# Drinking Water Treatment Methods to Reduce THM

**Authors:** Lian-Shin Lin[1], Paul Ziemkiewicz[2], Melissa O'Neal[2] and Nashid Mirza[1]
**Affiliations:** West Virginia University[1] and West Virginia Water Research Institute[2]

## Project Description and Objectives :

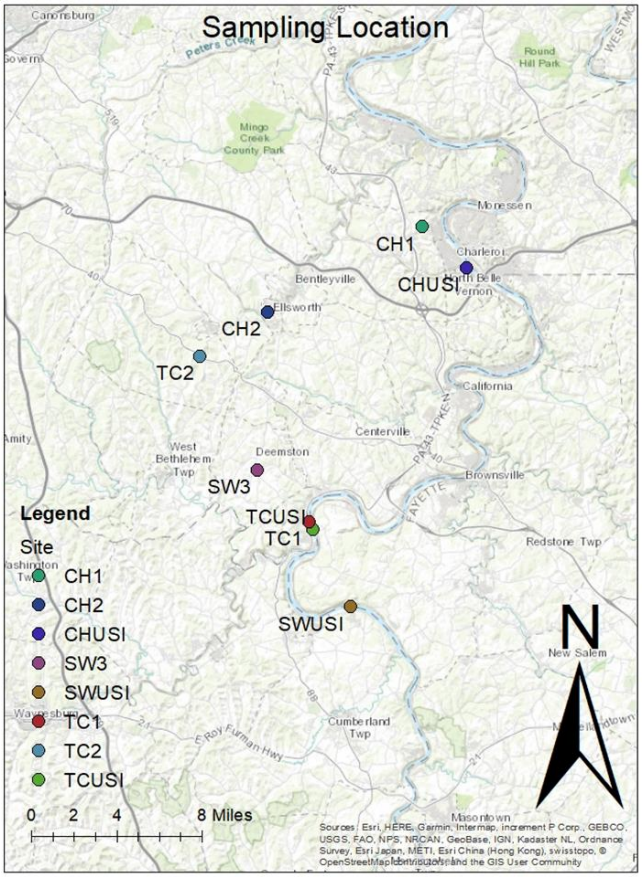
Trihalomethanes, a family of halogenated disinfection byproducts is ubiquitously present in finished drinking water. This is a great concern for the public health since daily intake of those compounds can create toxicity and cancer in humans. According to USEPA's Disinfectants/Disinfection Byproducts Rule (D/DBPR), the regulatory standard of the total Trihalomethanes (TTHMs) is 80 µg/L, and water treatment plant operators are required to closely monitor TTHMs in the finished water on quarterly basis. The Disinfectants/Disinfection Byproducts Rule (D/DBPR) also requires water systems that treat surface water to remove a percentage of the total organic carbon (TOC) in the source water influent based on concentration and alkalinity. Although TOC has been identified as a precursor for the TTHMs, knowledge gaps still exist in how treatment plant specific factors (e.g., intake water quality, seasonal variation, contact time, and treatment units) affect TTHM formation water.

Focusing on water treatment plants in southwestern Pennsylvania, the objectives of this study are to 1) develop a statistical model for predicting TTHM levels using source water quality data, and 2) examine the effects of water treatment and distribution on TTHMs formation.

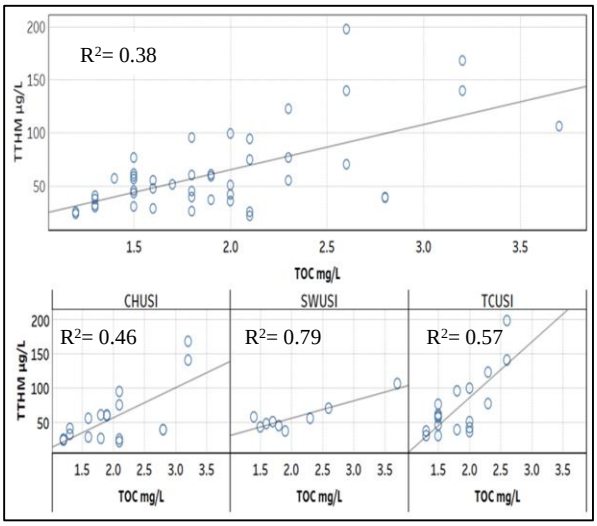
## Methodology :

Water samples were collected from the intake of the following three water authorities : Borough of Charleroi Water Authority (CHUSI), Tri County Joint Municipal Authority (TCUSI) and Southwestern Pennsylvania Water Authority (SWUSI). Additionally samples from five points (CH1, CH2, TC1, TC2, and SW3) in the finished water distribution network. Samples were taken on monthly basis from September 2018 through May 2019.

Moreover, treatment related data were collected from the Borough of Charleroi Water Authority which included the daily chlorine dose added for the water treatment, quarterly organic carbon test in raw water, and quarterly THM check according to Disinfectants/Disinfection Byproducts Rule (D/DBPR) in the finished water. Additional analyses were conducted to investigate the controlling factors and remedies for TTHM formation in this water authority.




Map of southwestern Pennsylvania showing the sites for sample location both for the intake water and water in distribution network.

