



Design of water distribution system for expanded area of Jamnagar Municipal Corporation

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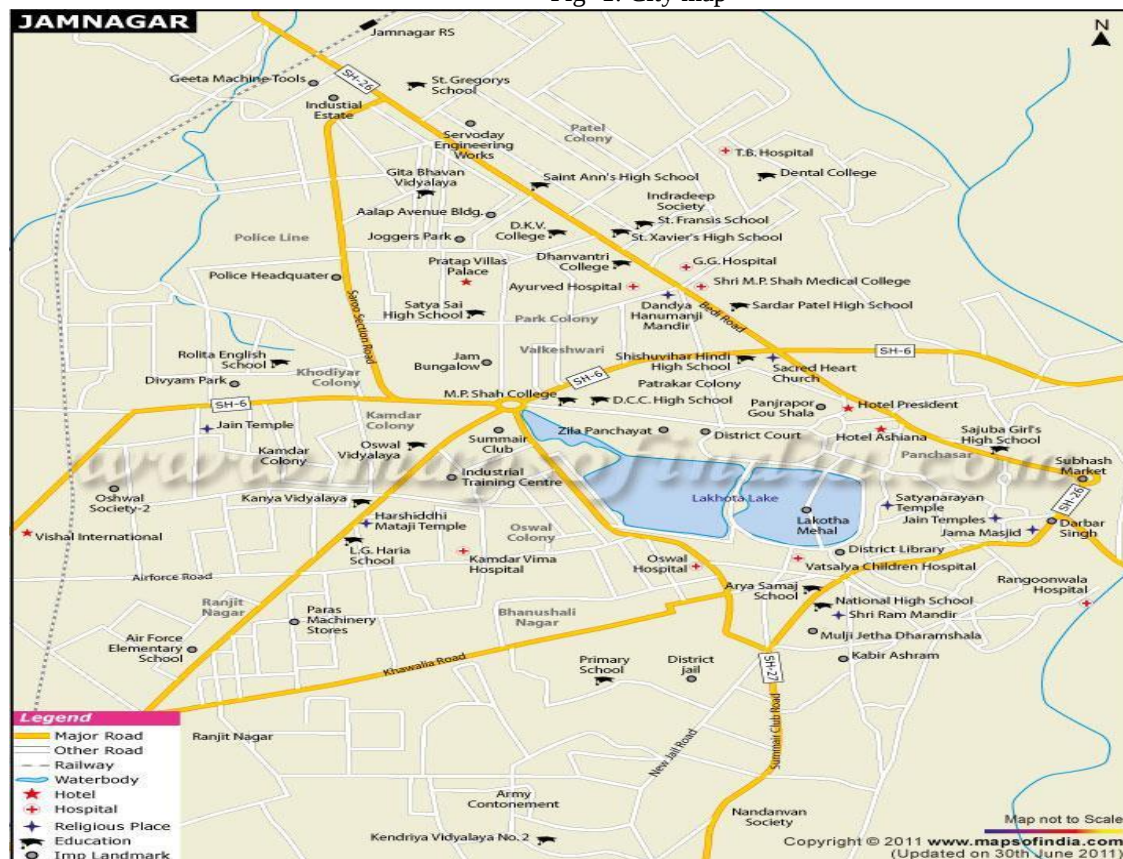
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Abstract — The present system of supply adopted in Jamnagar Municipal Corporation is an intermittent supply and the network adopted is a dead end system. This system of supply of water in Jamnagar Municipal Corporation may or may not be reliable to the upcoming years. Hence the research is all about the analysis of the existing network and concludes about the reliability on the network for the future. The analysis is carried out based on various public demands, quantities of inflows and out flows of the over-head reservoirs. This analysis provides the information about various demands, losses, and uses of the public. The design of a new network of supply will make the municipality be aware of the new demands, rate of increase in the demands. The design is made keeping in view of the population growth rate, and the developing town. The design brings out an improvement in the existing network

