Study of Water Distribution Network Using EPANET

Ishani Gupta[1], Dr. R.K. Khitoliya[2], Dr. Shakti Kumar[3]
Department of Civil Engineering, PEC University of Technology, Chandigarh, India
[1] *M.E Environmental Engg.,.Final year Student, PEC Chandigarh, India*
[2] *Professor and Head, Post Graduate Department of Civil Engineering, PEC, Chandigarh, India*
[3] *Associate Professor, Post Graduate Department of Civil Engineering, PEC, Chandigarh, India*

ABSTRACT:

An attempt has been made to simulate the water distribution network of urban estate, city of Punjab, India, based on the observation taken in the month of April 2013. The area under study is served by Municipal Corporation, which relies on water supply from ground water deep bore wells. In this study attempt has been made to develop a water distribution system using EPANET software as a tool to assist the assessment of the hydraulic behaviour of hydraulic parameters.

This report has presented the following aspects of the overall assessment of hydraulic behaviour of a water distribution network

- *Data gathered for simulation for the period of April 2013.*
- *Development of water distribution model*
- *Calibration of water distribution model*

The present day water distribution system has four deep bore tube-wells to serve. The simulation of network was carried out for 24 hour period supply for afternoon shift of 12 noon to 3pm. Elaborate calibration was not possible but attempt has been made to check simulation results at 12 different locations. Comparison of these results indicates that the simulated model seems to be reasonably close to the actual network.

KEYWORDS: *calibration, EPANET, hydraulic losses, simulation, distribution system.*

I. INTRODUCTION

With increasing population, particularly in the urban areas of developing countries, finding new water resources either from surface or groundwater sources to supply the needed water is becoming more difficult both with respect to quantity and quality. The ability to better manage water supplies is becoming increasingly important as demand for water continues to escalate.In the last decade, changing climatic conditions and high temperatures have led to water shortage and restrictions in many countries. As a result, hydraulic losses have become high priorities for water utilities and authorities because there is a greater understanding of the economic, social, and environmental costs associated with water losses. The primary task for water utilities is to deliver water of the required quantity to individual customers under sufficient pressure through a distribution network. The distribution of drinking water in distribution networks is technical challenge both in quantitative and qualitative terms. It is essential that each point of the distribution network be supplied without an invariable flow of water complying with all the qualitative and quantitative parameters. The water supply in most Indian cities is only available for a few hours per day, pressure is irregular, and the water is of questionable quality. Intermittent water supply, insufficient pressure and unpredictable service impose both financial and health costs on Indian households.Current Study will present a model based optimization method for hydraulic losses of water distribution systems. Leakage hotspots are assumed to exist at the model nodes identified. For this study area of urban estate of a city of Punjab has been identified and the network model for the area under consideration will be prepared and studied for water losses.

II. METHODOLOGY

Urban Estate phase-II comes under the administration of Municipal Corporation. The area under consideration is well developed and has all the basic amenities. Geographically the area is plain; there is no variation in the levels of the area.

2.1.Data Collection

[1] Distribution network drawing- A copy of the drawing of the existing distribution system was taken from the Municipal Corporation. The drawing helps in the understanding of the distribution of the mains, sub-mains, how they move in the area, presence of dead ends etc.

[2] Source data- Ground water is the main source of water. The ground water table is present at a depth of 250 ft.

[3] Four tube-wells are used to pump out the water for the drinking water supply. The pumping capacity, head and other required data regarding them was taken from the municipal corporation.

[4] Topography- Although the elevations of the area were present with corporation office, it was decided to go through the level measurements again to better understand the topography of the area. The equipments used for level measurements were

a) Auto level

b) staff.

The measurements were taken in the following manner starting from tube-well no 1 covering tube-well no. 2 and 3 and the whole area along with tube-well no. 4 in the end.

It was not an easy task to move through the busy streets of the area. Therefore, there was lot of shifting in the auto level positions, which led to increase in the foresight and backsight readings and increase in the calculation work. With so much shifting in the instrument positions there is always the chance of occurrence of errors but utmost care was taken to reduce the possibility of error occurrence.

[5] Population data- As per the census of 2011, the population of the urban estate is 9150 persons. The total population was available with the municipal corporation.

Now, when all the data collection work was done, the first job was to draw the computer aided model. The model was prepared on the EPANET software.

[6] Distribution system- The distribution system itself is a complex network of transmission mains, distribution pipelines and pumping stations. The mains and sub mains has the size ranging from 200mm, 150mm and 100mm along with small house connection pipes.

[7] Pumping stations- There are four tube-wells used for supply of drinking water to the village, namely tube-well no.1, 2, 3 and 4 respectively. Ground water is the main source of water. Each pumping station is equipped with a pressure gauge for documentation of the pump gauge.

Preparation of the model

From the original drawing of the distribution network provided by the municipal corporation, the distribution network was reproduced on the graph paper. It was difficult to mark every house on the graph sheet and then on the model. So the whole network was divided into different junctions where each junction represents a definite set of houses. Each junction is given a serial no. j1, j2, j3 etc. X-Y co-ordinates were given to all the junctions of the network, which were needed for computer aided model.

After marking of the junctions, the co-ordinates of all the junctions were noted down from the graph sheet. In similar fashion the elevations which were measured earlier as per junction locations, were noted down on the separate plain sheet but as there was hardly any variation in the elevations of different junctions so we considered all the elevations to be equal and marked it levelled one in all junctions. Next job was to draw these junctions on the EPANET software and then assigning them the required properties calculated above, in the properties box of each junction.

