CS/AR-27/99-2000

EVALUATION OF WATER SUPPLY SYSTEM OF KAKINADA TOWN IN A.P.

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1999-2000

PREFACE

Drinking water assumes first priority among many water uses. Growing urban centres and increasing population have been and will continue to be major features of the development process. In India, the urban growth is noted to be much faster in the recent years. Water budget studies can be undertaken with all the available records and may result in improving the functioning of such systems and in identifying additional or alternate resources.

For evaluating a water supply system, the different levels at which accounting can be made to undertake water budget is to be identified. In the present study, 'Evaluation of water supply system of Kakinada Town in A.P.', the different levels identified are (i) elevated level surface reservoir (ELSR) (ii) water treatment plant and (iii) Source of supply or intake. The analysis on water budget and on urban water demands for 2025 resulted in a systematic evaluation of water system of Kakinada town at present use and at source level for future use by 2025.

The study is part of the work-plan of Deltaic Regional Centre, Kakinada of the Institute and was undertaken by Sri S.V.Vijaya Kumar, Scientist 'C' and assisted by Sri S.M.Saheb, PRA along with Sri Y.R.S.Rao, Scientist 'C' under the supervision of Dr K.S.Ramasastri, Scientist 'F'. The study and analysis were reviewed by and Dr. Arvind Kumar of Centre for Environmental Engineering, University of Roorkee, Dr. P. Udaya Bhaskar of JNTU college of Engineering, Kakinada.

KSRamasastri

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ABSTRACT

Neglect of hydrology of the region, while undertaking planning and development works in an urban environment, will have serious consequences. One of such a consequence is non-availability of enough potable drinking water to citizens. Water budget studies can be undertaken with all the available records and may result in improving the functioning of such systems and in identifying additional or alternate resources.

Kakinada town in coastal Andhra Pradesh with a population of about 18,000 in 1870 has grown to about 300,000 by 1991 and is expected to touch 1000,000 by 2040. In this paper the water supply system of Kakinada town, which is more than a century old, is evaluated by accounting for water budget of supply and use components. Considering the surface water inflows available, capacities of water treatment works and the demands of urban environment supply and use of water is estimated at three levels of the water supply system. The information of the last 100 years is evaluated and the additional requirement for the future is estimated. The analysis on the future urban water requirements indicates that demands will increase by 3 times by 2025 and hence plans have to be drawn in this direction. In this study the availability of surface water through the eastern delta canal system for urban use is also evaluated.

The methodology applied to estimate balance/shortfall of water at different levels and by 2025 might be duplicated and used for evaluating similar systems elsewhere.

INTRODUCTION

Though the 'Earth' is covered 2/3rd by water the non-availability of enough potable drinking water, for most of the populations of the nations of the world called 'developing countries', is a persistent problem. With the ever increasing charm of living in urban areas there is a need for more efficient and sustainable water management methods to protect local water resources, to optimize the use of surface and groundwater, to help create attractive urban environment. According to Lindh (1987) for solving urban water problems there is necessity of an approach that identifies the water management problem in its widest context.

Water balance studies can be undertaken with all the available records and may result in improving the functioning of such systems and in identifying additional or alternate resources. For a system, a water budget can be developed to account for various flow pathways and storage components. Water balance for a city can be undertaken for an 'inner system' corresponding to hydrological cycle or for an 'outer system', which visualises the various types of urban water uses (house holds, industries, and public uses) assuming a water supply system from external surface water and/or groundwater sources. In this study the concept of outer system is adopted for evaluation of water supply system. Proper accounting of water supply and use components and arriving at the balance will help in making the system an efficient one. Also it will help to make operation and maintenance of such systems optimal by taking necessary corrective steps.

2.0 REVIEW

According to Ramaseshan (1988) urban water resources systems deal with quantitative and qualitative aspects of water resources. They include water distribution systems. Water and waste water systems are also included along with systems for reuse or multiple use of water. It may be noted that in the hydrologic networks of an urban system. The inter-relationship of several components of the urban water resources system is shown in Fig. 1. He stated that in India the urban water resources systems include both surface water and groundwater components even though it is not explicit in Fig. 1.

Ramrakhyani & Jain (1990) discussed in detail the treated water supply scenario for Delhi and Suggested steps in order to mitigate problems during drought and on how water conservation will bridge the gap between demand and supply.

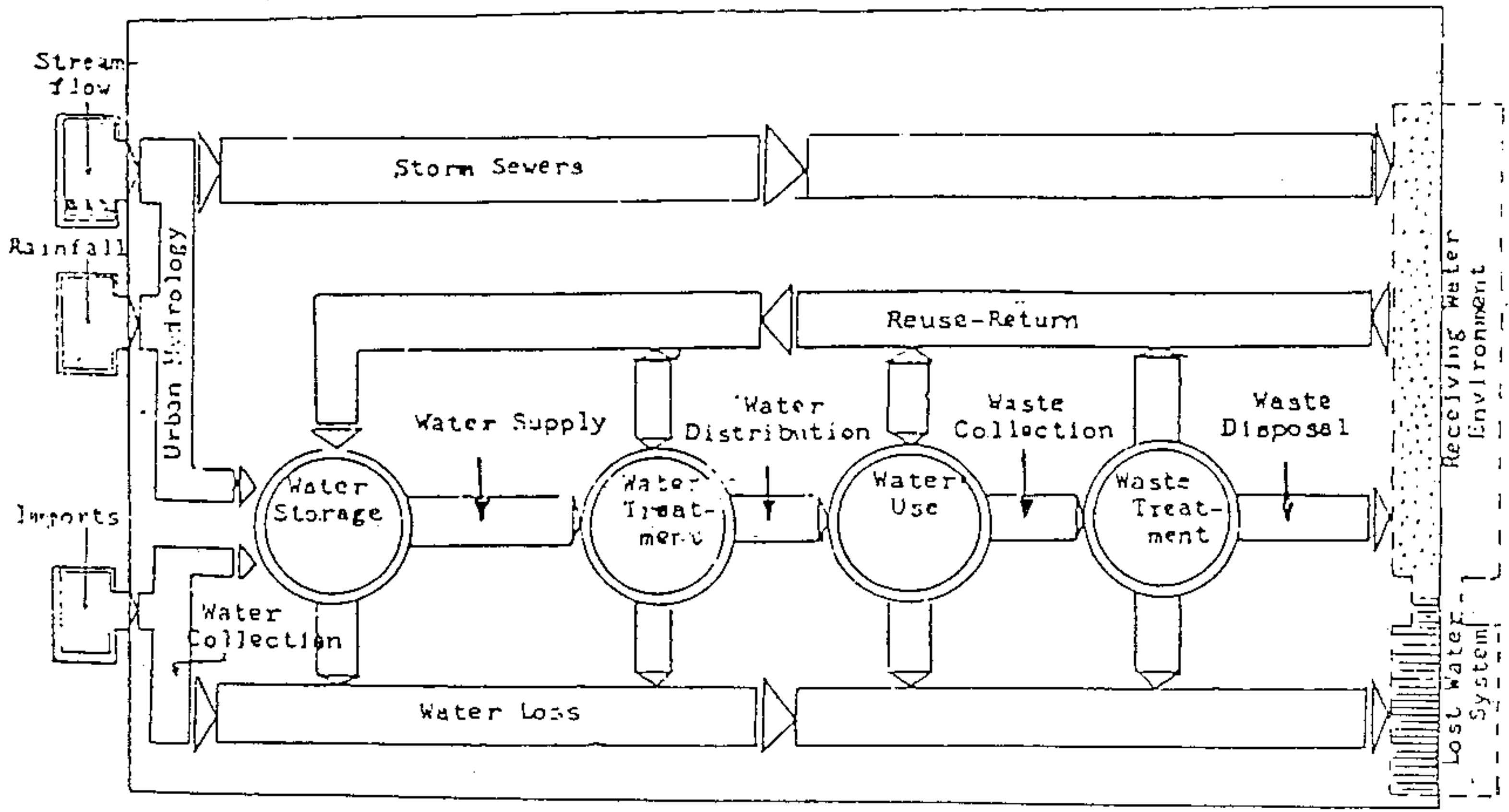


Fig. No. 1 : The Urban Water Resources System (Ramaseshan S , 1990)

Precipitation is the decisive input variable for a large number of dimensioning methods and models in urban hydrology. Due to the small catchment areas and the shorter flow paths, the runoff processes are characterised by a high degree of dynamics. Giesecke (1998) described the methods used in Germany for supplying precipitation data, and reference is also made to alternatives that may be used in cases where the database is insufficient.

