Research Paper Engineering

Case Study on Designing Water Supply Distribution Network Using Epanet for Zone-I of Village Kherali

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ABSTRACT

This study presents the use of EPANET software in the design of water distribution network for Zone-I of Kherali Village. EPANET
is a computer program that performs extended period simulation of hydraulic and water quality behavior within pressurized pipe networks. A network consists of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs. EPANET tracks the flow of water in each pipe, the pressure at each node, the height of water in each tank, and the concentration of a chemical species throughout the network, EPANET is designed to be a research tool for improving our understanding of the movement and fate of drinking water constituents within distribution systems. It can be used for many different kinds of applications in distribution systems analysis. In this paper it was used to carry out the hydraulic analysis of the distribution network in the study area. The results obtained verified that the pressures at all junctions and the flows with their velocities at all pipes are feasible enough to provide adequate water to the network of the study area.

KEYWORDS EPANET, Water Distribution Network, System

INTRODUCTION

The resource management issues have become more critical in places where rainfall is less. The water distribution system is component connected between the water supply sources and the consumer. It is careful conveyance system that allows water to be moved through piping before reaching the consumer's tap. Water distribution systems are usually owned and maintained by local governments such as cities but are irregularly operated by a commercial enterprise. Firstly planning of water distribution systems city planners' engineer who must consider many factors such as location, current demand, future growth, pipe sizes, head loss, firefighting, leakages, etc. using pipe network analysis and other tools.

Water distribution system is a hydraulic infrastructure consisting of elements such as pipes, tanks pumps and valves etc. It is crucial to provide water to the consumers; effective water supply is of paramount importance in designing a new water distribution network or in expanding the existing one. It is also essential to investigate and establish a reliable network ensuring adequate head. Computation of flows and pressures in network pipes has been of great value and interest for those involved with designs, construction and maintenance of public water distribution systems. This study aimed at performing the hydraulic analysis of Zone-I of Kherali Village water distribution network using Epanet Software.

LITERATURE STUDY:

Jacob (1991), proposed a technique for simulation of water distribution system in developing countries, where supply is less than demand i.e., intermittent supply.

Walski (2001), while discussing the issues related to water distribution system focused on some of the most compelling problems facing optimization viz. (i) Designer must strike a balance between cost minimization and net benefits (benefit minus costs) (ii) Reliability of the water distribution networks should not be reduced for the sake of cost reduction.

Chunping Yang, ZhiqiangShen, Hong Chen, Guangming-Zeng, YuanyuanZhong (2006)A lot of technological problems including advanced treatment processes, pH regulation, sterilization, and pipe selection have been solved cost-effectively.

Vicki L. Van Blaricum and Vincent F. Hock (2007) This paper describes the demonstration and validation of multi-parameter water quality sensors and corrosion rate sensors that were permanently installed at a U. S. Army installation to detect corrosion problems and fine-tune the chemical treatment program. The use of water qualityand corrosion rate sensors has been demonstrated and validated in the field.

Andrea Bolognesi, Cristiana Bragalli, Angela Marchi, SandroArtina DISTART, (2009) This paper proposes a newmodel named Genetic Heritage Evolution by Stochastic Transmission GHEST, a multipopulation evolutionary strategy like algorithm applied to the design of water distribution networks

(WDN). GHEST makes use of hydraulic network solver EPANET 2.

STUDY AREA:

In this paper, the brief notes about the study area selected, methodology adopted for data collection, population of Kherali village in 2043 and total water requirement in that year will be worked out. The methods adopted for obtaining the data are by direct measurements, quantitative estimates or by interview with staff of Water And Sanitation Management Organization (WASMO) & Gujarat Water Supply and Sewerage Board (GWSSB).

