should have a higher percentage of sand and gravel. It is usually satisfactory to replace or repair damaged areas with soils like those originally in place.

An important soil property affecting compaction is moisture content. Soils that are too dry or too wet do not compact well. One may test repair material by squeezing it into a tight ball. If the sample keeps its shape without cracking and falling apart (which means it is too dry), and without depositing excess water onto the hand (which means it is too wet), the moisture content is near the proper level.

Before placement of earth, the repair area needs to be prepared by removing all inappropriate material. All vegetation, such as bushes, roots, and tree stumps, along with any large boulders/rocks or trash need to be removed. Also, unsuitable earth, such as organic or loose soils, should be re-moved, so that the work surface consists of exposed, firm, clean embankment material.



Following clean up, shape and dress the affected area so that the new fill can be compacted to the level specified in the technical specifications. Also it should properly key with the existing fill. Further trim the slopes and roughen the surfaces by scarifying to improve the bond between the new and existing fill and to provide a good base to compact against.

Place soils in loose layers up to 20 cm thick and compact manually or mechanically to form a dense mass free from large boulders/rock or organic material. Keep soil moisture in the proper range. The fill should be watered and mixed to the proper wetness and allowed to dry if too wet.

Erosion is one of the most common maintenance problems at embankment structures. Erosion is a natural process and its continuous forces will eventually wear down almost any surface or structure. Periodic and prompt maintenance is essential to prevent continuous deterioration and possible failure.

Turfing, free from weeds and bushes, is an effective means of preventing erosion.

Rills and gullies should be filled with suitable soil, compacted, and then seeded for growing the turfing. Erosion in large gullies can be slowed by stacking bales of hay or straw across the gully until permanent repairs can be made.

Paths due to pedestrian, livestock, or vehicular traffic (two and four-wheeled) are a problem on many embankments. If a path has become established, vegetation will not provide adequate protection and more durable cover will be required unless traffic is eliminated. Stones may be used effectively to cover such footpaths.

In addition, steps can be provided/ constructed at regular intervals along the length of the dam for going from downstream toe to the dam top. All vehicular traffic, except for maintenance, should be restricted from the dam.

Erosion is also common at the point where an embankment and the concrete walls of a spillway or other structure meet. Poor compaction adjacent to such walls during construction and later settlement can result in an area along the wall that is lower than the grade of the embankment.

Runoff, therefore, often concentrates along these structures, resulting in erosion. People also often walk along these walls, wearing down the vegetative cover.

Workable solutions include re-grading the area so that it slopes away from the wall, adding more resistant surface protection, or constructing steps.

#### **4.3.2 Upstream Riprap**

The upstream face of a dam is required to be protected against wave erosion. Riprap is normally provided for the purpose with filter layers below. Nonetheless, erosion can still occur in existing riprap. Water running down the slope under the riprap can erode the embankment. Sections of riprap that have slumped downward are often signs of this kind of erosion. Effective slope protection must prevent soil from being removed from the embankment.

When erosion occurs on the upstream slope of a dam, repairs should be made as soon as possible. (Refer IS: 8237- Code of practice for protection of Slopes for Reservoir Embankments for specifications of stones to be used as riprap). The sunk riprap may be brought back to its original levels by backfilling with suitable material duly compacted and with inverted filter as originally provided under the rip-rap. Further the riprap must be tightly packed.

#### **4.3.3 Controlling Vegetation**

Keep the entire dam clear of unwanted vegetation such as bushes or trees. All bushes/trees should be as far as possible removed by roots. The resulting holes should be filled with well compacted earth. It would be desirable to remove the plants/vegetation at their early stage to prevent their growing into big trees/bushes. In cases where trees and bushes cannot be removed, the root systems should be treated with herbicide (properly selected and applied) to retard further growth. Concerned Government Agencies should be consulted for selection of appropriate herbicides & their use for control of vegetation on dam structures.

Further, it is desirable that there are no trees or bushes within 500 m of the toe drain on the downstream side of the dam. Mowing of turfing needs to be carried out at least twice in a year depending on its growth.

#### **4.3.4 Controlling Animal Damage**

Livestock should not be allowed to graze on an embankment surface. When soil is wet, livestock can damage vegetation and disrupt the uniformity of the surface. Moreover, livestock tend to walk in established paths and thus can promote erosion. Such paths should be regraded and seeded, and the livestock permanently fenced out of the area.

The burrows and tunnels of burrowing animals (beaver, muskrat, groundhogs and others) weaken earthen embankments and serve as pathways for seepage from the reservoir. Large burrows on an embankment should be filled by mud packing. This involves placing vent pipe over the entrance of the den. Making sure that the pipe connection to the den does not leak, the mudpack mixture is poured into the pipe until the burrow and pipe are filled with the soil water mixture. The pipe is removed and more dry earth is tamped

into the entrance. The mud pack is generally made by adding water to 90% earth & 10% cement mixture until a slurry or thin cement consistency is attained. For bigger holes, bentonite coated stones can also be used. All entrances should be plugged with well compacted earth & vegetation re-established. Dens should be eliminated without delay.

#### **4.3.5 Controlling Ants and Termites (White Ants)**

Ants and termites have become one of the most serious pests for Embankment dams. They both need water to survive and have been found on most of the embankment dams in India. These insects can create problems in the dam itself and with any of its electrical components.

In some habitats, ants and termites can move as much or more soil as earthworms, thereby reducing soil compaction. Nest galleries can penetrate in a V-shaped pattern below the nest, penetrating as much as more than one meter deep in the soil. These galleries can create pathways for surface water to penetrate in the dam, resulting in internal erosion and collapse of the surface.

Ants and termites left undisturbed can build mounds that can become quite large. These can create problems for mowing. However, frequent mowing can induce the colonies to migrate to neighbouring, undisturbed areas.

