North Carolina Area-Wide Optimization Program
2021 Annual Report

Prepared by:

NC Division of Water Resources
Public Water Supply Section

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Maintaining the Program

The North Carolina Department of Environmental Quality (DEQ), Public Water Supply (PWS) Section has participated in the U.S. Environmental Protection Agency (EPA) Region 4 Multi-State Area Wide Optimization Program (AWOP) since 2000. The program's goal is to provide North Carolina's water utilities with needed training and tools that can assist in maximizing water system operations, thus improving public health. Optimization goals adopted by the North Carolina AWOP are in APPENDIX A.

Data from all surface water treatment facilities are evaluated annually to maintain a status component. Data evaluated include turbidity, microbial, and disinfection byproduct (DBP) performance information. In 2021, 148 surface water plants operated during the year. The following is a summary report of the 2021 NC AWOP findings and activities.

While North Carolina's AWOP team continues to engage in a number of beneficial activities that support the maintenance of its AWOP, the team also faces challenges.

Institutional Barriers

The NC AWOP is a volunteer effort for participating systems and PWS Section staff. Time dedicated to the implementation of the NC AWOP is limited because of necessary attention to regulatory requirements and other PWS Section activities. While compliance with drinking water regulations is our primary goal, the NC AWOP Team recognizes and operates with the understanding that optimization provides an additional level of public health protection and strives to meet the program goals.

Internal Support

Program support remains high on both the Section and Division levels. Prior to the Covid19 pandemic, our staff was not restricted from traveling to meetings or from conducting optimization activities in the state. During the pandemic, staff have continued to remotely participate in NC AWOP Team quarterly meetings and EPA Region 4 AWOP planning meetings/workshops. Funding has also been made available in the past for purchasing equipment used to grow the program.

The Drinking Water State Revolving Fund set-asides are the primary source of funding for the NC AWOP. Continued demonstration of the benefits of the NC AWOP will allow for future staff recruitment to ensure program maintenance and enable growth.

Core Team Structure and Capacity

In 2021, the NC AWOP Team consisted of thirteen staff participants from the PWS Section who worked to sustain the program by participating in varying activities, such as evaluating system capabilities and providing technical training to systems (Table 1).

Four members functioned as the core team and are responsible for ensuring the program's continued viability. The other members are in different stages of certification, technical knowledge, experience, and understanding of the AWOP philosophies, and provide expertise as opportunities present themselves.

Table 1

PWSS Staff	Program Activity	AWOP Certified
Eric Hudson	Core Team Member Program Manager	Yes
Rebecca Sadosky	Core Team Member CPE Technical Support Central Office Technical Advisor	Yes
Mark Hahn	Core Team Member Regional Technical Advisor	Yes
Kimberly Barnett	Core Team Member Regional Technical Advisor	No (2 DS CPE)
Clif Whitfield	Regional Technical Advisor	No (2 DS CPE, 1 DBP PBT)
Tommy Overby	Regional Technical Advisor	No
Meredith Guglielmi	Regional Technical Advisor	No (1 Microbial, 1 DS CPE)
Emily Lester	Central Office Technical Advisor	No (1 Microbial CPE)
Katherine Richardson	Central Office Technical Advisor	No
Haris Ali	Central Office Technical Advisor	No
Brad Whitman -left team 10/2021	Central Office Technical Advisor	No (1 DS CPE)
Turner Morrison -left team 10/2021	Central Office Technical Advisor	No (2 DS CPE)
Nicole Hairston -left team 10/2021	Regional Technical Advisor	No

DS – Distribution System
DBP – Disinfection Byproducts
PBT – Performance Based Training
CPE – Comprehensive Performance Evaluation

Program Assessment

NC AWOP activities included: participation in the EPA Region 4 AWOP planning meetings, National AWOP Meeting, NC AWOP Team quarterly meetings, evaluation of system data, and training events throughout the year. These activities, along with previous DBP performance based trainings (PBTs) and microbial and DBP comprehensive performance evaluations (CPEs), have served as valuable training opportunities and have allowed key NC AWOP members to obtain their AWOP

certification, while aiding others in their progress towards certification. The NC AWOP is currently a strong and knowledgeable workgroup comprised of both seasoned veterans as well as up-and-coming staff.

