# ANALYSIS OF ROOT CAUSES OF THE EXCESSIVE CHLORINE DEMAND IN WATER TREATMENT

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Degree of Master of Science/Master of Engineeering

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September 2017

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## ACKNOWLEDGEMENTS

1 would sincerely like to thank my supervisor Prof. Niranjanie Ratnayake, for her continued guidance with patience and encouragement throughout the course of this research.

Further, my grateful thanks are expressed to Prof. Jagath Manatunge, the Course Coordinator of Master of Science in Environmental Engineering and Management Degree for giving the opportunity to undergo through the dissertation and for the knowledge gained. Further thanks go to Prof. Mahesh Jayaweera and all the academic and non-academic staff of the Department of Civil Engineering, University of Moratuwa for their kind help given to make this piece of work a success.

I would like to make very special reference to, Eng. Harsha Abekoon and Mrs. Narmada Janadari for their continuous support to collect the data. I would also like to thank Eng. Danesh Gunathilaka for his much valued comments on this research.

I would like to extend my grateful appreciation to Eng.C.R.Perera, Deputy General Manager (NWSDB), Eng.K.W.Premasiri, Deputy General Manager (NWSDB), Eng.S.Sumanaweera, Deputy General Manager (NWSDB), Eng.H.M.R.D Wijekoon, Manager (NWSDB) who were my superiors at work for providing this opportunity to continue my higher studies.

Further, I should convey my gratitude to Biyagama Water Treatment Plant Chemist, Mr. Hasitha Vishwajith, OIC, Mr. Kamal Rathanayake for their support during various parts of the study.

Finally 1 would like to express my sincerest thanks to my son Dulanjana, father and brother Chamly, for their continued patience and support.

Analysis of root causes of the excessive chlorine demand in water treatment

## ABSTRACT

To make water suitable for human consumption, water from most sources must first be treated, and the source water that can be used as raw water for public water supplies should conform to quality standards stipulated in the Sri Lanka Standard SLS722. However, sometimes, National Water Supply and Drainage Board (NWSDB) water treatment plants do not receive raw water according to SLS722 due to contamination. In some cases, existing treatment facilities is not enough to face emergency situations, even though the average quality conforms to the SLS 722. In such situations, the operation of treatment plants becomes a challenge, as it is the responsibility of the NWSDB to provide safe drinking water to the consumers, which means that disinfection, has to be carried out even though the chlorine demand may become very high due to excessive amounts of contaminants during such events. The purpose of this research was to analyze the root causes of the excessive chlorine demand in water treatment and recommend an appropriate system capable of removing dissolved iron, ammonia and manganese from the raw water, avoiding the use of chemical treatment if possible, and prepare an emergency plan to face the situation at the Biyagama Water treatment Plant.

According to the past water quality data at BWTP colour, turbidity, BOD, faecal coliform, free ammonia content, nitrate, sulfate etc. of raw water were rapidly varying with the occurrence of extreme events such as sudden rainfall followed by prolonged dry season, a few days after flood events etc. In addition, it was found that foul odour is present in the raw water which has been abstracted from the river during the drought season and right after flooding events, etc. In spite of these variations in raw water quality, the treated water quality is achieved through the treatment process without any failure. However, during the drought season and right after flooding event, Chlorine demand at Biyagama Water Treatment Plant was increased and intermediate chlorination was implemented to maintain the optimum Rcl level recently. Hence, aim of this study is to analyze the root causes for the excessive chlorine demand in raw water, investigate adverse effects of treated water due to high chlorine dosages, and prepare an emergency plan to face the situation and suggest the appropriate long term solution to avoid high chlorine demand on treating water without chemicals at the Biyagama Water treatment Plant.

Presence of Fe, Mn and TOC in the raw water is known to cause for high chlorine demand at the Biyagama water Treatment Plant. These high chlorine demands have been attributed to the presence and oxidation of Fe, Mn, and TOC by chlorination.

In order to find the root causes for the high chlorine demand in the BWTP, it is necessary to first investigate the mechanisms that cause the problem in this particular situation. As such, a comprehensive water quality study was carried out in 19/10/2016 to 21/10/2016, 7/10/2016 to 11/10/2016 and 4/6/2016 to 9/6/2017 by the Biyagama Water Treatment Plant laboratory, Central Laboratory and Bureau Veritase laboratory samples from the intake (raw water), Treated water tank (treated Water), Pattiwila canal and suspected points of connected Marshy

area, along the Kelani River up to 5km upstream of Kelani River and along the Ragahawatta Ela up to BOI waste water treatment plant out let.

This study revealed, that the chlorine demand was increased when Fe, Mn or TOC were present alone or together and DO level was less than 5mg/l in raw water at BWTP due to oxidation of Fe, TOC and Mn by chlorination. BWTP is used pre chlorine to alter taste and odor producing compounds, to suppress growth of organisms in the treatment plant, to remove Fe2+, manganese, and to reduce the interference of organic compounds in the coagulation process. However, according to literature, pre chlorination can affect the undesirable THM content of the finished water.

According to the WSP at BWTP, there should be an emergency response plan to risk mitigation due to emergency cases. Hence, it is proposed to use the emergency response plan for any similar incident happened in future.

However, in the long-term, it is recommended to install tailor made bubble aerator to Biyagama Water treatment Plant to use when the DO content is less than 5.0mg/l in raw water, after pilot scale studies, to include aeration and activated carbon dossing facility to upcoming Kelani Right Bank Project Stage II, to implement the proper catchment management plan to Pattiwila and Mabima Catchment areas to avoid the Mn and Fe contamination, to implement continuous monitoring system to monitor the Fe and Manganese in the raw water at BWTP and to maintain a residual chlorine level of 0.1 to 0.2 mg/l throughout the distribution system in all the time. This may require installing booster chlorination equipment at appropriate locations.

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**Abbreviation Description**

| | |
|---|---|
| TTHM | - Total Trihalomethane |
| RCl | - Residual Chlorine |
| TOC | - Total Organic Carbon |
| DBP | - Disinfection by Products |
| NWSDB | - National Water Supply and Drainage Board |
| SLS | - Sri Lanka Standards |
| WHO | - World Health Organization |
| WSP | - Water Safety Plan |
| WTP | - Water Treatment Plant |
| SACDA | - Supervisory Control And Data Acquisition |
| O&M | - Operation and Maintenance |
| USEPA | - United States Environmental Protection Agency |
| DOC | - Dissolved Organic Carbon |
| Mn | -Manganese |
| Fe | - Ferrous |
| CDC | -Centre for Disease Control and Prevention |
| UN | -United Nation |
| WHO | -World Health Organization |
| BOD | –Biochemical Oxygen Demand |
| POU | -Point of Use |
| E- Coli | -Escherichia Coli |
| MAC | - Minimum Acceptable Concentration |
| NTU | -Nephelometric Turbidity Unit |

## LIST OF APPENDICES