Figure 1: Google Map image of Kherali Village
Sources:
https://www.google.co.in/maps/place/Kherali,+Gujarat+363020/@22.6897398,71.6018435,1468m/data=!3m2!1e3!4b1!4m2!3m1!1s0x3959406c20d1f173:0x9619e6125dfeb593?hl=en

The Kherali village, Taluka: - Wadhwan, District:-Surendranagar is selected for the study purpose. The existing Elevated Service Reservoir (ESR) of 1,20,000 lit. Capacity and 12 m height and sump of 5,00,000 lit. Capacity in usable condition. During the summer and monsoon season, it become very difficult task to go for water because during summer season, the temperature raises up to 42 to 45^0 C, and during the monsoon season the surface became slippery & muddy. Hence, it becomes necessary to upgrade the existing system of water supply arrangement. Following data are collected for present study:

1. Hydrological data: Average rainfall of Surendranagar district is 760mm.
2. Geological data: Kherali is a village in Surendranagar district in the Indian state of Gujarat. It comes on the way from Surendranagar to Limli, and this route leads to Muli. The village is grown around one abandoned palace. The village has got one big lake and other many wells including one step-well. It has few temples including Swaminarayan temple, Rama temple and one well-built mosque. The village is mostly surrounded by farms.
3. Water quality data: The Available water is of good quality. The source of water is Dholidhaja Dam.
4. Public survey: Opinion poll regarding need of village people has been carried out.

POPULATION FORECAST:
Population for the Year of 2023, 2033 and 2043

Types of Methods	2023	2033	2043
Arithmetical Increase Method	4917	5424	5931
Incremental Increase Method	5298	6567	8217
Geometric Increase Method	5232	6208	7366

The demand is adopted as 70 lpcd. (Considering domestic requirements only without sewer line).

Types of Methods	Demand in year 2043 litres per day
Arithmetical Increase Method	5931 × 70=415170
Incremental Increase Method	8217 × 70=575190
Geometric Increase Method	7366 × 70=515620

Public Demand in LPCD In 2043
The population of Kherali is considered as per Incremental Increase Method 8217 (because in this method the combination of arithmetic & geometric comes.) and water demand is worked out as 575190 litres per day for year 2043. Here only Zone-I is considered, so the Population of Zone-I is as 1826 considered as shown in Table.

Information about EPANET 2.0 Software:
Program version: EPANET Version 2.0 (Release 2.00.09a)

Distribution: Web downloads(http://www.epa.gov/ORD/NRMRL/wswrd/epanet.html)

OS requirements: DOS, MS-Windows (95, 98, ME, NT, 2000)

Hardware requirements:
Processor: 80486 or higher
Hard disk: 2 Megabytes
RAM: 16 Megabytes

Calculation method: Hazen-Williams, Darcy-Weisbach, Chezy-Manning

Calculation capacity: No limit on number of nodes, pipes, pumps, valves, reservoirs, etc.

Data Input: Graphic oriented input with optional import of ASCII text file

Data Output: Graphic and tabular output including export to Windows clipboard and files.

Network Layout: True scale or unscaled network layout with optional background map

Language: English

Handbook: English, 200 pages with tutorial (pdf-file, downloadable)

Support: On-line help, web page, EPANET Users Group list server

No. of installations: Thousands of users world-wide

Pricing: Free

Freely Available: Full source code and Programmer's Toolkit (for customization).

EPANET Workspace:

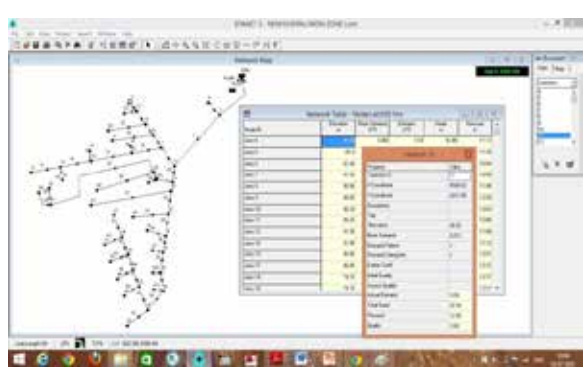

Figure 2: Print screen of EPANET in working mode.

RESULTS AND DISCUSSION:
In this research the distribution network of Zone-I of Kherali village was obtained and analyzed. It consists of 49 pipes of PVC materials, 49 junctions, 1 tank and 1 source reservoir from which water is pumped to the surface reservoir and later distributed to the network, as shownbelow:

Figure 3: Print screen of Map in EPANET.