Seckler et. al. (1999) reported on a study of the projections of water supply and demand for 118 countries for the period 1990 - 2025. Despite the limitations of the country-level data, it has been possible to identify the nature and geographic regions of growing water scarcity. They estimated that a quarter of the world's population or a third of the population in developing countries live in regions that will experience severe water scarcity within the first quarter of the next century.

Drinking water assumes first priority among many water uses. Growing urban centres and increasing population have been and will continue to be major features of the development process. In India, the urban growth is noted to be much faster in the recent years. The Chennai city is one such urban centre where to augment water supply construction of additional reservoirs is planned. The capacity of a reservoir is based on economic considerations using streamflow and demand-record to provide the stored water for late use. This paper analyses the safe yield from the proposed water supply system and suggests the basic operation rules. Neelakantan and Pundarikanthan (1999) analysed the existing urban water supply system for Chennai city and the problems are described along with the proposals. They analysed the dependable flow and the effect of construction of additional reservoirs with Linear Decision Rule and Linear Programming application.

3.0 METHODOLGY

For evaluating a water supply system, the different levels at which accounting can be made to undertake water budget is to be identified. In the present study, the different levels identified are (i) elevated level surface reservoir (ELSR) (ii) water treatment plant and (iii) Source of supply or intake as far as space is considered. The water quantities are estimated at daily level in million gallons per day (MGPD) for above. The balance equation adopted is as below:

$$\sum I - \sum O = \Delta \qquad \text{(i)}$$

where I supply component, O is use component and Δ is the difference which may be positive if use is less than supplies and negative if estimated uses are more than the supplies. Correctness of the data and relevant technique applied to estimate different supply and use components at any level of a system governs the accuracy of the budgeting. The study area for which this water budget study was undertaken along with the data and techniques used are discussed in detail in the following section.

4.0 STUDY AREA

Kakinada is the district head quarters of East Godavari district of Andhra Pradesh with a population of about 2,79,980 as per the 1991 Census. It is a major municipality established way back in 1866 and growing into a major port, fertiliser and power industries based city. The geographical area of this well planned Municipality is about 30 sq. km. (fig. 2). Urbanisation is taking place at a fast rate into adjoining northern and western rural areas, which are good agricultural lands under Godavari delta canal system. The schematic water supply system of the town is shown in fig.3. The water works namely 'Victoria Water Works' of the town were commissioned in 1909. It slowly developed into a supply system having nearly 12000 domestic taps, 2C00 street posts, which run with water for 2 to 3 hours in a day. The system is catered through 6 elevated surface reservoirs (ELSR) and a treat plant of capacity of 4.7 MGPD (million gallons per day) which works round the clock. The approximate jurisdiction of service areas of each ELSR is shown at Fig. 4 and the particulars of areas served are at Annex -1. The source of supply is the Godavari eastern delta canal system at Samarlakota of the Samarlakota canal and Aratlakatta of the Kakinada canal and is drawn through a pipe of about 10 km length. The hydraulic particulars of the canals at Samarlkota and Aratlakatta is at Annex - 2. The historical growth of water works of Kakinada is presented i the following section.

4.1 Details of Victoria water works

Kakinada Municipality was constituted in the year 1866 on 01.11.1866. For drinking water the town depended on shallow wells and tanks fed by the Canal Water. As the wells getting dried up during summer public was put to lot of trouble for drinking water. So the Municipality requested the Government in 1891 for a protected water supply scheme which was approved in 1894.

4.1.1 Pre-independence growth:

The scheme started with storage cum settling tank, 2 numbers of standard filter beds of size 22.86 m x 15.24 m (75' x 50') under ground reservoir and a pump house with pumping plant driven by the steam engine and distribution system. All the above components were completed and commissioned on 01.06.1903. Due to non-availability of drinking water for the public and to meet the demands, construction of 2 more filter beds, cover drain from water works to Yeleru drain to drain of scour

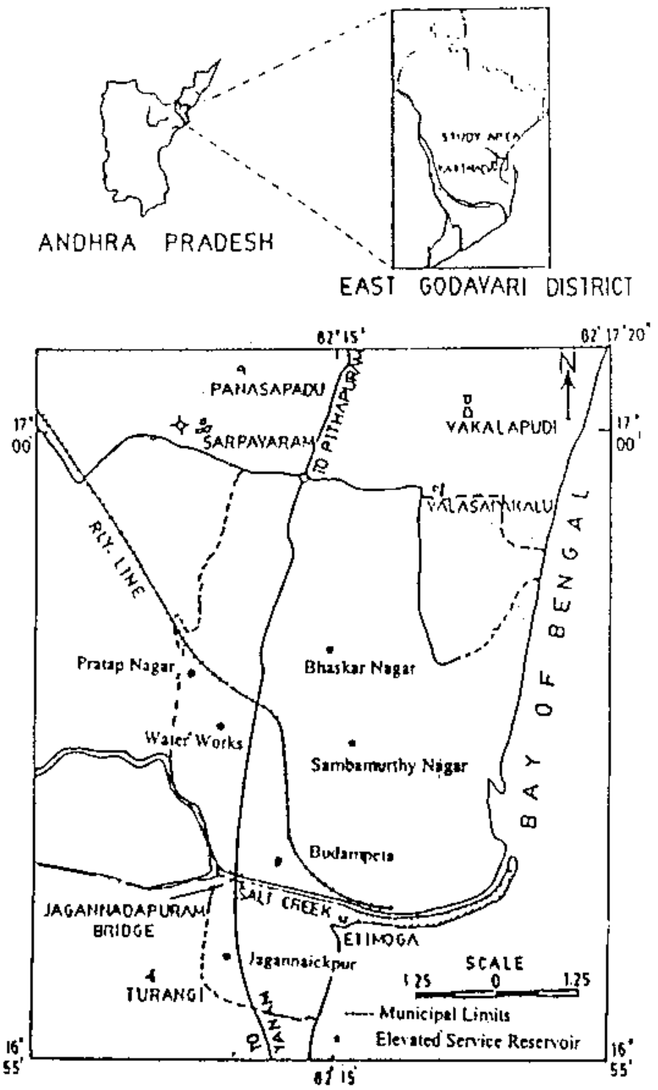
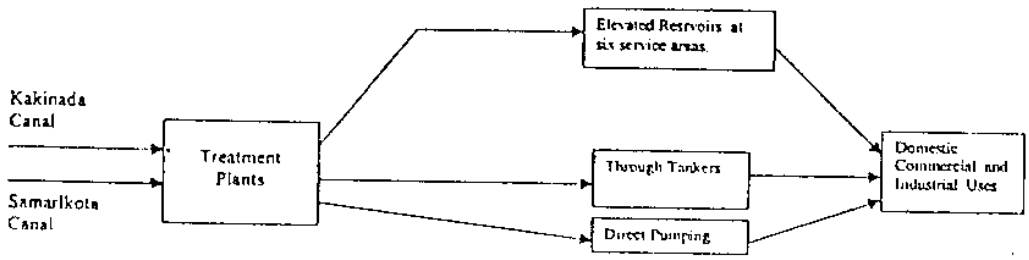


Fig. No. : 2 Location of the Study Area.

