Extended Period Simulation of Continuous Water Supply System for Floating Population City

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Abstract – In infrastructural advancement the public drinking water circulation network which incorporates pipes, bents, valves, siphons, tanks and so on is one of the significant ventures. The plan, demonstrating of dissemination network with proficient result is a significant errand. Therefore, the current review is focused on plan of continuous just as irregular water conveyance systems with sufficient water strain with the utilization of Water GEMS Vi8 software. Dynamic (extended period simulation) models have generally swapped consistent state models for simulation of water quality in dispersion organizations. Dynamic demonstrating by and large has been restricted to periods of a day or a couple of days. This paper portrays three demonstrating concentrates on that involved long time-series investigations to describe pollution in the water appropriation system of a significant city

Keywords – Simulation, Continuous, Water, Supply, System

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INTRODUCTION

No standard or equation might address the worth of water to make due in human, plant and creature forms. Without water a lifecycle on this planet can't continue. In antiquated occasions, people will more often than not, live in networks near natural water sources the stream or little water channel to fulfil the requirement for endurance water. Water is a main consideration that can be socially strategically, and so forth, exceptionally affecting human existence (Urban Water II, 2014). Water is one of the most essential conveniences that each living animal necessities. Aside from involving the water for home grown necessities, since man involved this world, water assets were the most generally taken advantage of natural system. Other valuable employments of water incorporate electric power age, transport, amusement and numerous different uses for businesses. Not exclusively does the utilization of water heighten dramatically with population development, yet there is likewise an intense deficiency of surface and profound water because of numerous synthetic practices, and man himself has been the underlying driver of many issues and legitimate administration water use, which having fundamental significance in this time (Punmia et al., 1995).

24 X 7 continuous, compressed water supply beats shortages in irregular supply and guarantees comfort for the client and helps the defenceless. Continuous top notch water supply system diminishes the danger of pollution as the lines. The software give required norm and efficient climate for plan, examination and investigating of new and existing supply network with least time term. With software we can distinguish and tackle a wide range of issues in new just as existing organization. The software is additionally utilized for development of existing water appropriation organization (Rajeshwari and Kumar, 2014). By utilizing WaterGEMS the activity of the system will be so natural and in the event that some issue is noted than it tends to be followed effectively by the software. There are so many diverse kind of devices utilized for the water circulation system that included is distinctive writing, yet when contrasted with others, WaterGEMS is more exact (Pathan and Kahalekar, 2015). The current review means to plan continuous water supply, displaying of organization system by involving WaterGEMS software for Elevated Storage Reservoirs (ESRs) situated at Manisha Nagar and Padmavati in Pandharpur, Maharashtra, India. Concentrate likewise incorporates the itemized cost investigation for the project.

Continuous Availability of Water Supply

A civil water supply system can't support its clients except if there is a continuous supply of water to meet home grown consumption needs in the broadest sense and water needs for underlying fire insurance. Water sources should be chosen cautiously to ensure that this major prerequisite is met. Two primary factors that influence water supply determination are

1) **Quality of water:** Water should be dealt with or filtered to meet Regulatory Requirements set up by the EPA (United States Government). The necessities are isolated into 2 classes: a. private networks with populations not surpassing 3,000; and b. consolidated private and business networks that serve a population interest more than 3,000. Water quality guidelines are shrouded in 3.

2) **Quantity of water:** The amount of water should be sufficient to meet purchaser consumption and fire stream requests whenever of the day, day of week, and seven day stretch of the year.

Ground Water

In the first preparation of ground water supplies, little should be possible about deciding the synthetic quality of the water in light of the fact that the water will be gotten from a few distinct and diverse water bearing topographical layers or layers. The synthetic or mineral quality of the water contributed from every one of these water-bearing formations or springs will be reliant upon the disintegration of material inside the formation. Therefore, water removed from any ground water source will be a composite of these singular springs. The water quality not entirely set in stone by real inspecting and investigation of the completed wells. Nearby and State wellbeing offices, alongside State branches of natural protection (DECs), will have general and accommodating information on water quality inside their purview from long periods of test information. Most State geologists and hydrologists likewise will have information on both amount and quality of water inside specific districts of their State. All such information is important, and ought to be acquired when considering ground water sources as one or the other essential or auxiliary supply sources.

