Design of Multi Village Rural Water Supply Scheme of Yeola

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Abstract— The study examine water supply schemes in Yeola taluka (Nashik). Data were collected through planning, implementation and maintaining rural water supplies have always been considered there responsibility of the central government and external support agencies. The study therefore recommended some management strategies in order to improve the sustainability of water schemes in the study area by designing the economical rural multi village water supply scheme.

Key words: WTP (Water Treatment Plant), MBR (Master Balancing Reservoir), ESR (Elevated Service Reservoir), Distribution Network, Cost Estimation (By Regional DSR-Nashik)

I. INTRODUCTION

In India rural water supply mainly carried out either single village scheme or multi village scheme. While most of villages are served by single village schemes. Rural water supply systems that cover more than one village are becoming increasingly common in India. The desire to provide full water supply coverage to rural areas, Multi-village water supply schemes have the potential to capture economies of scale and to facilitate higher levels of service, and they appear to offer a feasible and long-term solution to the acute water scarcity faced by many regions in India. According to Indian constitution water is subject of state. The state of Maharashtra is leading in the field of improvements and decentralization of rural water supply and sanitation.

A water supply system is a system for the collection, transmission, treatment, storage and distribution of water from source to consumers, for example, homes, commercial establishments, industry, irrigation facilities and public agencies.

A. Need of Water Supply Scheme

It is necessary that the water which is supplied to the public must be free from all types of impurities, either suspended or dissolved in it. Therefore it is important to plan and build such a water supply scheme which would provide portable water free from any kind of contamination. Generally the water is obtained from well or springs i.e., groundwater free from impurities and it may be supplied to the public without adopting any method of purification. But it is found that the groundwater is filtered naturally through sand and gravel by filtration process. By this process, minute suspended and dissolved particles are removed. But it still contains harmful disease producing bacteria which are minutely-size living organisms not visible to eye. Thus public water supplies must be such that it should be provide adequate and reliable water to public.

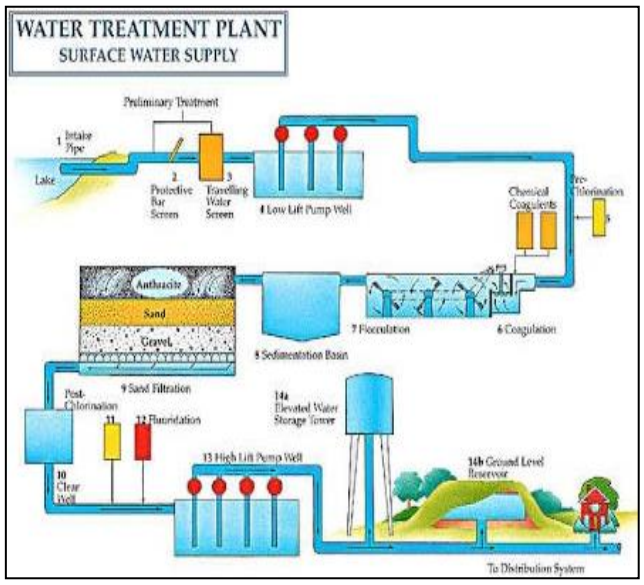

Fig. 1: The layout of Water Supply Scheme

II. LITERATURE REVIEW

1) Maurya, S., et.al (2013), "cost Estimation and Comparative study of Intermittent & continuous Water Supply System of Dulhi Village, Kheri" has investigated, The intermittent supply system may sometimes lead to some saving in water consumption due to losses occurring for lesser time and more vigilant use of water by consumers[1].
2) Piplewar, S. K., et.al (2013), "Design of Distribution Network for Water Supply Scheme and Pindkepar Village by Branch Software" has investigated, Population forecaste and optimal cost is given by software[2].
3) Neog, R., et.al (2014), "Panchayat and Rural Development and case study of Amguri under Siva sagar district, Assam, India" has investigated, existing facilities should be redesign in accordance to the demand of the society[3].
4) ManikandaPrabhu, C., et.al (2015), "Proposed Rural Water Supply and Sanitation System For Nedungundram Village" has investigated, To meet the scarcity of water In Non-Monsoon seasons 'Rainwater Harvesting Technique ' was suggested in that village for conserving water[4].
5) Gandhre, N. S., et.al (2016), "Water Supply Scheme for MamdapurVillage " has investigated, To proposed new water supply scheme for the village to meet their water demands[5].
6) Bharambe, V., et.al (2016), "Analysis of Multivillage Rural Regional Piped Water Supply Scheme" has investigated, The modifications in the design are suggested to overcome this issue considering feasibility[6].