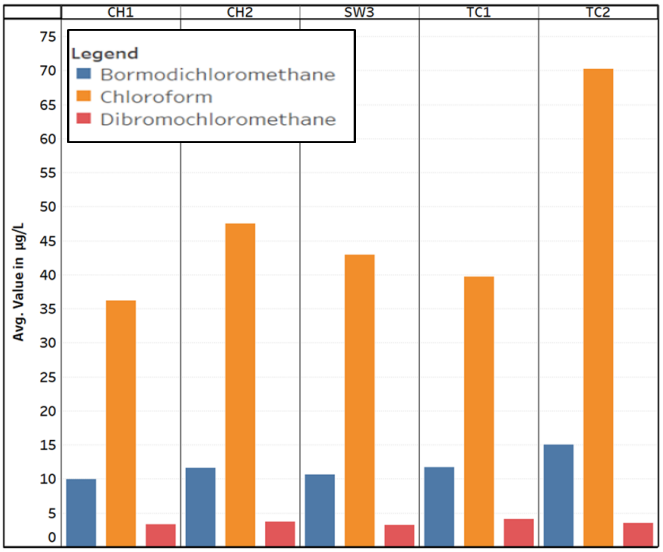



*Scatter plots of TOC vs TTHM (September 2018 to May 2019) showing positive correlation of TTHM formation with the intake water TOC levels .*

**Continued on Back >**

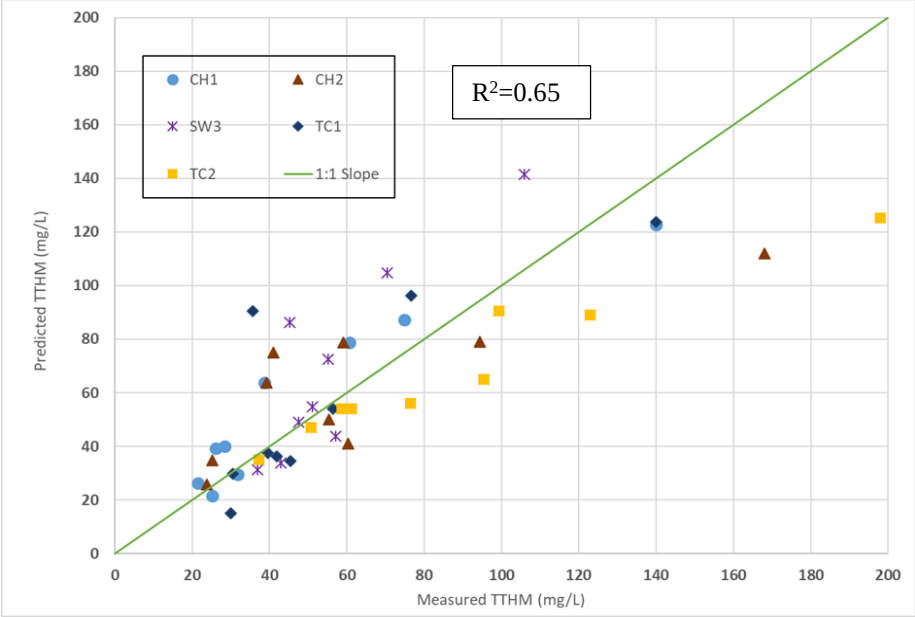
## Findings :

- TOC concentration in the intake water positively correlated with the TTHM formed in the finished water of distribution system. The correlation improved when plotted for individual treatment facility indicating that THM formation potential varies with the treatment practices of the individual facility.
- The concentration of TOC was higher during the months of September and May when the temperature was also higher than other months. There was slight increase in TOC with increase in temperature during March and April, but the TOC levels were still lower than the level in September. As a result, TTHM levels were found to be highest in each distribution point and reached above 80 µg/L.
- Our sampling showed that the bromide levels in the intake water were mostly below the reporting limit (0.01 mg/L). Thus, among the trihalomethanes, chloroform was the most dominant species in all the finished water samples.




*Distribution of trihalomethane species in the finished water samples.*

A linear regression model for predicting TTHM in finished water within the distribution network was developed. The predictors included TOC in the intake water, whereas chloride and temperature in the distribution network. TOC was included in the model because it directly contributes to THM formation during chlorination. Chloride concentration was used to represent the added chlorine into the water, and temperature represented the seasonal variation.




*Comparison of measured TTHM vs the predicted TTHM concentration from the model*

Based on the model the TTHM can be calculated from the following equation:

TTHM (µg/L): -2.95*chloride (mg/L) +16.15*TOC (mg/L) +4.65*Temp (in C) -10.52

The analysis showed that the developed model tends to under-estimate the TTHM concentration when TTHM concentration are above 100 µg/L. The inclusion of actual chlorine dose (other than chloride) and retention time may yield a better model to predict the TTHM in the finished water.

## Recommendations :

Based on the data analysis from the sampling locations and Borough of Charleroi Water Authority following recommendations are stated:

- Installation of sedimentation tank for THM removal.
- Consideration of installation of flushing devices at low demand area and dead ends where the water retention time will be higher.
- Reduction of disinfection dose during fall time when the TOC level is higher and apply boost chlorination in distribution system for THM control.
- Consideration of alternative disinfectant (e.g. chloramine) during higher TOC concentration period.

## Fact Sheet Contact Information

**PRINCIPAL INVESTIGATOR (PI) :**
Lian-Shin Lin; lianshin.lin@mail.wvu.edu;
West Virginia University

Paul Ziemkiewicz;
paul.ziemkiewicz@mail.wvu.edu;
West Virginia Water Research Institute

Melissa O'Neal; moneal@mail.wvu.edu
West Virginia Water Research Institute

Nashid Mirza; nm0070@mix.wvu.edu
304-413-5742; West Virginia University