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Design And Analysis of Pipe Distribution System Using Watergems For Asoada Town In Jalgoan District, Maharashtra State

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Abstract
Water is a vital component needed for life to exist. With population growth, there is a constant rise in the demand for freshwater resources. This increasing need is met by creating well-organized water distribution networks. Advanced computing systems are used to develop the water distribution system. It incorporates contemporary hydraulic modelling and software design. The water distribution network is an essential infrastructure component that connects customers to water sources via components for hydraulic systems such as pipes, pumps, valves, and tanks. The basic goal of the water distribution network is to supply high-quality, pressured water to every consumer. Water Geospatial Engineering Model System (WaterGEMS) is used to analyses and create water distribution systems. Comparing the two results yields the most cost-effective pipe size. The velocity, residual pressure at each node, head loss, pipe material, peak factor, enhanced service reservoir level, and commercially accessible pipe diameters are taken into account while designing the affordable pipe sizes. The water distribution system has finally been examined for long-term modelling. The acquired findings confirmed that the pressure at every junction and the flow rate via every pipe are sufficient to supply water to every consumer point. Ultimately, it is determined that the WaterGEMS model is a potential tool for efficiently scheduling pump operational schedules and pipelines in water distribution networks. The water supply should be compared to Central Public Health and Environmental Engineering Organization (CPHEEO) standards. India's ASODA TALUKA, JALGOAN DISTRICT, Maharashtra, is the subject of a study that includes hydraulic analys.

Keywords: water distribution network, watergems software, pipeline network, junction network.

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I. INTRODUCTION

Water is very precious natural resource for all living beings. A single living being is impossible to sustain without water. In ancient time people were also concern about water quantity, quality, availability and conservation. People were using many methods and ways to water conservation Water distribution network is combination of all appliances which helps in delivering the supply of water from a specific source to consumer point. It comprises of reservoir, main pipes, distribution pipes, different type of valves and pump station etc. Water treatment removes contaminants and undesirable components, or reduces their concentration so that the water becomes fit for its desired end-use. Treatment for drinking water production involves the removal of contaminants from raw water to produce water that is pure enough for human consumption without any short term or long term risk of any adverse health effect. Measures taken to ensure water quality not only relate to the treatment of the water, but to its conveyance and distribution after treatment. It is therefore common practice to keep residual disinfectants in the treated water to kill bacteriological contamination during distribution. WaterGEMs involves variable decisions that are pipe diameters, reservoir elevation & its capacity with a primary variable. The result obtained is represented by using various colour coding of pipe dia., tables and graphs which helps to discover what better can be adopted. WaterGEMS also track the flow of water, pressure at each node, each pipe and height of water in tank during simulation. WaterGEMs involves variable decisions that are pipe diameters, reservoir elevation & its capacity with a primary variable. The result obtained is represented by using various colour coding of pipe dia., tables and graphs which helps to discover what better can be adopted. WaterGEMS also track the flow of water, pressure at each node, each pipe and height of water in tank during simulation.

Necessity

Asoda is a large village in Jalgoan district. Which is connected with the neighboring village by a good road network. The village is developing as a livable place due to the good educational facilities and market available for the essentials of life in the village Consequently, the town is experiencing water stress due to limited water availability and a growing demand resulting from population growth and urbanization. The existing water supply is insufficient and therefore there is need of redesigning the network. Moreover, it is crucial to ensure that the water supply maintains sufficient pressure and velocity. In addition to these challenges, the study aims to address the issue of uneven waterdistribution in the town.

Scope of Study

1. Analysing the existing water supply network and studying its limitations.
2. Population forecasting and future demand calculation of the study area.
3. To design pipe distribution network for Asoda Village.
4. The designed pipe distribution network should provide water to every consumer with adequate pressure and velocity.
5. In order to assess the hydraulic parameters of the region's current WDS.
6. Proposed Designed should be cost effective

II. Literature Review

Karolin et al. (2017) presented paper on the optimisation of a water distribution system using Bentley WaterGEMS software. The research took place in the Lublin Region, where six water distribution systems were in operation. Computer simulations conducted using Bentley WaterGEMS software formed the basis for analyzing optimal connection and operational solutions. The study confirmed the effectiveness and cost efficiency of Bentley WaterGEMS software in achieving desirable outcomes.