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7) Krishna, P. R., et.al (2016), "Sustainability of Rural Water Supply: A Case Study of Jalanidhi, Kerala" has investigated, Integration of Watershed development programmes to generate water conservation activities, effective and complete community participation and quality assurance can make the schemes sustainable[7]

III. OBJECTIVES

- To undertake observations on available infrastructure and distribution networks of Multi Village Rural water supply in Yeola with reference to regional rural water supply schemes.
- To analyze the performance of regional water supply schemes with special reference to its source of water, coverage, quality of water, treatment facilities, technical efficacy & adequacy for the distribution of water.
- To develop the performance indicators for overall service, management and financial performance evaluation of RRWSS (Source sustainability, Adequacy of water, Service reliability, Acceptable water quality, Cost on capital, operation & maintenance).
- To scale up the potential for development of efficient & equity water distribution amongst the villages in Yeola.
- To identify the impact of implemented schemes on socio economic activities as well as the overall life of the rural habitants.
- To provide the potable and safe drinking water to all villages in Yeola Taluka.

IV. METHODOLOGY

Multivillage Water Supply Scheme for Yeola

A. Demographic Details

Yeola is the town located in the state of Maharashtra, india on the boundary of Nashik and Ahemadnagar district. Solapur - Dhule national highway and 105 km away from Nashik. The town is having Primary School, High school & Engineering Colleges, and various commercial and technical institutes. Due to carrier opportunities city and industries the temporary public is living in Yeola. This temporary public & students are considered as floating population. The town is known for its handloom weaving culture, and special techniques are being used for many centuries for weaving. Electricity is available in Yeola as well as all villages. Main occupation of the villagers is agriculture. North-east and North-west side containing hilly area. Yeola town is situated almost centered position in Yeola taluka.

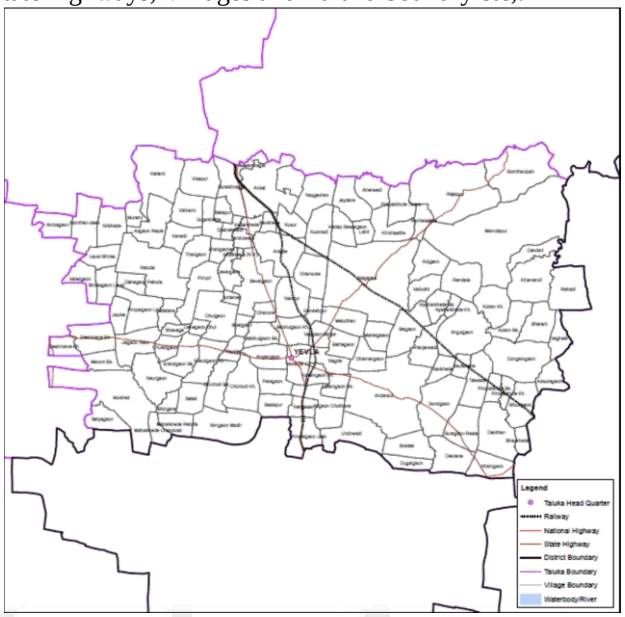
The latitude of yeola, Maharashtra, india is 20.04980, and the longitude is 74.486618.yeola, Maharashtra, india is located at india country in the town place category with the GPS coordinates of 20^0 2' 58. 1280" N 74° 29' 11.8 248" E.

B. Topographic Details

Yeola is a town, a municipal council and a taluka headquarters in Nashik Districts in the Indian state of Maharashtra. Yeola is 83 KM From Nashik on Nashik-Aurangabad highway and 28 KM south of Manmad on the Manmad-Ahemadnagar road. It has a station on the Ahemadnagar-Manmad Rail route.

Topographic surveys are used to identify and map the contours of the ground and existing features on the surface of the earth or slightly above or below the earth surface (i.e. trees, building, streets, walkways, utility poles, retaining walls etc).