Plant Status and Rankings for Microbial Contaminants and DBPs

Microbial Status and Ranking Component

The PWS Section has maintained a plant status and ranking component for microbial contaminants since 2001. The microbial and turbidity plant ranking methodology was revised in 2014 to better reflect which systems receive more violations and have higher finished water turbidities (see APPENDIX B). Emphasis was placed on these two parameters because they most directly affect public health and, therefore, are of the greatest concern. To calculate the ranking scores, the average monthly finished water turbidity for a system is multiplied by 100, while the average settled turbidity is multiplied by 3.16, giving the finished water turbidity more weight than the settled water turbidity in the revised ranking scores. The lower the water plant's ranking score, the better their performance on turbidity and microbial indicators. Typically, water plants meeting AWOP finished water turbidity goals year-round have a ranking score of 200 or below.

Prioritized List of Facilities - Microbial

The NC AWOP Microbial Ranking Score is used to identify and prioritize surface water facilities for technical assistance in optimizing microbial performance. The calculated ranking scores for the facilities with the highest 15 (top 10 percent) microbial rankings for 2021 are presented in Table 2 along with the system's 2020 ranking score.

Table 2

2021 Rank	System Name	2020 Rank
1	City of Lenoir (Lenoir WTP)	40
2	Anson County Water System (Anson County WTP)	1
3	City of Winston-Salem (Neilson WTP)	12
4	Town of Waynesville (Waynesville WTP)	2
5	Town of Ramseur (Ramseur WTP)	7
6	Town of Mount Pleasant (Mt. Pleasant WTP)	6
7	Enfield Water System (Enfield WTP)	10
8	Town of Yanceyville (Yanceyville WTP)	4
9	Town of Siler City (Rocky River WTP)	26
10	Pilgrim's Pride Water System (Pilgrim's WTP)	13
11	City of Rocky Mount (Tar River Reservoir WTP)	2
12	Town of North Wilkesboro (North Wilkesboro WTP)	5
13	Town of Bryson City (Deep Creek WTP)	16
14	Davie County Water System (Cooleemee WTP)	11
15	Town of Smithfield (Smithfield WTP)	75

The City of Lenoir's ranking changed from 40 in 2020 to 1 in 2021. The primary reason for this change is because the water system received a treatment technique violation in 2021 for a single combined filter effluent turbidity reading above 1 NTU. The Town of Smithfield's ranking changed from 75 in 2020 to 15 in 2021. The primary reason for this change is because the water plant was undergoing a construction project and only had two of three sedimentation basins in service resulting in higher settled and filter water turbidities.

DBP Status and Ranking Component

The PWS Section has maintained a DBP status component since 2006. In 2021, NC AWOP established a numerical ranking system for DBP that compares the difference of actual DBP values versus goal limits and generates a numerical ranking score (see APPENDIX C). The lower the water system's ranking score, the better their performance. Water systems meeting AWOP DBP goals for all four calendar year quarters have a ranking score of zero.

Prioritized List of Systems - DBPs

The NC AWOP DBP ranking score is used to identify and prioritize surface water facilities for technical assistance in optimizing DBP performance. The ranking can be used to separate systems previously grouped together in bins and can identify systems that have more serious Maximum Contaminant Limit (MCL) violations versus systems that did not meet the goal. Our initial prioritization included surface water systems only; however, we are considering expanding the ranking to include purchase and/or groundwater systems.

The calculated ranking scores for the facilities with the highest 15 (top 10 percent) DBP rankings for 2021 are presented in Table 3.

Table 3

2021 Rank	Water System	Score
1	Town of Ramseur	64
2	Hamlet Water System	63
3	Henderson-Kerr Lake Regional Water Authority	31
4	Montgomery County	26
5	Town of Dallas	15
6	City of Concord	12
7	City of Albemarle	11
8	Appalachian State University	10
9	Town of Southern Pines	9
10	Town of Yanceyville	6
11	Town of Tarboro	6
12	Salisbury-Rowan	4
13	City of Hickory	3
14	City of Brevard	3
15	Town of Mayodan	3

Targeted Performance Indicator (TPI) Implementation

Running List of Activities

The NC AWOP Team activities include participation in EPA Region 4 quarterly meetings, assimilating/evaluating system data and training/evaluation events. The following is a list of North Carolina activities for 2021 (Table 4).

