Analysis of Water Supply Distribution Network in Mehsana City

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Abstract

This is a must for engineers, professors and water utility messengers involved in the security of water supply system. Mehsana is the one of the largest city and district in north Gujarat region having population 1, 50, 000 in 2014. Looking to the fast urbanization, industrialization and infrastructure development of Mehsana city, proper water supply system is the need of current time. This paper provides professional guidance on designing, operating, maintaining and rehabilitating water supplies to ensure state- of the art of - and security. The required quantities of water supply, water demand, water pressure, pipe network junction are the key segment which is required to be analyzed for the same.
Keyword- Water demands, distribution network, pressure, etc.

I. INTRODUCTION

Water distribution networks are the most important part in the distribution of water and is considered the most expensive part in the process and purpose of these networks is the distribution of water in the city for normal consumption and distribution of water under certain pressure. The purpose of distribution system is to deliver water to consumer with appropriate quality, quantity and pressure. Distribution system is used to describe collectively the facilities used to supply water from its source to the point of usage.

A. Objective

1) Water distribution network and review of sources & quantity of water.
2) Details of overhead tank and sump of Mehsana city.
3) Methods of water distribution system in Mehsana city.
4) Calculation of Population and water requirement in future.
5) Fire demand

B. Scope

1) It should convey the treated water up to the consumers with the same degree of purity.
2) Sufficient quantity of treated water should reach for the domestic and industrial use.
3) It should be economical and easy to maintain and use.
4) It should be able to transport sufficient quantity of water during emergency.
5) During repair work, it should not cause obstruction to the traffic.
6) It should be safe against any future pollution.
7) The quantity of pipes laid should be good and it should not trust.
8) It should be water tight and the water losses due to leakage should be minimum as for as possible.

C. Study Area

Mehsana city
District: Mehsana
State: Gujarat
Country: India
Elevation 81m (266ft)
Established by Mehsaji Chavda, a Rajput
Mehsana city located at 23° 36′ 0″ N, 72° 24′ 0″ E

Fig. 1: Mehsana city

II. METHODOLOGY

A. Source and Quantity of Water Distribution in Mehsana City

Mehsana has than informed the municipality that the water supply project for nagalpur area, prepared by consultant, is based on the tapping point near GIDC area on the existing transmission main of GWSSB from Dediyasan pumping station to mehsana town, supplying 18 to 20 MLD of water to mehsana town. However now the water demand of nagalpur area is also worked out to 18 MLD of water, which is not then feasible to supply to both Mehsana as well as nagalpur area through the existing transmission pipeline, which will not be capable to carry this much volume of water.

In view of above, GWSSB has then suggested that mehsana municipality should construct additional pumping station near Dediyasan treatment plant.

1) Narmada water treatment plant (WTP)
2) Bore well

- On an average, MMC draws 26 MLD from Narmada canal and 6 MLD from bore well capable of transmitting of total 30 MLD of discharge in Mehsana city
- The average per capita water supply is around 110 lpcd with a daily supply for 45 minutes twice a day
- Tube wells are an alternate source of water supply in MMC. Depending upon the area served, the tube wells work from 1 to 18 hours every day. Based on the capacity of pumps and working hours, the water supplied is believed to be 06 MLD from about 30 tube wells.

The Narmada Main Canal Off take Point Wide Section M-2 at NMC Chainage 311.36 Kms near Modhera Village.

The Trunk main line for Mehsana taluka Village/ Urban considered 1200mm dia for 24.0 Kms length at for project summary In the M- 2 project packge of Sardar Sarovar Canal Based Drinking Water Supply Project. This Work and all retated pertain to this trunk main line is carried out by Gujarat Water Infrastructure Limited, Gandhinagar. The Company is providing Raw Water at Dediyasan head Works in present stage incl. Demand of society vistar outer of Mahesana Nagarpalika vistar.