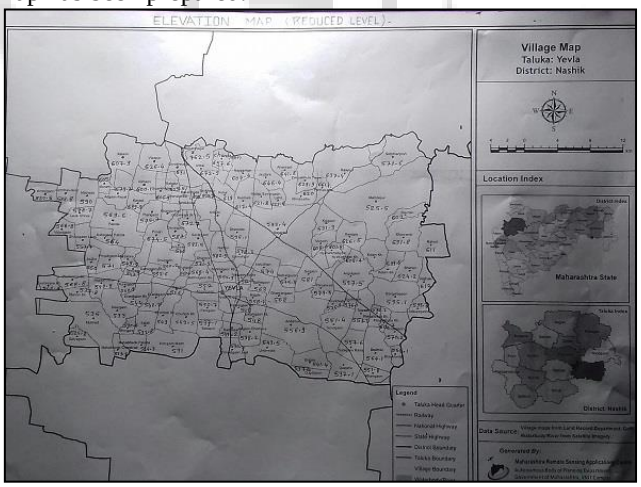
Following map shows the villages in the Yeola taluka. It also shows the Yeola headquarters, National and State highways, Villages and Taluka boundry etc,.



Map 1: Yeola Taluka Map

1) Reduced Level in Graphical Form

Based on Google Earth, elevations are estimated, as shown in the Table 3.2.1 reduced level map and accordingly thematic map has been prepared.



Map 2: Elevation Map

2) Thematic Map for Elevation

Thematic map has been prepared for different classes of elevation ranging from 500m to 550m, 550m to 600m, 600m to 650m, 650m to 700m, and above 700m. Map shows the variation of reduced level for different locations.

Elevation greatly varies along the North-South direction. Due to mountains at Northern side it has higher elevation than the southern site of the region.

Highest elevation is 762.5m at Basantnagar, and lowest elevation is 519.9m at Mahalkhede Chandwad.

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Map 3: Elevation Map

3) Observation From Above Map

It is observed that maximum elevation is at northern villages and sloping towards southern villages. Maximum elevation at Basantnagar is 762.5 m and minimum elevation at Mahalkhede Chandwad is 519.9 m.

C. Population Details

All villages in Yeola Taluka are denoted by specific village code for better understanding about the population. According to the 2011 and 2001 census the population data has been collected by using the reference of www.censusindiacom. The population gives the total no of households along with number of male and female in every village. These website also give the total area of each village.

D. Population Forecasting

Population forecast is a scientific procedure to work out future population scenario. In order to sustain the region water supply scheme over the period of time and to propose the improvement in existing region water supply scheme consumption and design parameters are depending on population of today and coming 4-5 decades. The design population is estimated considering all the factors governing the future growth and development of the project area in the industrial, commercial, educational, and social and administration spheres. Special factors causing sudden immigration or influx of population should also be considered. In present study Population of four decades from 2001 to 2011 is taken as base and forecasted from the year 2021 to 2041. Increase in population over decades is calculated and mean of increase is worked out the paper we presented the population forecasting is done for 124 villages of Yeola regional water supply system, using average of results obtained by Arithmetic increase method. The statistics of projected population is the basic criteria for the addition of diameter of pipe and its length. Also the magnitude of total head assigned to reservoir and horse power capacity of pump may be prescribed as design parameter of region water supply scheme.

In the present work population of 2001 and 2011 is considered from www.villageinfo.in, and for population forecasting 2021 and 2041 Arithmetic Increase method used. By using population forecasting the population of all villages is calculate for future 20 years design period of this scheme. Arithmetic Increase method is used for population forecasting.

1) Arithmetic Increase Method

In this method it is assumed that for all the decades, the birth rates, death rates are constants, the following equation is use for the Arithmetical method.

- Pn = Po + ND
- Where in,
- Pn - population after n^{th} decade
- Po - present population
- N - number of decades
- D - growth rate of population per decade

This provides accurate growth of any region but the assumption about the birth rates & death rates may vary from the reality because for longer period of 25 to 15 years the birth or death rates cannot remain constant.

E. Villages Zones Wise

On the basis of population the water demand has been calculated for each village comes under scheme. There are six zones which consist of number of villages. A master balancing reservoir is provided to each zone. Through MBR water get supplied to every ESR. Two cases of water supply network are used for this scheme, due to which water losses get reduced for shorter length of pipeline.