I. INTRODUCTION

1.0 TOWN PROFILE:

Fig -1: City map



Jamnagar city is about 277 km from state capital Gandhinagar and is a coastal city situated to the south of northern sea coast of Saurashtra region and at height of approx 20 m above mean sea level. The Jamnagar city lies between latitude 22° 28' N and Latitude 70° 04' E. it is one of the important industrial hub and is popular for brass industries catering to nearly 70% of the countries requirement and is popularly known as brass city of Gujarat. Jamnagar is the preferred location for most of the Industrial Players. Two Special Economic Zones are developed by the Government of Gujarat. It has nine Industrial Estates. Other major business of the district includes fishing, processing, plastic, Machineries,

Engineering, Oil mills, Solvent Plants, Bandhani (Sarees) etc. Due to availability of deep sea and favorable location for ports, major industrial houses like Reliance Industries Limited and ESSAR are attracted to set up oil refineries.

Jamnagar city is one of the major cities in Gujarat State having Status of Municipal Corporation and the administrative headquarters of the district having 622 villages in the 10 talukas and 9 towns. Total population of the district was 5,00,208 out of which the population of Jamnagar City was 4,47,734 as per 2001 Census. The city is of strategic importance due to existence of international boundaries nearby. It has all the three wings of defense viz. Air Force, Navy and Army.^[5]

It is well connected by air with Bombay, Ahmadabad and Bhuj. It is also well connected by road through four (4) state highways with Rajkot, Ahmadabad, Kutch, Porbandar and Dwarka etc. Broad Gauge railway connected with Dwarka - Porbandar and Rajkot- Ahmedabad- Bombay. It has good sea ports viz. Bedi Bandar, Nava Bandar, Sikka Port, Rozi Port and Vadinar Port.

1.2 Jamnagar Municipal Corporation and Jamnagar Area Development Authority:

Due to very rapid growth if heavy industries and the surrounding area of Jamnagar City, the fast development in the activities of Commerce and trade have rapidly increased. Also the heavy mega industries lead to develop the surrounding area of Jamnagar City. The Government of Gujarat has developed the Authority viz. Jamnagar Area Development Authority (JADA) on February 1st 1978. The authority acts under the provision of Gujarat Town Planning and Urban Development act – 1976. The revised development plan of JADA sanctioned by State Government came to effect from 6th December 2000. Besides, it is also responsible for development of infrastructures like road – sewage – water supply and other basic civic amenities.

JADA covers Nagarsim area (Out Growth) and 26 villages of Jamnagar Taluka. JADA has 285 Sq.Km. area which includes approximate 33.70 Sq.Km. area of Jamnagar Municipal Corporation.^[4]

1.3 Topography:

Topography of Jamnagar is almost flat, having gentle slope towards North and towards Rangmati River in East. The level difference between high and low level areas is almost 13 meters. As far as the District Topography is concerned, its Southern periphery is hilly and sloping towards Northern and North Western directions. Central regional is Undulating and at places plain or gently sloping towards the sea. The area comprises of alluvium, milliolite, limestone, laterite and deccan trap formulations. Deccan trap is the oldest rock formation extensively spread in the district.

1.4 Climate:

The climate of Jamnagar city is pleasant and fair throughout the year. The seasons being divided into four periods, i.e. dry winter from December to February, Summer from March to May followed by South West monsoon season from June to September and post monsoon moderate climate from October to November. January is the coldest month of the year with average daily maximum Temperature of 26°C and average of minimum 9°C. May is the hottest month with maximum temperature of 36°C and minimum of round about 24°C then temperature gradually decreasing from the middle of June and ultimately becomes pleasant during the entire monsoon season.

1.5 Demographic Characteristics:

Jamnagar Municipal Corporation (JMC) presently has an area of 34.0 Sq.Mt. Under its jurisdiction divided into 19 wards. As per census 1991, JMC has recorded population of 3.42 lacs. As per latest 2001 census, JMC had a population of 4.48 lacs, which shows and decade growth of 31.00% during decade of 1991-2001. While the tremendous growth occurred in OG – JADA area during decade 1991-2001

JADA consist of OG & 26 villages. Presently JADA has area of 332.00 Sq.Km. including JMC area under its jurisdiction and as per 2001 census population was 5.00 lacs.