Fig. No. : 3 Schematic Flow Diagram of Kakinada Water Supply System



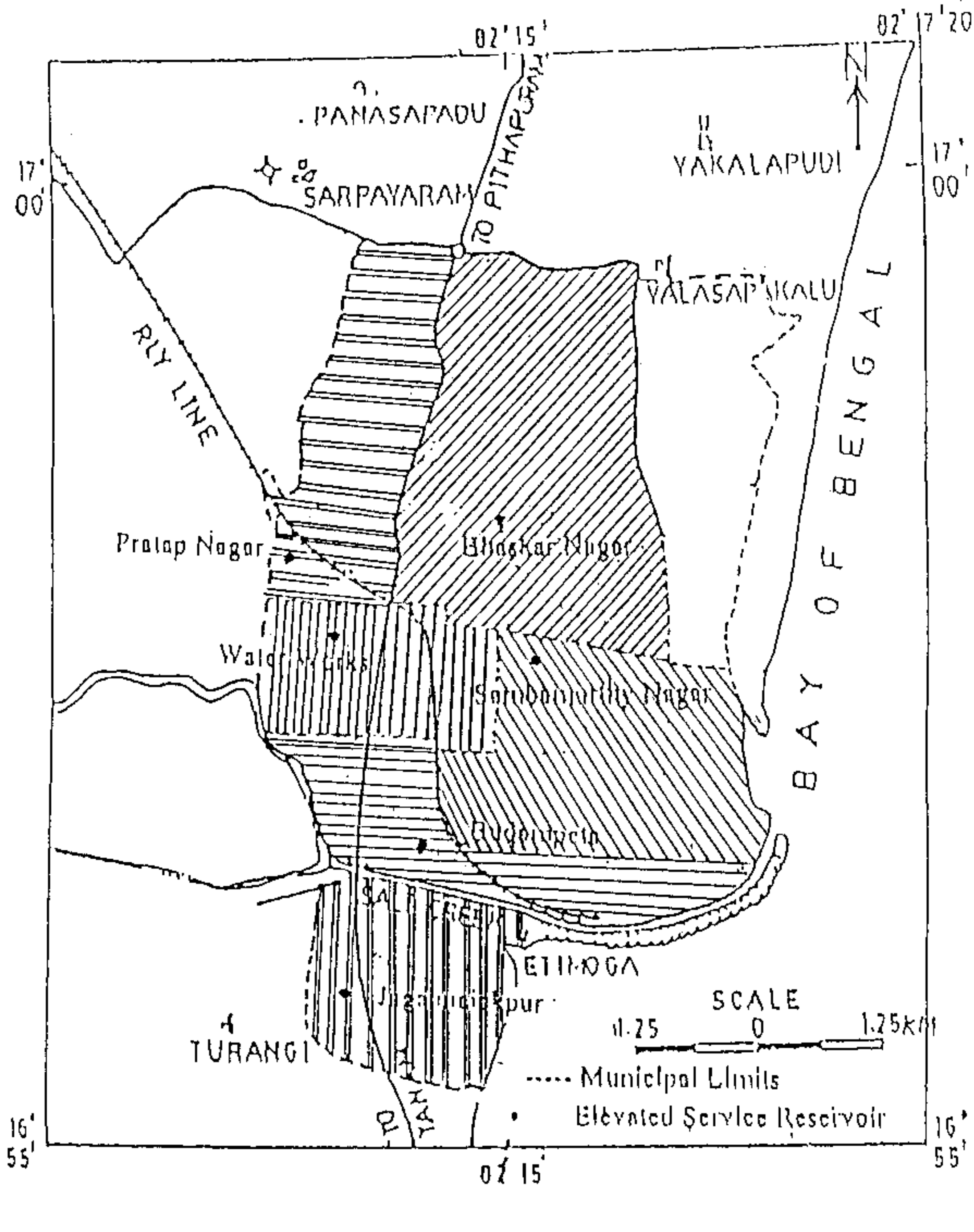


Fig. No. 4 : Service Areas under each ELSR water, wash water and rain water were taken up and completed and put to use by November, 1909.

In 1932 the pumping station was first Electrified dispensing with the steam Engines. In 1938 One High-Level service reservoir of 1,87,500 capacity was constructed. In 1943 during the 2nd world war the Military Department required 4.55 lakh litres (1.00 lakh gallons) of water per day and accordingly the Military has agreed to construct 5th filter Bed install summer pump set and booster pump set. These works were completed in 1944. In 1946 the remaining 2 steam engines were replaced with Electric Motors.

4.1.2 Post-independence developments:

In 1957 a summer storage tank named Sambamurthy Reservoir was constructed 22" dia C.I. gravity mains to Victoria Water Works was laid for the ultimate population 1,25,000 anticipated by 1981. Another scheme consisting of expansion of works completed by Military i.e., RCC elevated reservoirs constructed in 1939 and cost of 5th filter and construction of 3 more additional slow sand filters and repairs to existing filters. Construction of 3 filters was completed in 1952. The total filtrate capacity of the 8 Nos slow sand filters is nearly about 12,00,000 gallons/day considering two filter beds stopped for scrapping etc., maintenance. Next scheme of 1950's comprised of re-arrangement and extension of distribution system. The total length of distribution system contemplated in this scheme was nearly 36 miles. Elevated level storage reservoir of 125000 gls capacity was constructed in the year 1956 in Victoria Water Works. A rapid gravity filtration plant of 0.60 MGPD capacity was constructed in the year 1964.

One RCC elevated service reservoir of capacity 1,75,000 gallons was constructed and the same was commissioned during 1980. The total quantity of water used to be supplied to the town is increased to 18,00,000 gls/ day is found to be inadequate to the Town Public increased population of 2,26,682 as per 1981 Census and water supply improvements were take-up. In order to cater the needs of water supply to the Kakinada Town Public the improvements were proposed and taken up in a phased programme in 3 stages and completed by 1986.

The first stage involved off take works from low level canal at Aratlakatta located about 12 Km from Kakinada and construction of Raw Water tower of 12000 gls capacity to draw water by gravity. A 36" RCC gravity main from Aratlakatta up to water works in the town was constructed. The second stage comprised of construction of 2 elevated service reservoirs one at Jagannaickpur and other one at Pratapnagar and construction of 3.10 MGPD filtration plant. The third stage comprised of construction of S.S.Tank at Aratlakatta of 346 M.G. Capacity (1580 ML Capacity) and raw water collection well at S.S.Tank. All the works were completed and commissioned in the year 1986. In 1987 Master Plan proposals were proposed for a projected population 3,50,000 by the year 2001 end for an ultimate population of 5,00,000 to be reached by 2016. The works as below were completed and commissioned in the year 1995.

1. Construction of 1600 KL (3.52 lakhs gls capacity) ELSR at Budampeta.
2. Laying of 400 mm dia AC pumping main to Budampeta Reservoir.
3. Construction of 1000 KL (2.22 lakhs gls) capacity ELSR at Bhaskar Nagar.
4. Laying 300 mm dia AC pumping main to Bhaskar Nagar Reservoir.
5. Construction of sump and pump house in Head Water works (Victoria Water Works).
6. 176 KL clear water sump.
7. 30 KW pump sets for Zone - V & VI B.
8. Clear water gravity main from the existing 3.10 MGD Filtration plant to the above said pump.
9. 1200 KL ELSR at Sambamurthy Nagar (2.65 lakhs gls).
10. Pumping mains and distribution system.

4.2 Present status

The scheme of Victoria Water Works, Kakinada as on 1997 is shown at Fig. 5 and the status is as below.

1. There are 8 slow sand filter beds. Out of which one i.e., No.4 filter bed was handed over to Public Health, Engineering Department for construction of sump well in the year 1995. The filter water yield from the other 7 filter beds will be 10.00 lakh gallons per day considering two nos. slow sand filter beds will be stopped for scraping and other maintenance works. There are two rapid sand filters one of 0.6MGPD capacity and another of 3.1 MGPD. Thus the total installed capacity is 47,00,000 GPD.
2. There are 4 ELSRs in Water works area, one each in Jagannickpur, Budampeta, Sambamurthy Nagar, Bhaskar Nagar and Pratap Nagar areas. These total to about 9 ELSRs and serve the entire distribution system along with direct pumping in some areas.

The electrical equipment available to pump water to the ELSRS for town distribution is as below.

1. MAIN PUMP HOUSE : 2 Nos. 60 HP Motors to pump water to 1,87,500 gls ELSR and 1,25,000 gls ELSR.
2. Pump House : 2 Nos. 20 HP Motors to pump water to 1,75,000 gls ELSR.

