ADEQ
Arizona Department of Environmental Quality

Stage 2 Disinfection Byproducts
Operational Evaluation Level Report – Full

Part 1: Purpose and General Information

The purpose of the operational evaluation level (OEL) is to allow a system to take action to reduce the elevated disinfection byproduct levels in the system before a violation of the maximum contaminant level (MCL) occurs. The OEL is calculated for each sampling site by using the disinfection byproduct (DBP) analytical data for the current and previous two quarters:

OEL = [Results from *the previous two quarters* + (2 x current quarter's result)] / 4

That value is then compared to the MCL for TTHM and HAA5. If the OEL exceeds the MCL, the system is required to conduct an investigation and write a report that is submitted to your regulating agency. The OEL report is due to your regulatory agency 90 days after a calculated OEL exceeds the MCL.

Listed below are the various areas in a system that could contribute to DBP formation. Each area must be evaluated and addressed in the report, unless allowance to limit the scope of the evaluation has been requested in writing by the system and approved in writing by your regulating agency. To be eligible for a limited scope, you must be able to identify the cause of the operational evaluation level exceedance.

This evaluation and report is meant to be completed by the system operator. A consultant is not needed at this time. This report is an adaptation of the EPA's OEL checklist. It is strongly recommended that you read the EPA Stage 2 Disinfectants and Disinfection Byproducts Rule Operational Evaluation Guidance Manual before gathering information and evaluating your system. This manual provides technical information about completing the evaluation. Notes at the end of this document are included to help you understand how certain factors or actions could affect DBP formation.

Regulatory Agency: ☐ **ADEQ** ☐ **PDEQ** ☐ **MCESD**	**Date:**
PWS Name:	**PWS ID#:**
OEL Report Due Date:	**Number of Sites Sampled:**
OEL exceeded for: ☐ TTHM, Level: ☐ HAA5, Level:	**Number of Sites Above OEL:**
Beginning Period for Evaluation: (First sample quarter included in OEL)	**Provide Compliance Monitoring Site(s) where OEL was exceeded:** (Note: The site name or number should correspond to a site in your Stage 2 DBPR Compliance Monitoring Plan)
Has an OEL been completed for this PWS previously? ☐ Yes ☐ No	**If yes, when?**

Part 2: Initial Data Review and Evaluation Process

Did the lab report include any additional information about the sample results that might indicate a laboratory problem? ☐ **Yes** ☐ **No**

Review the TTHM and HAA5 data from all sites in the sampling plan to determine if the exceedance is localized or system-wide:

☐ **One Site Exceeded OEL** ☐ **Multiple Sites Exceeded OEL**

1. If you know the cause of the OEL exceedance, you may request approval from the regulatory agency in writing to limit the scope of the OEL report. The entire system must be evaluated unless a limited scope is approved by your regulatory agency in writing.

2. Evaluate the system and identify steps that could reduce the TTHM and HAA5 levels in the system in the future. Include short-term and long-term steps where applicable. Add additional pages as needed in the explanation.

3. Submit the written report to your regulatory agency by the 90 day deadline (OEL Report Due Date).

Part 3: Distribution System Evaluation Checklist

Note: Refer to Chapter 3 in the USEPA's Stage 2 D/DBPR Operational Evaluation Guidance Manual.

A. Do you have disinfectant residual or temperature data for the monitoring location where you experienced the OEL exceedance? If NO, proceed to item B. If YES, answer the following questions for the period in which an OEL exceedance occurred:	☐ **Yes**	☐ **No**
Was the water temperature higher than normal for that time of the year at that location?	☐ **Yes**	☐ **No**
Was the disinfectant residual lower than normal for that time of the year at that location?	☐ **Yes**	☐ **No**
Was the disinfectant residual higher than normal for that time of the year at that location?	☐ **Yes**	☐ **No**
B. Do you have maintenance records available for the time period just prior to the OEL exceedance?	☐ **Yes**	☐ **No**
Did any line breaks or replacements occur in the vicinity of the exceedance?	☐ **Yes**	☐ **No**
Were any storage tanks or reservoirs taken off-line and cleaned?	☐ **Yes**	☐ **No**
Did flushing or other hydraulic disturbances (e.g., fires) occur in the vicinity of the exceedance?	☐ **Yes**	☐ **No**
Were any valves operated in the vicinity of the OEL exceedances?	☐ **Yes**	☐ **No**