There are many options for managing ants and termites. Use only pesticides labelled as suitable for the location you want to treat. Make every effort to avoid contaminating water with pesticides. Concerned agencies dealing with anti-termite treatment can be contacted.

#### **4.3.6 Controlling Damage from Vehicular Traffic**

As mentioned earlier, vehicles driving across an embankment dam can create ruts in the crest if it is not surfaced with roadway material. The ruts can then collect water and cause saturation and softening of the dam. Other ruts may be formed by vehicles driving up and down a dam face; these can collect runoff and cause severe erosion.

Entry of vehicles should be restricted on the dam top and kept out by fences or barricades. Any ruts should be repaired as soon as possible.

#### **4.3.7 Masonry and Concrete dams/Spillways and appurtenant works**

Various issues that may need routine maintenance in concrete and masonry dams/spillways and appurtenant works may include but are not limited to:

- Removal of vegetation growth on the surfaces of the dam, spillways, energy dissipaters and spill channel.

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- Minor repairs of routine nature.

For complicated problems advice of experienced engineers/ experts will need to be obtained.

### **4.3.8 Outlet Works**

Outlet conduits should be inspected thoroughly once a year.

### **4.3.9 Trash Racks**

Trash racks should be checked during and after floods to ensure that they are functioning properly and to remove accumulated debris.

### **4.3.10 Gates and Hoisting Equipment**

A satisfactory operation of a dam envisages proper operation of its Gates & their Hoisting Equipment. If routine inspection of the Hydro-Mechanical Equipment shows the need for maintenance, the work should be completed as soon as possible.

The O&M Manuals of the Gates Manufacturer's would however govern the overall maintenance of Gates & Hoists whenever there is any contradiction with the instructions given in the Manual.

#### **4.3.10.1 vertical lift fixed wheel and slide Gates**

Vertical gates are provided in the old spillway of the Rallapadu dam. The aspects to be inspected and maintained periodically for ensuring proper operation of these gates are as under:

- i) The gate slot and bottom platform/sill beam should be cleaned periodically. Scales formed over the embedded parts should be removed. Second stage concrete should be checked for any development of cracks/leakages and repairs should be attended to immediately.
- ii) The gate leaf should be thoroughly cleaned and repainted as and when necessary according to the procedure or guidelines- indicated in **IS: 14177** or as per the recommendations of the paint manufacturer. All drain holes provided in the gate assembly should be cleaned.
- iii) Rubber seals should be smoothened, if required, for proper alignment. All nuts and bolts fixing the seal to the gate should be tightened uniformly. Seals, if found damaged or found leaking excessively should be adjusted, repaired or replaced as considered necessary.
- iv) The wheel shall be rotated to check their free movement. Gate roller bearings and guide roller bushes should be properly lubricated. Whenever necessary these should be opened for rectifications of defects, cleaning and lubrication and should thereafter be refitted. These may be replaced if repairs are not possible.

- v) Hoisting connection of the gate leaf should be lubricated where necessary and defects if any should be rectified.
- vi) All nuts, bolts, check nuts and cotterpins of the lifting devices should be checked periodically.
- vii) All components should be greased and lubricated. Recommended and approved oils and grease only should be used.
- viii) Roller assembly should be adjusted by the eccentricity arrangement to ensure all rollers rest uniformly on the track plates particularly in the closed position of the gate.
- ix) Where filling valves are provided as part of the gate structure, all the nuts, bolts, check nuts etc. should be tightened.
- x) All welds shall be checked for cracks/damages. Any weld that might have become defective should be chipped out and redone following the relevant code provisions. Damaged nuts, bolts, rivets, screws etc. should be replaced without delay.
- xi) The filling-in valves allow passage of water when it is lifted by lifting beam & crane due to creation of space between stem seat and exit passage liner. The springs and associated components should be checked periodically for damages and replaced if necessary.
- xii) The guide-assemblies, wheel-assemblies and sealing-assemblies shall be cleared off grit, sand or any other foreign material.
- xiii) The wheel pin shall be coated with corrosion resistant compound.
- xiv) All nuts and bolts shall be tightened.
- xv) The leakage of water through 5 vertical gates can be measured by observing the depth of flow over rectangular notch provided in baffle wall on downstream of old spillway as per clause 2.1.9.2 of IS 14750 (2000): Code of practice for installation, maintenance and observation of seepage measuring devices for concrete/masonry & Earth/Rockfill Dams.
- xvi) The leakage calculated above shall be within the permissible limits as specified in clause 8.5 of IS 7718 (1991): Recommendations for inspection, testing and maintenance of fixed wheel and slide gates.

#### **4.3.10.2 Radial Gates**

The main components of these gates are as under;

##### **a) Embedded Parts:**

➤ **Common Anchorages (Bonded Anchorages)**

- Sill beam Assembly
- Wall plate Assembly
- Horizontal Anchor Rods
- Trunnion Girder
- Trunnion girder chairs
- Vertical rods
- Thrust block (If tie between trunnion is not used)

➤ **Independent Anchorages (Un bonded Anchorages)**

- Sill beam assembly
- Wall plate assembly
- Anchor girders
- Load Anchors / Tie flats
- Yoke girders
- Rest plate
- Vertical rods etc.
- Thrust block (If tie between trunnion is not used).