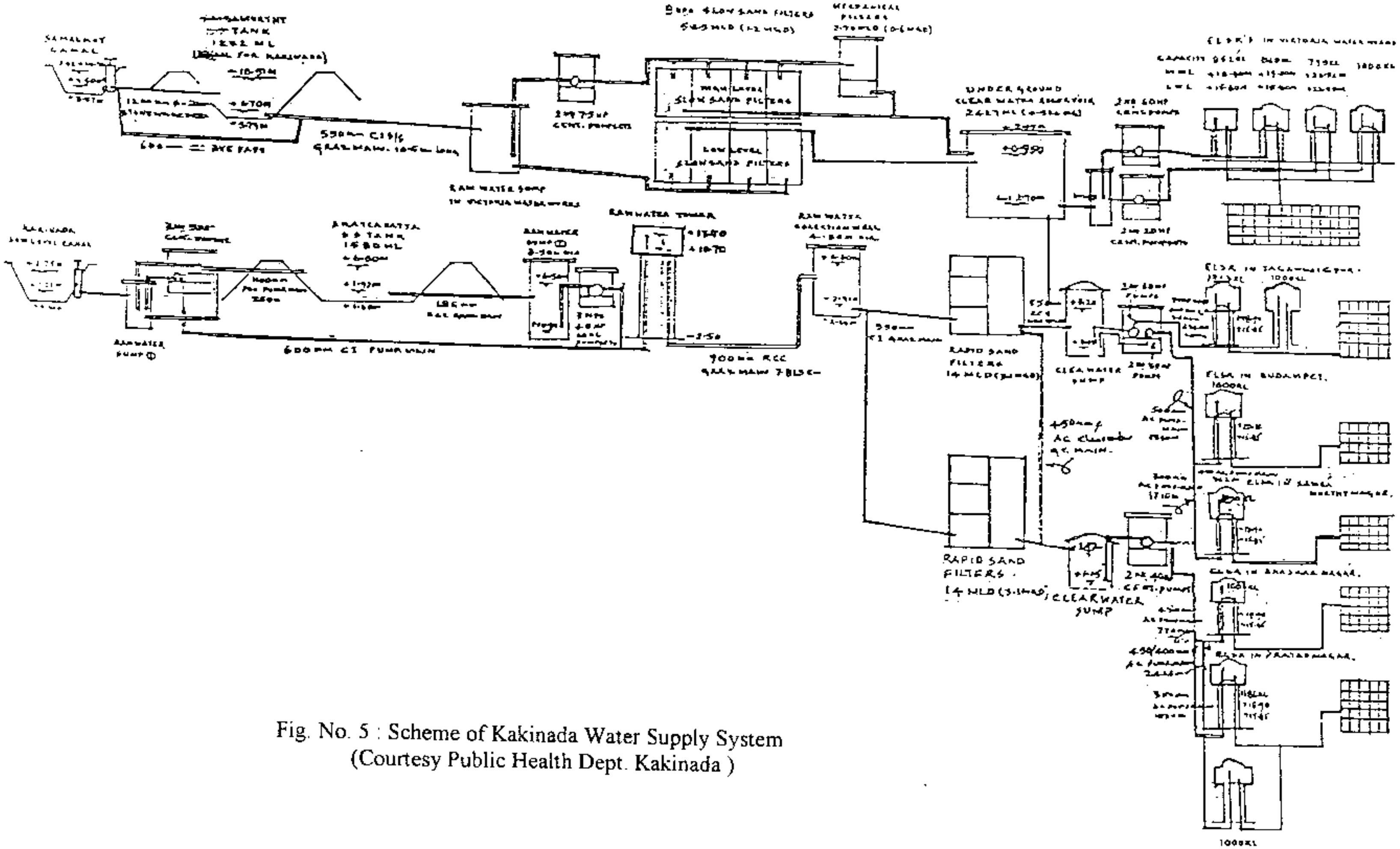


Fig. No. 5 : Scheme of Kakinada Water Supply System
(Courtesy Public Health Dept. Kakinada)

3. Pump House :

(A) 2 Nos. 60 HP Motors to pump water to Jagannaickpur ELSR of capacity 1323 KL or 2.95 lakh gallons capacity.

(B) 2 Nos. 35 HP Motors to pump water to

1. Pratap Nagar ELSR of capacity 1186 KL or 2.65 lakh gallons capacity.
2. Budampeta ELSR of capacity 1600 KL or 3.52 lakh gallons capacity.
3. Bhaskarnagar ELSR of capacity 1000 KL or 2.22 lakh gallons capacity.
4. Sambamurthy Nagar ELSR of capacity 1200 KL or 2.65 lakh gallons capacity.

As there is no sufficient filtered water available to fill up the above 4 Nos. ELSRS, they are being filled Half capacity twice in a day in addition to direct pumping to distribution during town distribution time. The Jagannaickpur ELSR is being filled fully twice in a day in addition to direct pumping to distribution during town distribution time.

4.2.1 Summer Storage Tanks:

1. Sambamurthy reservoir situated at Samarlkota :

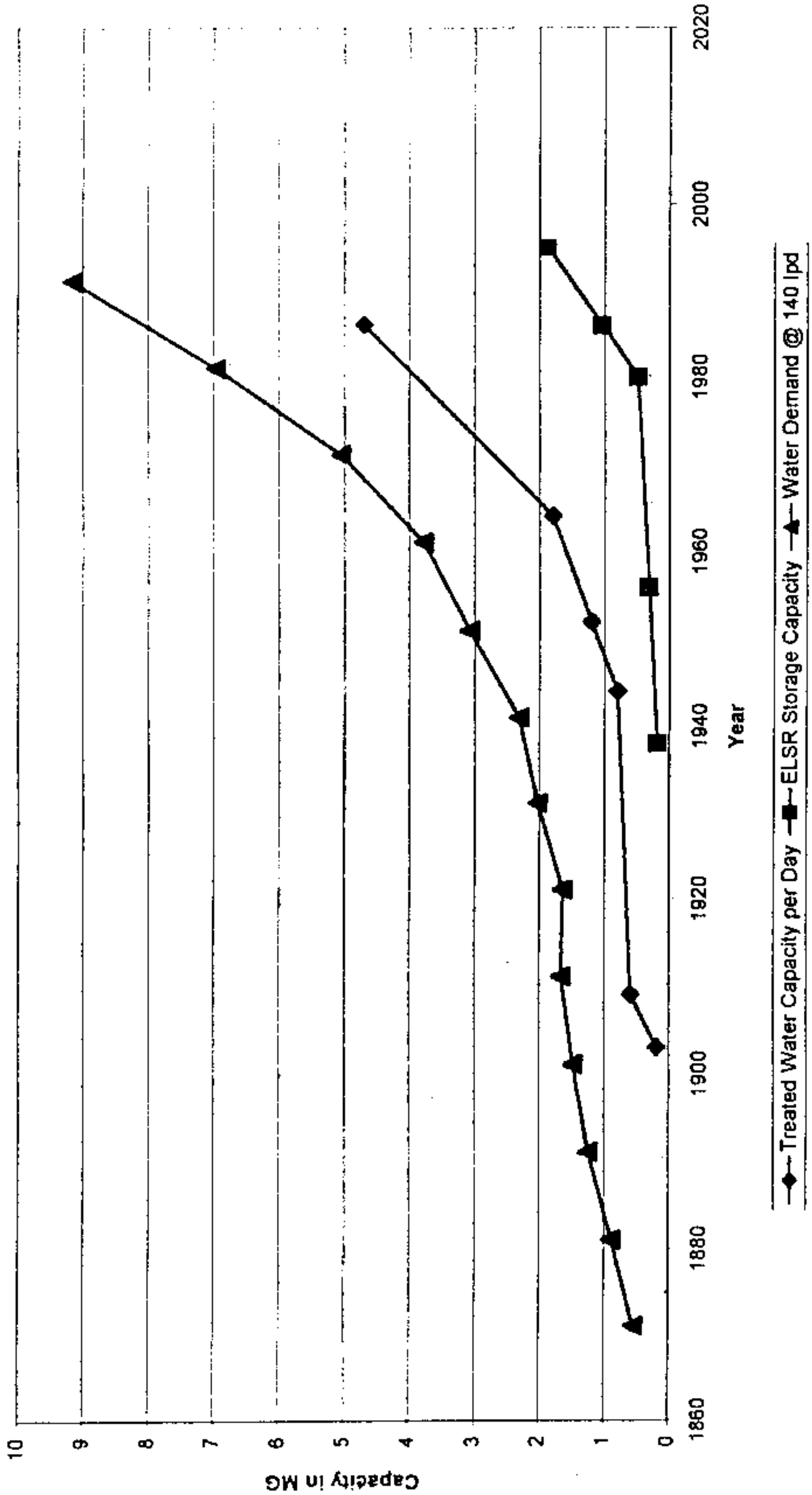
The capacity of S.S. Tank is 271 MG. The tank was constructed and commissioned in the year 1957. The water from the S.S.Tank is drawn to Kakinada Victoria Water works by gravity main of 22" dia C.I. raw water gravity main.