Table 4

Date – 2021	Activity	Attendee(s)
Jan. 7	NC AWOP Team Meeting - virtual	NC AWOP Team
Mar. 9-11	EPA Region 4 AWOP Planning Meeting - virtual	Eric Hudson Kimberly Barnett Emily Lester Rebecca Sadosky
May 6	NC AWOP Team Meeting – virtual	NC AWOP Team
July 15	NC AWOP Team Meeting – virtual	NC AWOP Team
July 19-21	National AWOP Meeting - virtual	Eric Hudson Kimberly Barnett Emily Lester Rebecca Sadosky
Aug.	AWOP Article for NC Waterworks Operators Association - Go With The Flow Publication	Kimberly Barnett
Sept. 7	Presentation of 2020 AWOP Award to City of King Council meeting.	Eric Hudson
Oct. 6	Presentation on Iron and Manganese Optimization at NC Waterworks Operator Association section meeting and acknowledged AWOP award winners in the section.	Eric Hudson
Oct. 7	NC AWOP Team Meeting – virtual	NC AWOP Team
Nov. 4	Staff gave presentations at NC Waterworks Operator Association virtual training event on 1) Iron and Manganese Optimization, and 2) Manganese Interference with Chlorine Residual Measurement Using the DPD Method.	Eric Hudson Kimberly Barnett
Nov. 16-18	EPA Region 4 AWOP Planning Meeting - virtual	Kimberly Barnett Emily Lester Rebecca Sadosky Mark Hahn
Sept. – Dec.	AWOP Team members presented AWOP Turbidity Optimization Awards to water systems and their governing bodies if so requested.	NC AWOP Team

Site Selection Process

Facilities are selected for CPEs and PBTs based on their priority rankings (microbial and DBP), their regional proximity, and by request. It is important that NC AWOP efforts are evenly distributed throughout the state. This approach allows for a more diverse program that still serves the most in-need facilities. The site selection process was not used in 2021 because the Covid19 pandemic limited field work opportunities.

Covid19 Pandemic

Travel restrictions due to the Covid19 pandemic prohibited staff from conducting on-site optimization activities in 2021. Staff did not conduct special studies at water plants or participate in multi-state CPEs like previous years.

Building Awareness & Recognition

Participation in the NC Waterworks Operator Association and NC American Water Works Association and Water Environment Association activities has been instrumental in introducing AWOP tools and concepts into routine operator training. In conjunction with the NC AWOP events, these activities have contributed to the overall improvement in North Carolina's facilities.

Additional effort to facilitate and educate North Carolina's water system operators about the benefits of the AWOP has led to the production of NC AWOP flyers and posters. These flyers contain basic information about the program along with the AWOP goals. The flyers have been provided to water treatment facility staff and discussed during routine inspections. NC AWOP Team members distributed water resistant AWOP posters to each surface water plant. More work is needed to develop innovative approaches that will reach additional facilities and provide the necessary technical assistance to achieve their goals.

The PWS Section issues annual certificates to facilities that meet the NC AWOP microbial optimization goals for settled and finished water turbidity. The awards reflect the number of years that a plant has achieved optimized status and also includes special recognition for plants that have received the award for 10 or more consecutive years.

The PWS Section also issues a press release listing the facilities that received the annual certificates. In many communities the achievement of the AWOP goals and certificate award has been reported by the local media. DEQ has also posted pictures of the award presentations on Facebook and Twitter.

AWOP Impacts

The total number of systems that met the optimization goals for finished and settled water turbidity since 2002 and the population serviced by these systems are presented in Figure 1. In general, there has been an increase in the number of optimized plants and in the population served. In 2020, there were 64 optimized water treatment plants that served a population of 2,543,059. In 2021, there were 66 optimized water treatment plants that served a population of 2,808,777. This represents a 10% increase in population from 2020. The primary reasons for the change in the number of optimized plants may be attributed to water plant treatment procedure changes, construction project impacts and weather events.