**b) Radial Gate Leaf:**

➤ **Common Anchorages (Bonded Anchorages)**

- Skin plate
- Side guide and seal assembly
- Vertical stiffeners
- Horizontal Girders
- Horizontal Girder Bracings
- Arm Assembly
- Trunnion

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- Trunnion pin
- Trunnion Bush
- Trunnion Bracket
- Tie between trunnion and thrust Block

### ➤ **Independent Anchorages (Un bonded Anchorages)**

- Lifting Bracket
- Skin plate
- Side guide and seal assembly
- Vertical stiffeners
- Horizontal Girders
- Horizontal Girder Bracings
- Arm Assembly
- Trunnion
- Trunnion pin
- Trunnion Bush
- Trunnion Bracket
- Tie between trunnion or Thrust block

Radial gates are provided in the additional spillway of the Rallapadu dam. The aspects to be inspected and maintained periodically for ensuring proper operation of these gates are as under:

#### **i) Rubber Seals**

- Seals shall be inspected for leakages. Locations of excessive leakages shall be recorded for taking remedial measures. Weeping or slight flow in localized area will not require immediate remedial measures. However, measures like tightening of bolts are carried out. Further adjustment is carried out during annual maintenance.
- If leakage is excessive & immediate repair is considered necessary, the seals should be repaired as soon as the reservoir water level is below the spillway crest level.

**ii) Trunnion block assembly and its anchorages**

- All the nuts and bolts of Trunnion block assembly and its anchorages shall be checked for tightness.
- Check all the welds for soundness and rectify defects.
- Check whether the Yoke girder and thrust block is covered or not. If not, cover it with mild steel plates.
- Cover the trunnion pin with anticorrosive jelly.
- Remove all dirt, grit etc. from trunnion assembly and lubricate trunnion bearings of the gate with suitable water resisting grease as recommended by bearing manufacturers (Annexure – A).

**iii) Gate structure**

- Check all the welding for soundness and rectify defects.
- Check welding between arms and horizontal girders as well as between latching bracket and skin plate with the help of magnifying glass for cracks/defects and rectify the defects.
- Clean all drain holes including those in end arms, trunnion blocks and horizontal girders and ensure no stagnation of water on them to prevent corrosion.
- Check all the nuts and bolts and tighten them. Replace damaged ones.
- Check upstream face of skin plate for pitting, scaling and corrosion. Scaling may be filled with weld and grinded. Corroded surface shall be cleaned and painted.

**iv) Embedded Parts**

- All the sill beams and wall plates shall be inspected for crack, pitting etc. and defects shall be rectified.
- The guide roller pins shall be lubricated (Annexure – A).

**v) General Maintenance**

- Defective welding should be chipped out and it should be re welded duly following the relevant Codal provision (IS: 10096, Part-3).
- Damaged nuts, bolts, rivets, screws etc. should be replaced.



- Any pitting should be filled up by welding and finished by grinding if necessary.
- The gate leaf, exposed embedded metal parts, hoists and hoist supporting structure etc., should be thoroughly cleaned and repainted when required keeping in view the original painting system adopted and as per the guidelines contained in IS: 14177.

Trunnion bearing should be greased as and when required (Annexure –A). Keeping trunnion bearings in perfect working condition is very important. All other bolted connections should also be checked up for proper tightness.

- Bolts and Trunnion bearing housing should be tightened wherever required.
- The seals of the gate should be checked for wear and tear and deterioration. These should be adjusted/replaced as and when necessary.
- The wall plates, sill beams shall be checked and repaired if necessary.
- Wire ropes should be properly lubricated (Annexure – A).
- Oil level in the worm reduction unit should be maintained by suitable replenishment. Oil seals should also be replaced if required. Lubrication of other parts of hoists such as chains, position indicators and limit switches should also be done (Annexure – A).
- The stroke of the brake should be reset to compensate for lining wear. Worn out brake linings should be replaced in time.
- Flexible couplings should be adjusted if required.
- Repairs and replacements of all electrical relays and controls should be attended to.
- Maintenance of alternative sources of Power such as Diesel Generating sets and alter-native drives wherever provided should be carried out.
- The list of essential spare parts to be kept available should be reviewed and updated periodically. The condition of spares should be checked periodically and protective coating given for use.

#### ***4.3.10.3 Electrically operated fixed hoists***

##### **a) General Instructions**

- Never open any bolt or nut on motor, gear boxes, rope drums and other load carrying hoist components when the gate is in raised position. The gate should be fully closed or rested on the gate latches before carrying out any work on hoist components including motor brake and other electrical equipment.

##### **b) Inspection and Maintenance**

The aspects to be inspected and maintained periodically for ensuring proper operation of Rope drum hoists are as under;

- Entrance to all hoist platforms shall be kept locked. All keys shall remain with the shift supervisor.
- A cursory daily inspection shall be made of hoist and gate to ensure that there is no un-usual happening.
- Clean all hoisting equipment and hoist platform.
- Check oil level in gear boxes and replenish as and when required with oil of proper grade.
- Apply grease of suitable grade by grease gun (Annexure –A).
- Lubricate all bearings, bushings, pins, linkages etc (Annexure –A).
- Check all the fuses on the power lines.
- All bolts and nuts on gear boxes, hoist drum and shaft couplings should be checked for tightness.
- Check the supply voltage.
- Drain sample gear oil from each of the gear boxes. If excessive foreign particles or sludge is found, the gear box shall be drained, flushed and filled with new oil.
- All the geared couplings shall be greased (Annexure –A).
- Raise and lower the gate by hoist motor and check for smooth, and trouble free operation of gate without excessive vibration.
- Observe current drawn by motor at the time of lifting and check if it is more than normal. If so, stop the hoist and investigate the cause and rectify.
- Check the condition of painting of various components and remove rust wherever noticed and repaint the portion after proper cleaning as per painting schedule.
- All trash, sediments and any other foreign material shall be cleared off the lifting rope and lifting attachment.
- All ropes shall be checked for wear and tear and if broken wires are noticed, the rope shall be replaced.
- All the wire ropes shall be checked and all visible oxidation shall be removed.
- All wire ropes shall be greased with **cardium compound** (Annexure –A).
- Check the overload relays for proper functioning.