Municipal Water System Demands

The interest for water provided by a metropolitan water system has two driving parts: 1) shopper consumption: how much water in gpm or gallons each day that is utilized by every one of the taps on the water mains to supply single-family homes, different family homes of numerous types, medical care offices, schools at all degrees of training, business undertakings, modern edifices, and assistant uses (road cleaning; water wellsprings; watering public lush spaces; bushes, trees, and blossoms; parks and entertainment including pools; and the offer of water to project workers for building streets, structures, and so on) and 2) a sufficient and dependable water supply for fire assurance. Every one of these points is considered long in later sections. Be that as it may, a few significant terms related with water request should be distinguished and functionally characterized right now on the grounds that these terms will be utilized all through both the Concepts Manual and the Evaluation Manual on Municipal Water Supply Systems.

OBJECTIVES OF THE STUDY

1. To Study on Continuous Availability Of Water Supply

2. To Study On Municipal Water System Demands

RESEARCH METHODOLOGY

Allocation of data on the ground

Google image was used for digitization of various components. The shape files of the features such as road edge boundaries, buildings, water bodies were created in the software. For GIS maps ESRI's latest ARC-VIEW and ARC-EDITOR software has been used. The procedure to develop road network (shape files) is shown in Fig. 1. The shape files are geo-referenced (spatial) with the coordinate system of Pipe, Junctions, Valves and tanks etc, are drawn on the background layer.

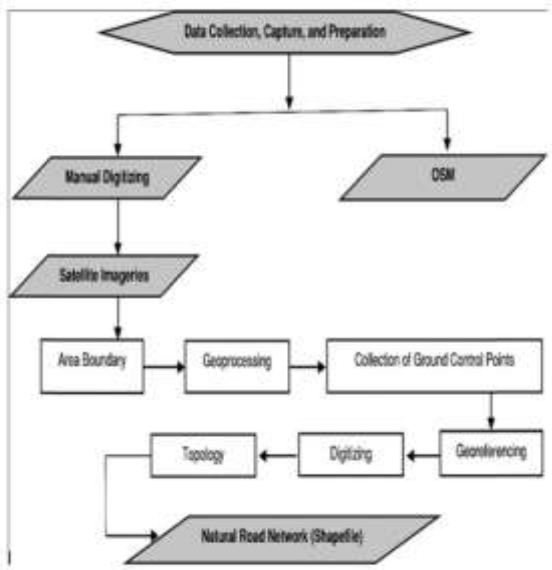

Fig.1 Flow chart of methodology for ground data collection

Population Estimation and Distribution

As per the CPHEEO, the design population should be estimated by considering the future growth and development of the project area in the industrial, commercial, educational, social and administrative sphere. The Pandharpur city is divided into 33 wards with over 20,000houses to which it supplies basic amenities like water and sewerage. As per the 2011 census, the Pandharpur Municipal Council had a population of 98,923 as per report released by Census India 2011.The population growth of Pandharpur can be estimated using decadal population data given in Table 1.

Table 1 Decadal Population from Census Data of Pandharpur Municipal Council

Census Year	Population (Souls)	Decadal Growth Rate (%)
1971	53634	
1981	64338	19.96%
1991	79798	24.03%
2001	91381	14.52%
2011	98923	8.25%

For the 24 X 7 water supply scheme design, the projected population must be estimated for the considered design period. Under estimating the population leads to in adequate system design for the purpose, whereas overestimating the population will increase the project's cost .Change in the city population takes place over a period of time, and the system should be designed, taking into account the population at the end of the design period.

