NAGARJUNA SAGAR PROJECT

Preamble:

The multipurpose Nagarjunasagar Project (NSP) is one of the modern temples of Independent India. This is the largest and highest masonry dam in the world. Nagarjuna Sagar took its name after the Buddhist Scholar and Savant, Nagarjuna, a great scholar of ancient culture who lived in the vicinity of this area in the 2nd Century A.D

Earlier Proposals:

The then Hyderabad State started investigation of Lower Krishna Project in 1930. The proposal was at Yelleshwaram village which is about 21 km upstream of present location at Nandikonda, with an FRL of 725 feet. The lowest feasible off-take level for the canal is RL 615 feet. The advantage of Yelleshwaram site is that off-take level for the canal being higher, a larger command area in Telangana could be brought under irrigation by gravity.

This site was abandoned and Nandikonda was selected only to ensure utilisation to both States from the same project. Madras State wanted to have a joint project so that their areas could also be irrigated. The State of Hyderabad agreed for a reservoir at lower down i.e at Nandikonda as a good will gesture to enable Madras (Andhra areas) also benefited from right side, though this has resulted in loss of command in Telangana.

But, later in the absence of any gesture from Madras State, Hyderabad State was forced to design an independent scheme to serve the needs of the Hyderabad State in 1952 as Lower Krishna Project (Nandikonda site) with only main canal on left side. A conference was held by the Planning Commission on 8th December, 1952, to consider the recommendations of Khosla Committee. According to the suggestions of the Khosla Committee it was decided by the Conference to take up the investigation of the Nandikonda Dam as detailed below:

- The Government of Hyderabad will furnish existing data in full to the Madras Government and to the Planning Commission immediately.
- Detailed investigations on the canal system on the Madras side will be made by the Madras Government within a period of ten months.
- Investigations made by the Hyderabad Government on the canal from Nandikonda dam on the Hyderabad side will be brought upto date within a period of three months.

The joint report of Nandikonda was prepared by both the States in 1954. The same was revised in 1956 with the cropping pattern for irrigating an area of 6.6 lakh acres in Telangana, 1.3 lakh acres in Andhra region on left side and 9.7 lakh acres in Andhra region on right side. The areas proposed in the scheme were changed from time to time during execution, reducing the ayacut and diluting the cropping pattern in Telangana under left canal duly increasing the ayacut in

Andhra on left side and right side as well. The second crop wet of 1.2 lakh acres in Telangana is also deleted by the erstwhile State of Andhra Pradesh.

In February 1955, the planning commission agreed for taking up Nandikonda Project at an estimated cost of 75.08 crores which was prepared as per the recommendations of the Khosla committee. In June 1955 Government of India constituted Nagarjunasagar Control Board consisting of representatives of Government of India, Government of Andhra and Hyderabad Government. Planning Commission sanctioned the commencement of preliminary works. Foundation stone was laid by Pandit Jawaharlal Nehru, Prime Minister of India on 10-12-1955. Water utilization under Nagarjunasagar dam was also restricted to 264 TMC, as such the ayacut envisaged was as per estimate of 1956 under phase-I of joint report of 1954 to the extent of 20.54 lakh acres. Power dam has 8 units out of which 1 unit is of 110 MW installed capacity and the other 7 are of reversible hydro generating units each of 100 MW capacity.

The water was let into both the two main canals i.e. right main canal (Jawahar Canal), left main canal (Lalbahadur Canal) by the then Prime Minister Smt. Indira Gandhi on the 4th August 1967.

Location:

The Project is located on River Krishna, It is about 2.4 Km downstream of the then Nandikonda Village, Peddavoora Mandal, Nalgonda District.

Hydrology at Dam Site:

Source	RIVER:KRISHNA	Sub Basin:	K-7
Catchment area	2,15,185Sq km or (83,083 Sq.miles)	Live storage	180.376 TMC (As per 2011 survey)
Flood Discharge (observed)	30,050 Cumecs (10.61 Lakh Cusec)	Designed Discharge	58,340 Cumecs (20.60 Lakh Cusec)
Maximum annual rain fall in the Catchment		35" (889 MM)	
Minimum dry weather flow		2.80 cumecs (100 Cusec)	
Assessed the 75% Dependable yield of the river for the entire catchment			2060 TMC
Latitude	16^0 - 34'-23" North	Longitude	79^0 -18'-47" East