1.6 Population of Demography:

Table1: Population Growth^[3]

Sr. No.	Census Year	Population of Jamnagar City With O.G		
		J.M.C. Area	Outgrowth Area	Total
1	1931	55,056	--	55,056
2	1941	71,588	--	71,588
3	1951	1,04,419	--	1,04,419
4	1961	1,48,572	--	1,48,572
5	1971	2,14,516	--	2,14,516
6	1981	2,94,344	--	2,94,344
7	1991	3,41,637	8,907	3,50,544

8	2001	4,47,734	52,474	5,00,208
9	2011	600411		600411

2.0 PROJECTED FUTURE POPULATION FIGURES BY VARIOUS METHODS OF ESTIMATION AND WATER REQUIREMENT FOR JAMNAGAR CITY:

Project future population for Jamnagar city is shown in following table:

Table2: Population Calculation

Sr. No.	Year	Arithmetical Increase Method	Geometrical Increase Method	Incremental Increase Method
1	2011 AD	6,00,411	6,00,411	6,00,411
2	2015 AD	6,76,762	8,95,037	7,27,801
3	2020 AD	7,04,030	10,32,207	7,82,331
4	2025 AD	7,31,298	11,90,400	8,41,617
5	2030 AD	7,58,566	13,72,836	9,05,656
6	2035 AD	7,85,834	15,83,231	9,74,451
7	2040 AD	8,13,102	18,25,871	10,48,000
8	2045 AD	8,40,370	21,05,697	11,26,305

Water Requirement:

Table3: Water Requirement

Sr. No.	Year	Population Adopted	Water Requirement (in MLD)
1	2015 AD	7,27,801	127
2	2030 AD	9,05,656	153
3	2045 AD	11,26,305	187

3.0 PRESENT STATUS OF WATER SUPPLY:

3.1 Source of Water supply:

At present Jamnagar Municipal Corporation is drawing water from different sources i.e. Sasoi, Und, Aji, Narmada and Ranjit Sagar. Water is received at Pump house head work site and Khijadiya headwork site. The average incoming water is about 90 MLD including MES area

Table4: Source of water

Ranjit Sagar Dam	-	35 MLD
Sasoi Dam	-	15 MLD
Und-I Dam	-	25 MLD
Narmada water	-	15 MLD
Total	-	90 MLD

Potential sources:

Aji – III Dam

Und – II Dam

Ranjit Sagar Dam:

The water supply scheme of Ranjit Sagar Dam was taken up in 1954 approximately 10 km south of the city. It was subsequently put into operation in February 1966. Initially the scheme was to supply raw water of about 6.82 MLD to Jamnagar. At present Jamnagar city is getting 37.20 MLD water.

Sasoi Dam:

Water supply from Sasoi Dam located approximately 22 km southwest of the city was subsequently put into operation in about 1986. Initially 8 MLD of water was drawn/ supplied which was gradually increased to 18 MLD in the year 1985. There are three lines of dia. 400 mm, 450 mm and 500 mm respectively supplying water into WTP situated in Jamnagar. At present Jamnagar city is drawing 18 MLD.

Und-I Dam:

With the increase in demand, further shortfall of water was experienced in the city. The frequency of inadequate rainfall with drought conditions also added to the strains of water shortage. Thus in the year 1986-87, Und-I Dam was taken up to supply 25 MLD of water. A pipeline of 46 km length having 700 mm dia. is laid to collect water into various Head work located in Jamnagar.

Narmada Pipeline:

The government of Gujarat has implemented a state level pipeline project based on Narmada canal to cater to the drinking water requirements for entire Saurashtra and Kutch region villages, towns and cities. Jamnagar Municipal Corporation has been allocated 68 MLD of water from this pipeline project from July 2003 onwards. This supply is proposed to be increased subsequently as per the future requirement of the city for the next 20 to 30 year

Aji III Dam:

During the scarcity of water in the year 1989 - 90, it became necessary to draw water from the Aji-III Dam about 55 km away from Jamnagar, located east of the city to meet the shortfall of water demand. Two pipelines of 500 mm dia. and 450 mm dia. were laid for a total potential of 13 MLD. An average 10 MLD water is drain from Aji-III as and when required.