2. S.S.Tank situated at Aratlakatta

The 2nd S.S.Tank with a capacity of 346 MG was constructed and commissioned in the year 1986. In order to draw water to Kakinada Victoria Water works a Tower of 12000 gls capacity was constructed and 900 MM dia RCC main was laid upto Victoria Water Works for a length of 9 kms.

4.2.2 Method Of Treatment Being Adopted For Raw Water Purification:

Copper sulphate is also being added to the S.S.Tanks to kill the microscopic growth and Algae growth. The dosage is 0.4 ppm. Toxicity left by mixing of copper sulphate needs checking. Water quality in the reservoirs depth-wise as well as that of treated water should be monitored to check adequacy of treatment for potability. Maximum and minimum turbidity and efficiency of treatment deserves to be studied and reported Alum treatment is being done for sedimentation and coagulation of raw water in the sedimentation tank and clarifier. The alum dosage various from 1 grain per gallon to 3 grains per gallon depending upon the turbidity of raw water. The chlorination is being done @ 2 PPM to 4 PPM in Victoria Water Works (Head Water Works) to give residual Chlorine of 0.1 PPM to 0.2 PPM at the tail end taps


Capacity in MG
10
9
8
7
6
5
4
3
2
1
0
1860
1880
1900
1920
1940
1960
1980
2000
2020
Year
Treated Water Capacity per Day
ELSR Storage Capacity
Water Demand @ 140 lpd

alternative arrangement with bleaching powder is also available in emergency purposes. The periodical cleaning of all the elevated service reservoirs is being done every month.

The slow sand filter beds are being maintained regularly adopting the scraping and other maintenance's when ever low-yield of filter water is observed (i.e.) once in a month. The sedimentation tank of 0.6 MGD filtration plant and clarifier of 3.1 MGD filtration plant are regularly maintained duly sludging out the deposited silt and slush in the sedimentation tank and clarifier. The sedimentation tank and clarifier are being cleaned once in an year or twice in an year according to the necessity.

5.0 DATA & ANALYSIS

The chronological growth of treated water supply available along with ELSR storage capacity and water demand for Kakinada town as a whole is shown in fig. 6. To evaluate the water supply system at different levels the water budget account was undertaken at 3 levels as detailed below.

5.1 At ELSR level

The budget was accounted for a peak rate and low rate of water delivery through taps. The water supplies are as reported by the water works authorities on the daily routine of filling each reservoir. The filling scheme is twice a day for all reservoirs to half capacity, except ELSRs at Water Works and Jagannaickpur which are filled to full capacity twice. According to the authorities this is because of non-availability of sufficient treated water. The use of water under ELSRs is calculated based on the water available at the domestic and street taps at two average rates of flow of 1085 lpd (peak rate) and 360 lpd (low rate). The number of taps in each reservoir service area is arrived at by considering the water tax records of the revenue authorities for all the 70 blocks of the municipality. To have delivery at peak rate at tap end it is assumed that all the reservoirs are filed to the full capacity from supply aspect. These are the rates actually observed at random in December 1999 and February 2000 under different ELSRs. The supplies and use components thus calculated are presented in Table 1 A and B. The same are shown in bar chart form at fig.7 for peak rate and at fig.8 for low rate, where uses are shown on negative Y-axis. On basis of results of the study for both rates, the effect for any intermediate rate of flow can be interpolated accordingly. The water supply statistics for service area of each ELSR is shown at Table 2. The quality of groundwater from total dissolved solids (TDS) concentration aspect is presented in the same table. The highest values of TDS in mg/l as reported by Rao (1998) and its deviation from the maximum

Table No.1: Water budget for Kakinada water supply system
At Elevated Reservoir Level (in MGPD)

A. AT PEAK RATE OF SUPPLY THROUGH TAPS (1085LPD)

ELSR NAME	Supply	Use	Balance
WATER WORKS	0.7253	-1.0156	-0.2903
JAGANNAIKPURAM	0.5815	-0.6629	-0.0814
BUDAM PETA	0.7033	-0.3851	0.3182
SAMBAMURTHY NAGAR	0.5213	-0.2916	0.2297
PRATAPNAGAR	0.5213	-0.449	0.0723
BHASKAR NAGAR	0.4396	-0.1824	0.2571
TOTAL IN MGPD	3.4923	-2.9867	0.5056

B. AT LOW RATE OF SUPPLY THROUGH TAPS (360LPD)

ELSR NAME	Supply	Use	DIFF
WATER WORKS	0.7253	-0.337	0.3883
JAGANNAIKPURAM	0.5815	-0.22	0.8015
BUDAM PETA	0.3516	-0.1278	0.4794
SAMBAMURTHY NAGAR	0.2607	-0.0968	0.3574
PRATAPNAGAR	0.2607	-0.149	0.4096
BHASKAR NAGAR	0.2198	-0.0605	0.2803
TOTAL IN MGPD	2.3996	-0.991	3.3905

Fig. No. :7 SUPPLY & USE AT PEAK RATE FOR ELEVATED RESERVOIR LEVEL

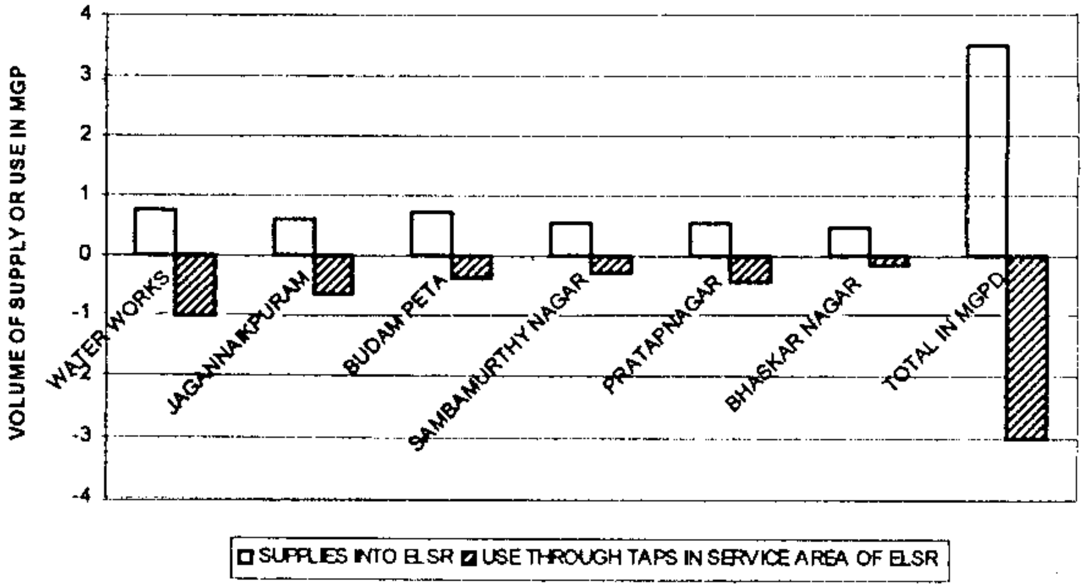


Fig. No. : 8 SUPPLY & USE AT SLOW RATE FOR ELEVATED RESERVOIR LEVEL

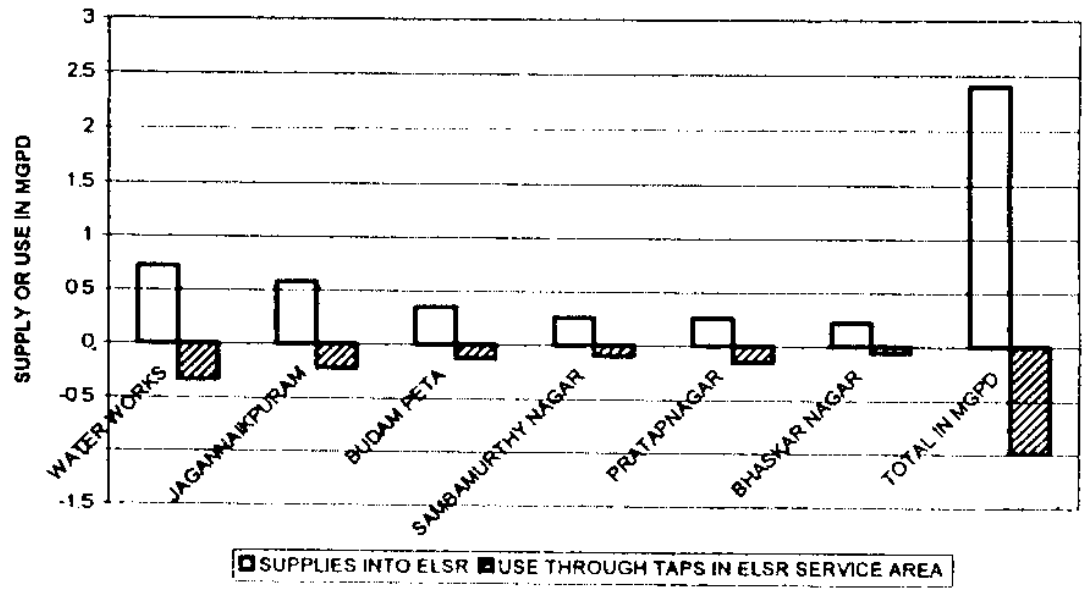


Table No. 2 : ELSR wise water supply statistics & TDS values of Groundwater in service area