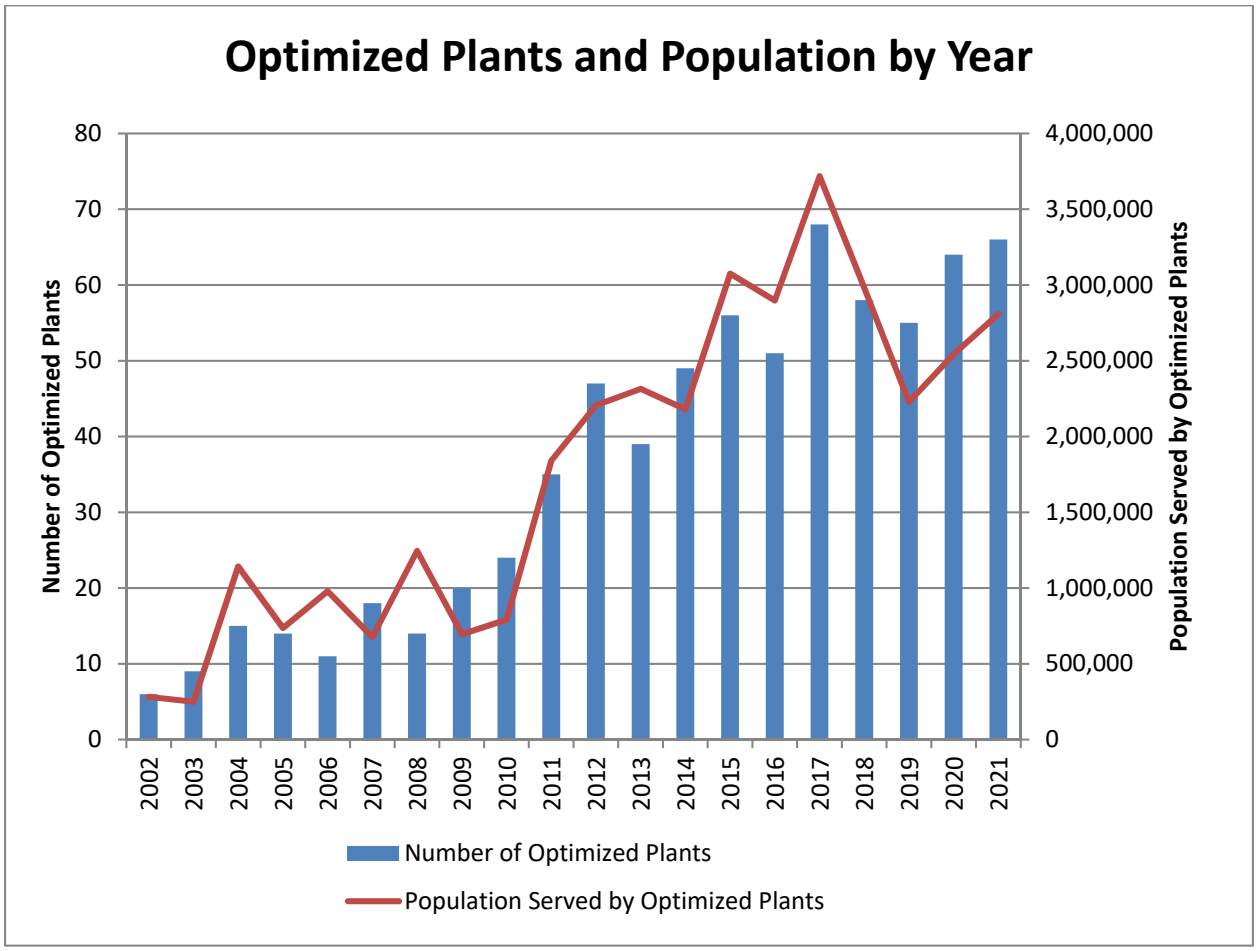

Figure 1

Average Finished Water Turbidity

The number of facilities that averaged <0.10 NTU finished water turbidity in each year from 2004 to 2021 is presented in Figure 2. The number of plants meeting this goal has fluctuated from a low of 65 plants in 2004 to a high of 96 plants in 2021.

