



Assessment of Water Supply at Patan, Gujarat

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ABSTRACT

About 85% of the global population had access to piped water supply through house connections or to an improved water source through other means than house, including standpipes, "water kiosks", protected springs and protected wells. However, about 14% did not have access to an improved water source and had to use unprotected wells or springs, canals, lakes or rivers for their water needs.

A clean water supply, especially so with regard to sewage, is the single most important determinant of public health. Destruction of water supply and/or sewage disposal infrastructure after major catastrophes (earthquakes, floods, war, etc.) poses the immediate threat of severe epidemics of waterborne diseases, several of which can be life-threatening.

Water supply systems get water from a variety of locations, including groundwater, surface water, conservation and the sea through desalination. The water is then, in most cases, purified, disinfected through chlorination and sometimes fluoridated. Treated water then either flows by gravity or is pumped to reservoirs, which can be elevated such as water towers or on the ground.

Keywords : Water supply system; water distribution network; intermittent water supply; water treatment plant; ESR;

INTRODUCTION

Clean drinking water and safe water supply is vital to our life. Water planners have two fundamental options available to ease water restrictions – to encourage water conservation or to increase water supply. Voluntary water conservation is often the most affordable, environmentally sensitive option available to urban water users. In general practice the water is supplied for restricted hours in morning or in evening for various reasons, known as intermittent water supply (IWS).

The main objectives is to bench–mark and improve the level, quality and sustainability of Urban Areas of importance and rapidly developing cities, with a strong focus on up-gradation of Civic Infrastructure and enhance delivery of Civic Services.

2 SALIENT FEATURERS OF THE TOWN

Patan, a capital of Gujarat during medieval times, is a historic town with a history spanning over centuries. It is an important settlement and a district headquarters. It has also one of the oldest Municipalities. Patan situated at a distant of 120 km from Ahmedabad and 108 km away from the state capital Gandhinagar, is an ancient town of temples and other architecture monuments. Patan is known for its numerous architectural and cultural heritages like Ranki Vav, Sahastralingi Talav, Fort Wall and Gates, Panchasara Parshvanath Jain Derasar, Hemachandracharya Jain Ghyan Mandir and Kalika Temple.

It is an important settlement and a district headquarters. It is a class-I town as per census of 2001 with total population of 1,13,749. The Patan city has immense potential for growth and development as revealed by the figures made available by the census 2001.

Presently, Patan is home to the Hemachandracharya North Gujarat University previously known as North Gujarat University. Patan is a prominent medical centre in North Gujarat with around 140 clinics and laboratories with almost 393 practicing medical professionals. Patan serves as a central market

place for local farmers. Close to Patan, Unjha has the biggest Asian market in Zira, Isabgol. Patan is still known for its patola saree which are highly expensive, involve high degree of skill and time and is one of the finest hand-woven saree produced today in the world. Patan is also a tourist destination with a rich religious and cultural history and landmarks. Patan has numerous Hindu and Jain temples as well as Muslim mosques.

2.1 Topography

Patan city is situated at latitude of 76 m. (249 feet) and is located at 23.83°N 72.12°E. The city has shape like that of an inverted saucer. Most of the rain water flows through natural drains leading to ponds like Pitambar Talav, Gungadi (Anand Sarovar) Talav, Siddhi Sarovar, Sahastraling sarovar and Vatrasar canal. With the natural topography it is observed that there is no major problem of water logging in the city areas. The city has Sahastraling Talav – a beautiful lake present which forms a tourist attraction to the city. There is old historical fort and ancient Saraswati River which dignifies the city. Patan has a very old archaeological monument of sun temple nearby which is visited by the tourist both from the state and outside the state in large numbers. This sun temple is second in the country, first being in Konark.

2.2 Climate & Rainfall

Patan has large variation of temperature ranging from maximum of 41.7° C in summer and 11.3°C minimum in winter. The average rainfall recorded during last 17 years has been found to be order of 588.33 mm. However, there are not many water bodies within or outside the city which help in modulating the climate. The rainfall of the town has been found to be lower than that of state average. Lowest rainfall of 160.75 mm was recorded in the year 1999-2000 in highest of 1476.17 mm in the year 1997-98. The annual rainfall for the Patan city is given in Table-1.