Laxman et. Al (2018) Presented a Paper on Analysis and Design of Continuous Water Distribution System against Existing Intermittent Distribution System for Selected Area in Pandharpur The objective of this research paper was to design a water distribution system that provides continuous and intermittent supply with adequate water pressure using Watergems software. The study focused on the areas of Manisha Nagar and Padmavati in Pandharpur, Maharashtra. The network design was created for the intermediate stage and final stage. The findings of the study indicated that as the population increases from 2021 to 2051, the demand, pressure and head loss gradient,in the system will also increase. The utilization of Watergems software proved to be highly beneficial for the author in designing, analyzing, and resolving various issues in both new and existing networks.

B. Kowalska et al. (2022) presented paper on Division of district metered areas (DMAs) in a part of water supply network using WaterGEMS (Bentley) software: a case study. The research focused on identifying and addressing undetected leakages within the water distribution system. To achieve this, the WaterGems software was utilized, specifically the DMA-Tool module, to divide the DMAs (District Metered Areas) in the system. The existing zone of the municipal water supply network was analyzed using the WaterGEMS software, and modifications were proposed for areas with a high number of DMAs.The simulation results demonstrated that implementing DMAs led to improved pressure throughout the area. Consequently, recommendations were made to implement a double-pipe water supply system and modify operational parameters at the pumping station in the identified area.

Study Area

The majority of the region's precipitation is caused by the Southwest Monsoon. The monsoon season, which lasts from June till September, is when it rains in Asoda . Heavy precipitation is brought on by the Southwest Monsoon winds, which deliver clouds loaded with moisture from the Arabian Sea. Agriculture and lovely flora depend on showers. Rainfall in Asoda averages between 600 and 700 mm (per year, the majority of which falls between June and September. The monsoons produce average rainfall, while the summers are scorching and dry. As per 2011 Census of India the total population of Asoda   is 13816 of which 7239 were male and 6577 were female.

Figure 1: Asoda map

Water Distribution Network

A water distribution network is an important element of hydraulic infrastructure and is a part of the water supply system. Components of WDN includes source, rising main, water treatment plant, master balancing reservoir, primary network, elevated service reservoir. WDN connects consumers to water sources by utilizing hydraulic components. WDN pipelines are typically branched and looped in configuration. The flow is the major parameter in the network. The constraints must be satisfied, and pressures at particular network junctions must be maintained within predetermined bounds. Design parameters such as reservoir capacity, pipe diameters, and elevation are among the decision variables. The network system is modelled, analyzed, and evaluated in terms of performance. This is referred to as "simulation." Using pressurized pipe networks, WaterGEMS models hydraulic and water quality behavior over extended time periods. WaterGEMS keeps track of the pressure at each junction, the flow of water via each pipe, the height of water in each tank, and the concentration of water across the network during a simulation time.

Population forecasting

Population forecasting methods are techniques used to estimate and predict future population size and composition based on current and historical data. These methods help policymakers, urban planners, and researchers make informed decisions about resource allocation, infrastructure development, and social policies.

Arithmetic Increase Method

Growth Rate = (Final Population - Initial Population) / Number of Years

The Geometric Increase Method

Growth Rate = (Final Population / Initial Population) ^ (1 / Number of Years) –1

Incremental Increase Method

Average Annual Increment = (Final Population - Initial Population) / Number of Years.

Forecasted Population = Most Recent Population + Average Annual Increment

Peak factors

Population	Peak Factor
Up to 50000	3
50001-200000	2.5
Above 200000 Lakhs	2
For Rural area	3