SALIENT FEATURES OF NAGARJUNASAGAR DAM (PROJECT)

Reservoir:	
Full Reservoir Level	: 590.00 ft. (179.95 m)
Maximum Water Level	: 594.00 ft. (181.10 m)
MDD Level for Hyderabad Water Supply	: 510.00 ft. (161.58 m)
Gross storage capacity at El. +590.00 ft.	: 312.045 TMC
Dead storage capacity at El. +510.00 ft.	: 131.669 TMC

Live storage capacity	: 180.376 TMC
Water spread area	: 285 Sq.Kms
OUT LETS:	
Spillway:	
No. of bays	: 26
Location	: Blocks 25 to 51
Size	: 45 ft. x 44 ft. (13.7 m x 13.4 m)
Crest level	: +546.00 ft. (166.5 m)
Pier thickness	: 15 ft. (4.56 m)
Type of crest gates	: Radial
Energy dissipation	: Flip bucket
Power sluices: (Right side)	
No. of sluices	: 3
Location	: Blocks 71 and 72
Size	: 15 ft. x 38 ft. (4.56 m x 11.58 m)
Sill level	: + 479.00 ft. (146.0 m)
Type of gates	: Vertical, fixed wheel type
Construction sluices	
Number of sluices	: 6
Size	: 10 ft. (3.0 m) dia; Circular.
Central line level	: + 270.00 ft. (82.30 m)
IRRIGATION SLUICES:	
Jawahar (Right side) Canal:	
Number of sluices	: 9
Location	: Blocks 73 & 75
Size	: 3.05 m x 4.57 m (10 ft x 15 ft.)
Sill level	: + 489.00 ft. (149.00 m)
Top of gate level	: + 504.00 ft.*
Discharge at head sluice (all vents open) At + 500.00 ft. At + 510.00 ft. At + 520.00 ft.	 : 12,024 Cusecs : 24,606 Cusecs : 33,147 Cusecs
Design discharge of canal	: 11,000 Cusecs
Type of gates	: Vertical lift.
Energy dissipation	: Sloping apron.
Lalbahadur (Left side) Canal:	
Number of sluices	: 3
Location	: Foreshore of Reservoir
Size	: 3.05 m x 7.62 m (10 ft x 25ft)
Sill level	: + 489.00 ft. (149.00 m)
Top of gate level	: + 514.00 ft.**
Discharge at head sluice (all vents open) At + 500.00 ft. At + 510.00 ft. At + 520.00 ft.	 : 2,901 Cusecs : 7,899 Cusecs : 12,774 Cusecs

Design discharge of canal	: 11,000 Cusecs
Type of gates	: Vertical lift.
Energy dissipation	: Sloping apron.
Earth Dam:	
Length (a) Left Earth Dam	: 8400.00 ft. (2559 m)
(b) Right Earth Dam	: 2800.00 ft. (852.50 m)
(c) Total	: 11200.00 ft. (3411.5 m)
Maximum height of dam above average foundation level	: 85.50 ft. (25.9 m)
Top level of dam	: + 610.00 ft. (186.00 m)
Top width at road level	: 30.50 ft. (9.30 m)
Type of section	: Zoned earth fill
Man Power:	
Maximum number employed during peak period	:45,000

* As per the gate operation schedule of right canal, at +500.00 ft., the design discharge of 11,000 cusecs can be drawn.

**As per the gate operation schedule of left canal, at +514.00 ft., the design discharge cannot be drawn. It is required to maintain a level of +520.00 ft. in order to draw design discharge of 11,000 cusecs. The Committee on Plan Projects (COPP), 1960 on Nagarjunasagar Project had recommended for "lowering the full supply level of the Left Bank Canal by 10 feet (by suitably widening the intake channel in the first phase and making provision for constructing a second tunnel in the second phase), thus enabling the reservoir storage between RL 520 and RL 510 to be utilised, thereby increasing the second crop irrigation by 42,000 acres per annum on the average."

Scope:

The Project intends to provide irrigation facilities to an extent of 6.6 Lakh in Telangana and Feeding of tanks in the command area at the time of need, 1.3 lakh acres in AP under Left Main Canal (Lal Bhadur Canal) and 9.7 lakh acres in AP under Right Main Canal (Jawahar Canal). It also provides drinking water to urban & rural areas along the canal system. It also meets the water demands of twin cities of Hyderabad and Secunderabad. In addition to the above, 960MW Power Generation set up at Nargarjunasagar Reservoir.