Water treatment Plant:

Khijadiya filter plant – capacity 55 MLD
Pump house filter plant – capacity 62 MLD
Storage capacity at WTP – 190 ML at Khijadiya and 16.5 MLD at Pump house

3.2 Present water supply Demand:

Present water supply Demand is for

- (a) Population of 7 lacs as above and
- (b) Defense units which happens to be major consumer and
- (c) Industrial as well as institutional demand within the city as Under:

Table5: Present water supply demand

Population 7 lacs at 113.6 l/head/day	98 MLD
Defense units and others, institutional and industrial within and outside the Municipal periphery or outer growth	22 MLD
Total	120 MLD

Present shortfall of Water supply:

Present water supply Demand	120 MLD
Present potential of sources	90 MLD
Short fall	30 MLD

3.3 Measures to tide over the shortfall:

The problem of the shortfall of Jamnagar Municipal Corporation was put up with the proposal to draw it from Aji-3 Dam.

3.4 Proposed water supply scheme:

JMC will get additional 15 ML water from water supply scheme based on Sasoi Dam which is under progress granted by GoG and additional 30 ML water from water supply scheme based on Aji-3 Dam Under proposed UIDSSMT.

The water is supplied to the entire city from two proposed Head works i.e. Headwork No. 1 at pump house and Headwork No. 2 at Khijadiya.

At present Narmada water is supplied to Khijadiya filter plant only. Water at Pump house head work is received from local source, Ranjit Sagar Dam, Und-I Dam and Sasoi Dam.

From pump house headwork, the water is transmitted to three water distribution stations of

- Pump house
- Shankar Tekri
- Ranjit Nagar

From Khijadiya headwork the water is transmitted to five remaining water distribution stations of

- Gulabnagar
- Solarium
- Samarpan
- Navagam ghed
- Bedi

Table6: Source water drawl

Source	Water Drawl
Ranjit Sagar Dam	35 MLD (Water draws by 700 mm dia. and 500 mm Gravity Pipeline)
Sasoi Dam	15 MLD (JMC Draws water with 3 no of old pipeline (laid in 1970, 1986, 1988) after augmentation work completed JMC will get 30 MLD water)
Und-I Dam	25 MLD Water draws by 700 mm dia. pumping main pipeline laid in 1986-1987
Aji-3 Dam	15 MLD (In scarcity conditions JMC gets water through 2200 mm Narmada pipeline after augmentation work completed JMC will get 30 MLD water)
Narmada water	15 MLD (it can raised as required, Allocation of Narmada pipeline is @ 68 MLD)
Total	105 MLD

3.5 Shortfall of water:

Scarcity of water:

Jamnagar is scarcity prone area having 40 year of scarcity in last 100 years. The general conditions are poor as rainfall below 400 mm is found, which is inadequate for Jamnagar. At present JMC supplies 75 MLD water to the people once in three days at the rate of 90 LPCD against 92 MLD in normal condition. On alternate days it is at the rate of 125 LPCD.

Whenever rainfall deficits, all sources of water dry up. In these conditions Narmada canal water will be the main source for drinking water to Jamnagar.

Hence a proposal has been made by JMC to Government to draw the water from NC-8 and to supply water to pump house filter plants.

4.0 PROPOSED PROJECT REQUIREMENT:

At present Distribution network already exists at town area of JMC. There is not any existing distribution network for Outskirts/ outer growth area of JMC. At present water is being supplied by tankers and bore wells only. Hence it is

proposed to lay distribution network for these area of JMC. Head works including Sump, ESR, Pump house are already exists at these area. The detail of the same is shown in following table.

