

Hydraulic Modelling of Water Distribution System with Reference to Technical Sustainability by using Water Gems

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ABSTRACT: Water is an essential requirement of human being and water supply is becoming a challenging problem everywhere. It is necessary to use available limited resources to resolve this problem. Many researchers have used techniques, various models and different software's based on various analysis methods to design the water distribution supply system. A safe supply of potable water is the basic necessity of people. It include transport of water over long distances for supply of water to urban area, water distribution system for a group of rural towns, water distribution network of a city, and so forth. A water pump supplies water through primary, secondary, and distributor water mains to supply water to consumers and for fire protection. For the optimization of water distribution network by Water GEMS tool is used. The analysis of the distribution system is made using Water GEMS software. It is an efficient method of designing new pipe layouts and pipe rehabilitation projects.

KEYWORDS: Existing water supply system, Distribution Network, Water Gems, AutoCAD

I. INTRODUCTION

The Government of Maharashtra has undertaken "Sujal-Nirmal Abhiyan" project under which Government insisted various urban local bodies to participate. ULB improvement program has been taken up to increase serviceability of the system. Khuldabad Municipal Council (KMC), intended and participated to conduct various reforms works in the field of water supply such as Carrying out Consumer Survey, Water Audit, Energy Audit, Providing and Installing Flow Meter, GIS Mapping, Hydraulic Modelling and Computerized Water Billing & Collection System. The work of Carrying out Consumer Survey, Water Audit, Energy Audit, Providing and Installing Flow Meter, GIS Mapping, Hydraulic Modelling and Computerized Water Billing & Collection System for Khuldabad Water Supply Scheme is carried out in this work.

In Maharashtra State, since more than 42 per cent citizens live in the urban areas and rate of population growth is increasing. So it is necessary to increase serviceability & an access to the urban poor communities. Computation of flows and pressures in network pipes have been of great value and interest for those involved with designs, construction and maintenance of urban water distribution systems. Analysis and design of pipes networks create a relatively complex problem, particularly if the network consists of range of pipes as frequently occurs in water distribution systems of large metropolitan areas. In the absence of significant fluid acceleration, the behaviour of a network can be determined by a sequence of steady state conditions, which form a small but vital component for assessing the adequacy of a network. Such an analysis is needed each time changing pattern of consumption or delivery are significant or, added features such as supplying of water, addition of booster pumps, pressure regulating valves or storage tanks, change the existing supply system.

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II. OBJECTIVES

Objective of this work is to collect the details of existing water distribution system, to find whether the existing system is sufficient to cater existing demand as well as future demand also to find the area which is needed to be upgraded as per future demand. The main objective is to provide economic solution for distribution network with optimum utilization of existing system.

III. STUDY AREA

Khulatabad is situated at 20.05° North latitude & 75.18° longitude to the east. It is situated on Aurangabad – Dhulia State Highway at a distance of 30 Km from Aurangabad City. The average rainfall in this area is about 700 mm. There are three natural tanks in the Vicinity. The total area within municipal limit is 5.12 sq.km. As of 2011 India census Khuldabad had a population of 15,749. The average growth rate of population in last five decades is 26.49 %.

Climate of Khuldabad is characterized by a hot summer and general dryness throughout the year except during south–west monsoon season. The south-west monsoon rains last for about four months from middle of June to September end. From about mid-October, the district also, gets a few showers of the north-east monsoons. This rainfall is always helpful for the growth and good yield of rabi crops, it also helps in recouping water in the wells.

IV. MATERIALS USED

The materials used for this study includes; Land Use Map, contour map, satellite images, then water distribution parameters such as; water demand, population, and also distribution network parameters such as; elevations, pipe diameter, pipe length, finally Auto Cad & Water Gems software's.