EARMARKED UTILISATION

Sl. No.	Description	Utilisation in TMC
1.	Utilisation earmarked to Telangana	105.70 TMC.
2.	Utilisation earmarked to Andhra Pradesh	174.30 TMC.

The above earmarked utilisation is as per the adhoc arrangement dt: 18/19 June, 2015. However, the State of Telangana is contending the earmarked quantities before the Tribunal. The aforesaid earmarked quantities in respect of Andhra Pradesh are highly exaggerated and required to be reassessed on the basis of original ayacut, cropping pattern and changed circumstances. The realistic requirement of Andhra Pradesh under NSP is assessed as 85.64 TMC on scientific basis.

RESERVOIR:

Sl. No.	Description	Length
1	F.R.L. / Capacity	+590.00 Ft.(+179.832M) / 312.045 TMC
2	Maximum water level	+594.00 Ft. (+181.051 M)
3	Dead storage level / Capacity	+400.00 Ft. (+121.920M) / 100.114 TMC
4	M.D.D.Ls/ Capacity	+510.00 Ft. (+155.450M)/ 131.669 TMC
		In order to draw design discharge of 11,000 cusecs in left canal, it is required to maintain MDDL of +520.00 ft.
5	Water spread area	110 Sq.Miles (285 Sq.KMs)
6	Live storage above +510.00 Ft.	180.376 TMC
I	**Masonry Dam:**	
1	Length of Spill way of Dam	1545 Ft. (470.916 M)
2	Length of Non-over flow Dam	3211 Ft. (978.612 M)
3	Length of Masonry Dam	4756 Ft. (1449.628 M)
4	Maximum height of Dam (above deepest foundation)	409 Ft. (124.663 M)
5	Top width of Dam	28 Ft. (8.534 M)
6	Maximum base width of Dam	320 Ft. (97.536 M)
7	Over-all width of road way at top	30' 9" (9.373 M)
8	Deepest foundation level	+196.00 Ft. (+59.741 M)
9	Average river bed level	+245.00 Ft. (+74.676 M)
10	Spillway crest level	+546.00 Ft. (+166.421 M)
11	Top of crest gates	+590.00 Ft. (+179.832 M)
12	Top of Dam	+605.00 Ft. (184.404 M)
13	Invert level of flip bucket	+240.00 Ft. (73.15 M)

GATES

Sl No	Description	Particulars	
		Crest gates	Chute sluices
1	Numbers	26	02
2	Size	45' x 44'(13.716 x 13.410M)	10' x 25'
3	Type	Redial	Vertical

II	Earth dam:	Left side	Right side
1	Length of earth dam	8400Ft. (2560.32 M)	2800 Ft. (853.44 M)
2	Maximum height	85 Ft. (25.908 Mts.)	
3	Top level	+610 Ft. (+185.928 M	
4	Top width of Earth dam	30 Ft. 6" (9.296 M	

POWER GENERATION		
1	Penstocks (8numbers)	16.00 Ft. Ø (4.88 M) Ø
2	Dam Power House Units	1 X 110 MW –Conventional 7 X 100MW – Reversible
3	Centre line elevation	+405.00 ft. (+123.40 M)
4	MDDL	+506.00 Ft. (+154.23 M) - for conventional +495.00 Ft. (+150.88 M) – Reversible
5	Discharging capacity	4,700 C/s (133.09 Cumecs) - for conventional 4,300 C/S (121.76 Cumecs) – Reversible
6	Left Canal Power House	60 MW (2 x 30 MW)
7	Right Canal Power House	90 MW (3 x 30 MW)

NAGARJUNASAGAR TAIL POND

1	Location	Damaracharla village of Nalgonda Dist 21.065 km downstream of Nagarjunasagar dam
2	Description	Designed to store 1.04 TMC of water and to facilitate pump mode operation of 7 Nos. 100.8 MW reversible units of Nagarjunasagar Powerhouse for 8 hours delivering a peaking capacity of 500 MW throughout the year
3	Installed Capacity at Tail Pond	50 MW (2 x 25 MW)

N. S. LAL BAHADUR CANAL SYSTEM:

Lal Bahadur Main Canal run for a length of 178.60 Kms., i.e., upto Munneru Aqueduct. Thereafter it is called as 21ST MAIN BRANCH CANAL and runs for a length of 117.01 Kms. The designed discharge of N.S. Lal Bahadur Main Canal at Head Regulator is 11,000 cusecs and contemplated ayacut under Tekulapally Circle is 2,54,408 Acres and under Miryalaguda Circle is 3,75,681, thus total NSLC ayacut is 6,30,089 Acres.