Table 1: Peak factors

III. Methodology

Methodology Flow Chart consist of following steps

Step 1*:* Study map of Asoda area using AutoCAD Software

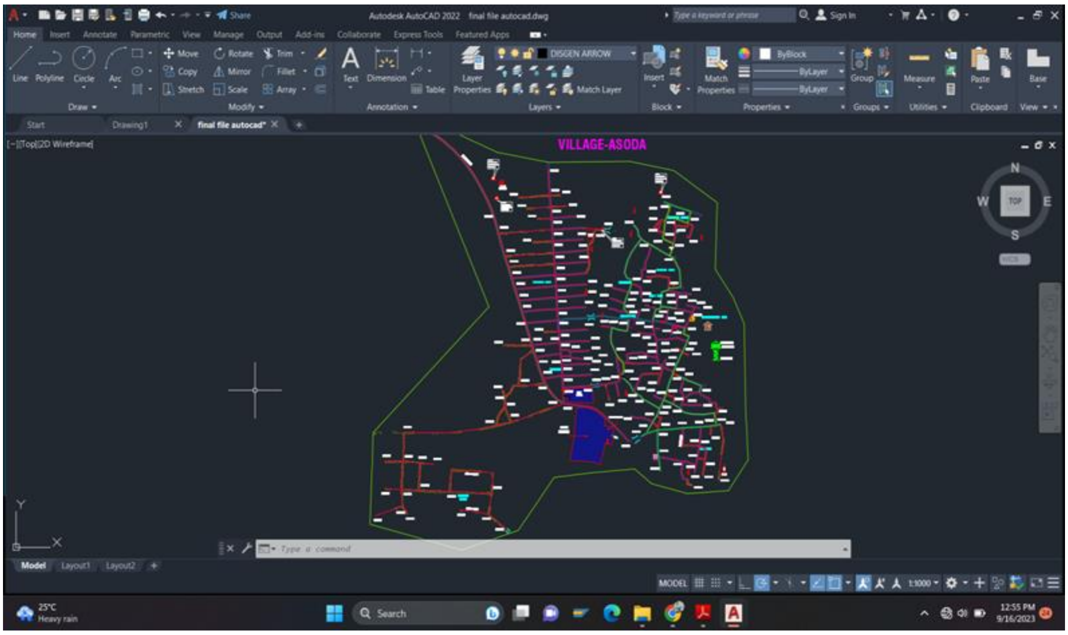

Figure 2:Autocad drawing

Step 2: Convert "dwg".file to ".dxf"file. (WaterGEMS software only support the .dxf file)