Table7: Details of head works

OG area	Population (year 2011)	Details of Head works
Zone-1 Gokulnagar Area	11975	UG Sump: Capacity 15 Lac lit, UG Sump: Capacity 20 Lac lit, ESR: Capacity 15 Lac lit, Staging height 18 m
Zone-2 Survey no. 747	27500	UG Sump: Capacity 35 Lac lit, ESR: Capacity 15 Lac lit, Staging height 18 m
Zone-3 Mahaprabhuji ni Bethak	27500	UG Sump: Capacity 35 Lac lit, ESR: Capacity 15 Lac lit, Staging height 18 m
Zone-4 Gyanganga School	11974	ESR: Capacity 6.5 Lac lit, Staging height 18 m
Total	78949	

5.0 PROPOSED PROJECT COMPONENTS:

The proposed project includes Water supply distribution along with the head work for Woollen Mill and Dhichada OG Area. Raw water will be supplied from WTP existing at Gyanganga school having capacity 20 MLD. Water is being pumped to Gokulnagar CWS. There is an existing pumping main of 300 mm Dia. (Dual pipe), DI pipe from Gyanganga WTP to Gokulnagar sump. There are two nos. of CWS having capacity 20 lac liter and 15 lac liter respectively at Gokulnagar. Hence it is proposed to supply water to proposed Woollen Mill Area from Existing CWS at Gokulnagar. The pumping machinery existing at Gyanganga CWS is having capacity to satisfy the Demand of Gokulnagar zone only. Hence it is proposed to replace pumping machinery at Gyanganga CWS having capacity to satisfy water demand of Gokulnagar and Woollen mill area. 2 nos. of pump (1W+1S), 321 cum/hr, 22 mt. head, 30 KW are proposed for the same From Gokulnagar ESR, gravity main of Dia. 700 mm +500 mm having total length of 4200 mt. (1200+3000) exist upto Jakatnaka junction. From Jakat naka junction the gravity main of 450 mm Dia. DI K-7 pipe, 3670 mt. length is proposed to be extended upto CWS at Woollen mill area. Pumping main of Dia. 350 mm Dia. DI K-9, 50 mt. length is proposed to be connected from Gokulnagar CWS to this existing gravity main with sluice valve on both the pipeline. 2 nos. of pump (1W+1S), 289 cum/hr, 5 mt. head, 7.5 KW are proposed at Gokulnagar CWS. At Woollen mill area Distribution network and Head work including CWS, ESR and Panel room are proposed to supply the water.

Population projection:

The population has been forecasted based on the area density method and growth rate of the city.

Rate of water supply;

As per size of town and activities of the people, the maximum per capita water would be 140 LPCD + 15 % unaccounted for losses i.e. total 161 LPCD as per recommendation of CPHEEO manual.

- The detail of Population projection and projected water demand has been shown in following **Table No.**
- The details of the proposed components are shown in following **Table No.**

Table8: Total water requirement

Water Demand in lpcd	140
UFW 15%	21
Total	161

Table9: Project Population

PROJECTED POPULATION (SOULS)	2015	2030	2045
	13440	21504	34406

Table10: Projected Water Demand

WATER DISTRICT	ZONE	CONTRIBUTORY AREA (HECTARE)	CONTRIBUTORY POPULATION	DENSITY (2012)	FORECASTED DENSITY			FORECASTED POPULATION AS PER FORECASTED DENSITY			PROJECTED WATER DEMAND (MLD)		
Woolle nMill and Dhichada OG Area	Woollen Mill and Dhichada OG Area		2012		2015	2030	2045	2015	2030	2045	2015	2030	2045
		341.38	12000								2.16	3.46	5.54
				35	39	63	101	13440	21504	34406	2.16	3.46	5.54
	TOTAL	341.38	12000					13440	21504	34406	2.16	3.46	5.54
Total Area Project		341.38	12000					13440	21504	34406	2.16	3.46	5.54

Table11: Rising main details

Location	DESIGNED FLOW IN MLD			Static Head (M)	Length (M)	Designed Rising Main dia. (MM)	Existing / Proposed
	2015	2030	2045				
	Base	Intermediate	Ultimate				
Pumping Main from sump at Gyanganga school to sump at Gokulnagar (Dual Pipe)	4.4	7.04	11.26	11	2500	300	Existing
Pumping Main form sump at Gokulnagar to Existing Gravity main	2.16	3.46	5.54	4	50	350	Proposed
Pumping Main from CWS to ESR for Woollen Mill area	2.16	3.46	5.54	26	30	400	Proposed