Districts and Mandals benefited:

Sl. No.	Districts	Mandals
1	Nalgonda	Miryalaguda
		Damarcherla
		Vemulapally
		Anumala
		Peddavoora

		Tripuraram
		Nidmanoor
2	Suryapet	Penpahad
		NeredCherla
		Garudepally
		Huzurnagar
		Mattampally
		Mellacheruvu
		Chillkur
		Nadigudem
		Munagala
		Kodad
3	Khammam	Thallada
		Kalluru
		Penuballiu
		Vemsoor
		Nelakondapally
		Khammam (rural)
		Bonakal
		Chintrakani
		Madhira
		Mudigonda
		Yerrupalem
		Konijerla
		Wyra
		Enkoor
		Khammam (urban)

Irrigation Potential

Telangana Region	District	Ayacut(in acres)			Main Canal Jurisdiction
		Wet	ID	Total	
Left main canal	Nalgonda Suryapet	---	---	1,45,720 2,29,961	}Km.0.00 to 136.79(uptoPalair)
	Khammam	---	---	2,54,408	Km.136.79 to 178.27 (tail end of main canal) and Km.0.00 to Km.102.00 of 21st Main Branch Canal
Total				6,30,089	

MODERNIZATION & REHABILIATATION (WSIP-TS) OF NAGARJUNASAGAR PROJECT

1. Introduction:

Over a period of more than half a century since its construction, the NSP canal system has been damaged badly, losing its designed discharge capacity. It was assessed during

1996-97 by the Government that the irrigation water was not reaching to one fourth of the ayacut. Poor maintenance is one of the prime reasons for canals' dilapidation. The then Government of erstwhile State of Andhra Pradesh has taken up the Andhra Pradesh Water Sector Improvement Project (APWSIP) to modernize and rehabilitate the NSP with the financial assistance of the World Bank, to restore the NSP canal system to its originally designed discharge capacity under Water Sector Improvement Project (WSIP) and considering existing ayacut of about 22 lakh acres under irrigation area in the combined State.

2. *Water Sector Improvement Project (WSIP)*

The WSIP has come into effect from 10th September, 2010. The project cost was Rs. 4,444.41 crore out of which the World Bank loan share was Rs. 2025.00 Cr. (48%) and the State Government share was Rs. 2419.41 Cr. (52%). The project duration was initially six years, but it was extended by two years upto 28th July, 2018.

3. *Project objectives*

- To improve irrigation service delivery on sustainable basis so as to increase productivity of irrigated agriculture in the Nagarjuna Sagar Project, and;
- To strengthen the State's institutional capacity for multi-sectoral planning, development and management of its water resource.

4. Localized Ayacut (in Lakh Acres):

Name of the Canal	District	Wet	ID	Total
Jawahar Canal	Guntur	2.47	4.22	6.69
	Prakasam	1.90	2.59	4.49
	Total	**4.37**	**6.81**	**11.18**
Lal Bahadur Canal	Nalgonda	3.24	0.57	3.81
	Khammam	1.13	1.63	2.76
	Krishna	0.59	3.16	3.75
	West Godavari	0	0.07	0.07
	Total	**4.96**	**5.43**	**10.39**
	Grand Total	**9.33**	**12.24**	**21.57**

5. Project components

The project consists of the following four components:

- Component A: Improving irrigation service delivery in NSP

- Component B: Irrigated Agriculture Intensification and Diversification
- ComponentC: Water Sector Institutional Restructuring and Capacity Building
- Component D: Project Management

6. Project implementation:

The Government has established the Project Preparation and Management Unit (PPMU) to oversee the implementation of the project. The PPMU started functioning from March, 2007 and rehabilitation works were started in the year 2008 with state Government funding and the World Bank has provided retroactive funding for the period of one year preceding the signing of the project agreement vide Loan no: 7897-IN, Dated:14.08.2010, and vide Loan no: 7897-IN, Dated:02.06.2014 after State bifurcation.