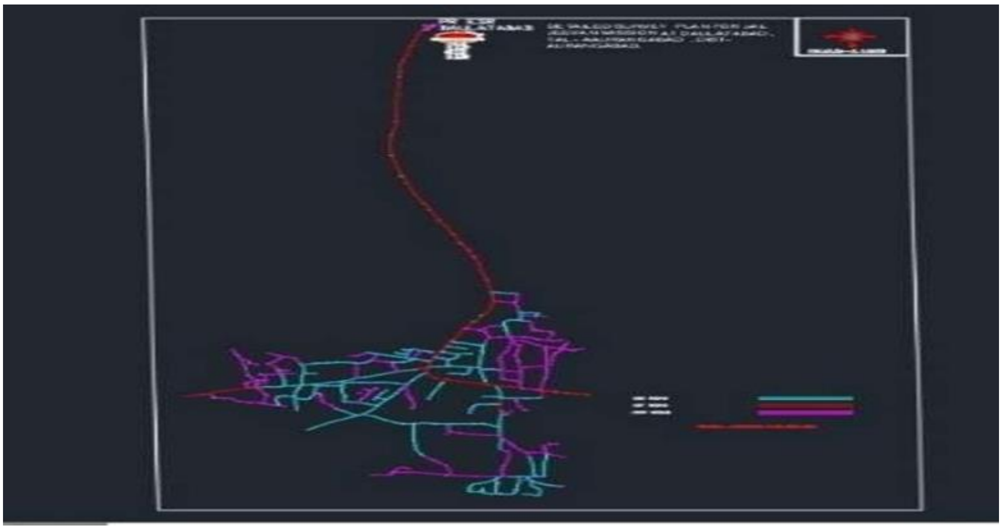

Figure 3:Autocad drawing to watergems

Step 3: Input Basic data in Water GEMS

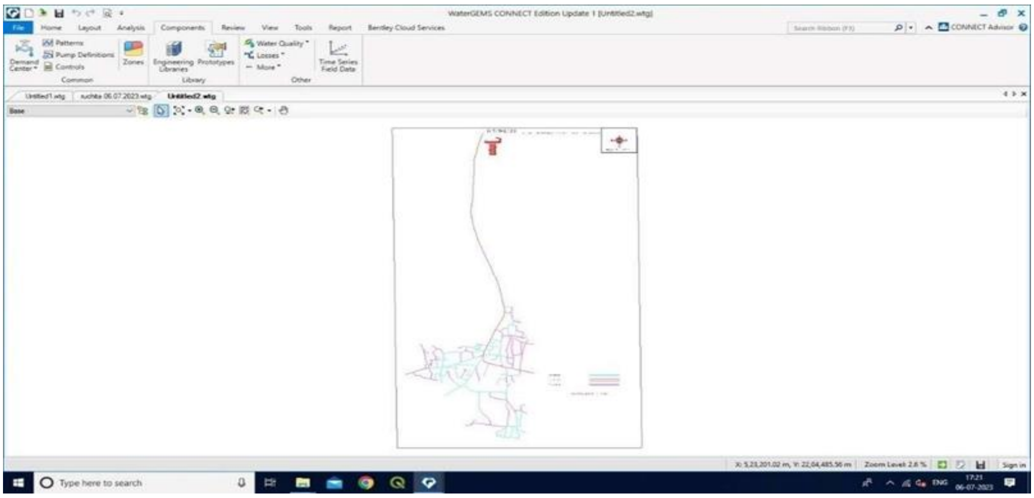

Figure 4:watergems

Step 4: Network Layout design using Water GEMS.

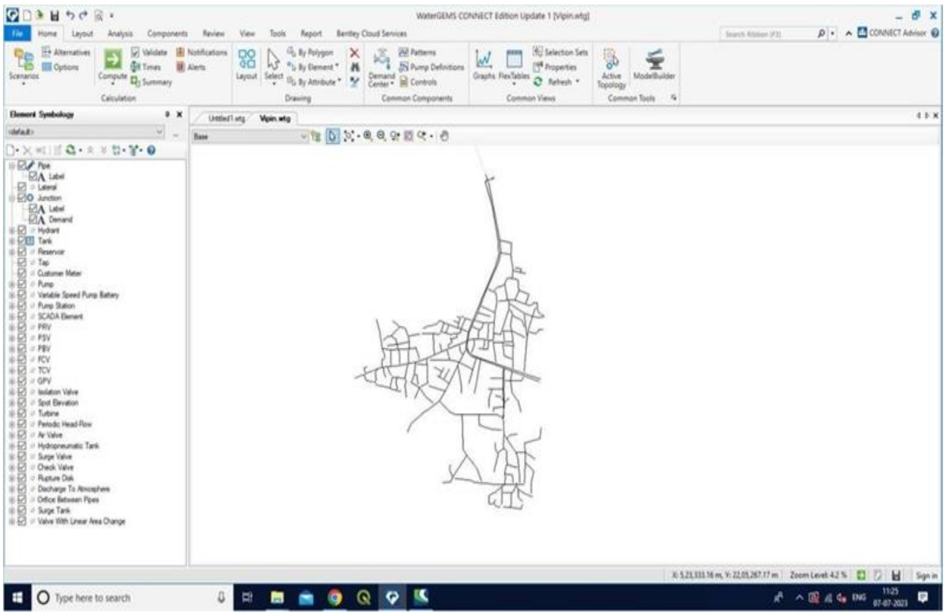

Figure 5:Network layout

Step 5: Run the Simulation

FlexTable: Junction Table (Current Time: 0.000 hours) (ruchita 06.07.2023.wtg)

