Annexure 12.7: Optimization of Pipe Diameters

Case Study of Operational zone of 'Sajipur Old' in Ahmedabad. Operational zone of 'Sajipur Old' in Ahmedabad city (Figure 1) is illustrated. This zone is situated in North of the city and is densely populated zone. Optimisation steps as discussed in Section 12.11.4 are adopted.

Figure 1: Operational zone of 'Sajipur Old' in Ahmedabad (existing pipes in green and new pipes in blue colour)

The population of this zone is 71,506 (for ultimate design population of the year of 2050). The flow for the ultimate year (2050) with 10% losses in distribution system the pipe network in this OZ is designed to cater for the total demand of 12.46 MLD. The ESR of this zone is yet to be constructed. In view of the dense population and paucity of land, the city administration rightly decided to construct the ESR for ultimate stage. The capacity of ESR is for 8 hours, i.e., 1/3 of total demand. By this method, the requirement of capacity works out to 12.46/3, i.e., 4.15 ML.

GIS based hydraulic model is prepared. It was ensured that the boundary of the OZ was designed optimally, i.e., ESR do not get empty or get overflowing. The elevations are assigned to each node using GIS based contours and the demands are also assigned to all the nodes using the method of 'Future population density method' as described in the Annexure 2.7.

Scenario1: Earlier Design (before optimisation)

The major scenario was run with pipe diameters of the earlier consultant and the results of velocity and hf/km in the pipe table and nodal pressures in junction table are noted.

Scenario2: Optimised Design

Process: Various steps required for optimization of pipe diameters are shown in Figure 12.3 which is reproduced as Figure 2 below.

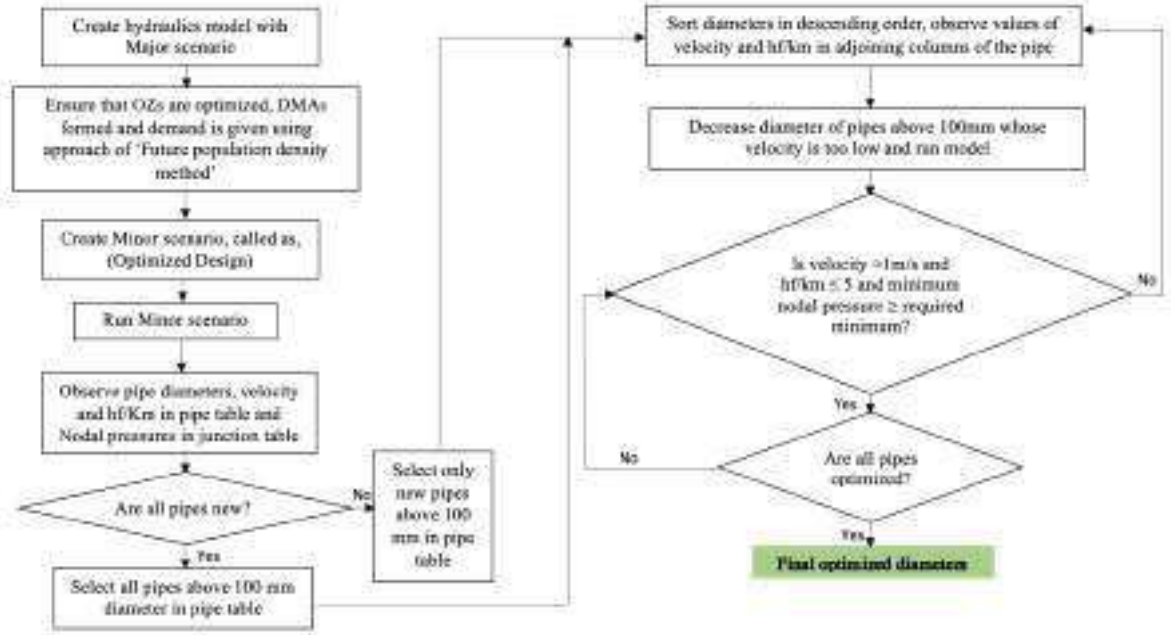

Figure 2: Iterative process of optimising diameters

Optimisation techniques from IWWA paper, "Optimisation of Distribution Pipe Network without Using Specialized Optimization Software" Journal of IWWA Oct- Dec 2020 is used here to make initial guess of pipe diameter.

These steps are followed.

a) Select pipe diameter for each pipe based on general prudence and by using capacity of pipe in MLD for velocity equal to 0.8 m/s (Column 2 of Table1 from the above paper) and assign it along with pipe label.

b) Under the major scenario, a minor scenario, called as 'Optimized Design' is created. The Alternative of 'Physical' is attached to this minor scenario. Alternative 'Physical' means a *data set* which can store different values of diameters other than those in major scenario.

c) Run the minor scenario and observe pipe diameters, velocity and hf/km in the pipe table and nodal pressures in junction table.

d) Select only new pipes in pipe table and which are more than 100mm diameter. Following steps are taken for new pipes keeping existing pipes undisturbed.

e) Sort diameters in descending order, observe values of velocity and hf/km in adjoining columns of the pipe table

f) Decrease diameters of those pipes in which velocity is low and hf is also low and then run model

g) Observe the revised values of velocities in the pipe table. If velocity is less than 1 m/s and hf/km is also less than 5 m/km and minimum nodal pressure is also more than 17m (as minimum nodal pressure is 17m), then steps (e), (f) and (g) are repeated.

h) The process is repeated for all the pipes whose diameters are more than 100mm, till we get all optimized diameters.

i) The comparison of the diameters of earlier design, (ED_Diameter) and the optimised diameters (OP_ Diameter) is shown in Table 1.

j) It is experienced that one operational zone can be optimized within half hour using this technique.

Table 1: comparison of the diameters of earlier design, (ED_Diameter) and the optimised diameters (OP_ Diameter)

Scenario1: Earlier Conventional Design (before optimisation)					Scenario2: Design using "Age-old-prudence" method (after optimisation)			
Diameter (mm)	Total Length (m)	Rate (Rs/m)	Total ED_Cost (Rs)		Diameter (mm)	Total Length (m)	Rate (Rs/m)	Total OP2_Cost (Rs)
100	22362	703	15720486		100	23776	703	16714528
150	218	1,009	219962		150	6	1,009	6054
200	1415	1,322	1870630		250	213	1,734	369342
300	11	2,179	23969		300	592	2,179	1289968
400	590	3,134	1849060		400	9	3,134	28206
600	15	5,285	79275		450	15	3,575	53625
Grand Total	24611		1,97,63,580		Grand Total	24611		1,84,61,908
Length of 200mm and above= 2031m					Length of 200mm and above= 829 m			

Amount saved in one operational zone (OZ) = Rs 13 Lakhs and % saving in cost=6.6%

There are about 250 such Ozs in Ahmedabad, likely saving > Rs 25 Crores