B. Water Demand

For Rural Area : 70 liters/capita/day

For Urban Area: 1. With Drainage Facility- 140 liters/capita/day 2. Without Drainage Facility- 100 liters/capita/day

Source of water	*Quantity of water*
Narmada canal	*24 MLD*
Bore	*06 MLD*
Total supply	*30 LD*

Table I: Source and quantity of water supply Approximate Mehsana command area

C. Filter Plant

Filtration Plant at Dediyasan H/W of 91 MLD Capacity is working under NCD-5 Project is proposed to be utilized for society vistar area at Present stage & also 50 MLD capacity Filter Plant Proposed at society vistar sub H/W site on Radhanpur Road in 2nd Stage.

D. Pumping Machinery

- Dediyasan Main H/W Site - HSCF Pump with motor 60 H.P. discharge capacity 154 LPS 20mt. Head 3 Nos. (2W+1S)
- Panchot OG Society Vistar H/W Site -HSCF Pump with motor 60 H.P. discharge capacity 109 LPS 30 mt. Head 3 Nos. (2W+1S)

Sr No.	Name of E S R (tanks)	Capacity Lacks lit
	Mehsana-1	
1	Kharakuva	5.0
2	Water works head work opp.city bus-stand	
	Gayatri Temple	
	Patelnagar	1.80
3	Amarpara	5.0
4	Rang mahel opp.	5.0
5	Nagarpalika	5.0
6	Somnath road	10.0
	Rana vas	
7	Savardi kuva near	2.5
8	Haidari choek staff-	3.4
9	Quarter	
	Gujarat-housing board	
	Vasahat	5.0
10		
		1.5
	Nagalpur	
1	Rayanvah Tank	50.0
2	Nagalpur Panchyat office (Gam tal)	2.1
	Somnath behind Ruturaj	
3	Ranujanagar	50.0
	Gautamnagar	
4	Lucky Park	50.0
5		50.0
6	O.G.Area	50.0
	Golden bunglows	
1	E.S.R.	5.0

Sr No.	Name of E S R (tanks)	Capacity Lacks lit
	Mehsana-2	
1	Prashent-cinema	5.0
2	Mahashakti ground	5.0
3	T.B.Road	5.0
4	Jail Road	5.0
5	Airodram	5.0
6	Dharam cinema	5.0
7	Laskari kuva	5.0
8	Radha Krishna Town Ship	5.0
	Underground Sump	
1	Water work opp.city(1) Bus stand (2)	5.0
		12.50
	(3)	50.0
2	Mahashakti head works	
	(1)	7.5
	(2)	20.0
	(3)	50.0
3	Prashant-U/G Sump	7.5
4	Dwarkapuri U/G Sump	7.5
5	Haidari chowk U/G Sump	10.0
6	Nagalpur gram panchayet	1.0
7	Rayanvalo U/G Sump	1.0
8	Ranujanagar U/G Sump	1.0
9	Gautamnagar U/G Sump	1.0

E. Pump House

- Dediyasan H/W Site: 60 Sqmt. Area 1 No.
- Panchot OG H/W Site: 45 Sqmt. Area 1 No.
- Dediyasan OG H/W Site: 45 Sqmt. Area 1 No.

F. Rising Main

750 mm dia D.I. K-7 Pipe 5 kms. Long rising main from Dediyasan Filter Plant to U/G (city) Sump at Society Vistar H/W Site at present stage but it is proposed to be utilized Raw Water line in future planning.

G. Storage

- Mahesana OG Society Vistar H/W Site –
  - U/G Sump - 40 Lac Liters. Capacity
  - R.C.C. E.S.R. - 12 Lacs Liters Capacity 18 mt. Height
- Dediyasan OG Society Vistar H/W Site
  - U/G Sump - 25 Lac Liters. Capacity
  - R.C.C. E.S.R. - 8 Lacs Liters Capacity 15 mt. Height

H. Cost per 1000 Liters: Rs. 4.00

I. Distribution Network

– It is proposed to Lay Pipeline of various dia as under
- 300 mm dia D.I. Pipe – 2900 Rmt.
- 250 mm dia D.I. Pipe – 2900 Rmt.
- 200 mm dia D.I. Pipe – 5300 Rmt.
- 150 mm dia D.I. Pipe – 1500 Rmt
- 100 mm dia D.I. Pipe – 400 Rmt

J. Society wise Facility

U/G sump along with pumping machinary are constructed near society ESR site of each society by society authority/ Committee.