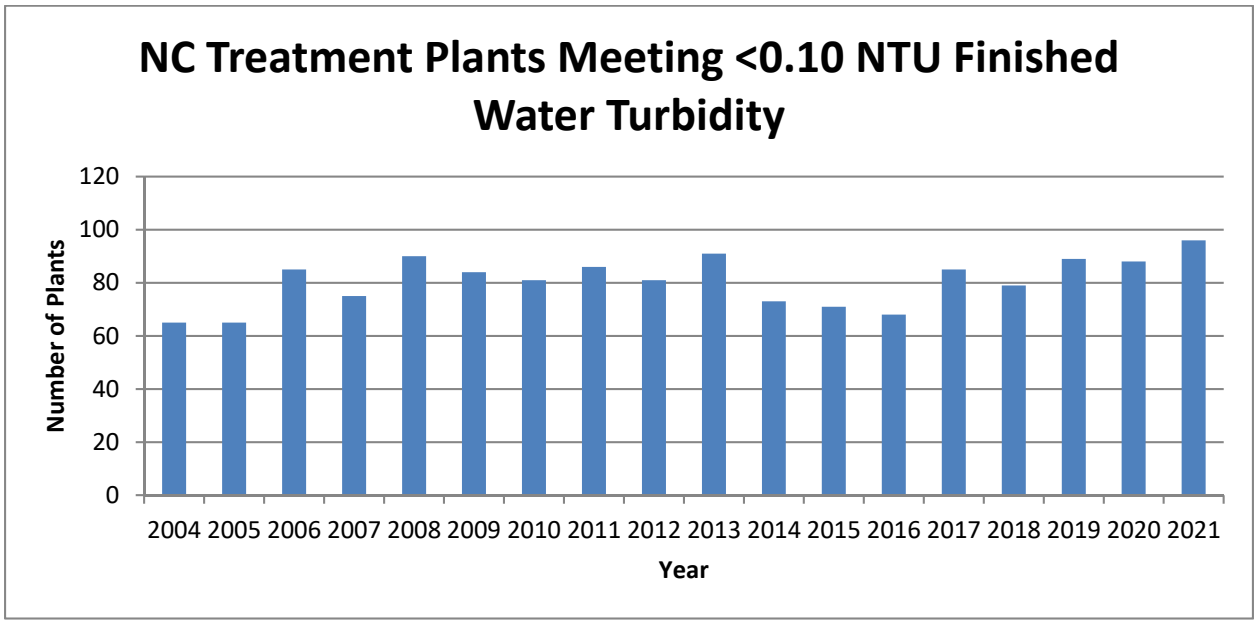

Figure 2

Figure 3 shows the decreasing average finished water turbidity rankings which demonstrates the continued improvements made by surface water facilities in North Carolina.

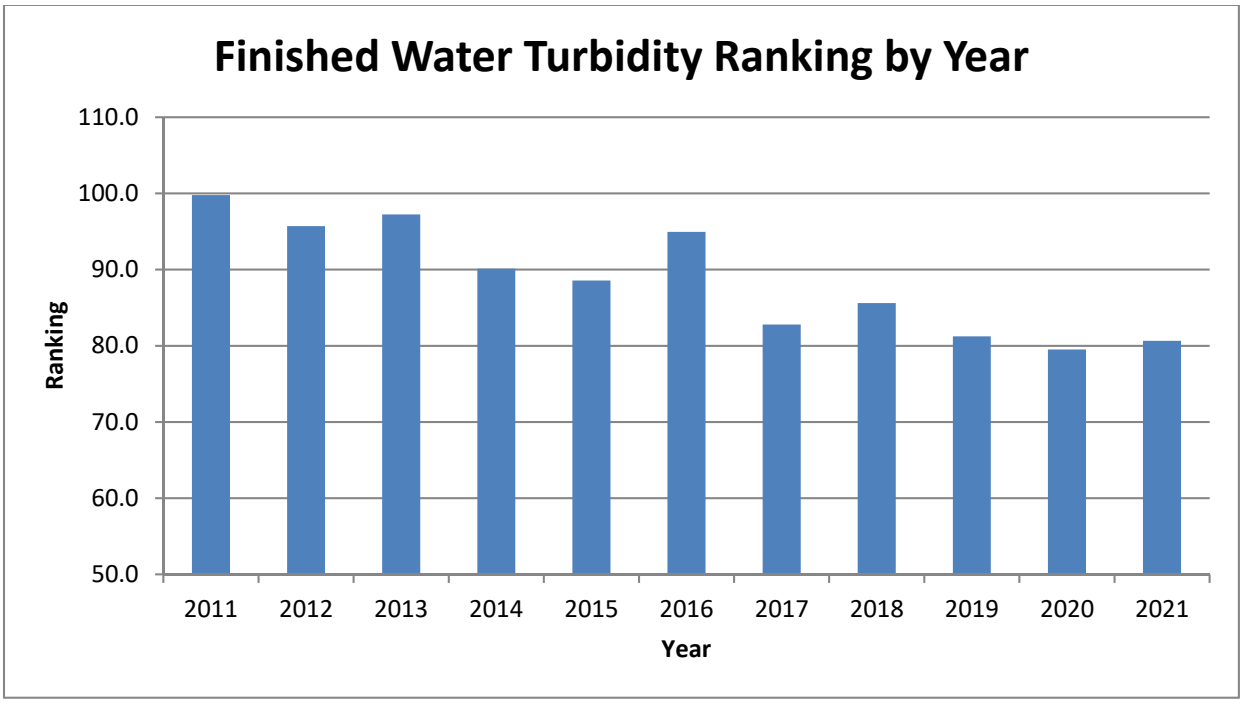

Figure 3

Maintaining compliance with disinfection byproduct regulations presents a significant challenge to water systems in North Carolina. Figures 4 and 5 below display the ten highest five Haloacetic acid (HAA5) and Total Trihalomethanes (TTHM) Locational Running Annual Averages (LRAAs) from 2021 for surface water systems. Two systems had one sampling site exceed the HAA5 MCL (0.06 mg/L) based on the LRAA. Similarly, three systems had one sampling site exceed the TTHM MCL (0.08 mg/L).

