OPTIMIZATION OF WATER DISTRIBUTION NETWORKS: A CASE STUDY OF MORATUWA WATER DISTRIBUTION SYSTEM IN SRI LANKA

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DECLARATION OF THE CANDIDATE & SUPERVISOR

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Signature: ………………………….   Date: 22/08/2024

J. P. S. Chamila

The above candidate has carried out research for the ~~PhD/MPhil/~~Masters thesis/dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of the supervisor: Eng. H. K. P. K. Jinadasa

Signature of the supervisor: Date:

Name of the supervisor: Professor J. M.A. Manatunge

Signature of the supervisor: Date:

DEDICATION

I dedicate this thesis to my loving parents, whose constant support and belief in me have been the foundation of my success. To my dear husband, whose patience, encouragement, and unwavering faith have been my pillar of strength throughout this journey. And to my wonderful children, whose smiles and boundless energy have been a source of inspiration and joy. This work is for all of you.

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ABSTRACT

Water distribution networks are engineered to provide consumers with an adequate quantity of water at the required pressure. The initial design demands, or water quantities to be delivered, are determined based on factors such as per capita consumption, population growth, anticipated migration, industrial development, and the presence of fire hydrants. Most of the existing water distribution networks are old and operate beyond their design horizon. Therefore, many issues have arisen in the existing systems, resulting in no-water complaints, low-pressure areas, water quality issues, limitations to 24-hour water supply, and consumer dissatisfaction. Hence, modification of the existing pipe networks is necessary to avoid the above issues. However, redesigning and relaying a new system is not practical due to financial limitations. Therefore, augmenting the existing systems has become the best solution for addressing the challenges in the distribution networks. While augmenting the existing networks, proper attention must be given to optimizing the network to minimize operation and maintenance costs, including energy costs.

The Moratuwa distribution network in Colombo District, Western Province, Sri Lanka, which is more than 50 years old, was selected for this study. Modeling was carried out using Bentley WaterGEMS software with the aid of the ArcGIS platform. Demand data needed for the modeling were obtained from the bulk flow meters of the supply reservoir of the Water Distribution Network. Simulated results of the computed model were compared with actual field data at selected locations obtained through digital pressure loggers. After calibrating the model, possible options to augment the existing network were analyzed, and prevailing issues that can be minimized were investigated. Three major scenarios were investigated in this study, focusing on the optimization of total operational costs: direct pumping with Variable Speed Drive, direct pumping using an overhead tank as a balancing tank, and entire gravity water distribution by overhead tank

Keywords: *Water Distribution Networks, Hydraulic Modelling, WaterGEMS, demand allocation, scenarios, optimization*

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ABBREVIATIONS

WDN	-	Water Distribution Network
GIS	-	Geographic Information Systems
N	-	North
NWSDB	-	National Water Supply & Drainage Board
NRW	-	Non-Revenue Water
UFW	-	Unaccounted-for Water
PVC	-	Polyvinyl Chloride
HDPE	-	High Density Polyethylene
DI	-	Ductile Iron
AHFR	-	Average Hourly Flow Rate
ADD	-	Average Daily Demand
AHF	-	Average Hourly Flow
EPS	-	Extended Period Simulation
DEM	-	Digital Elevation Model
MSL	-	Mean Sea Level
dia.	-	Diameter