Table12 : Gravity Main Details

Location	DESIGNED FLOW IN MLD			Peak Flow in MLD	Length (M)	Designed Gravity Main dia. (MM)	Existing / Proposed
	2015	2030	2045				
	Base	Intermediate	Ultimate				
Gravity Main from CWS at Gokulnagar to Jakatnaka Junction	-	-	-	-	1200	700	Existing
	-	-	-	-	3000	500	Existing

Design of Grvity main from to CWS at woollenmill area	2.16	3.46	5.54	11.08	3670	450	Proposed
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Table13: Pumping machinery details

Location	Pumping machinery at CWS near Gyanganga WTP for existing Pumping Main (Dual pipe each of 300 mm) from sump near Gyanganga WTP to sump at Gokulnagar	Pumping machinery at CWS near Gokulnagar for Pumping to Gravity main from Gokulnagar ESR to CWS at Woollen mill area	Pumping machinery at CWS near Woollen mill area for Pumping to ESR
Intermediate MLD	7.04	3.46	3.46
G.L. of CWS (M)	18	22.5	13.87
Bottom Level of Sump (M)	16	20.5	11.87
G.L. of ESR/CWS (M)	22.5	22.5	14.13
FSL/BSL of ESR/CWS (M)	24.5	22.5	35.13
Height of ESR (M)	-	-	15
Residual head (M)	2	2	2
Static heam (M)	11	4	26
Total Head as per Design (M)	22	5	26
Discharge in CUM/H	321	289	433
Discharge in LPM	5350	4817	7217
HP	40.3	10.1	60.5
KW	30	7.5	45
No. of Pump	2(1W + 1S)	2(1W + 1S)	2(1W + 1S)

Table14: Total pipes required

Proposed diameter & Length of distribution system - DI - K-7 class										
Water District	Location	DI K-7 Pipe								Total
		100mm	150mm	200mm	250mm	300mm	350mm	400mm	500mm	
Woollen Mill and Dhichada OG Area	Woollen Mill and Dhichada OG Area	25340	2840	2050	1050	890	140	690	570	33570
Total									=	33570

6.0 Storage calculation

6.1 Statement showing inflow and outflow hours for and ESR

Table15: Statement showing inflow and outflow hours for and ESR

Sr. No.	Zone		Inflow				Outflow				Remarks
1	CWS at WTP near Gyanganga School	CWS	2	to	12	10 hrs	2	to	10	8 hrs	Existing CWS and ESR
			12	to	24	12 hrs	14	to	22	8 hrs	
					Totla	22 hrs			Total	16 hrs	
2	CWS1 (20 Lac Liter) at Gokulnagar	CWS1	2	to	10	8 hrs	4	to	10	6 hrs	Existing CWS
			14	to	22	8 hrs	14	to	20	6 hrs	
					Totla	16 hrs			Total	12 hrs	
3	CWS2 (15 Lac Liter) at Gokulnagar	CWS2	2	to	10	8 hrs	6	to	9	4 hrs	Existing CWS and ESR
			14	to	22	8 hrs	15	to	19	4 hrs	
					Totla	16 hrs			Total	8 hrs	
	ESR at gokulnagar	ESR	5	to	9	4 hrs	6	to	10	4 hrs	
			15	to	19	4 hrs	16	to	20	4 hrs	
					Total	8 hrs			Totla	8 hrs	
4	CWS at Woolen Mill	CWS	4	to	10	6 hrs	5	to	9	4 hrs	Assuming CWS and ESR
			14	to	20	6 hrs	15	to	19	4 hrs	
					Total	12 hrs			Total	8 hrs	
	ESR at Woolen mill	ESR	5	to	9	4 hrs	6	to	10	4 hrs	
			15	to	19	4 hrs	16	to	20	4 hrs	
					Total	8 hrs			Totla	8 hrs	