S.No.	ELSR at	% of Geographical Area	Population of 1991	Water filled in a day (KL)	Daily per capita supply (L)
1	Jagannaickpur	11.36	78499	2646	33.71
2	Budampeta	10.94	35615	2400	67.39
3	Sambamurthy Nagar	19.35	35286	1779	50.42
4	Waterworks	13.78	68875	3299	47.90
5	Pratap Nagar	19.98	37521	1779	47.41
6	Bhaskar Nagar	24.61	24184	1500	62.02

S.No.	ELSR at	House taps	Street taps	Total taps	Daily supply per tap (L)
1	Jagannaickpur	2420	340	2760	958.70
2	Budampeta	1440	155	1595	1504.70
3	Sambamurthy Nagar	1050	153	1203	1478.80
4	Waterworks	3940	299	4239	778.25
5	Pratap Nagar	1700	163	1863	954.91
6	Bhaskar Nagar	640	105	745	2013.42

S.No.	ELSR at	High TDS value of groundwater	% deviation from higher limit for drinking water
1	Jagannaickpur	2200	46.67
2	Budampeta	2000	33.33
3	Sambamurthy Nagar	1200	-20.00
4	Waterworks	1200	-20.00
5	Pratap Nagar	1000	-33.33
6	Bhaskar Nagar	1000	-33.33

permissible value for drinking water of 1500 as per WHO & other agencies is shown in Table 2.

5.2 At treatment plant level

At this level the supplies are considered as per the designed capacity of the treatment plant having 4.7 MGPD. The uses at this level are for filling ELSRs, for commercial supplies and for Tankers for distribution in non-served and ill-served areas. Two cases are presented i.e, one is peak one, in which all reservoirs are filled to the capacity and the other one is slow one of general scheme of filling as at present explained in earlier section. The other uses are fixed ones i.e, Industrial uses at 0.1 MGPD, Commercial at 0.5 MGPD at an assumed rate of 10000 lpd through 240 commercial connections and through tankers at 0.27 MGPD. The water budget thus undertaken at treatment plant level is shown in Table 3. The results are shown in fig.9 as bar chart plot for both peak and low rates. The uses are shown on negative Y-axis side.

5.3 At source of supply level

At this level uses are as per the design capacity of the treatment plant i.e, 4.7 MGPD. Supplies are calculated based on the discharge capacity of the CI pipeline of 550 mm diameter over a length of 10.5 km from Samarlakota canal and RCC pipeline of 900 mm diameter over a length of 7.865 km from Kakinada canal. The estimated gravity flow that can be drawn by both are 2.7 and 9.6 MGPD respectively subjected to the accuracy of the roughness factor assumed. The budget thus arrived at this level is presented in Table 4 and at fig.10 as bar chart plot.

5.4 Demands by 2025

The projected population of 2025 is estimated based on the population record data available since 1871-1991 for Kakinada using the arithmatical increase method, geometrical method and incremental increase method and shown in fig.11. Based on the trend of past data the geometrical method of projection is a reasonable estimate. The projected population from 2001 to 2050 by the geometrical method along with the historical population record is shown at Table 5. The population thus estimated for 2025 is used to find the urban water requirements for domestic, industrial purposes. The per capita requirements by 2025 for India as considered in a similar study (IWMI, 1998) i.e., 28,000 litres per year for domestic use and 24,000 litres per year for industrial use are adopted to calculate the daily urban demands. The demands calculated for 2025 with present demands and installed capacity of urban water supply for Kakinada are presented in Table 6 and same as bar chart plot is at Fig.12.

Table No.3: Water budget for Kakinada water supply system
At Treatment Plant Level (in MGPD)

A. SUPPLIES	Peak	low use
1. SLOW SAND FILTERS	1	1
2. RAPID GRAVITY FILTERS	0.6	0.6
3. RAPID GRAVITY FILTERS	3.1	3.1
TOTAL IN MGPD	4.7	4.7

B. USES	Peak	low use
1. THROUGH ELSRS	-3.492	-2.4
2. THROUGH TANKERS	-0.27	-0.27
3. COMMERCIAL	-0.5	-0.5
4. INDUSTRIES	-0.1	-0.1
TOTAL IN MGPD	-4.362	-3.27

DIFFERENCE OF A&B	0.338	1.43

Table No.4: Water budget for Kakinada water supply system
At Water Source Level (in MGPD)
INTAKE & DELIVERY