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- Check all the nuts, bolts, rivets, welds and structural components for hoisting platform and its supporting structure for wear, tear and damage. All damages shall be rectified. All bolts shall be tightened. The portion with damaged painting shall be touched up.
- Check the pulleys, sheaves and turn-buckles.
- Raise and lower the gate for its full lift several time (at least three to four) and observe the following:
  - a. Check the limit switches and adjust for design limits.
  - b. The effectiveness and slip of the breaks shall be checked by stopping the gate in raising and lowering operations. The brakes shall be adjusted if needed.
  - c. When the gate is operated, there should not be any noise or chatter in the gears.
- Adjust the rope tension of wires if unequal.
- Check for all gears and pinions for uneven wear and adjust for proper contact. Grease the gears (Annexure –A).
- Repaint the hoist components, hoisting platform and its supporting structures as per requirement.
- The periodic maintenance of commercial equipment like motors, brakes, thrusts etc. shall be carried out as per manufacturers operation and maintenance manual.

### ***4.3.10.3.1 Maintenance of Electrical components of Fixed Rope Drum Hoists***

The Electrical components to be inspected and maintained periodically are as under;

- Starters should be cleaned free of moisture and dust.
- Each individual contactor should be tried by hand to make sure that it operates freely.
- All wearing parts should be examined in order to take note of any wear which may have occurred during operation.
- If the contactor hums, the contact faces should be cleaned.
- Examine all connections to see that no wires are broken and no connections are loose.
- Clean the surface of the moving armature and magnet core which comes together when the contactor closes, free of dust or grease of any kind.

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- Examine the mechanical interlocks between the reversing contactor and see when the contact tips of one of the contactor units are touching, it is impossible to get the contact tips of the other unit to touch.
- The contact tips should be kept free from burns or pits by smoothening with fine sand paper or emery paper.
- Replace the contact tips which have worn away half way.
- Do not lubricate the contacts.
- Blow out windings thoroughly by clean and dry air to clear air passage in the stator and the rotor of any accumulated dirt. The air pressure shall not be too high to damage the insulation.
- Examine earth connections and motor leads.
- Examine motor windings for overheating
- Examine control equipment's
- Examine starting equipment for burnt contacts
- Check and tighten all nuts and bolts
- Clean and tighten all terminals and screw connections all contact surfaces shall be made clean and smooth.
- Lubricate the bearings
- Overhaul the controllers
- Inspect and clean circuit breakers.
- Wipe brush holders and check bedding of brushes.
- Blow out windings thoroughly by clean and dry air. The pressure shall not be so high that insulation may get damaged.
- Check the insulation resistance of the motor between any terminal and the frame. If the measured resistance is less than the prescribed value, then steps shall be taken to dry-out the motors either by passing a low voltage current through the windings or by placing the stator and rotor only in a warm dry place for a day or so.  
**Important:** The complete motor shall never be put in an oven for drying as that may melt the grease out of bearings.
- Coat the windings with an approved high temperature resisting insulation enamel or varnish.

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- Over haul the motor, if required.
- Check the switch fuse units and renew, if required.
- Check resistance or earth connections.
- Check air gap.

### **Solenoids Operated Brakes**

- All fixing bolts shall be checked and tightened at least once in three months.
- The magnet stroke should be reset to compensate for wear.
- Re adjust the brake when the magnet stroke reaches the value given on the instruction plate.
- Brake lining should be checked and replaced when required.
- Examine all electrical leads and connections.
- Rubber bushes or couplings should be checked and replaced if defective.
- The pins should be tightened.
- Brake drum shall be cleaned to remove any dust or grease.

#### **4.3.10.4 Stop log gates & Gantry crane**

*No stop log gates and gantry crane is provided to the additional spillway of project.*

#### **4.3.10.5 Painting of radial gates and hoists**

Painting of gates is essential to prevent rusting and corrosion since the gates are exposed to sun, rain and air.

Brass plates, stainless steel flats and rubber seals shall be cleaned only and shall not be painted.

Painting for hydro-mechanical works is to be carried out as prescribed in IS: 14177 for newly manufactured as well as old & used gates, hoists and associated works after proper surface preparation. The preparation includes thorough cleaning, smoothing irregular surfaces, rusted surfaces, weld spatters, oil, grease, dirt, earlier applied damaged layers of primers/paint by use of mechanical tools, by use of solvents, wire brush etc.

Painting schedule should be planned in such a way that 50% gates and hoists with allied components in a project are painted every year. The following paints are recommended for painting of gates and hoists.

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S.No	Item	Paints recommended	Frequency of painting
1	Gate Leaf upstream side	Anti-corrosive black paint HD (Coal tar based epoxy paint)	Two coats in alternate years
2	Gate Leaf (downstream side) and other parts of gates and hoists	Anti-corrosive black paint LC (Coal tar based epoxy paint)	Single coat in alternate years
3	Hoist covers and railing pipes	a)primary coat: Red oxide b)Final Coat: Aluminium Oxide or Enamel paint	Single coat in alternate years

Each coat of primer and paint shall be compatible with previous and subsequent coats and shall be free from runs, drops, pinholes, waves, laps, sags and unnecessary brush marks and shall be allowed to dry or to harden before succeeding coat is applied.

During painting the air temperature shall be well above the dew point and not less than 7°C and the relative humidity not greater than 80% .The time of painting shall be such that moisture does not condense on gate before or during painting or until the paint is dry.

Painting shall be discontinued during rain and dust storm and shall not commence until the surfaces are perfectly dry and clean. Wherever practicable, surfaces shall be painted when in shade or when the temperature is falling.

Coats of coal tar epoxy paint shall be provided at an interval of 24 hours and each coat shall give a dry film of 100 microns.