Table 1 Rainfall Data For Patan City

Sr. No.	Year	Total Rainfall, mm.	Average Rainfall in the State, mm
1	1988-1989	752.75	-
2	1989-1990	430.00	-
3	1990-1991	623.00	-
4	1991-1992	563.25	658
5	1992-1993	563.25	859
6	1993-1994	614.00	823
7	1994-1995	1087.50	1407
8	1995-1996	543.25	636
9	1996-1997	312.50	848
10	1997-1998	1476.17	1088
11	1998-1999	605.00	1072
12	1999-2000	160.75	642
13	2001-2002	254.75	530
14	2002-2003	525.75	796
15	2003-2004	279.25	629
16	2004-2005	670.00	1073
17	2005-2006	540.50	-
	Average	588.33	850.85

2.3 Demography & Growth Pattern

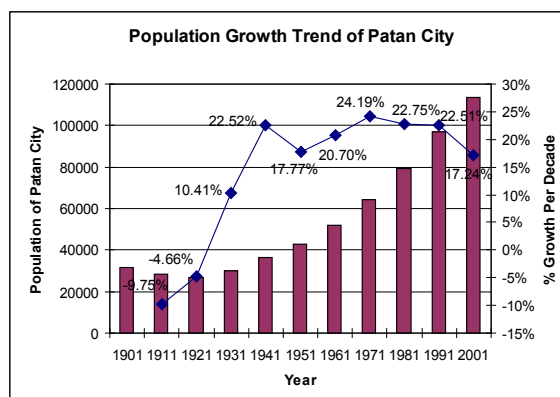
Total population of Patan is 1, 1,749 as per the census 2001 Table-2. gives trends in urbanization in Patan between 1901 and 2001.

Table 2 Population Growth Trend of Patan City

Sr. No.	Year	Population	% Growth Per Decade
1	1901	31402	-
2	1911	28339	-9.75
3	1921	27017	-4.66
4	1931	29830	+10.41
5	1941	36549	+22.52
6	1951	43044	+17.77
7	1961	51953	+20.70
8	1971	64519	+24.19
9	1981	79196	+22.75
10	1991	97025	+22.51
11	2001	113749	+17.24

Patan city has shown a moderate rate of growth. During the last decade (1991-2001), the city recorded a growth rate of 17.24%. During the last century, the town has recorded negative growth rate during 1901-11 and 1911-21. As against a population of 31402 at the beginning of the century, the population recorded in 2001 was 113749. The percentage growth rate of population for the city, is given in the Table-2. Despite of enormous potential, city has, due to neglect, haphazard and unplanned growth, the population of the town is lower than the state and national average.

Figure-1 Population Growth Trend



There are 14 administrative wards within Patan city. Recently few areas of three outgrowths have been included in the total population of the city. The ward wise population for the Patan city is given in Table-3.

Table 3 Ward Wise Population Distribution

Sr. No.	Wards	Population	Residential Area*, sq.km.	Population Density, Persons/sq.km.
1	No. 1	7978	1.01	7903
2	No. 2	8622	0.68	12627
3	No. 3	8451	0.24	35459
4	No. 4	8503	1.81	4700
5	No. 5	7431	1.31	5667
6	No. 6	8630	0.82	10564
7	No. 7	8445	0.18	46913
8	No. 8	7918	0.20	38881
9	No. 9	7863	0.56	13952
10	No. 10	7767	0.18	42087
11	No. 11	8120	0.23	34563
12	No. 12	7447	1.79	4161
13	No. 13	7467	0.82	9143
14	No. 14	7477	0.71	10734
15	Matarwadi OG	330	0.43	767
16	Gungarpati OG	579	0.04	14367
17	Hansapur OG	621	0.37	1683
	Total	113649	11.39	9990

* Excluding agricultural area and water bodies.

Ward no. 3, 7,8,10 and 11 covers old city area. These wards have high population density and limited growth. The total area of the Patan city is 12.09 sq. km. excluding the out-growth areas.

2.4 Land Use Pattern

Table 4 Area Existing Land Use Map

Sr. No.	Type of Usage	Area in Hectares	Percentage of Total Area
1.	Residential Zone	888.65	67.64%
2.	Commercial Zone	48.67	3.80%
3.	Public Purpose	87.34	6.81%
4.	Industrial Zone	6.73	0.53%
5.	Open space/ Garden	10.05	0.78%

6.	Crematorium, Crematory	13.22	1.03%
7.	Water Body	21.34	2.13%
8.	Agriculture Zone	214.06	17.28%
	Total	1290.07	100.00%

Table-4 shows area under existing land use. There are very less industrial units in Patan city as GIDC which is a notified industrial having around 54 units. There is a spurt in residential demand beyond municipal limits and therefore the area has developed particularly for residential purpose. Patan city is growing extensively towards eastern side.

The commercial activities have developed along the main arterial roads of the city having a great impact over the land prices of the city. No commercial hubs have been established in the city, the gamtal area is one of the prominent commercial areas promoting traditional shopping to the citizens of the city.