F. Thematic Map of Zone Wise Distribution of Villages

Following map shows the classification of all villages into 6 number of zones, which considerably helps in the further planning process. Based on water demand of individual villages, zones are formed. Total water demand of each zone is approximately 5 MLD by considering all water losses.

G. Water Demand Estimation

For estimating the total daily drinking water demand the population is multiplied with the per capita drinking water demand. 12^{th} five year plan focusing on piped water supply with 55 lpcd, earmarking of 5% funds for coverage of quality affected as well as60 JE/AES affected districts. Therefore we can take the 60 lpcd water demand for calculating the total daily water demand. Consider the 10% losses while distributing the water from ESR to households. Therefore total water demand after is increased by 10% of original demand

Map 7 Thematic map for water demand. Thematic map for water demand is prepared based on ranges as 5 to 10 mld, 3 to 5 mld, 1.5 to 3 mld, 1 to 1.5 mld, 0.5 to 1 mld and below 0.5 mld used for showing the details of villages of different water demand.

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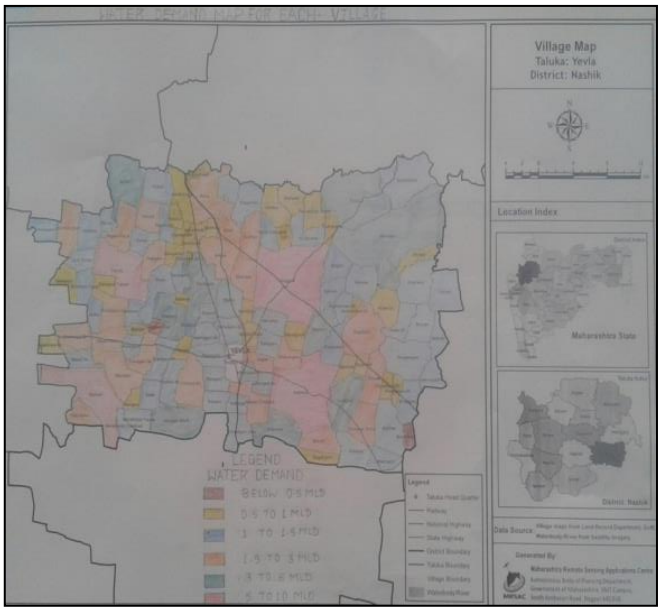


Map 4: Thematic Map for Water Demand

V. CONCLUSIONS

A. Design of Multi Village Water Supply Scheme

In the present world design of multi village water supply scheme is based following design steps

1) Water demand estimation for each zone.
2) MBR and ESR allocation.
3) Water Supply Distribution Network.
4) Calculation of Length of Primary & Secondary Pipe line Network.

– Location of MBR at higher elevation.

5) Cost estimation of water supply scheme.

a) Capital Cost

– Cost of WTP
– Cost of MBR
– Cost of ESR
– Cost of distribution network

b) Operating cost

B. Water Demand Estimation for Each Zone

Total water demand is calculated with the help of future population of region. According to these demand ESR is provided in each village. Total number of ESR and their capacity gives the total water demand for every zone. Total water demand for each zone is 4.5 MLD. In these demands consider 10% water losses while distribution of water from MBR to ESR. Therefore the total water demand for one zone is 5 MLD.

C. Water Supply Distribution Network

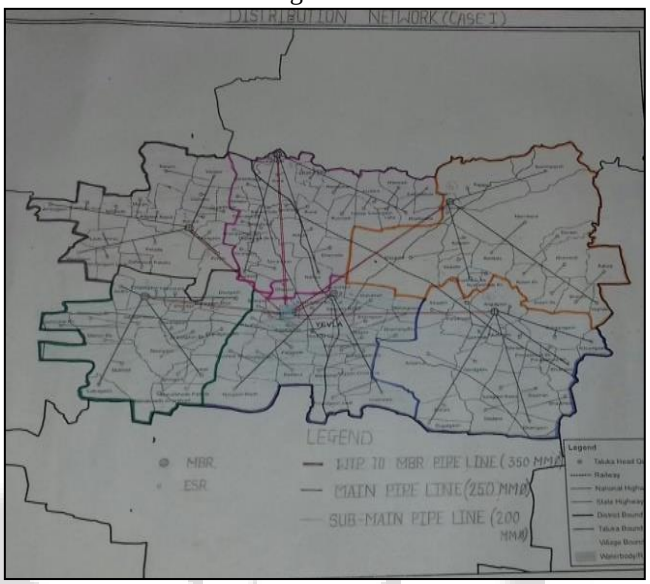
In this scheme, different types of pipe are used for supply of water. Water mains supplies water from WTP to MBR, called as primary network. 350 mm diameter pipes are used for primary network. Sub-mains supplies water from MBR to ESR under gravity, called as secondary network. 250 & 200 mm diameter pipes are used for secondary network. By using T & Bents some branches are taken from Sub-mains to adjacent ESR.