6.2 Sump storage calculation

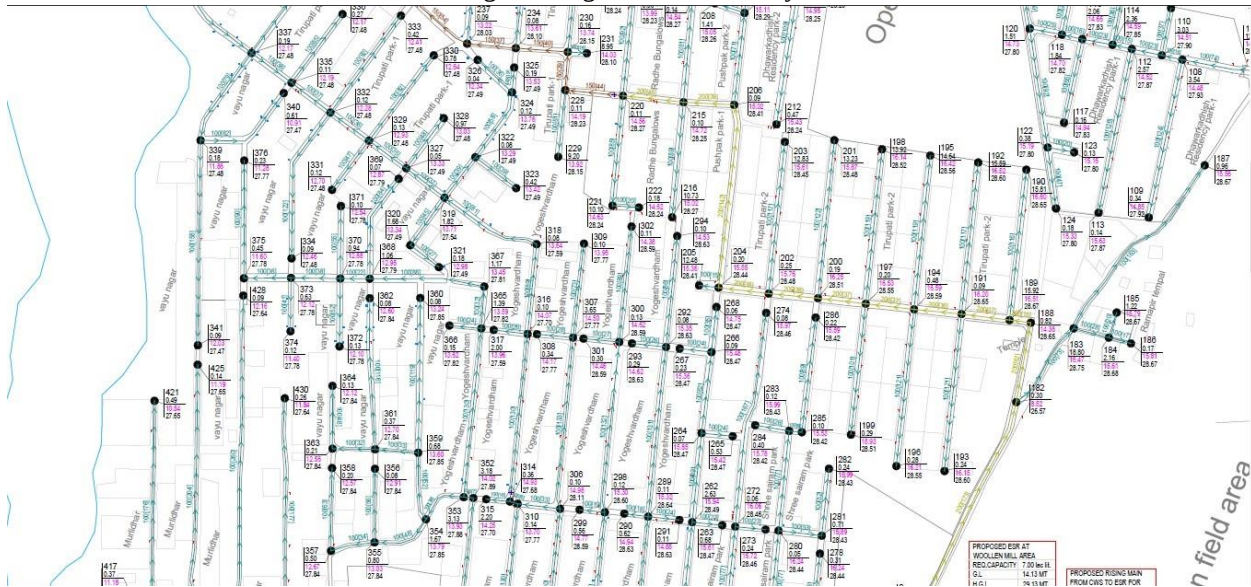
Table16: calculation of storage sump

Timing			Hourly Demand		Cumulative Demand (out-flow)		Cumulative Demand (Out-Flow) in litters	Hourly Supply		Cumulative Supply (in-flow)		Cumulative Supply (In-Flow) in litters	Surplus or Deficit(-)Amount of water in litters	
2	To	3	0	a	24	a	5539430	0	a	21	a	4847001	-692429	Liters
3	to	4	0	a	24	a	5539430	0	a	21	a	4847001	-692429	Liters
4	to	5	0	a	24	a	5539430	0	a	21	a	4847001	-692429	Liters
5	to	6	0	a	24	a	5539430	3	a	24	a	5539430	0	Liters
6	to	7	3	a	3	a	692429	3	a	3	a	692429	0	Liters
7	to	8	3	a	6	a	1384858	3	a	6	a	1384858	0	Liters
8	to	9	3	a	9	a	2077286	3	a	9	a	2077286	0	Liters
9	to	10	3	a	12	a	2769715	0	a	9	a	2077286	-692429	Liters
10	to	11	0	a	12	a	2769715	0	a	9	a	2077286	-692429	Liters
11	to	12	0	a	12	a	2769715	0	a	9	a	2077286	-692429	Liters
12	to	13	0	a	12	a	2769715	0	a	9	a	2077286	-692429	Liters
13	to	14	0	a	12	a	2769715	0	a	9	a	2077286	-692429	Liters
14	to	15	0	a	12	a	2769715	0	a	9	a	2077286	-692429	Liters
15	to	16	0	a	12	a	2769715	3	a	12	a	2769715	0	Liters
16	to	17	3	a	15	a	3462144	3	a	15	a	3462144	0	Liters
17	to	18	3	a	18	a	4154573	3	a	18	a	4154573	0	Liters
18	to	19	3	a	21	a	4847001	3	a	21	a	4847001	0	Liters
19	to	20	3	a	24	a	5539430	0	a	21	a	4847001	-692429	Liters
20	to	21	0	a	24	a	5539430	0	a	21	a	4847001	-692429	Liters
21	to	22	0	a	24	a	5539430	0	a	21	a	4847001	-692429	Liters
22	to	23	0	a	24	a	5539430	0	a	21	a	4847001	-692429	Liters
23	to	24	0	a	24	a	5539430	0	a	21	a	4847001	-692429	Liters
0	to	1	0	a	24	a	5539430	0	a	21	a	4847001	-692429	Liters
1	to	2	0	a	24	a	5539430	0	a	24	a	4847001	-692429	Liters
Total			24				Total	24				Total Supply	0	Liters
Total deficit													-692429	Liters
(Total Supply + Total Deficit) Total Storage Required =													692429	Liters
Say													700000	Liters