2.5 Hydrology

The topography of the town is like an inverted saucer, so most of the rain water flows through natural drains leading to ponds like Pitambar Talav, Gungadi Talav, Siddhi Sarovar, Sahas-traling sarovar and Vatrasar canal. With the natural topography it is observed that there is no major problem of water logging in the city areas. The storm water drainage system does not exist in Patan.

3 EXISTING WATER SUPPLY SCENARIO

In Patan presently the source of drinking water is ground water. Water from 16 nos. of tube wells is being drawn. The town receives the water supply of 20.0 MLD water from ground water to supply to the town. The water from the tube wells is unpotable due to high TDS and fluoride content more than 2.5 mg. 2.15 m. dia. 20.5 km long NMC Pipeline from Khorsam connecting Saraswati barrage is laid by irrigation department to pump water from NMC for Saraswati barrage and Siddhi Sarovar. Canal is constructed from Saraswati barrage towards Chanasma which is connected with Siddhi Sarovar. To supply surface water from Narmada Canal Water Treatment Plant (WTP) at Siddhi Sarovar is completed. WTP is to be connected with Sub-headwork's, for which ULB have invited the tender for laying pipelines to connect the Sub-headwork's with WTP. The water treatment plant near Siddhi sarovar pond is of capacity of 27.0 MLD. Water from Siddhi Sarovar pond will be pumped to WTP for Patan city. A sump of 20.0 Lacs litre and E.S.R. of 10.0 Lacs litre capacity are already constructed by GWSSB under Sujalam Sufalam Scheme. Intake well of 8m dia is constructed at Siddhi Sarovar. The water from intake well is supplied by 814 mm dia. M.S. rising main to Siddhi Sarovar filtration plant. The pipe is approximately 200 m in length. The water treatment plant of capacity 27.0 MLD near Siddhi Sarovar pond with a cost of Rs. 5.5 crores is already constructed.



Figure-2 Pump House at Siddhi Sarovar



Figure-3 Water Treatment Plant at Siddhi Sarovar

The treated water from Siddhi Sarovar filtration plant is being collected in clear water sump, which is again pumped into ESR constructed at main head works located within the filtration plant premises. It is proposed to supply treated water from ESR to sub stations in all different zones through gravity under Siddhi Sarovar Scheme. Presently the entire town is divided into 11 water supply zones. Water is distributed in the town through network of ESRs and underground sumps. The distribution network consists of pipelines varying from diameter of 50 mm to. 450 mm. The length of the total distribution network is 120.0 km. However the actually marked distribution network on site comes out to be 110.01 km. Water is supplied for only 30 minutes in morning and evening. The existing pipelines are old and there are leakages at several places. The existing distribution network is laid in a haphazard manner.

4 POPULATION PROJECTION

Population projection for the town can be done using four methods namely Arithmetic Increase Method, Increment Increase Method, Geometric Increase Method and Graphical Method. Considering the large variations of population arrived at by these methods, averages of the figures are proposed to be adopted for working out the population distribution.

The population of Patan city for year 2001 is 1,13,749 as per census 2001 including three outgrowth areas viz. Matarwadi, Gungarpati & Hansapur shown in Table-5.

Table 5 Population Projection for Patan City

Year	Population of Patan City	Increment (X)	Incremental increase (Y)	Rate of Growth Per Decade
1961	50,264	--	--	
1971	64,519	14,255	--	0.284
1981	79,196	14,677	422	0.227
1991	97,025	17,829	3,152	0.225
2001	113,749	16,724	-1,105	0.172
Total		63,485	2,469	0.909
Average per decade		15,871	823	0.224

In calculating the water demand for the town the demand for the resident population, industrial demand and fire fighting demand has been taken into consideration. Considering Patan as city with piped water supply and where sewerage system will be provided in near future the residential demand of 135 LPCD has been taken into consideration. It is envisaged the design period shall be completed in one year and two to three years for construction activities. If design period has been considered as 2010 and proposes to complete the

construction activities during 2011-2013.

So for population projection the base year 2014 has been considered. Accordingly 2029 shall be the intermediate year and 2044 shall be the ultimate design year for this project. Details of population projection is shown in Table- 6

Table 6 Summary of Population Projection

Year	Arithmetic Progression Method	Geometric Progression Method	Incremental Increase Method	Graphical Method	Average Population Considered
2001	---	---	---	---	113749
2010	128,035	136,445	128,740	142,000	133805
2014	134,385	147,935	135,615	152,500	142609
2029	158,190	200,330	162,570	198,500	179898
2044	181,995	271,275	191,375	269,500	228536

5 WATER DEMAND

In calculating the water demand for the town the demand for the resident population, industrial demand and fire fighting demand has been taken into consideration.