### **4.3.11 Electrical System**

Electricity at Rallapadu dam is used for lighting and operation of the gates, hoists, recording equipment, and other miscellaneous equipment. It is important that the Electrical system be well maintained, including a thorough check of fuses and a test of the system to ensure that all parts are properly functioning. The system should be free from moisture and dirt, and wiring should be checked for corrosion and mineral deposits.

All necessary repairs should be carried out immediately and records of the works kept. Maintain generators used for auxiliary emergency power change the oil, check the batteries and anti-freeze and make sure fuel is readily available.

Monitoring devices usually do not need routine maintenance. Open areas are particularly susceptible to vandalism. As such all electrical fittings like bulbs, lights, loose

wires etc. in open areas should be checked routinely and replaced/repared where needed. The recommendations of the manufacturer should also be referred to.

#### **4.3.12 Metal Component Maintenance**

All exposed, bare ferrous metal of any installation, whether submerged or exposed to air, will tend to rust. To prevent corrosion, exposed ferrous metals must be either appropriately painted (following the paint manufacturer's directions) or heavily greased in respect of moving parts & on surfaces like guides & track seats on which there is movement of gates. When areas are repainted, it should be ensured that paint is not applied to gate seats, wedges, or stems (where they pass through the stem guides), or on other friction surfaces where paint could cause binding. Heavy grease should be applied on friction surfaces to avoid binding. As rust is especially damaging to contact surfaces, existing rust is to be removed before periodic application of grease.

#### **4.3.13 Access Roads**

For a dam to be operated and maintained there must be a safe means of access to it at all times. Access road surfaces must be maintained to allow safe passage of automobiles and any required equipment for servicing the dam in any weather conditions. Routine observations of any cut and fill slopes along the sides of the road should be made. If unstable conditions develop assistance of experienced Engineers/Expert Panels should be obtained and remedial measures initiated.

Drains are required to be provided and maintained along roads to remove surface and subsurface drainage. This will prolong the life of the road and help reduce deterioration from rutting. Road surface should be repaired or replaced as necessary to maintain the required traffic loadings. In most cases, specialized contractors will be required to perform this maintenance.

#### **4.3.14 General Cleaning**

For proper operation of spillways, sluiceways, approach channels, inlet and outlet structures, stilling basin/ energy dissipation arrangements, discharge conduit, dam slopes, trash racks, debris control devices etc., regular and thorough cleaning and removal of debris is necessary. Cleaning is especially important after large floods, which bring a lot of debris.

#### **4.4 *Materials requirements for maintenance during monsoon period***

Materials required during monsoon period for both immediate maintenance and preventive maintenance should be stocked in adequate quantity. A 24x7 hour patrolling is to be carried out during the monsoon period.

The dam owner should have a list of labourer's and contractors who can be engaged immediately at the time of emergency.

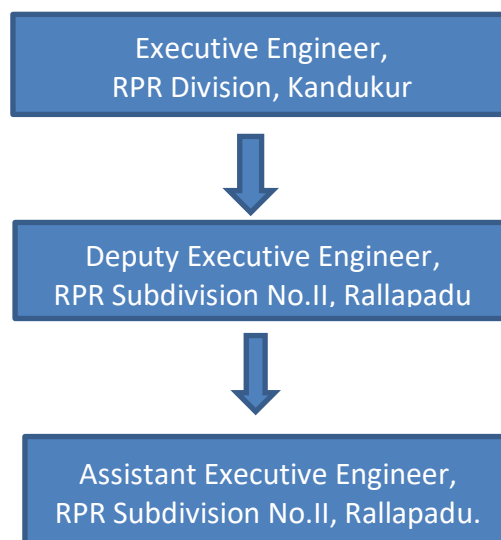
The materials normally required to be stocked in sufficient quantity are:-

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- Gunny Bags
- Sand, Boulders/Wire crates
- Bamboos / Bali's
- Baskets, ropes
- Petromax Lamps with Spares
- Torches with spare cells
- Diesel for DG set
- Kerosene Oil
- Match Boxes
- Rain Coats
- Gum Boots
- Life Jackets
- Warning sign indicator
- Danger zone lights

### **4.5 Establishment Requirements**

The following figure shows the Organizational Structure for the Operation and Maintenance of Rallapadu dam. The Hydro-Mechanical components of the dam are being looked after by the General Superintendent, P.W Workshop Division, Sitanagaram, Vijayawada.



### **Engineering O&M Organization Structure for Rallapadu dam**

In addition to the personnel shown above, there will be other supporting staff (skilled/unskilled), regular/ work charged staff/ Labour and clerical staff depending upon the requirements in monsoon& non-monsoon period.



#### **4.6 Preparation of O&M budget**

The clause 21 of dam safety act, 2021 states that “Every owner of the specified dam shall earmark sufficient and specific funds for maintenance and repairs of the specified dam and to implement the recommendations of the State Dam Safety Organisation”.

The O&M budget for Rallapadu Project should essentially include but not limited to the following items:

**Establishment Cost of Regular Staff** - Salaries and allowances, Bonus, Medical Reimbursement, LTC, Leave Encashment, pension benefits, etc. (as applicable).

**Establishment Cost of Work charged Staff** - Salaries and allowances, Bonus, Medical Reimbursement, LTC, Leave Encashment, Pension benefits, TA and DA, etc. (as applicable).

**Establishment Cost of Daily wage Staff** - Salaries and allowances, TA and DA etc. (as applicable).

**Office Expenses** –Rent for office, Telephone/Mobile/any other Telecommunication bills, Electricity bills, water bills, Office stationery, Day to day office requirements.

**Motor Vehicles** - Running and Maintenance cost of inspection vehicles, Cost of hiring of vehicles as required

**Maintenance of Colony** - Maintenance of staff quarters, colony roads, Electricity, Sanitary and Water supply systems etc.