Sr. No.	Distribution Network	Type of pipe lines	Dia. Of Pipe
1.	WTP- MBR	Mains (Primary)	350mm
2.	MBR- ESR	Sub mains (Secondary)	250mm
3.	ESR- Households	Tertiary Network	200mm

Table 1: Distribution Network

D. Primary & Secondary Pipe Line Network

– Location of MBR at higher elevation.



Map 5: Primary & Secondary Network in Graphical Form

E. Cost Estimation of Rural Multi Village Water Supply Scheme

1) Scheme Costs

A World Bank review of the rural water supply sector in India (The World Bank, 1999) suggests that typical per capita costs for multi-village (regional) water supply schemes are significantly higher than for 'small' or 'mini' piped water supply schemes.

*Source: State rural water supply agencies and GOI, in The World Bank (1999)

F. Capital Cost Estimation of Various Components

– Cost of WTP
– Cost of MBR
– Cost of ESR
– Cost of Distribution Network
– Cost of Valves

1) Cost of WTP

Reference From: MJP DSR of Nashik Region
Section - I - (XVII) - TREATMENT PLANT (W.T.P. & S.T.P.)

Sr. No.	Capacity in Mld.	Unit	Rs. In Lakhs
1	Upto 5 MLD	MLD	33.26
2	Cost of 5 MLD Treatment Plant	--	166.30
3	Add for capacity above 5 MLD upto 10 MLD	MLD	23.76

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4	Cost of 10 MLD Treatment Plant	--	285.10
5	Add for capacity above 10 MLD upto 20 MLD	MLD	15.44
6	Cost of 20 MLD Treatment Plant	--	439.50
7	Add for capacity above 20 MLD upto 50 MLD	MLD	14.26
8	Cost of 50 MLD Treatment Plant	--	867.30
9	Add for capacity above 50 MLD upto 100 MLD	MLD	11.88
10	Cost of 100 MLD Treatment Plant	--	1461.30
11	Add for capacity above 100 MLD	MLD	9.50

Table 2: WTP Capacity by DSR

- Total capacity of water treatment plan=5MLD * 6 zones = 30 MLD
- Consider 10% water losses in treatment plant and 10% conveying losses up to MBR.
  Therefore,
- Total capacity of WTP = 36 MLD

sApproximate cost for WTP
DSR gives total cost for WTP of 20 MLD capacity = 439.50 lakh
Add for capacity above 20 MLD upto 50 MLD = 14.26 lakh per MLD increase in capacity.
Total cost of WTP for 36 MLD capacity = 667.66 lakh
2) Cost of MBR:
Reference from- MJP DSR of Nashik Region.
Section - I - (XIX) - R.C.C. E.S.Rs