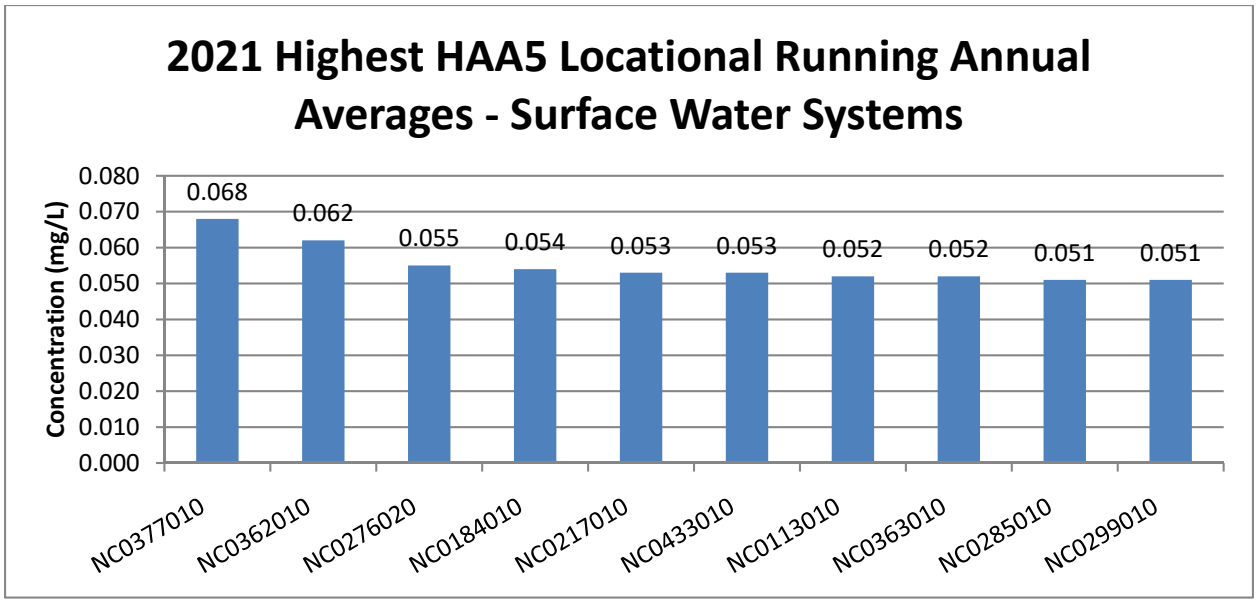

Figure 4

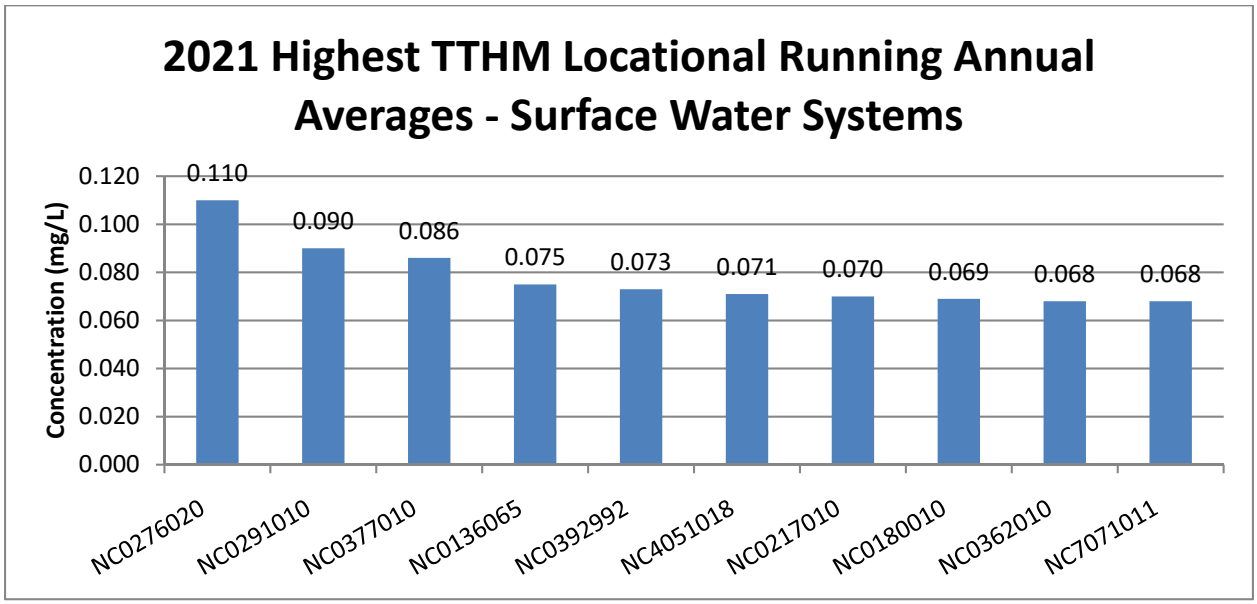

Figure 5

Figure 6 below displays the number of DBP MCL violations that have been issued to all water systems (surface water, surface water purchase, groundwater and groundwater purchase) since 2006. TTHM MCL violations account for approximately 65% of the total and HAA5 MCL violations account for approximately 35% of the total.