Table17: calculation of ESR

Timing			Hourly Demand		Cumulative Demand (out-flow)		Cumulative Demand (Out-Flow) in liters	Hourly Supply		Cumulative Supply (in-flow)		Cumulative Supply (In-Flow) in liters	Surplus or Deficit(-)Amount of water in liters	
1	to	2	0	a	24	a	5539440	0	a	22	a	5077820	-461620	Liters
2	to	3	0	a	24	a	5539440	0	a	22	a	5077820	-461620	Liters
3	to	4	0	a	24	a	5539440	0	a	22	a	5077820	-461620	Liters
4	to	5	0	a	24	a	5539440	2	a	24	a	5539440	0	Liters
5	to	6	3	a	3	a	692430	2	a	2	a	461620	-230810	Liters
6	to	7	3	a	6	a	1384860	2	a	4	a	923240	-461620	Liters
7	to	8	3	a	9	a	2077290	2	a	6	a	1384860	-692430	Liters
8	to	9	3	a	12	a	2769720	2	a	8	a	1846480	-923240	Liters
9	to	10	0	a	12	a	2769720	2	a	10	a	2308100	-461620	Liters
10	to	11	0	a	12	a	2769720	0	a	10	a	2308100	-461620	Liters
11	to	12	0	a	12	a	2769720	0	a	10	a	2308100	-461620	Liters
12	to	13	0	a	12	a	2769720	0	a	10	a	2308100	-461620	Liters
13	to	14	0	a	12	a	2769720	0	a	10	a	2308100	-461620	Liters
14	to	15	0	a	12	a	2769720	2	a	12	a	2769720	0	Liters
15	to	16	3	a	15	a	3462150	2	a	14	a	3231340	-230810	Liters
16	to	17	3	a	18	a	4154580	2	a	16	a	3692960	-461620	Liters
17	to	18	3	a	21	a	4847010	2	a	18	a	4154580	-692430	Liters
18	to	19	3	a	24	a	5539440	2	a	20	a	4616200	-923240	Liters
19	to	20	0	a	24	a	5539440	2	a	22	a	5077820	-461620	Liters
20	to	21	0	a	24	a	5539440	0	a	22	a	5077820	-461620	Liters
21	to	22	0	a	24	a	5539440	0	a	22	a	5077820	-461620	Liters
22	to	23	0	a	24	a	5539440	0	a	22	a	5077820	-461620	Liters
23	to	24	0	a	24	a	5539440	0	a	22	a	5077820	-461620	Liters
0	to	1	0	a	24	a	5539440	0	a	22	a	5077820	-461620	Liters
Total			24				Total	24				Total Supply	0	Liters
Total deficit													-923240	Liters
(Total Supply + Total Deficit) Total Storage Required =													923240	Liters
Say													1000000	Liters

Fig -3: design of distribution system



6. REFERENCES

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