A. SUPPLIES	
1. SAMARLAKOTA CANAL*	2.7
2. KAKINADA CANAL#	9.6
TOTAL	12.3

B. USES	
1.SLOW SAND FILTER	-1
2.GRAVITY FILTER	-0.6
3. RAPID GRAVITY FILTER	-3.1
TOTAL	-4.7

DIFFERENCE	7.6

* AS PER DESIGN DISCHARGE 725.91 MGPD IS THE CAPACITY
# AS PER DESIGN DISCHARGE 110 MGPD IS THE CAPACITY

Fig. No. .9 SUPPLIES AND USE AT TREATMENT PLANT LEVEL

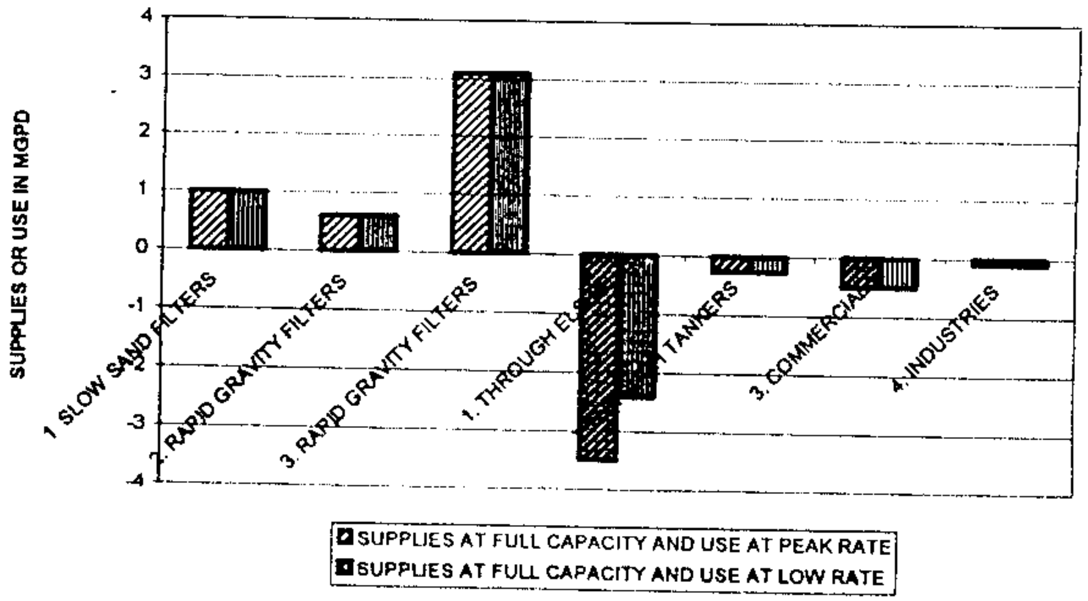


Fig. No. 10 SUPPLIES AT FULL CAPACITY OR USES AT SOURCE OF SUPPLY LEVEL

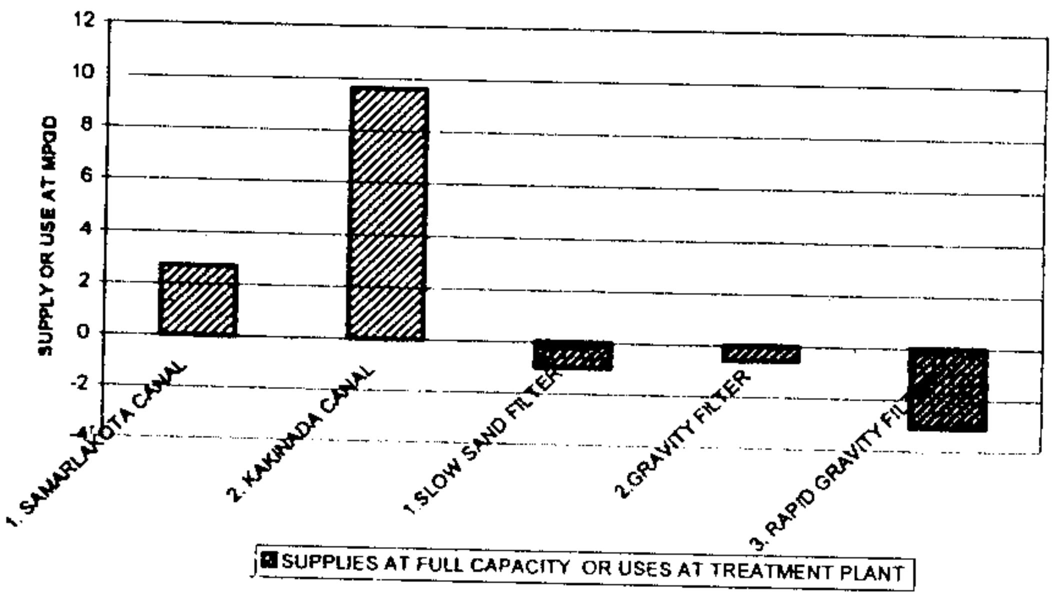


Fig. No. 11 : Growth and Projection of Population of Kakinada

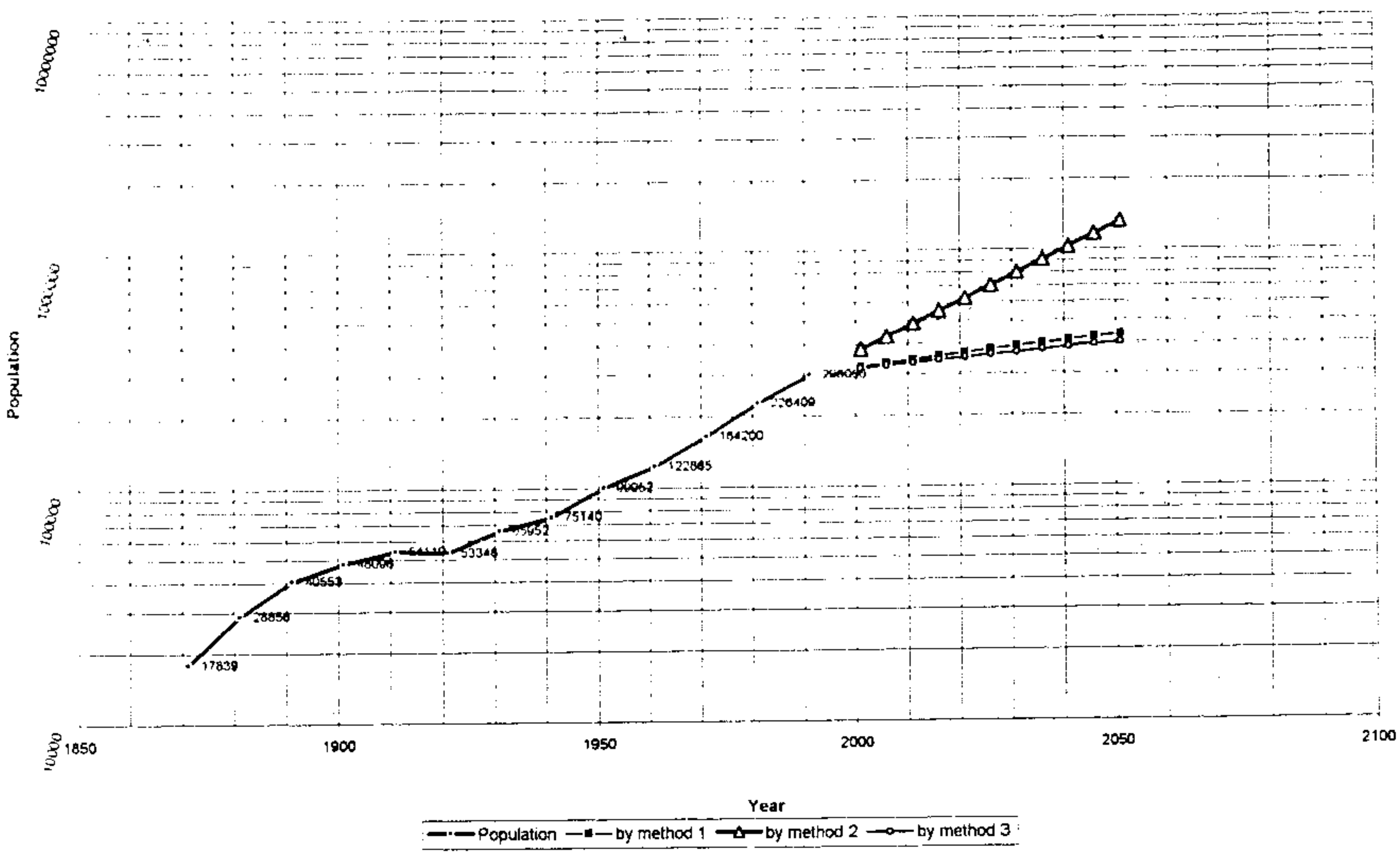


Table No. 5 : RECORDED AND PROJECTED POPULATION FOR KAKINADA

YEAR	RECORDED	YEAR	PROJECTED
1871	17839	2001	382181.1696
1881	28856	2006	432772.2094
1891	40553	2011	490060.2127
1901	48096	2016	554931.6865
1911	54110	2021	628390.4891
1921	53348	2026	711573.3636
1931	65952	2031	805767.5292
1941	75140	2036	912430.6001
1951	99952	2041	1033213.141
1961	122865	2046	1169984.21
1971	164200	2051	1324860.281
1981	226409		
1991	298050		

Table No. 6 :PROJECTED POPULATIONAND WATER REQUIREMENT FOR KAKINADA TOWN BY 2025

	BY 2025	PRESENT	DIFFERENCE	CAPACITY in MGPD
POPULATION	711000	311000	400000	-
DOMESTIC	12.4	3.37	9.03	7.8
INDUSTRIAL	10.27	4.44	5.83	INCLUDED ABOVE
TOTAL	22.67	7.81	14.86	7.8