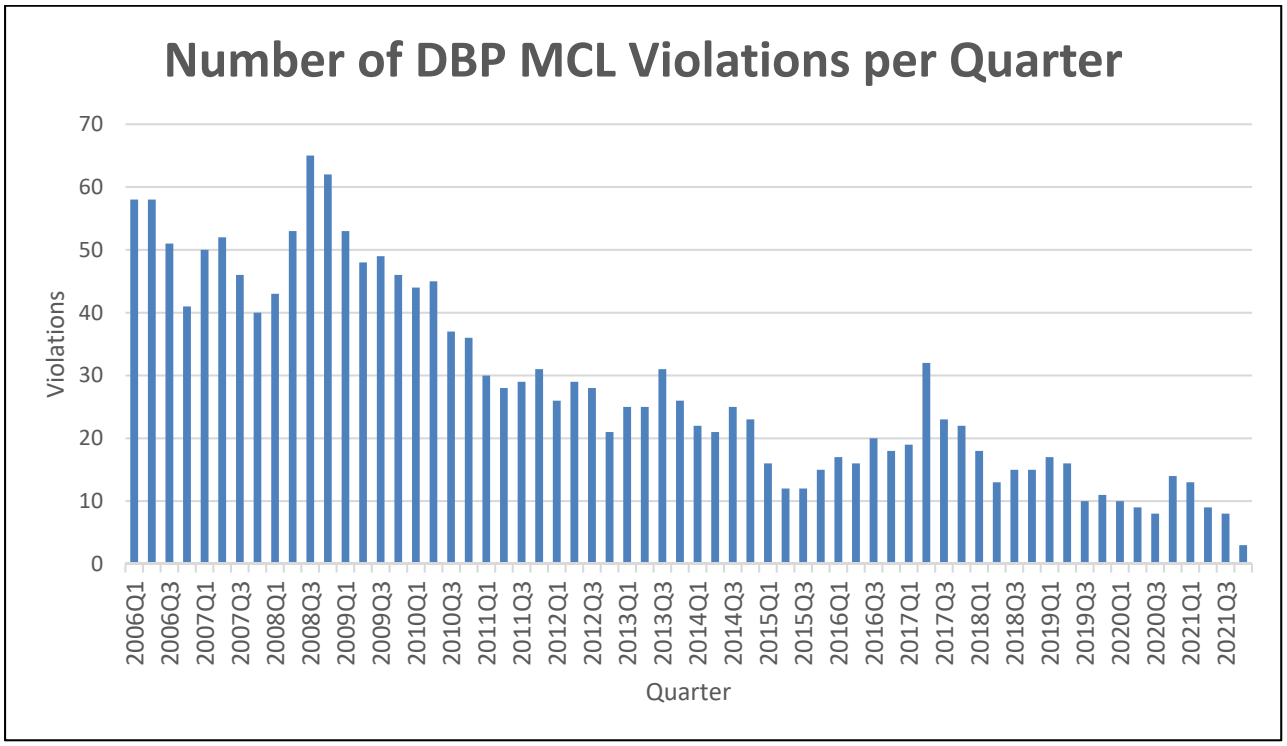

Figure 6

DBP concentration data were evaluated for surface water and surface water purchase systems required to sample for DBPs. In 2021, 95 out of 118 (81%) surface water systems, serving a population of 5,855,122 customers, and 238 out of 296 (80%) surface water purchase systems, serving a population of 1,277,864 customers, met the NC DBP distribution system goals (provided in APPENDIX A).