K. Land Acquisition:

The Required Land for the Mahesana & Dediyasan OG Society Vistar are available for Local Gram Panchayat in free of cost.

L. Additional Requirement of Water Supply for Growing Needs

The proposed project of GWSSB is anticipated to cover 118 villages of 6 regional rural water supply schemes for augmentation at the rate of 70 lpcd. The project also includes a special provision of water supply to Mehsana town at the rate of 140 lpcd. Thus, the project would facilitate bulk water supply to Mehsana town to the tune of 22.23 MLD, and an additional 6.66 MLD for industrial purpose, which totals to 28.89 MLD of water in this project.

The water demand of Mehsana Taluka is worked out at 75.17 MLD including industrial water demand for the urban area. A pipeline of 1000 mm. diameter of 24.50 km length will be laid by Gujarat State Drinking Water Infrastructure Co. Ltd. Gandhinagar. The other works like filtration plant, pump houses, pumping machineries, rising mains, storage structures, etc. will be implemented by GWSSB.

M. Most Common Complaints Received by The Water Supply Department of MMC Are

inadequate water supply/pressure and quality of supply. At present, water is supplied
once a day for 40 to 70 minutes. The supply is inadequate in cases when there is change in either one or more features, such as:
Less water made available, even though it may be adequate for daily use
Change / reduction in frequency / timing of water supply
Water with less pressure, even if it reaches the consumer taps at less pressure
Drought-like situations or technical problems

N. Requirement of Distribution System

After complete treatment of water, it becomes necessary to distribute it to a number of houses. industries and public places by means of a network of distribution system. The distribution system consists of pipes of various sizes, valves, pumps etc. The following are the requirements of a good distribution system.

1) It should convey the treated water up to the consumers with the same degree of purity.
2) The-water should reach to every consumer with the required pressure head.
3) Sufficient quantity of treated water should reach for the domestic and industrial use.
4) It should be economical and easy to maintain and use.
5) It should be able to transport sufficient quantity of water during emergency.
6) During repair work, it should not cause obstruction to the traffic.
7) It should be safe against any future pollution.
8) The quantity of pipes laid should be good and it should no trust.
9) It should be water tight and the water losses due to leakage should be minimum as for as possible.

Sr. no	*Proposed water supply sub-zone*	*Residential area in Ha.*	*Density for the year 2011*	*Population for the year 2011*	*Water Demand in mLD*
1	*OG-Mehsana*	*56*	*100*	*5600*	*0.90*
2	*Chavelinagar*	*41*	*100*	*4100*	*0.66*
3	*Greenpark*	*44*	*130*	*5720*	*0.92*
4	*Gautamnagar*	*32*	*125*	*4000*	*0.64*
5	*Ranujanagar*	*3*	*125*	*375*	*0.06*
6	*Sahkarnagar*	*4*	*125*	*500*	*0.08*
7	*Luckypark*	*8*	*125*	*1000*	*0.16*
8	*Dharam cinema*	*5*	*125*	*625*	*0.10*
9	*Mangal park*	*17*	*125*	*2125*	*0.34*
10	*Somnath*	*26*	*125*	*3250*	*0.52*
11	*Vardhmannagar*	*60*	*125*	*7500*	*1.21*
12	*Punitnagar*	*41*	*125*	*5125*	*0.83*