	ID	Label	Elevation (m)	Hydraulic Grade (m)	Zone	Demand (L/s)	Pressure (m H2O)
137: J53	137	J53	593.18	615.57	<None>	0.171	22
140: J55	140	J55	593.81	615.57	<None>	0.171	22
139: J54	139	J54	593.81	615.57	<None>	0.056	22
420: J184	420	J184	593.91	615.58	<None>	0.055	22
143: J56	143	J56	593.90	615.57	<None>	0.234	22
134: J51	134	J51	593.92	615.58	<None>	0.147	22
136: J52	136	J52	593.92	615.57	<None>	0.355	22
407: J179	407	J179	594.42	615.58	<None>	0.169	21
145: J57	145	J57	594.47	615.57	<None>	0.048	21
405: J178	405	J178	594.56	615.57	<None>	0.103	21
408: J180	408	J180	594.61	615.59	<None>	0.173	21
394: J175	394	J175	594.72	615.60	<None>	0.309	21
132: J50	132	J50	594.71	615.58	<None>	0.366	21
412: J182	412	J182	594.72	615.59	<None>	0.268	21
415: J183	415	J183	594.76	615.58	<None>	0.051	21
410: J181	410	J181	594.84	615.59	<None>	0.038	21
129: J48	129	J48	595.22	615.59	<None>	0.113	20
393: J174	393	J174	595.51	615.60	<None>	0.096	20
182: J75	182	J75	589.99	609.99	<None>	0.367	20
147: J58	147	J58	595.66	615.56	<None>	0.656	20
428: J187	428	J187	594.32	614.12	<None>	0.171	20
186: J77	186	J77	590.20	609.99	<None>	0.103	20
218: J94	218	J94	594.27	614.04	<None>	0.200	20
130: J49	130	J49	595.83	615.59	<None>	0.311	20
184: J76	184	J76	590.28	609.99	<None>	0.087	20
232: J101	232	J101	594.43	614.14	<None>	0.222	20
490: J216	490	J216	590.13	609.68	<None>	0.207	20
512: J227	512	J227	590.12	609.65	<None>	0.137	19
259: J115	259	J115	594.76	614.13	<None>	0.085	19
499: J220	499	J220	590.40	609.65	<None>	0.239	19
487: J214	487	J214	590.20	609.40	<None>	0.113	19
523: J232	523	J232	590.10	609.30	<None>	0.094	19
571: J247	571	J247	590.14	609.30	<None>	0.156	19
506: J224	506	J224	590.14	609.30	<None>	0.104	19
504: J223	504	J223	590.14	609.30	<None>	0.244	19
396: J176	396	J176	596.50	615.64	<None>	0.171	19
515: J228	515	J228	590.18	609.30	<None>	0.284	19
247: J109	247	J109	595.07	614.12	<None>	0.554	19
493: J217	493	J217	590.50	609.49	<None>	0.082	19
521: J231	521	J231	590.34	609.30	<None>	0.121	19
519: J230	519	J230	590.37	609.30	<None>	0.272	19

250 of 250 elements displayed

Figure 6: Pressure table

FlexTable: Pipe Table (Current Time: 0.000 hours) (ruchita 06.07.2023.wtg)