Sr. No.	Capacity in litres	Unit	for Seismic Zone- III Rate in Rs.
1	upto 25,000 litre	Litre	23.76
2	Cost of 25,000 Litre capacity E.S.R.	----- -	594000.00
3	Add for capacity above 25,000 upto 50,000 litre	Litre	13.07
4	Cost of 50,000 Litre capacity E.S.R.	----- -	920750.00
5	Add for capacity above 50,000 upto 75,000 litre	Litre	9.50
6	Cost of 75,000 Litre capacity E.S.R.	----- -	1158250.00
7	Add for capacity above 75,000 upto 1,00,000 litre	Litre	8.32
8	Cost of 1,00,000 Litre capacity E.S.R.	----- -	1366250.00
9	Add for capacity above 1,00,000 upto 1,50,000 litre	Litre	7.13
10	Cost of 1,50,000 Litre capacity E.S.R.	----- -	1722750.00
11	Add for capacity above 1,50,000 upto 2,00,000 litre	Litre	5.94
12	Cost of 2,00,000 Litre capacity E.S.R.	----- -	2019750.00
13	Add for capacity above 2,00,000 upto 2,50,000 litre	Litre	5.64
14	Cost of 2,50,000 Litre capacity E.S.R.	----- -	2301750.00
15	Add for capacity above 2,50,000 upto 3,00,000 litre	Litre	5.35
16	Cost of 3,00,000 Litre capacity E.S.R.	----- -	2569250.00
17	Add for capacity above 3,00,000 upto 4,00,000 litre	Litre	5.04
18	Cost of 4,00,000 Litre capacity E.S.R.	----- -	3073250.00
19	Add for capacity above 4,00,000 upto 5,00,000 litre	Litre	4.75
20	Cost of 5,00,000 Litre capacity E.S.R.	----- -	3548250.00
21	Add for capacity above 5,00,000 upto 7,50,000 litre	Litre	4.45
22	Cost of 7,50,000 Litre capacity E.S.R.	----- -	4660750.00
23	Add for capacity above 7,50,000 upto 10,00,000 litre	Litre	4.16
24	Cost of 10,00,000 Litre capacity E.S.R.	----- -	5700750.00
25	Add for capacity above 10,00,000 upto 15,00,000 litre	Litre	3.86
26	Cost of 15,00,000 Litre capacity E.S.R.	----- -	7630750.00
27	Add for capacity above 15,00,000 upto 20,00,000 litre	Litre	3.56
28	Cost of 20,00,000 Litres capacity E.S.R.	----- -	9410750.00

Table 3: ESR Capacity by DSR

Reference From- MJP DSR of Nashik Region.
Cost of 2 lakh lit MBR capacity = 9410750.00 RS.
Consider RS. 3 per lit increase in capacity above 2 lakh litre.
Therefore, cost of MBR having capacity 5 lakh lit is = 9410750.00 RS + (3* 300000)
= 10310750.00 RS.
Approximate Cost of 6 MBR = 6 * 10310750.00
= 61864500.00 RS
Cost of MBR = 618.645 lakh
Cost of ESR:
Reference From- MJP DSR of Nashik Region.
Section - I - (XIX) - R.C.C. E.S.Rs

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Sr. No.	Capacity of ESR	Cost As per DSR (Rs.)	No. of ESR	Cost in Rs.
1	0.5	920750.00	6	5524500.00
2	1.0	1366250.00	34	46452500.00
3	1.5	1722750.00	30	51682500.00
4	2	2019750.00	17	34335750.00
5	2.5	2301750.00	19	43733250.00
6	3	2569250.00	7	17984750.00
7	4	3073250.00	4	12293000.00
8	5	3548250.00	3	10644750.00
9	7.5	4660750.00	2	9321500.00
10	10	7630750.00	2	15261500.00
Total = Rs. 247234000/-				

Table 4: Cost Estimation for ESR & MBR

Cost of ESR = 2472.34 lakh

Cost of Distribution Network:

Reference From- MJP DSR of Nashik Region.

Section - I- (I)- C.I./D.I.Pipes

Sr. No.	Item Description	Unit	Rate (in Rs.)	
B	CLASS " A "		With ED	Without ED
1	Class "A" - 80 mm	RMT	956	852
2	Class "A" - 100 mm	RMT	1193	1063
3	Class "A" - 125 mm	RMT	1552	1383
4	Class "A" - 150 mm	RMT	1912	1703
5	Class "A" - 200 mm	RMT	2763	2461
6	Class "A" - 250 mm	RMT	3735	3327
7	Class "A" - 300 mm	RMT	4833	4306
8	Class "A" - 350 mm	RMT	6043	5384
9	Class "A" - 400 mm	RMT	7410	6602
10	Class "A" - 450 mm	RMT	8976	7998
11	Class "A" - 500 mm	RMT	10292	9170
12	Class "A" - 600 mm	RMT	13744	12245
13	Class "A" - 700 mm	RMT	17911	15958
14	Class "A" - 750 mm	RMT	19896	17725
15	Class "A" - 800 mm	RMT	22241	19815
16	Class "A" - 900 mm	RMT	27072	24119
17	Class "A" - 1000 mm	RMT	32562	29010