7. State and project bifurcation:

During the course of implementation of the project, the state of Andhra Pradesh was bifurcated from 2nd June, 2014. The divided project costs between the two states are as follows.

- WSIPAP: Rs. 2832.691 Cr.
- WSIPTS: Rs. 1611.718 Cr.

8. Districts covered under the project in Telangana:

S.No.	Name of the District	Ayacut in Lakhs Acres		Total Ayacut in Acres
		Gravity Canals	L.I Schemes	
1	Nalgonda	98,030	47,690	1,45,720
2	Suryapet	1,91,539	38,422	2,29,961
3	Khammam	2,49,608	4,800	2,54,408
Total Ayacut		**5,39,177**	**90,912**	**6,30,089**

- The canal rehabilitation works were completed by only 30% of the total works before State bifurcation.
- After formation of the Telangana State, the remaining **70%** of work was completed in just three years.
- The WUA level works have started and completed only after emergence of the new state of Telangana.

9. Implementation Status as on 28th July, 2018

There are 14 Main & Brach canal packages and all the works are completed as per schedule. Canal lining has been taken up throughout the main canal to arrest seepage

losses and muck removal in tunnels, deep cuts, and de-silting has been taken up from entire the canal bed, to increase the water carrying capacity of Main canal. Measuring devices are provided at every entry level of WUA. Rehabilitation of Palair channel has been taken up and completed within a period of six months.

All the Dam safety works as recommended by the Project DSRP have been completed.

10. INNOVATIVE INITIATIVES

- Supply of water from tail to head reaches, on and off method: The farmers of the NSP command have followed "ON and OFF" method of irrigation which resulted in improved water use efficiency.
- Dam Automation: Operation of the Dam Crest Gates and Head Regulator Gates has been automated under the project. The World Bank has all its praise for the efforts of the project in automating the gates operation system. This may be the first of its kind in the country.
- Dam safety panel: A Dam Safety Review Panel (DSRP), consisting of seven members, has been constituted by the Government, in the year 2007 to review the safety of the dam, identify the works to be taken up, suggest the project to take up required studies and review the works done.
- Conjunctive use practice increased: The water availability in the reservoir during the project period was inadequate. The awareness campaign initiated by the project on conjunctive use, motivating the farmers to practice conjunctive use of surface and groundwater.
- Mechanized transplantation: The Government of Telangana state has decided to purchase one Transplanter for each mandal initially, to facilitate the farmers avail the services.
- Mobile Veterinary Diagnostic Laboratories: The project has provided three mobile diagnostic laboratories (an Ambulatory Van) well equipped with the latest diagnostic equipment to the Animal Husbandry Department, to facilitate them in providing door-step diagnostic facilities to the farmers in NSP command.

11. SIGNIFICANT RESULTS OF THE PROJECT

- Improvement in Irrigation Service delivery-Perception of the farmers: More than 80% of the farmers in the NSP command in TS are satisfied with preparation of water release schedule. 85% of farmers opined that water is reaching to the fields faster after modernization of NS canal system.
- Water reaching the Tail end after modernization: 80% of the tail-end farmers of Nalgonda district and Khammam district, have expressed that their fields are receiving the water after completion of modernization.

- Crop Demonstrations organized and Diffusion of agricultural technologies demonstrated: Under the project 39,886 demonstrations were conducted in the command on nine different crops over a period of seven years. Over all diffusion rate in the NSP command under WSIPTS is 756% with the highest impact is in Khammam district where diffusion percentage is 836%.

- Crop yields increased: There is an increase of 16.78% in the yields of the paddy in demonstration plots over the non-demo plots, 46.2% in the yields of maize, 17.6% in chillies, 9.2% in cotton and 23% in groundnut.

- Calf mortality reduced: One of the anticipated benefits out of the project is reduction in calf mortality from 20% at baseline to 5% by the end of the project.

- Increased fodder availability: Fodder demonstrations conducted under the project has resulted in increased fodder area from 3% of the gross area sown in baseline to 4.3% at the end of the project.

- Household income increased: The annual household income has increased by 204.7% from Rs.60,296 in baseline to Rs 1,83,724 in 2017-18 (after correction to inflation is 59.1%).

- Increased farming income: There is an increase of about 300% from Rs.31,583.00 in baseline to Rs.1,26,587.00 in the farm income (after correction to inflation is 109.2%).