13	*Yogikrupa*	*22*	*125*	*2750*	*0.44*
14	*NR.panchayat office*	*30*	*125*	*3750*	*0.60*
15	*Kasba area*	*20*	*125*	*2500*	*0.40*
16	*PROP H/W*	*92*	*25*	*2300*	*0.37*
17	*NR.GIDC-1 west side*	*35*	*25*	*875*	*0.14*
18	*NR.GIDC-2 west side*	*135*	*25*	*3375*	*0.54*
19	*NR.GIDC-2 east side*	*51*	*25*	*1225*	*0.21*
20	*River south side*	*113*	*25*	*2825*	*0.45*
	TOTAL	*835*		*59570*	*9.59*

Table I: Details of proposed water supply sub-zone, area covered, density of population, total population and water demand for the year 2011

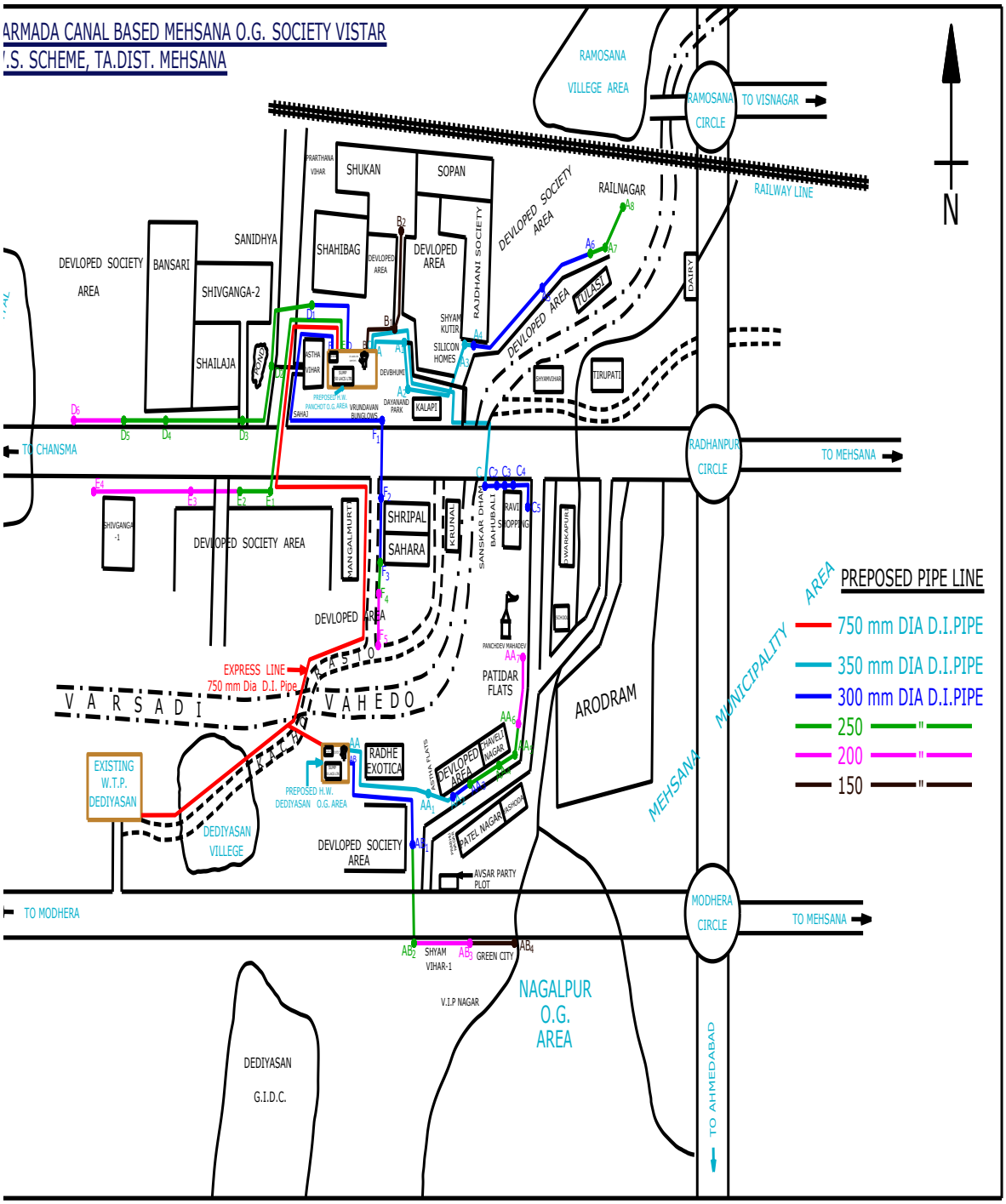

Fig. 2: Layout of dead end which is used in Mehsana city

– The following tables provide dimensional common operational loads for plastic pipes

Diameter (cm)	*15*	*20*	*25*	*40*	*50*	*56*	*80*	*100*	*150*
Max. Working Pressure(kg/cm^2)	*42*	*33.6*	*31.4*	*23.1*	*19.6*	*21.9*	*8.2*	*15.4*	*12.5*

Table II: Normal gauge PVC pipes

Diameter (cm)	*15*	*20*	*25*	*40*	*50*	*56*	*80*	*100*
Max. Working Pressure(kg/cm^2)	*59.9*	*48.3*	*44.3*	*32.9*	*28*	*29.4*	*25.9*	*22.4*

Table III: Heavy gauge PVC pipes

O. Requirements of Good Distribution System

1) Water quality should not get deteriorated in the distribution pipes.
2) It should be capable of supplying water at all the intended places with sufficient pressure head.
3) It should be capable of supplying the requisite amount of water during firefighting.
4) The layout should be such that no consumer would be without water supply, during the repair of any section of the system.
5) All the distribution pipes should be preferably laid one meter away or above the sewer lines.
6) It should be fairly water tight as to keep losses due to leakage to the minimum.