Reduced Level, Node and Length for Kherali Village Distribution pipe line						
Data of flow in LPS @ 70LPCD						
Zone - I						
Total Length = 2057		Pop	1826	LPCD	127841	
NODE		L	RL	POP.	LPCD	LPS
From	To		Node to			
ESR			83.00	0	0	0.000
ESR	4	97	81.85	86	6028	0.070
4	5	26	81.80	23	1616	0.019
4	6	111	82.90	99	6899	0.080
6	7	36	81.95	32	2237	0.026
7	8	25	80.95	22	1554	0.018
8	9	21	80.65	19	1305	0.015
9	10	26	80.30	23	1616	0.019
10	11	17	80.25	15	1057	0.012
7	12	51	81.05	45	3170	0.037
12	13	70	80.85	62	4350	0.050
13	14	53	79.75	47	3294	0.038
14	15	51	79.65	45	3170	0.037
12	16	11	81.80	10	684	0.008
13	17	15	80.80	13	932	0.011
14	18	21	79.75	19	1305	0.015
8	19	70	81.00	62	4350	0.050
9	20	63	80.70	56	3915	0.045
10	21	21	80.35	19	1305	0.015
6	22	25	82.85	22	1554	0.018
22	23	26	82.90	23	1616	0.019
23	24	15	82.80	13	932	0.011
23	25	13	82.55	12	808	0.009
25	26	100	82.50	89	6215	0.072
25	27	224	80.40	199	13921	0.161
27	28	25	80.55	22	1554	0.018
27	29	34	80.55	30	2113	0.024
22	30	13	83.25	12	808	0.009
30	31	137	81.20	122	8514	0.099
30	32	37	83.50	33	2300	0.027
32	33	59	82.65	52	3667	0.042
32	34	34	84.15	30	2113	0.024
34	35	32	83.95	28	1989	0.023
34	36	26	84.30	23	1616	0.019
36	37	18	84.20	16	1119	0.013
36	38	32	84.80	28	1989	0.023
38	39	14	84.60	12	870	0.010
38	40	28	85.35	25	1740	0.020
40	41	16	85.30	14	994	0.012
40	42	40	83.90	36	2486	0.029
42	43	40	83.80	36	2486	0.029
43	44	28	83.55	25	1740	0.020
44	45	25	82.95	22	1554	0.018
45	46	30	82.20	27	1864	0.022
46	47	36	81.70	32	2237	0.026
43	48	29	83.75	26	1802	0.021
44	49	30	83.60	27	1864	0.022
45	50	32	83.00	28	1989	0.023
46	51	32	82.25	28	1989	0.023
42	52	42	84.05	37	2610	0.030
		2057		1826	127841	1.480

KHERALI WDN					
Network Table - Nodes at 0:00 Hrs					
Node ID	Ele. m	Base Demand LPS	Demand LPS	Head m	Pressure m
4	81.85	0.06	0.18	92.98	11.13
5	81.8	0.019	0.06	92.98	11.18
6	82.9	0.08	0.24	92.94	10.04
7	81.95	0.026	0.08	92.94	10.99
8	80.95	0.018	0.05	92.93	11.98
9	80.65	0.015	0.05	92.93	12.28
10	80.3	0.019	0.06	92.93	12.63
11	80.25	0.012	0.04	92.93	12.68
12	81.05	0.037	0.11	92.93	11.88
16	81.8	0.008	0.02	92.93	11.13
13	80.85	0.05	0.15	92.92	12.07
17	80.8	0.011	0.03	92.92	12.12
14	79.75	0.038	0.11	92.92	13.17
18	79.75	0.015	0.05	92.92	13.17
15	79.65	0.037	0.11	92.92	13.27
19	81	0.05	0.15	92.93	11.93
20	80.7	0.045	0.14	92.93	12.23
21	80.35	0.015	0.05	92.93	12.58
22	82.85	0.018	0.05	92.94	10.09
23	82.9	0.019	0.06	92.93	10.03
25	82.55	0.009	0.03	92.93	10.38
26	82.5	0.072	0.22	92.92	10.42
24	82.8	0.011	0.03	92.93	10.13
27	80.4	0.161	0.48	92.9	12.5
28	80.55	0.018	0.05	92.9	12.35
29	80.55	0.014	0.04	92.9	12.35
30	83.25	0.009	0.03	92.93	9.68
31	81.2	0.099	0.3	92.92	11.72
32	83.5	0.027	0.08	92.93	9.43
33	82.65	0.042	0.13	92.93	10.28
34	84.15	0.024	0.07	92.93	8.78
35	83.95	0.023	0.07	92.92	8.97
36	84.3	0.019	0.06	92.92	8.62
37	84.2	0.013	0.04	92.92	8.72
38	84.8	0.023	0.07	92.92	8.12
39	84.6	0.01	0.03	92.92	8.32
40	85.35	0.02	0.06	92.91	7.56
41	85.3	0.012	0.04	92.91	7.61
42	83.9	0.029	0.09	92.91	9.01
52	84.05	0.03	0.09	92.91	8.86
43	83.82	0.029	0.09	92.9	9.08
48	83.75	0.021	0.06	92.9	9.15
44	83.55	0.02	0.06	92.9	9.35
49	83.6	0.022	0.07	92.9	9.3
45	82.95	0.018	0.05	92.9	9.95
50	83	0.023	0.07	92.9	9.9
46	82.2	0.022	0.07	92.9	10.7
51	82.25	0.023	0.07	92.9	10.65
47	81.7	0.026	0.08	92.9	11.2
SUMP	82	#N/A	-30.66	82	0
ESR	83	#N/A	26.28	93	10