Table No 7 : SUMMER STORAGE CAPACITY FOR 45 DAYS OF CANAL CLOSURE in MG

	BY 2025	AT PRESENT	SHORTAGE
DOMESTIC	558	526	32
DOMESTIC & INDUSTRIAL	1020	526	494

Fig. No. :12 WATER SUPPLY DEMANDS FOR URBAN USES

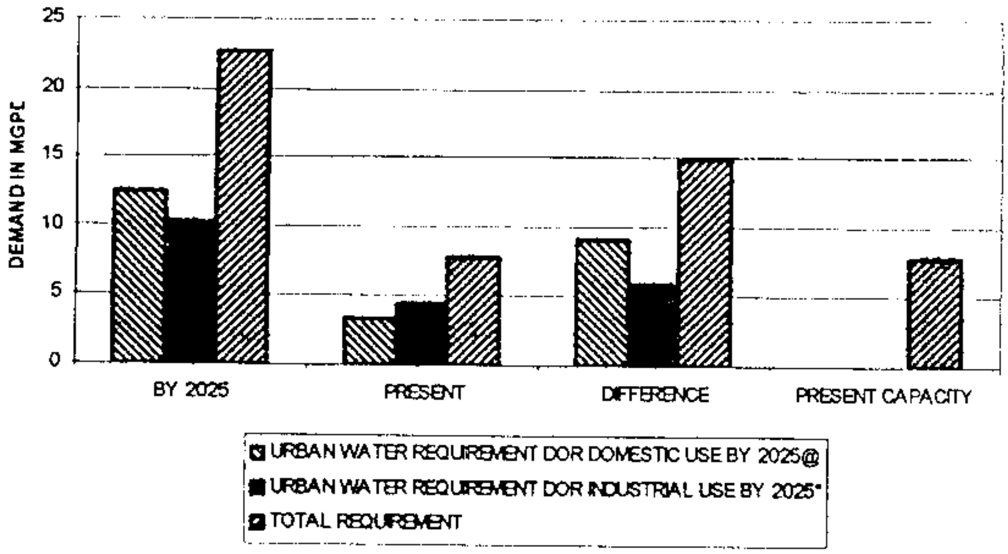
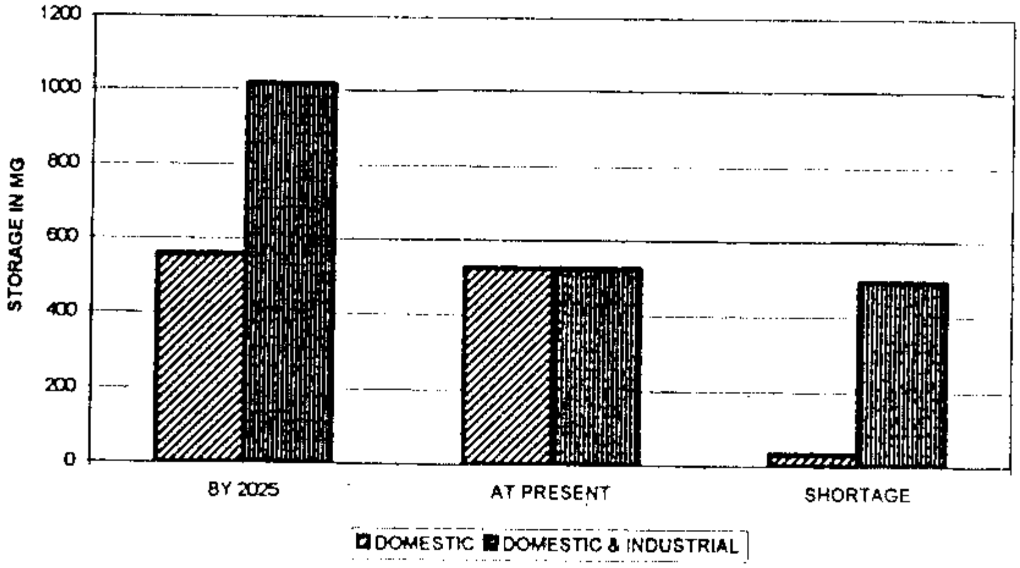


Fig. No. 13 SUMMER STORAGE CAPACITY REQUIREMNTS FOR 45 DAYS



5.5 Summer storage

The summer storage reservoir capacity to provide water for 45 days of canal closure during summer are also estimated for 2025 and Table 7 presents the balance summer storage requirements. The requirements are shown as bar chart plot at Fig. 13.

6.0 RESULTS & DISCUSSIONS

The analysis on water budget and on urban water demands for 2025 resulted in a systematic evaluation of water system of Kakinada town for 3 levels at present use and at source level of future use by 2025. The water supply at ELSR level can cope even for peak flows for present level of tap connections if filled to full level and by direct pumping in Water works and Jagannaickpur and Water works areas as sufficient water supplies are available. Though the quality of groundwater from dug wells and filter points is good, in general for different parts of Kakinada for drinking purpose, the groundwater is not fit for drinking in western parts of Jagannaickpur and most part of Budampeta area as total dissolved solids (TDS) concentration is about 50% in excess of allowable limits (Table 2). Hence making available treated water in these parts is necessary and future plans must have sufficient ELSR capacity to serve these areas.

At treatment plant level only enough water for present requirements is available. At source level additional supplies of raw water can be drawn for new treatment plants to double the present capacity. In this direction a new 3.1 MGPD plant is under commissioning.

The analysis on the future urban water requirements indicates that demands will increase by 3 times by 2025 and hence plans have to be drawn in this direction. The source for such a use can be the Samarlakota canal as its design discharge is high and most of the flows are allocated to irrigation requirements of the agricultural lands lying west and north of the Kakinada town towards which the city is spreading. Hence every 100 acres of agricultural land at tail end of the canal, when gets converted into urban land, can spare about 5 MGPD of supplies for urban use from Samarlakota canal. The methodology applied to estimate balance/shortfall of water at different levels and by 2025 might be duplicated and used for evaluating similar systems elsewhere.

Toxicity left by mixing of copper sulphate needs checking. Water quality in the reservoirs depth-wise as well as that of treated water should be monitored to check adequacy of treatment for potability. Maximum and minimum turbidity and efficiency of treatment deserves to be studied and reported.

Fluctuating inputs/outputs at different levels are to be separated from studying the hydrograph and shortfall/excess quantity has to be assessed during a year. Also the study may be extended to identify suitable sites for locating proposed new ELSRs to meet future demands depending upon groundwater quality for domestic use and areal growth of population.

7.0 ACKNOWLEDGEMENTS

The authors are grateful to the Municipal Commissioner, KMC, Kakinada and other authorities concerned for providing the information and data used in the study.

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Annex - 1

ELSRs AND ITS DISTRIBUTION TO THE DIFFERENT AREAS OF THE TOWN

S.NO	NAME OF THE ELSR	AREAS SERVED
01.	1,87,500 Gls Capacity constructed in Victoria Water Works	Salipeta, Satyanaprasanna Nagar, Venkataratnapuram, Ragampeta Part, Bakpeta and part of Old Town upto Main Market, Western side of Main Road, Temple street Part from Mosque Junction, Old Bus Stand, Frazerpeta, Kancheripeta, Atychutaramaiah Street etc.,
02.	1,75,000 Gls Capacity construction in Victoria Water Works	Ramaraopeta, Suryaraopeta, Ramakrishnarao Peta, Part of Elwinpeta, Gandhinagar, Kondaiahpalem, Recharlapeta and Perrajupeta etc.,
03.	1,25,000 Gls Capacity constructed in Victoria Water Works*	Unserved areas and ill-served areas of Town through water tankers. 1. 2 Nos. lorry mounted tankers. 2. 2 Nos. Tractor coupled tankers. 1 No. lorry mounted tanker supplied by S.R.M.T. at their maintenance cost.
04.	2,95,000 Gls Capacity constructed in Jagannaickpur park	Entire Jagannaickpur area.
05.	10,000 Gls Capacity constructed at Yetimoga*	Yetimoga area and unserved areas and ill-served areas through water tankers. 2 Nos. 5 HP capacity electric motors were installed to pump water from the underground sump provided.
06.	3,52,000 Gls Capacity constructed at Budampeta	Budampeta, Suryanarayanamurthy Puram, Part of Main Market area, Ragampeta, Old Town, East side of Main Road from Mosque Junction.

S.NO	NAME OF THE ELSR	AREAS SERVED
07.	2,22,000 Gls Capacity constructed in Bhaskarnagar	Bhaskar Nagar, Santhinagar, Gazetted Officer's Colony, 50 Buildings area, Godavarigunta, Jayaprakash Nagar, Jayendra Nagar, Bank Colony, Venkatnagar upto Ramanayyapeta, part of Recharlapeta and Srinagar.
08.	2,65,000 Gls Capacity constructed at Sambamurty Nagar	Sambamurthy Nagar, Sanjayanagar, Paralopeta, Dummulapeta, Pallamaraju Nagar, Ayodhyanagar, Part of Kotha Kakinada etc.,
09.	2,65,000 Gls Capacity constructed in Pratapnagar	Pratap Nagar, Dwaraka Nagar, Mehar Nagar, Narasanna Nagar, Ashok Nagar, Lalbahadur Nagar upto Gaigolupadu, Sriram Nagar, Mallayya Agraharam, S. Atchutapuram and Part of Elwinpeta, Gandhi nagar etc.,

* ELSRs not part of water supply system of the service areas studied.

ANNEX - 2

Hydraulic particulars of Godavari eastern delta canals at source of supply of Kakinada water supply system

Sl no.	Particulars	Samarlakota canal at Samarlakota	Kakinada canal at Artlakatta
1	Bed width (m)	15.0	9.15
2	Bed level (m)	+8.57	+0.61
3	FSL (m)	+10.70	+2.75
4	Design discharge (cusecs)	1350	206
5	Command area (acres)	8653	5000

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