V. METHODOLOGY

a) Base Scenario

A scenario is a set of Alternatives, while alternatives are groups of actual model data. Scenarios and alternatives are based on a parent/child relationship where a child scenario or alternative inherits data from the parent/base scenario or alternative. The base scenario of pipe network of an entire town is the first task in preparation of the hydraulic model.

b) Back Drop Drawing

A satellite image from Google earth is taken. This raster image was digitized and the shape files of the features such as road edge boundaries, buildings, water bodies, Highways were developed. The satellite image and the shape files were geo referenced (spatial) with the Co-ordinate system of WGS-1984 UTM 43 N.

c) Active Topology of Entire Town

The shape files of the roads, buildings, river etc. are exported to Water Gems and are created as background layers. The various components of the pipe network such as reservoir, pipe, junctions, valves, and tanks etc. are drawn on the background layer, Demand Allocation to Nodes.

d) Formation of Zones

After study of the elevation profile, entire town is divided into zones for distribution system, to satisfy the demand of the entire town for ultimate stage of 2048, for projected population of 29596 souls. Ten wards of town are covered under each zone.

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Water Zone-1 Boundary Map



Coverage of Wards under Proposed Water Zone 1

Zone 1 : Proposed ESR 4.85 LL			
Diameter (mm)	Proposed Length (HDPE)	Existing Retained Length	Length (All Materials) (m)
80	0	148	148
110	5,885	0	5,885
140	154	0	154
160	258	0	258
150	0	351	351
180	140	0	140
200	5	0	5
250	7	0	7
280	61	0	61
315	615	0	615
All Diameters	7,126	499	7,625

V. RESULTS

The zoning been made considering the capacity of the ESR and the topographical features of the town. The various scenarios are then run for the results. The results for ultimate stage scenario of the distribution network are show

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**Proposed ESR 4.85 LL at WTP campus Tank
Table**

Label	Elevation (Base) (m)	Elevation (Minimum) (m)	Elevation (Initial) (m)	Elevation (Maximum) (m)	Flow (Out net) (m ³ /h)	Hydraulic Grade (m)
P_4.85 LL ESR	739.00	745.00	746.00	748.00	66.29	746.00

Proposed ESR 4.85 LL at WTP campus Node Table

Label	Elevation (m)	Hydraulic Grade (m)	Pressure (m H ₂ O)
J-337	730.23	742.93	12.70
J-135	730.15	743.03	12.90
J-385	730.13	743.03	12.90
J-304	729.79	742.81	13.00
J-334	729.79	742.84	13.00
J-416	729.79	742.85	13.00
J-200	730.00	743.08	13.10
J-243	729.90	743.03	13.10
J-248	729.97	743.07	13.10
J-256	729.95	743.04	13.10
J-402	729.97	743.07	13.10
J-414	729.56	742.81	13.20
J-128	729.73	743.11	13.30
J-43	729.07	742.71	13.60

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J-93	729.21	743.08	13.80
J-325	728.86	742.76	13.90
J-65	729.36	743.26	13.90
J-172	728.76	742.83	14.00
J-255	729.11	743.17	14.00
J-568	731.43	745.45	14
J-428	728.91	743.07	14.10
J-454	728.81	742.96	14.10
J-133	728.71	742.96	14.20
J-184	728.56	742.76	14.20
J-330	728.74	743.01	14.20
J-351	728.71	742.96	14.20
J-306	728.81	743.10	14.30
J-412	728.52	742.93	14.40
J-104	728.20	742.70	14.50
J-182	728.46	743.00	14.50
J-206	728.53	743.04	14.50
J-410	728.61	743.27	14.60

VI. MASS CURVE FOR ZONE-1

In view to keep minimum 8 hr storage the ESR of capacity 485.00 m³ is proposed to feed the Zone-1.