For creating an EPANET model following network elements were used-:

[1] Junctions
[2] Pumps
[3] Valves
[4] Reservoirs
[5] Pipes

To draw the network X-Y co-ordinates limits were set up in the software from the graph sheet. First of all, all the junctions were put in model in serial order from the tool box of the software and then their required properties were assigned to them.Similarly, other major points like the reservoirs representing groundwater and pumps were drawn on the network with their required properties.After marking of all the major points and incorporation of all the required data on the computer aided model these points were then joined together by the lines representing pipes. The pipe data like the pipe roughness, pipe diameter etc was provided in the property box of all the pipes.

Static period analysis-When sufficient data was incorporated in the computer aided network model, next job was to run it for the static period analysis. The static period analysis was done to check that whether the data provided was correct and sufficient. Calibration of equipment -Well in advance of the field tests, all the equipments being used should be checked and recalibrated. Before taking the pressure gauges for field measurements they were calibrated. The gauges were found to be accurate.Pressure Measurements- For pressure measurements the pressure gauges of different ranges were used. These gauges were then installed at different locations to physically measure the pressure heads of tube-wells.After the pressure measurements of the tube-wells, the pressure heads at the different junctions of the distribution network were to be carried out for the calibration purpose. The junctions were selected as per their location from the pumping stations. The pressure readings were taken on 15th April 2013 at 1pm. The supply hours in the area under study are 10 hrs spanning three shifts. The first shift is from 5 am to 9 am, 2nd shift from 12 noon to 3 pm and third shift from 6 pm to 9 pm.Calibration work- After the job of pressure measurements, the model was calibrated for hydraulic analysis. There is a provision for the single stage simulation and the extended period simulation in the software. The model was calibrated for the extended period simulation. The results of the analysis and required discussion are given in the next chapter.

III. RESULTS AND DISCUSSION

Node Results-Ministry Of Urban Development (Govt. of India) manual on water supply stipulates a minimum residual pressure of 7m, 12m and 17m for single storey, double storey and triple storey buildings respectively at the end of design period. But the results are not attained even during the initial periods of commissioning. The residual pressure were checked at few points and found to be very low and ranging between 2m to 5m at the middle and far off points from the pumping stations in the area at the time of measurement. It clearly shows that the system is under performing and that the desired level of service is not achieved for residual pressure requirements. The software model results for pressure closely match with the field measurements and is shown in table I.Pipe Results- With available infrastructure of water supply it is only possible to measure the velocity and flow in pipes. No work was undertaken for the measurement of 'c' value and these were changed to match the field measurement values for flow in a pipe. From analysis of the water supply network it is clear that the carrying capacities of pipes are sufficient to serve the present requirement and may serve for many years to come.

TABLE NO. 1
CALIBRATION RESULTS-PRESSURE

Sr. No.	Node No.	Pressure as per field measurement(m)	Pressure as per Intermittent EPS Model(m)
1	J13	3.78	4.00
2	J31	3.24	3.66
3	J42	3.29	3.52
4	J57	2.98	3.48
5	J66	3.02	3.59
6	J83	3.72	3.69
7	J87	3.37	3.80
8	J100	4.02	4.08
9	J103	3.73	4.11
10	J125	3.96	4.14
11	J168	4.08	4.26
12	J197	3.29	3.57

IV. CONCLUSION

In this study attempt has been made to develop a water distribution system using EPANET software as a tool to assist the assessment of the hydraulic behaviour of water supply distribution network.
This report has presented the following aspects of the overall assessment of hydraulic behaviour of a water distribution network

- Data gathered for simulation for the period of April 2013.
- Development of water distribution model
- Calibration of water distribution model

The present day water distribution system has four deep bore tube-wells to serve. The simulation of network was carried out for 24 hour period supply for afternoon shift of 12 noon to 3pm. Elaborate calibration was not possible but attempt has been made to check simulation results at 10 different locations. Comparison of these results indicates that the simulated model seems to be reasonably close to the actual network.

ACKNOWLEDGEMENTS

The authors are grateful to PEC University of Technology, Chandigarh for their cooperation and encouragement to carry out the work.

REFERENCES

[1] Morris L. Maslia: Jason B Sautner Mustafa M Aral "Analysis of 1998 water distribution system serving the Dover Township Area, New Jersey : Fielad Data Collection Activities and Water Distribution System Modeling" Agency for Toxic Substances and Disease Registry, U S Department of Health and Human Services, Atlanta, Georgia, June 2000.

[2] EPANET 2, Users Manual : United States Environmental Protection Agency EPA/600/R-00/057 Sep 2000 available on internet at: http://www.epa.gov/ORD/NRMRL/wswrd/epanet.html

[3] Richard N. Stalford, Jasquiline : "Water Distribution Modeling , G I S and Facility Management Systems, what do they have in common? A Case Study" available on World Wide Web.

[4] Guillermo Yepes, Klas Ringskog and Shyamal sarkar (2001): The High Cost of Intermittent Service, Journal of Indian Water Works Association (IWWA), April-June 2001.

[5] N. Sashikumar : Proceedings of Annual Conference Of ASCE and Environmental Water Resource Institute(EWRI), June 22-26, 2003, Philadelphia, USA.

[6] Rajiv Batish : Proceedings of Annual Conference Of ASCE and Environmental Water Resource Institute (EWRI), June 22-26, 2003, Philadelphia, USA.

[7] Puli Venkateshwara Rao : Manual for Intermediate Vocational Course, 1st Year : WATER SUPPLY ENGINEERING (For the Course of Water Supply and Sanitary Engineering), State Institute of Vocational Education Andhra Pradesh. Hyderabad, 2005.