KHERALI WDN						
Network Table - Links at 0:00 Hrs						
Link ID	L in m	Dia. In mm	Flow in LPS	V in m/s	Unit Head loss in m/km	Friction Factor
7	36	110	1.19	0.13	0.2	0.028
8	25	90	0.52	0.08	0.12	0.031
9	21	90	0.32	0.05	0.05	0.033
10	26	90	0.14	0.02	0.01	0.038
11	17	75	0.04	0.01	0	0.049
12	51	90	0.59	0.09	0.15	0.03
16	11	75	0.02	0.01	0	0.042
13	70	90	0.45	0.07	0.09	0.031
17	15	75	0.03	0.01	0	0.049
19	70	75	0.15	0.03	0.03	0.036
20	63	75	0.14	0.03	0.02	0.037
21	21	75	0.05	0.01	0	0.044
14	53	90	0.27	0.04	0.03	0.034
18	21	75	0.05	0.01	0	0.038
15	51	75	0.11	0.03	0.02	0.037
22	25	140	2.72	0.18	0.29	0.025
23	26	110	0.91	0.1	0.12	0.029
24	15	75	0.03	0.01	0	0.049
25	13	90	0.82	0.13	0.27	0.029
26	100	75	0.22	0.05	0.06	0.034
27	224	90	0.58	0.09	0.14	0.03
30	13	140	1.75	0.11	0.13	0.027
31	137	75	0.3	0.07	0.1	0.033
32	37	125	1.43	0.12	0.15	0.028
33	59	75	0.13	0.03	0.02	0.037
34	34	125	1.22	0.1	0.11	0.028
35	32	75	0.07	0.02	0.01	0.04
36	26	125	1.08	0.09	0.09	0.029
37	18	75	0.04	0.01	0	0.039
38	32	110	0.98	0.1	0.14	0.029
39	14	75	0.03	0.01	0	0.042
40	28	110	0.89	0.09	0.12	0.029
41	16	75	0.04	0.01	0	0.039
42	40	110	0.79	0.08	0.09	0.03
52	42	75	0.09	0.02	0.01	0.038
43	40	90	0.61	0.1	0.16	0.03
44	28	90	0.46	0.07	0.09	0.031
45	25	90	0.34	0.05	0.05	0.033
46	30	90	0.21	0.03	0.02	0.035
47	36	75	0.08	0.02	0.01	0.04
48	29	75	0.06	0.01	0.01	0.042
49	30	75	0.07	0.01	0.01	0.039
50	32	75	0.07	0.02	0.01	0.04
51	32	75	0.07	0.02	0.01	0.042
28	25	75	0.05	0.01	0	0.04
29	34	75	0.04	0.01	0	0.045
5	26	75	0.06	0.01	0	0.041
6	111	160	4.15	0.21	0.33	0.024
1	97	180	4.38	0.17	0.21	0.025
Pump	#N/A	#N/A	30.66	0	-11	0

CONCLUSIONS:

At the end of the analysis it was found that the resulting pressures at all the nodes and the flows with their velocities at all links are sufficient enough to provide water to the study area.

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