**T&P** - T&P requirements for offices, colony, works etc. as applicable.

**Works** - Painting, oiling, greasing, overhauling of HM equipment's, Repair/replacement of gates seals & wire ropes, POL for pumps & generator sets, Electricity charges and maintenance of Electric systems of dam site, specific requirements for all Civil, H.M & Electrical maintenance works, vegetation removal and mowing of turfing on earth dams, maintenance/cleaning of drains in dam (as applicable), maintenance of access roads & basic facilities, provision for flood contingency works during monsoon, unforeseen events/items (about 10% of the cost of works) etc.

#### **4.7 Maintenance Records**

Maintenance records are of utmost importance. A record should be kept of all maintenance activities, both immediate and preventive maintenance works. Information that should be recorded includes the following as a minimum:

- Date and time of maintenance,
- Weather conditions,
- The type of maintenance,
- Name of person or contractor performing maintenance,

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- Description of work performed,
- The length of time it took to complete the work with dates,
- Equipment and materials used, and
- Before and after photographs.

The data should be recorded by the person responsible for maintenance.

### **ANNEXURE- A**

#### **(For Radial Gates and Hoists)**

<b>Sl.No.</b>	<b>Parts to be Lubricated</b>	<b>Method of Lubrication</b>	<b>When to Lubricate</b>	<b>Lubricants Recommended</b>
1	Trunnion Assembly (Brushes and Pins)	Volume grease gun	Once before rainy season	Multi purpose Grease
2	Guide roller assembly	Hand grease gun	Once before rainy season	Multi purpose Grease
3	Gears and Pinions of end reduction gear boxes	By brush/Hand	Once before rainy season	Multi purpose Grease
4	Hinges, pins and springs of Electromagnetic brake	Hand grease gun	Once before rainy season	Multi purpose Grease
5	Tooth wheel of position indicators	By brush/Hand	Once before rainy season	Multi purpose Grease
6	Bushes of position indicators	By oil can	yearly	Mobil oil
7	Electric motor bearings	Hand grease gun	yearly	Bearings Grease
8	Wire ropes	By brush/Hand	Once in every season	Cardium compound
9	Worm gear reducer	Fill upto mark on dip stick	Before operation	Gear oil
10	Line shaft bearings	Hand grease gun	Once before rainy season	Bearings Grease
11	Pins of wire rope attachment turn buckles and equaliser plate turn buckle thread	By grease gun	Once before rainy season (when the reservoir level permits)	Multi purpose Grease
12	Drum shaft bushing	Volume grease gun	Once before rainy season	Multi purpose Grease
13	Limit switches	By oil can	yearly	Mobil oil

**ANNEXURE- B**  
**(For Vertical bow Gates and Hoists)**

<b>Sl.No.</b>	<b>Parts to be Lubricated</b>	<b>Method of Lubrication</b>	<b>When to Lubricate</b>	<b>Lubricants Recommended</b>
1	Guide roller assembly	Hand grease gun	Once before rainy season	Multi purpose Grease
2	Gears and Pinions of Central drive unit	By brush/Hand	Once before rainy season	Multi purpose Grease
3	Hinges, pins and springs of Electromagnetic brake	Hand grease gun	Once before rainy season	Multi purpose Grease
4	Tooth wheel of position indicators	By brush/Hand	Once before rainy season	Multi purpose Grease
5	Bushes of position indicators	By oil can	yearly	Mobil oil
6	Electric motor bearings	Hand grease gun	yearly	Bearings Grease
7	Wire ropes	By brush/Hand	Once in every season	Cardium compound
8	Gear box sump of Central drive unit	Top up oil up to mark	Before operation	Gear oil
9	Line shaft bearings	Hand grease gun	Once before rainy season	Bearings Grease
10	Lifting chains	By brush/Hand	Once before rainy season	Multi purpose Grease
11	Plummer blocks of End drive units	Volume grease gun	Once before rainy season	Multi purpose Grease
12	Limit switches	By oil can	yearly	Mobil oil

## CHAPTER 5: INSTRUMENTATION AND MONITORING

Instrumentation, proper monitoring and evaluation are extremely valuable in determining the performance of a dam. Instrumentation in a Dam, helps in checking that whether it is functioning as per design or not.

### 5.1 Types of instruments at Rallapadu dam

The table below gives the details of instruments installed at Rallapadu dam along with their location and frequency of measurements.

Sl .No	Instrument	Location and Number	Parameter measured	Frequency of measurement	Condition of instrument
1	Automatic Water Level Recorder	Upstream of old spillway gate (one number)	Water Level	Hourly	Not functioning
2	Manual Water Level Gauge	Upstream of old spillway gate (one number)	Water Level	Daily during non-monsoon and hourly in monsoon	In working order
3	Rain Gauge	Rallapadu guest house compound (one number)	Rainfall	Daily	In working order

## **CHAPTER 6: UPDATING THE MANUAL**

The O & M manual should be reviewed and updated periodically based on additional data. Updating of O&M Manual should be done whenever major changes like revision of design flood, any change in project features, construction of any additional spillway, construction of a dam on the upstream etc. take place.

Aspects to be considered when updating include:

- Increase/decrease in the frequency of inspections or routine maintenance.
- Changes in the operation and/or maintenance procedures.
- Alterations to the project data because of changes/modifications in the dam.

All updates/revisions of the O&M Manual need to be sent to all the locations/addresses to whom the copies of the original O&M Manual had been sent earlier. The O&M Manual is to be reviewed/ updated after every 10 years by the Executive Engineer, Rallapadu Project Reconstruction Division, Kandukur.

Updates in the O & M Manual has to be approved by the Chief Engineer of the project after getting the needful checking done through the DSO of Andhra Pradesh, Water Resources Department.