5.1 Residential Demand

The total demand for the city includes residential demand is shown in Table-7

Table 7 Residential Water Demand For Patan City

Year	Population considered	Water demand @ 135 lpcd	Water Demand at ESRs & Sumps Including 15% UFW	Water Demand at Treated Water Sump Including 2% Transmission Losses	Water Demand at WTP Including 2% Treatment Losses	Water Demand at Source Including 1% Treatment Losses	Total Demand, MLD
2001	113,749	15.36	18.07	18.50	18.96	19.20	19.20
2010	133,805	18.06	21.25	21.76	22.30	22.58	22.58

intermediate year and ultimate year, for Patan city is given in Table-9.

Table 9 Total Water Demand For Patan City

Year	Population considered	Floating Population	Distribution Losses, 15%	Transmission Losses 2%	Treatment Losses 2%	Source Losses 1%	Total Demand, MLD (Table-7)	Fire Demand, MLD (Table-8)	Total Demand at Source, MLD	WTP Capacity, MLD (Excluding 1% source losses)
2001	113,749	0	18.07	18.50	18.96	19.20	19.20	1.067	20.2617	20.059
2010	133,805	0	21.25	21.76	22.30	22.58	22.58	1.157	23.7363	23.499
2014	142,609	0	22.65	23.20	23.77	24.07	24.07	1.194	25.2594	25.007
2029	179,898	0	28.57	29.26	29.98	30.36	30.36	1.341	31.6990	31.382
2044	228,536	0	36.30	37.17	38.09	38.57	38.57	1.512	40.0772	39.676

Year	Population considered	Water demand @ 135 lpcd	Water Demand at ESRs & Sumps Including 15% UFW	Water Demand at Treated Water Sump Including 2% Transmission Losses	Water Demand at WTP Including 2% Treatment Losses	Water Demand at Source Including 1% Treatment Losses	Total Demand, MLD
2014	142,609	19.25	22.65	23.20	23.77	24.07	24.07
2029	179,898	24.29	28.57	29.26	29.98	30.36	30.36
2044	228,536	30.85	36.30	37.17	38.09	38.57	38.57

5.2 Industrial Demand

The Patan city has small industries within the municipal limits. Some industries use municipality water where as some of them has their own source of water. Per capita rates of supply recommended will ordinarily include the requirement of small industries (other than factories) distributed within a town.

5.3 Fire Fighting Demand

It is usual to provide fire fighting demand on the distribution system along with the normal supply to the consumers as assumed. A provision in KL/day based on the formula of $100\sqrt{P}$ where P=population in thousands and may be adopted for communities larger than 50,000. It is desirable that one third of fire-fighting requirements form part of the service storage. The balance requirement is distributed in several static tanks at strategic points. Fire demand is calculated in Table-8 by the formula given in CPHEEO manual.

Fired Demand = $100\sqrt{148391/1000}=1218$ Eq. (1)

KL/day=1218000 L/day=1.218 MLD

Table 8 Fire Demand For Patan City

Year	Population considered	Fire Demand, KL/day	Fire Demand, MLD
2001	113,749	1066.53	1.067
2010	133,805	1156.74	1.157
2014	142,609	1194.19	1.194
2029	179,898	1341.26	1.341
2044	228,536	1511.74	1.512

5.4 Total Water Demand

The total water demand including fire demand, industrial demand and losses for various stages of design, i.e. base year,

6 CONCLUSIONS

The specific aims and objectives that are envisaged to be achieved by the implementation of the study are as follows:

- To optimize social and economic development in urban town like Patan, at Gujarat.
- To Improve and develop basic infrastructure in the Town water supply plays important role. It is observed from study that as population increases water demand also increases from 20.059 MLD in 2001 to 39.676 MLD in 2044.

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REFERENCES

CPHEEO-Central Public Health and Environmental Engineering Organization Manual on water supply and treatment, 3rd edn. Ministry of Urban Development and Poverty Alleviation, Govt. of India, New Delhi, 1999. | Richard Francey and Anand Jalakam, Water and Sanitation Program Report, the Karnataka Urban Water Sector Improvement Project, 2010. | Preliminary Design Report, Water Supply for Bhavnagar, Mott MacDonald Group Limited, 2010 | Sathya Sai Baba, in Sathya Sai Speaks X, Chap. 19, 123; VII, Chap. 59, 350; VI, Chap. 58, 288 | Mysore water supply scheme - Mysore City Water Supply Augmentation Report, Mott MacDonald Group Limited | City Assessment and Development Strategy Report | DPR of water supply project for Rajkot City, Rajkot Municipal Cooperation.