Lessons Learned

Participating water system management and staff have learned that notable change in performance will take both time and consistent effort. Significant improvement requires a concerted data collection effort, application of available tools, and diligent individuals who are willing to explore new approaches to old processes. System management must be willing to allow the needed changes to be made as well as maintain adequate operational staff to accommodate data collection and evaluation. Basic understanding of AWOP concepts and approaches helps water operators and management make informed decisions to accomplish improvements in plant and system operations.

The experience, skills, and knowledge gained with the participation in the AWOP benefit both water system and state staff. It provides both insight into the functional aspects of water treatment as well as improved knowledge, skills, and abilities that allow staff to make more informed evaluations and provide valuable technical assistance, which further contributes to protecting public health in North Carolina.

Effort is needed by the NC AWOP Team members familiar with local facilities and the AWOP to maintain and increase the participation of drinking water facilities. Development of innovative training approaches and partnerships would promote the program and ultimately benefit additional systems.

APPENDIX A

North Carolina's Optimization Goals

Category	Goal	Description
Microbial	Minimum Data Monitoring Requirement	▪ Daily raw water turbidity. ▪ Settled water turbidity from sedimentation basins at four-hour increments. ▪ On-line, continuous turbidity from each filter.
Microbial	Individual Sedimentation Basin Performance Goals	▪ Settled water turbidity < 2 NTU in 95% of readings when the annual average raw turbidity is > 10 NTU. ▪ Settled water turbidity < 1 NTU in 95% of readings when the annual average raw turbidity is ≤ 10 NTU.
Microbial	Individual and Combined Filter Performance Criteria	▪ Filtered water turbidity of less than 0.10 NTU in 95 percent of the maximum turbidity samples recorded each day (excluding 15-minute period following filter backwash). ▪ Maximum individual filtered water turbidity of 0.3 NTU. ▪ Filter backwash initiated before effluent turbidity exceeds 0.1 NTU. ▪ Filter to waste until turbidity is less than 0.1 NTU. ▪ Maximum filtered water measurement of less than 10 particles (in the > 2 micron range) per milliliter (if particle counters are available).
Distribution System	Disinfection Byproducts Performance Goals	▪ Individual Site Goal: Quarterly Maximum Locational Running Annual Average TTHM/HAA5 values not to exceed 70/50 ppb. ▪ Long-Term System Goal: Average of Maximum Locational Running Annual Average TTHM/HAA5 values not to exceed 60/40 ppb (the average of the last 8 quarters cannot exceed 60/40 ppb).

APPENDIX B

NC AWOP Microbial/Turbidity Ranking Score Calculation

1000*Total Number of Tier 1 Acute MCL Violations per Year (Fecal)

+

750*Total Number of Tier 2 MCL Violations per Year (TC / Turb.)

+

500*Total Number of Tier 3 Monitoring and Treatment Technique Violations per Year (CT / Turb.)

+

100* Average Monthly Finished Water Turbidity

+

10*Max Monthly Finished Water Turbidity

+

3.16*Average Monthly Settled Water Turbidity

+

0.316*Max Monthly Settled Water Turbidity

+

0.1*Average Monthly Raw Water Turbidity

+

0.01*Max Monthly Raw Water Turbidity

=

Total Ranking Score

Note that raw water coliform is only considered in the rankings if two systems have the same score using the calculation above. The raw water coliform will be used as a "tiebreaker" in this case.

APPENDIX C

NC AWOP DBP Ranking Score Calculation

DBP Goals	Ranking Score
TTHM Individual Site Goal -quarterly max LRAA not to exceed 0.070 ppm	= IF (value > 0.07, (value – 0.07) x 1000, 0)
TTHM Long Term Goal -avg. of max LRAA not to exceed 0.060 ppm	= IF (value > 0.06, (value – 0.06) x 1000, 0)
HAA5 Individual Site Goal -quarterly max LRAA not to exceed 0.050 ppm	= IF (value > 0.05, (value – 0.05) x 1000, 0)
HAA5 Long Term Goal -avg. of max LRAA not to exceed 0.040 ppm	= IF (value > 0.04, (value – 0.04) x 1000, 0)
Total Ranking Score	= sum of the above values