**Appendix-I**  
**Photographs of Rallapadu Irrigation Project**



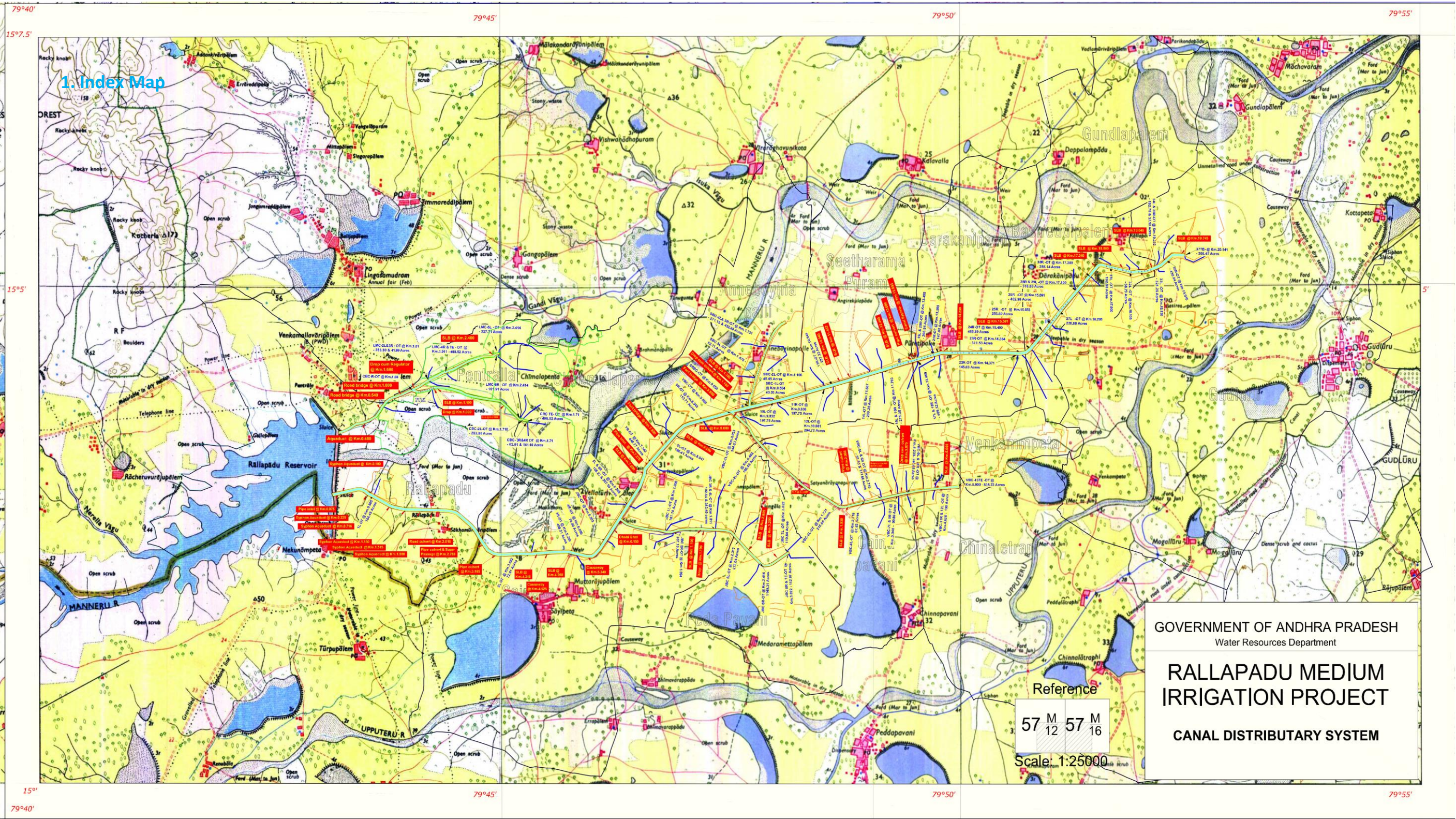




## **Appendix-II Basic Drawings of Dam & Spillway**