DATA ANALYSIS

Extended Period Simulation

While a steady state analysis is a valuable tool for evaluating system performance for a particular time, it cannot be used to evaluate tank fill/drain cycles, pump controls etc. for the continuous supply duration. For these types of analysis an extended period simulation (EPS)is utilized. An EPS provides a dynamic evaluation of system performance over a fixed time period, usually used for 24 to 72 hours. An EPS can be used to determine how quickly the system service reservoirs fill/drain, when system pumps turn on and off and fluctuations in pressure over the course of a given time period. Since the pumping machinery and service reservoir's capacity has to be checked for 15 years of performance, the EPS tool is primarily utilized. The EPS analysis is done to understand the behavior of the entire system from the raw water pump to the distribution network for the intermediate stage 2030. The EPS behavior fort his stage with 24 hours demand pattern will be checked in the hydraulic model. Also Mass curve computation for determining capacity of the storage service reservoir will be presented. The pattern with the 24 hours supply is considered for EPS analysis. Figure 2 shows hourly hydraulic pattern of the city. In Hourly Hydraulic Pattern graph, time in hours represented on abscissa and multipliers are shown on ordinate. Maximum supply of water is required during the morning from 6 a.m.to 9.00 am.

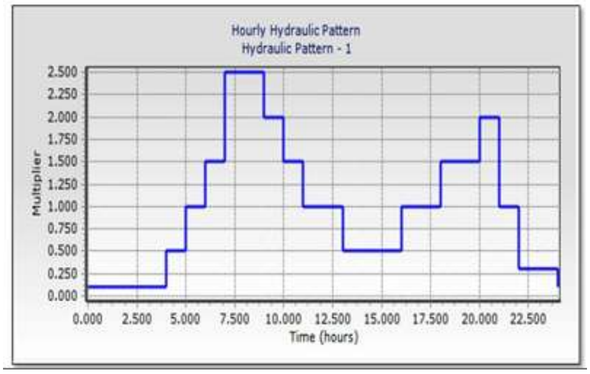

Fig.2 Hourly Hydraulic Patterns

The EPS for the intermediate stage is run and the behavior of the water supply system is analyzed for 24 hour supply in the city. Steady state approach is used for immediate stage and ultimate stage with the peak hour supply to check the flow rate and nodal pressure at each junction. The zone wise demand along with average inflow and average outflow is tabulated in Table 2. To calculate net demand for 13 zones, net residential water demand and industrial/ commercial demand taken in consideration. Gross demand is obtained with addition of 10% water losses in net demand. Gross water demand of Pandharpur city in 2015 is 19.68 MLD. Gross water demand of Pandharpur city in 2030 is 24.31 MLD. Gross water demand of Pandharpur city in the year 2045 is 29.41MLD.

Table 2 Details of Existing & Proposed ESR/GSR

Zone No.	Location & Cap. of ESR/GSR	Gross Demand in MLD	Gross Demand in M³	Average Inflow in M³/Hr for 20Hrs	Average outflow inM³/Hr for 24 Hrs
1	Ambedkar Nagar ESR, 0.70 Ml	1.36	1360	68	56.67
2	Ambika Nagar ESR, 0.70Ml	1.8	1800	90	75.00
3	Anil Nagar ESR, 1.0Ml	3.64	3640	182	151.67
4	Ganesh Nagar ESR, 0.4Ml	1.44	1440	72	60.00
5	Isbavi ESR, 0.5Ml	0.72	720	36	30.00
6	Karad Road ESR, 1.5Ml	1.6	1600	80	66.67
7	Mahaveer Nagar ESR, 1.5Ml	1.61	1610	80.5	67.08
8	Manisha Nagar ESR, 2.0Ml	3.38	3380	169	140.83
9	Padmavati ESR, 1.0Ml	2.12	2120	106	88.33
10	Takli Village ESR, 1.5 Ml	0.34	340	17	14.17
11	Prop. Isbavi ESR, 1.0 Ml	1.34	1340	67	55.83
12	Prop. Shivaji Chowk ESR, 2.5 Ml	3.24	3240	162	135.00
13	Prop. Bidari Bunglow ESR,1.0 Ml	1.72	1720	86	71.67

The ESR capacities are checked for 20 hour inflow and 24 hours outflow for the proposed thirteen zones to fulfill the requirement for intermediate stage (2030). The method of Extended Period Simulation (EPS) has been used in the analysis to model the water supply system. The ESR capacities with respect to the zones formed are verified to supply continuous water, observing that no overflowing or emptying of a service reservoir occurs. Also the capacities of service reservoirs are checked using mass curve method.