Table 5: Pipe Diameter by DSR

Sr. No	Dia. of Pipe (MM)	Rate Per Running Meter (Rs.)	Total Length of pipe Network (KM)	Total Cost in (Rs)
1	350	6043	74.4	449599.20
2	250	3735	179.4	670059.00
3	200	2763	165.24	456558.12

Table 5: Approximate Cost for Distribution Network:

Total cost of Distribution network = Rs.1576216.32/-

Add 10% for pipe fittings and 10% for lap joint = 315243.26/-

Cost of distribution network = Rs.1891459.58 /-

Cost of distribution network = 18.92 lakh

Total capital cost of Scheme = 3777.565 lakh

=37.77 Cr

Pumping Cost: It include daily pumping cost of drinking water by considering electricity charges on it.

The ideal hydraulic power to drive a pump depends on

the mass flow rate the

liquid density

the differential height

Sr. No.	Net Head (H)m	Shaft Power (Hp) Per day	Electricity Charges Rs.(Per month)
Zone-1	132.5	1049.07	1408691.19
Zone-2	25.6	202.69	272172.13
Zone-3	209.5	1658.71	2227315.79
Zone-4	25.3	200.31	272172.13
Zone-5	109.7	868.55	1166288.94
Zone-6	57.7	456.84	613444.75
Total Electricity Charges per Month =5960084.9			

Table 6: Calculation of Electricity charges

Consider installation of Condenser unit in power house for each pump and payment of MSCB bill regularly it gives 60% concession.

Therefore total electricity charges per month =Rs 3576050.96/-

= 35.76 lakh

Total Operating Cost=

Raw water charges per month =Rs. 692.2/- (Rs 1.72 per lakh lit)

Cost of Treatment Per Month = Rs.540000/- (Rs 50 per lakh lit)

Pumping cost per month = Rs 3576050.96/-

Total Operating Cost per Month = Rs 4116743.16/-

Total Operating Cost per Month =41.167 lakh

G. Break through Analysis

The breakeven analysis is determined what you need to sell, monthly or annually, to cover your costs of doing business your break-even point. Break even analysis entails the calculation and examination based on the revenues collected and associated costs.

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Analysing different price levels relating to various levels of demand, an entity uses break- even analysis to determine what level of sales are needed to cover total fixed costs.

Water supply systems by performing a break even analysis that compare operating costs with manual monitoring.

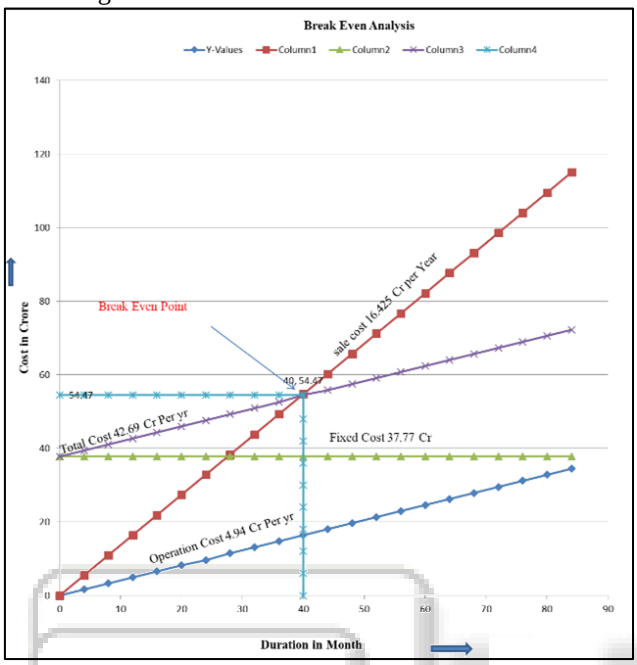

Fig. 1:

VI. Conclusion

- The population forecasting carried out using Arithmetic mean method provides qualitative support to the planning, design and allocation of water resources project. In this we have shown 3 decades population increases for years 2021, 2031, 2041 compared to the base year 2001, 2011.
- The population forecasting for design period of 30 years is obtained so that water supply network can be designed for yeola regional water supply scheme.
- The statistics of estimated population is basic consideration for the addition of diameter of pipe and its length.
- Also the magnitude of total head assigned to reservoir and capacity and type of pump may be prescribed.
- The effective use of this system can be done for convenient management of construction, cost analysis, reducing overall project duration and human efforts.

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