	Label	Length (User Defined) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Velocity (m/s)	Headloss Gradient (m/km)	Flow (Absolute) (L/s)	Zone
85: P26	P26	23	J25	J26	103.6	PVC	140.0	0.0047	0.000	0.039	TANK 2
105: P35	P35	10	J36	J37	103.6	PVC	140.0	0.0020	0.000	0.017	TANK 2
115: P41	P41	24	J41	J42	103.6	PVC	140.0	0.0049	0.000	0.041	TANK 2
118: P42	P42	16	J43	J44	103.6	PVC	140.0	0.0032	0.000	0.027	TANK 2
211: P88	P88	20	J89	J90	103.6	PVC	140.0	0.0041	0.000	0.034	TANK 2
310: P136	P136	26	J136	J137	103.6	PVC	140.0	0.0053	0.000	0.044	TANK 2
356: P151	P151	15	J152	J156	103.6	PVC	140.0	0.0030	0.000	0.026	TANK 2
411: P183	P183	22	J180	J181	103.6	PVC	140.0	0.0045	0.000	0.038	TANK 1
419: P186	P186	30	J179	J183	103.6	PVC	140.0	0.0061	0.000	0.051	TANK 1
448: P203	P203	17	J195	J196	103.6	PVC	140.0	0.0034	0.000	0.029	TANK 2
452: P205	P205	13	J197	J198	103.6	PVC	140.0	0.0026	0.000	0.022	TANK 2
475: P220	P220	17	J18	J208	103.6	PVC	140.0	0.0034	0.000	0.029	TANK 2
540: P257	P257	23	J239	J240	103.6	PVC	140.0	0.0047	0.000	0.039	TANK 1
1455: P158	P158	7	TCV9	J158	103.6	PVC	140.0	0.0085	0.000	0.072	TANK 2
81: P24	P24	40	J23	J24	103.6	PVC	140.0	0.0081	0.001	0.068	TANK 2
107: P36	P36	40	J36	J38	103.6	PVC	140.0	0.0081	0.001	0.068	TANK 2
122: P44	P44	40	J45	J46	103.6	PVC	140.0	0.0081	0.001	0.068	TANK 2
237: P103	P103	40	J102	J103	103.6	PVC	140.0	0.0081	0.001	0.068	TANK 1
379: P167	P167	40	J165	J166	103.6	PVC	140.0	0.0081	0.001	0.068	TANK 2
502: P235	P235	40	J220	J221	103.6	PVC	140.0	0.0081	0.001	0.068	TANK 2
556: P263	P263	40	J160	J244	103.6	PVC	140.0	0.0081	0.001	0.068	TANK 2
242: P105	P105	38	J105	J106	103.6	PVC	140.0	0.0077	0.001	0.065	TANK 1
470: P217	P217	38	J206	J21	103.6	PVC	140.0	0.0077	0.001	0.065	TANK 2
446: P202	P202	37	J194	J195	103.6	PVC	140.0	0.0075	0.001	0.063	TANK 2
264: P116	P116	36	J116	J117	103.6	PVC	140.0	0.0073	0.001	0.062	TANK 1
328: P144	P144	36	J144	J145	103.6	PVC	140.0	0.0073	0.001	0.062	TANK 2
1454: P157	P157	35	J157	TCV9	103.6	PVC	140.0	0.0085	0.001	0.072	TANK 2
53: P10	P10	34	J8	J9	103.6	PVC	140.0	0.0069	0.001	0.058	TANK 2
98: P32	P32	33	J32	J33	103.6	PVC	140.0	0.0067	0.001	0.056	TANK 2
141: P52	P52	33	J54	J55	103.6	PVC	140.0	0.0067	0.001	0.056	TANK 1
516: P244	P244	33	J224	J228	103.6	PVC	140.0	0.0068	0.001	0.057	TANK 2
529: P250	P250	33	J234	J235	103.6	PVC	140.0	0.0067	0.001	0.056	TANK 2
421: P187	P187	32	J179	J184	103.6	PVC	140.0	0.0065	0.001	0.055	TANK 1
511: P240	P240	30	J225	J226	103.6	PVC	140.0	0.0061	0.001	0.051	TANK 2
559: P264	P264	30	J245	J246	103.6	PVC	140.0	0.0061	0.001	0.051	TANK 2
526: P249	P249	27	J230	J233	103.6	PVC	140.0	0.0055	0.001	0.046	TANK 2
261: P114	P114	50	J115	J116	103.6	PVC	140.0	0.0101	0.001	0.085	TANK 1
494: P231	P231	48	J217	J82	103.6	PVC	140.0	0.0097	0.002	0.082	TANK 2
442: P199	P199	47	J192	J193	103.6	PVC	140.0	0.0095	0.002	0.080	TANK 2
59: P13	P13	46	J11	J12	103.6	PVC	140.0	0.0093	0.002	0.079	TANK 2
64: P15	P15	46	J14	J15	103.6	PVC	140.0	0.0093	0.002	0.079	TANK 2

274 of 274 elements displayed

Figure 7: Headloss Gradient

IV. RESULT AND DISCUSSION

The WaterGEMS software is used to analyze the existing water distribution network in Asoda . A continuous, water supply system is provided for the entire network. Pressure, diameter, and pipe material have all been designed to meet the demands. The design parameters are tailored to the projected future population. Three ESR's of capacity 2 lakh liters are provided. In this design total 208 junctions and 207pipes are provided.

V. CONCLUSION

The scheme so formulated provides following benefits to the habitants of the project area, in a manner that the water supply will be made available to the users at their door step, and they will have easy access to the service. The scheme will cover total population in the area. Optimizing a pipe distribution network involves various factors, such as minimizing energy consumption, reducing water losses, improving pressure management, and enhancing overall system efficiency. Through the use of Water GEMS, engineers can analyze and identify the most effective strategies for achieving these objectives. This study presents the findings derived from the Water GEMS software, encompassing the analysis of pressure, head loss, and velocity within the network of Asoda. The existing network in Asoda is not suitable to meet future demands. Therefore a new network is to be laid to meet the future demand. The outcomes indicate that WATERGEMS software canbe effectively utilized to develop an optimized network. The designed network is a well suitable network for collection of data generated. It is easy to prepare a proper water distribution network by software and also modified representation of the layout can be done in it.

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