Checking Capacity of Ambedkar Nagar ESR (Zone1)

The capacity has been checked using a mass curve method for 20 hour inflow and 24 hours out flow. The Gross Demand as per the zone created is 1360 m^3/day for intermediate stage which gives the hourly demand as 1360/20, i.e. 68 m^3/hr. As the system will distribute this water for 24 hours the average outflow is given as 1360/24 i.e. 56.67 m^3/hr. The inflow will remain constant over 20Hr whereas the outflow will vary as per the customer demand based on the hydraulic pattern shown in Figure3.

Table 3 shows the hourly distribution outflow, cumulative inflow and cumulative out flow from the Ambedkar Nagar ESR. Using this data the required capacity is calculated as a sum of the maximum ordinate of inflow and outflow, i.e., 237.994+164.411 = 402.41 m^3. Hence, the existing ESR of 7.0 Lakh liter is sufficient to feed the Zone-1. A mass curve (graph) of cumulative supply and cumulative demand is shown in Figure 5.56 and the hourly storage in the ESR is shown in Fig 3.

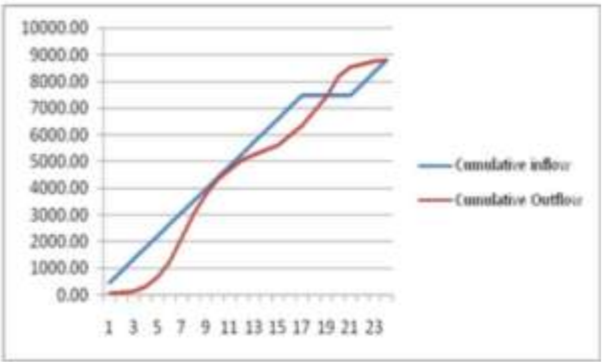

Fig3 Mass curve for Zone -1AmbedkarNagarESR

Checking Capacity of Ambika Nagar ESR (Zone2):

Similar to previous section, the hourly inflow for the Ambika Nagar ESR is 1800/20= 90m^3whereas the average outflow is 1800/24=75 m^3. The capacity has been checked using a mass curve method for 20 hour inflow and 24 hours outflow. The distributions of inflow and out flow along with their cumulative values are given in Table 2. The using the Table the capacity required for the Ambika Nagar ESR is 532.5 m^3 whereas the actual capacity of the ESR is 700 m^3.

The mass curve graph of cumulative supply and cumulative demand is shown in Fig 5.58. The result of EPS representing the performance of ESR, with percentage volume available in the ESR during 24 hour outflow is shown in the graph below shown in Fig 4

Table 3 checking capacity of Zone –2 ESR, for 24 hr. supply

Hours	Multiplying Factor	Inflow 20 HRS in M3/HR	Out flow inM3/Hr	Cumulative in flow (Cin)	Cumulative Out flow (Co)	C in -Co	Co -C in
0		1800	75.00	0	0	0	0
1	0.1	90	7.5	90	5.667	84.333	-84.333
2	0.1	90	7.5	180	13.167	166.833	-166.833
3	0.1	90	7.5	270	20.667	249.333	-249.333
4	0.5	90	37.5	360	58.167	301.833	-301.833
5	1	90	75	450	133.167	316.833	-316.833
6	1.5	90	112.5	540	245.667	294.333	-294.333
7	2.5	90	187.5	630	433.167	196.833	-196.833
8	2.5	90	187.5	720	620.667	99.333	-99.333
9	2	90	150	810	770.667	39.333	-39.333
10	1.5	90	112.5	900	883.167	16.833	-16.833
11	1	90	75	990	958.167	31.833	-31.833
12	1	90	75	1080	1033.167	46.833	-46.833
13	0.5	90	37.5	1170	1070.667	99.333	-99.333
14	0.5	90	37.5	1260	1108.167	151.833	-151.833
15	0.5	90	37.5	1350	1145.667	204.333	-204.333
16	1	90	75	1440	1220.667	219.333	-219.333
17	1	90	75	1530	1295.667	234.333	-234.333
18	1.5	0	112.5	1530	1408.167	121.833	-121.833
19	1.5	0	112.5	1530	1520.667	9.333	-9.333
20	2	0	150	1530	1670.667	-140.667	140.667
21	1	0	75	1530	1745.667	-215.667	215.667
22	0.3	90	22.5	1620	1768.167	-148.167	148.167
23	0.3	90	22.5	1710	1790.667	-80.667	80.667
24	0.1	90	7.5	1800	1798.167	1.833	-1.833
	24			Maximum of		316.833	215.667
Required capacity=532.50 m3							
Available capacity=700m3							