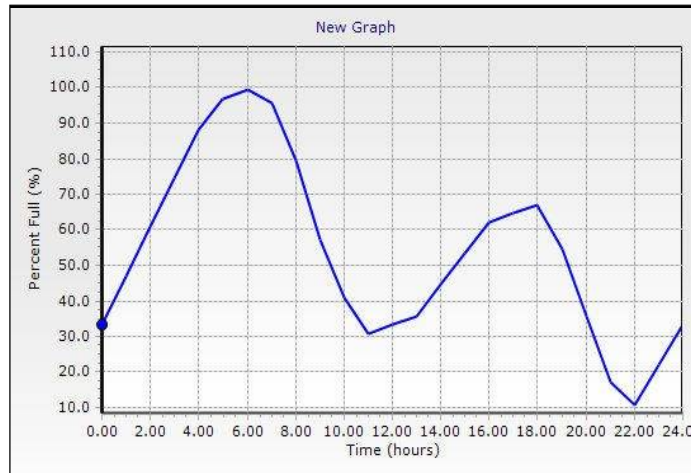
A mass curve (graph) of cumulative supply and cumulative demand is shown in Figure

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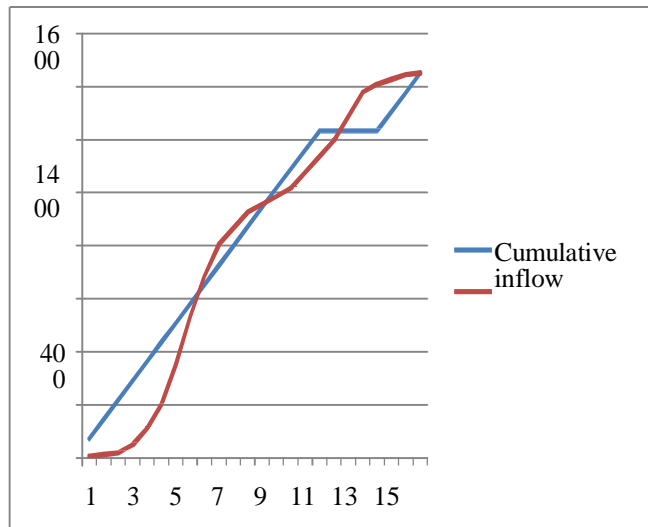
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The result of EPS representing the performance of ESR, with percentage volume available in the ESR during 24 hour outflow is shown in the graph below,



VII. NETWORK AFTER IMPROVEMENT

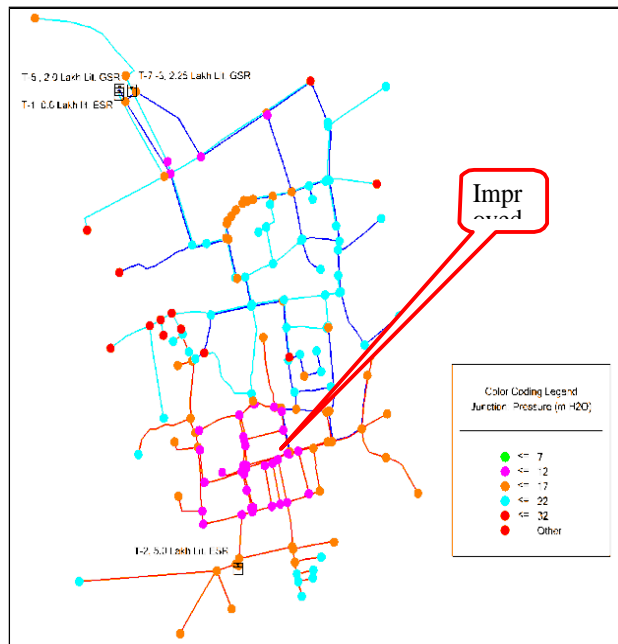
The present stage scenario is improved by proposing some additional new pipeline in the distribution system and isolating the ESR and Bore well zones and making separate DMA zones, so as to improve the behaviour of the present distribution system.

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VIII. CONCLUSION

The software provide required standard and economical environment for design, analysis, troubleshooting of new and existing supply network with minimum time duration The approach in this study shall help town administration not only to regularize the daily water supply but will also help to transform its current intermittent supply to 24/7 continuous water system.

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