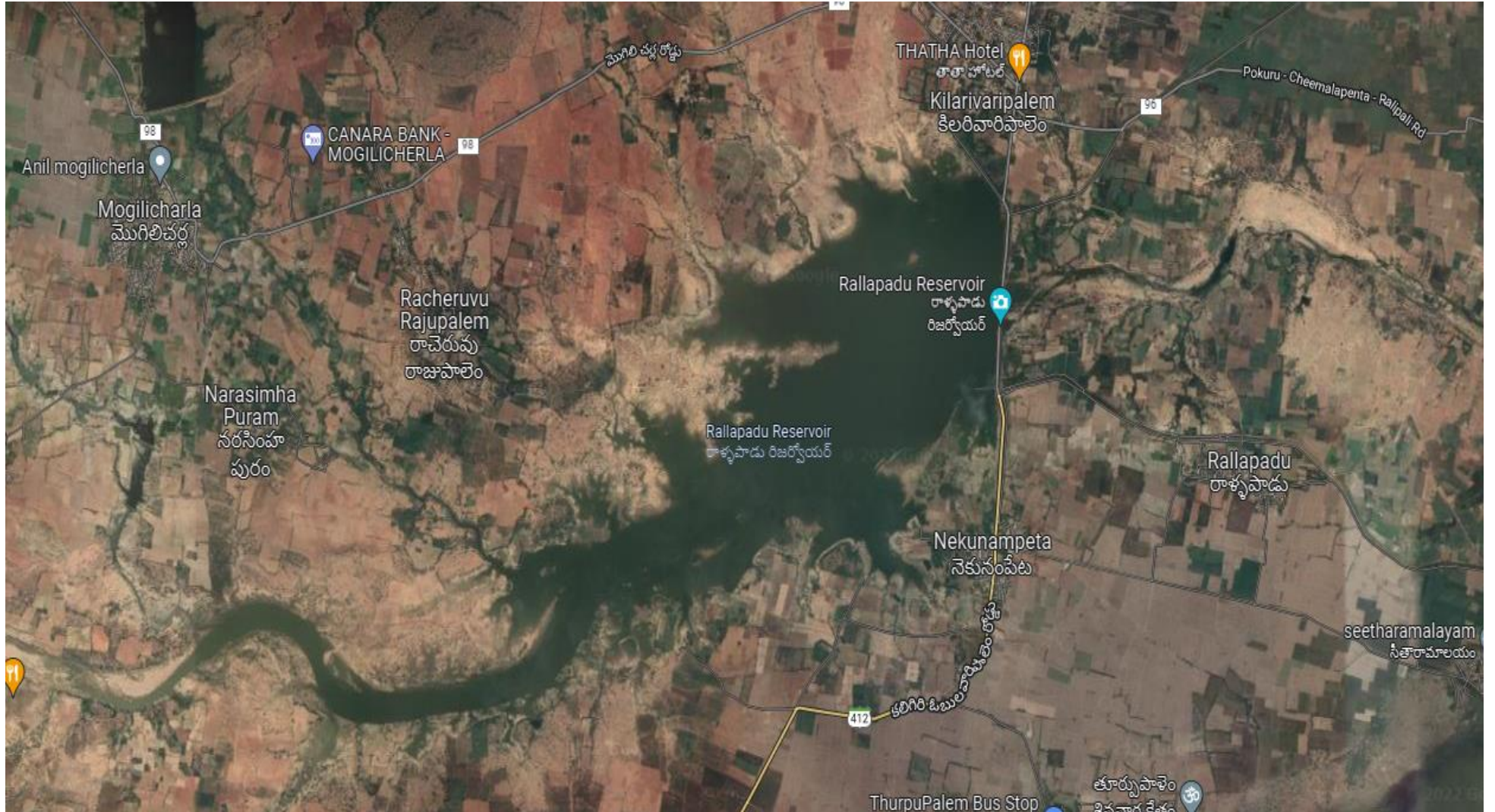


1. Index Map

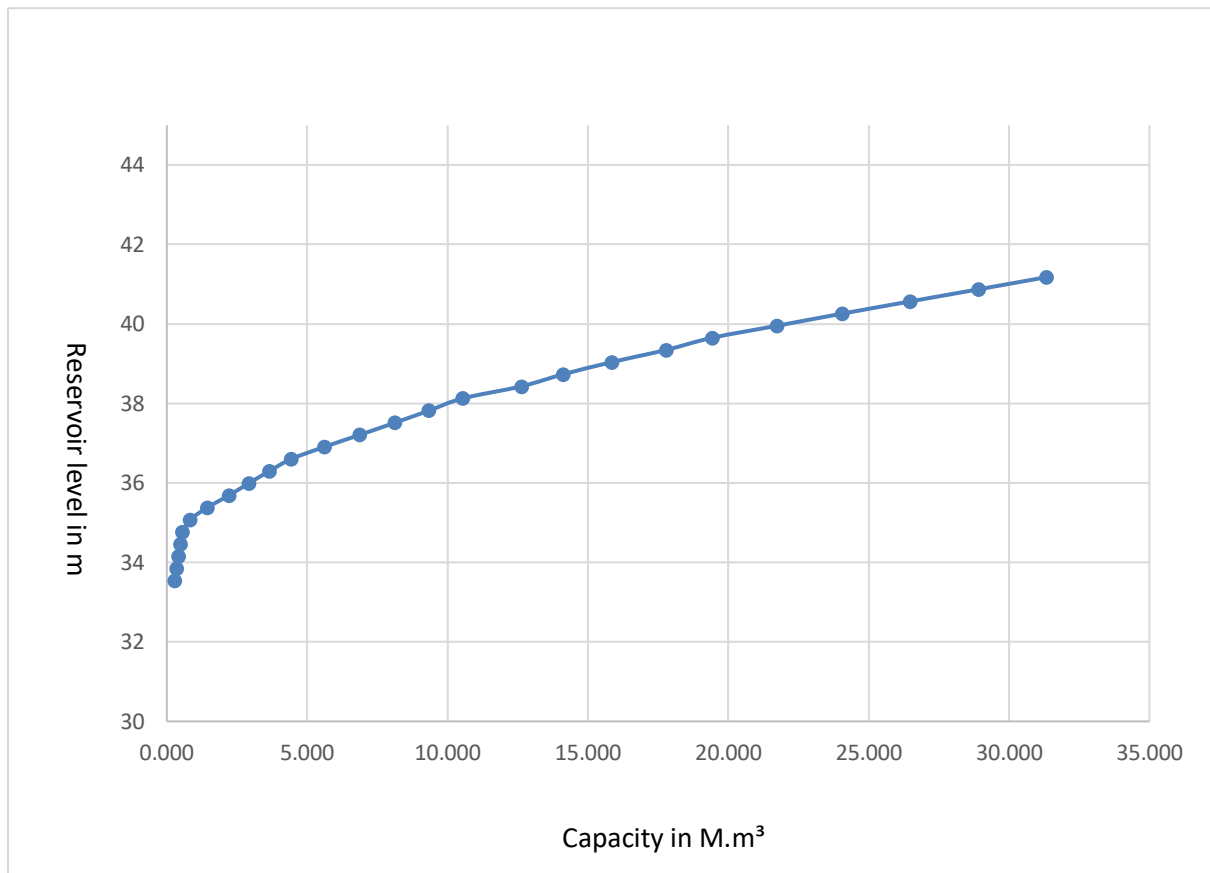




## 2. Satellite Map



### 3. Elevation-Capacity Curve



## 4. Layout Plan