– When selecting distribution networks it must take into account the following points

1) Pipes to be of durable material.
2) Pipes to be of sufficient capacity to transport the required discharge all the time.
3) The protection of water in the pipes of bacterial contamination.
4) The need to work on the existence of piped water constantly.

III. THEORETICAL CONSIDERATION

A. Population Forecasting:

1) Arithmetical Method
2) Geometric Increase Method
3) Incremental increase Method
4) Graphical comparison method
5) Master Plan method
6) Graphical Extension method

We used arithmetical increase method for population forecasting in our calculation part.

B. Arithmetical Method

Based upon the consideration that the rate of growth is constant.

$P_n = P + nI$

Where, P_n = Future Population after n decade

P = Present Population

n = Number of decade = $\Delta p / \Delta i$

I =Average Increase in Population

– Water distribution system is designed for:

Adequately satisfy the water requirements for

1) Domestic
2) Commercial
3) IndustrialFire
4) fighting purposes

– Performance evaluation:

Year	*Population*	*Increase Population*
2001	*122130*	-
2009	*143232*	*21102*
2011	*165696*	*22464*
Average Increase	-	*21783*

Residual pressure available in the system

IV. CALCULATIONS AND RESULTS

A. Population data with division:

Division	*2001*	*2009*	*2011*
1	*8910*	*10483*	*11710*
2	*7851*	*9237*	*10496*
3	*7893*	*9286*	*10552*
4	*7885*	*9277*	*10542*
5	*8180*	*9299*	*10567*
6	*9552*	*11118*	*12634*
7	*8874*	*10439*	*13048*
8	*8768*	*10316*	*11591*
9	*9086*	*10689*	*12575*
10	*9303*	*10945*	*12437*
11	*9455*	*11122*	*12782*
12	*8602*	*10121*	*11501*
13	*8415*	*9900*	*11511*
14	*9350*	*11000*	*13750*
Total	*122130*	*143232*	*165696*

Table 6:

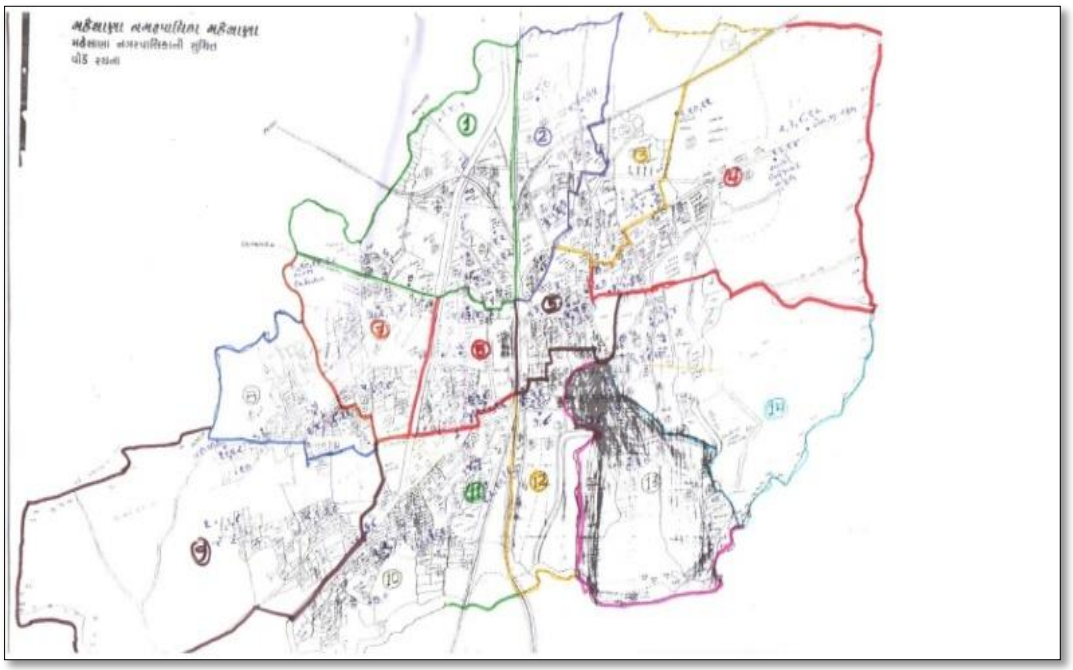

Fig. 3: Population division in Mehsana city

B. Calculation of Population

Using Arithmetical increase method,

Table.8 Arithmetical Increase

Using equation ,

$P_n = P + nI$

Where, P_n = Future Population after n decade

P = Present Population

n = Number of decade

I =Average Increase in Population

Now For 2020,

P = 1,65,696

n = 1

I = 21,783

Putting this values in equation 1 we get,

Therefore

$P_n = 1,65,696 + (1)\ (21,783)$

P_n = 1,87,479
Similarly we get,

2020	*1,87,479*
2030	*2,09,262*
2040	*2,31,045*
2050	*2,52,828*

Table I: Future Population of Mehsana City

C. Calculation of Water Supply

Mehsana city has population 165696 in 2011 and present water supply is 18.72 MLD & for population 252828 in 2050 water should be supply 28.56 MLD.

D. Water Used in Firefighting

- In Mehsana city, approximately 10-15 cases of firefighting are occurred per year
- 4 vehicles of each vehicle having capacity of 15000 litre.

The water consumption is depending upon the type of fire and which vehicle to be used.

V. SUMMARY AND CONCLUSION

Till now we have gone through overview of the water distribution system, i.e. how water is distributed to the consumers from the intake. We know that the population of the whole Mehsana city is increasing day by day and so water demand in future is also increasing day by day. To meet this demand current water distribution system is not capable to meet future demand. Thus our project will make the system easier to meet this future demand.

Everywhere people are increasingly with controlling the pollution of both surface and ground water. Ground water is the main problem, especially where cities have to rely on their own ground water for the fresh water provision.

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