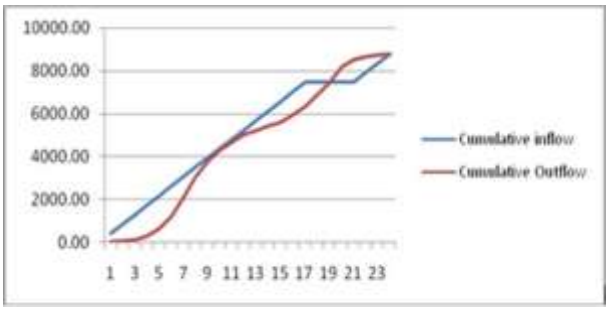

Fig4 Mass curves for Zone-2 Ambika Nagar ESR

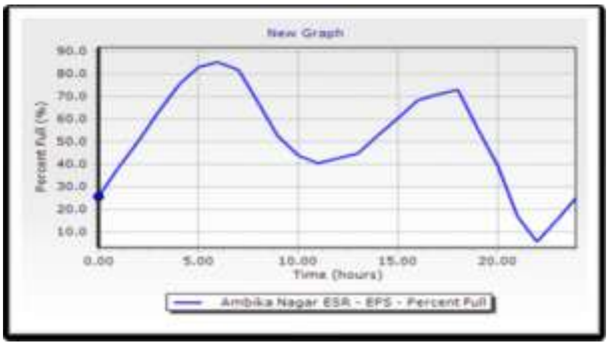

Fig 5 ESR Performance Graph

CONCLUSION

This study focuses on transforming an existing intermittent waters scheme into a24x7water supply scheme. For this study, the intermittent water supply scheme of Pandharpur city, which is a pilgrimage city and has a floating population, is chosen as a case study. This research is initiated by studying the existing water supply scheme in detail and understanding the existing water supply scheme components that can be utilized during its transformation in to a 24x7water supply scheme. Steady-state analysis is carried out to decide the elevated storage reservoir (ESR) capacity and pipe network for the future population water demand. The pipe network obtained for the 24 x 7 scheme is validated for its water pressure and head loss requirements. The cost analysis of the 24 x 7 scheme is performed by comparing it with the utilization of existing pipes. Further, the extended period simulation (EPS) analysis is carried out to check the feasibility of the designed network for 24 hours. Furthermore, the Darwin optimization technique is utilized to minimize the cost of the water supply network. The optimization results are also compared with the steady-state analysis results. The point wise conclusions of the study are presented below:

i. The initial data collected from Pandharpur municipality of the existing intermittent water supply scheme shows that for the pilgrimage city where the floating population is about ten times of local population, 24 X 7 water supply scheme will be useful to accommodate fluctuations in the populations, in turn, the water demand. Further, the initial survey also shows that some good quality components can be utilized while transforming the existing intermittent water supply scheme to 24 X 7 water supply schemes.

ii. Pandharpur City is divided into 13 zones, and the population growth is divided into three stages as initial (2015), intermediate (2030) and Ultimate (2045). The distribution of the city in various zones appropriately will help in dividing the whole system into part to design the water supply scheme more efficiently. Furthermore, considering the water demands at three stages as initial, intermediate and ultimate will help plant he

iii. Implementation of water supply schemes and helps reduce the cost burden by utilizing the existing pipe network and ESR for a particular period of demand satisfaction.

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