C. If your system is metered, do you have access to historical records showing water use at individual service connections? If NO, proceed to item D.	☐ **Yes**	☐ **No**
If YES, was overall water use in your system unusually low, indicating higher than normal water age?	☐ **Yes**	☐ **No**
D. Do you have high-volume customers in your system (e.g., an industrial processing plant)? If NO, proceed to item E.	☐ **Yes**	☐ **No**
If YES, was there a change in water use by a high-volume customer?	☐ **Yes**	☐ **No**
E. Is there a finished water storage facility hydraulically upstream from the monitoring location where you experienced the OEL exceedance? If NO, proceed to item F. If YES, review storage facility operations and water quality data to answer the following questions for the period in which the OEL exceedance occurred:	☐ **Yes**	☐ **No**
Was a disinfectant residual detected in the stored water or at the tank outlet?	☐ **Yes**	☐ **No**
Do you know of any mixing problems with the tank or reservoir?	☐ **Yes**	☐ **No**
Does the facility operate in "last in-first out" mode?	☐ **Yes**	☐ **No**
Was the tank or reservoir drawn down more than usual prior to OEL exceedance, indicating a possible discharge of stagnant water?	☐ **Yes**	☐ **No**
Was there a change in water level fluctuations that would have resulted in increased water age within the tank or reservoir?	☐ **Yes**	☐ **No**
F. Does your system practice booster chlorination? If NO, proceed to item G.	☐ **Yes**	☐ **No**
If YES, was there an increase in booster chlorination feed rates?	☐ **Yes**	☐ **No**
G. Did you have customer complaints in the vicinity of the OEL exceedance? If NO, proceed to item H.	☐ **Yes**	☐ **No**
If YES, explain.		
H. Did concern about complying with a rule other than Stage 2 DBPR, such as the Lead and Copper rule, the TCR, or any other rule constrain your options to reduce the DBP levels at this site? For example, are you limited by the need to maintain a detectable disinfectant residual in your ability to control DBP levels in the distribution system? If NO, proceed to item I.	☐ **Yes**	☐ **No**
If YES, explain below and consult EPA's *Simultaneous Compliance Guidance Manual* for alternative compliance approaches.		
I. Conclusion. Did the distribution system cause or contribute to the OEL exceedance(s)? If NO, proceed to evaluations of treatment systems and source water.	☐ **Yes** ☐ **No**	☐ **Possibly**
If YES or POSSIBLY, explain below.		

Part 4. Source Water Evaluation Checklist

Note: Refer to Chapter 5 in the USEPA's Stage 2 D/DBPR Operational Evaluation Guidance Manual.

A. Do you have source water temperature data? If NO, proceed to item B.	☐ **Yes**	☐ **No**
If YES, was the source water temperature high? If NO, proceed to item B. If YES, answer the following questions for the period in which an OEL exceedance occurred:	☐ **Yes**	☐ **No**
Was the raw water storage time longer than usual?	☐ **Yes**	☐ **No**
Did you place another water source on-line?	☐ **Yes**	☐ **No**
Were river/reservoir flow rates lower than usual? If yes, indicate the location of lower flow rates and the anticipated impact on the OEL exceedance.	☐ **Yes**	☐ **No**
Did point or non-point sources in the watershed contribute to the OEL exceedance?	☐ **Yes**	☐ **No**
B. Do you have data that characterizes organic matter in your source water (e.g., TOC, DOC, SUVA, color, THM formation potential)? If NO, proceed to item C.	☐ **Yes**	☐ **No**
If YES, were these values higher than normal? If NO, proceed to item C. If YES, answer the following questions for the time period prior to the OEL exceedance.	☐ **Yes**	☐ **No**
Did any line breaks or replacements occur in the vicinity of the exceedance? Did heavy rainfall or snowmelt occur in the watershed?	☐ **Yes**	☐ **No**

Did you place another water source on-line?	☐ Yes	☐ No
Did lake or reservoir turnover occur?	☐ Yes	☐ No
Did point or non-point sources in the watershed contribute to the OEL exceedance?	☐ Yes	☐ No
Did an algal bloom occur in the source water?	☐ Yes	☐ No
If algal blooms were present, were appropriate algae control measures employed (e.g. addition of copper sulfate)?	☐ Yes	☐ No
Did a taste and odor incident occur?	☐ Yes	☐ No
C. Do you have source water bromide data? If NO, proceed to item D.	☐ Yes	☐ No
If YES, were the bromide levels higher or lower than normal? If NO, proceed to item D. If YES, answer the following questions for the time period prior to the OEL exceedance.	☐ Yes	☐ No
Has saltwater intrusion occurred?	☐ Yes	☐ No
Are you experiencing a long-term drought?	☐ Yes	☐ No
Did heavy rainfall or snowmelt occur in the watershed?	☐ Yes	☐ No
Did you place another water source on-line?	☐ Yes	☐ No
Are you aware of any industrial spills in the watershed?	☐ Yes	☐ No
D. Do you have source water turbidity or particle count data? If NO, proceed to item E.	☐ Yes	☐ No
If YES, were the turbidity values or particle counts higher than normal? If NO, proceed to item E. If YES, answer the following questions for the time period prior to the OEL exceedance.	☐ Yes	☐ No
Did lake or reservoir turnover occur?	☐ Yes	☐ No
Did heavy rainfall or snowmelt occur in the watershed?	☐ Yes	☐ No
Did logging, fires, or landslides occur in the watershed?	☐ Yes	☐ No
Were river/reservoir flow rates higher than normal?	☐ Yes	☐ No
E. Do you have source water pH or alkalinity data? If NO, proceed to item F.	☐ Yes	☐ No
If YES, was the pH or alkalinity different from normal values? If NO, proceed to item F. If YES, answer the following questions for the time period prior to the OEL exceedance.	☐ Yes	☐ No
Was there an algal bloom in the source water?	☐ Yes	☐ No
If algal blooms were present, were algae control measures employed?	☐ Yes	☐ No
Did heavy rainfall or snowmelt occur in the watershed?	☐ Yes	☐ No
Has the PWS experienced diurnal pH changes in source water?	☐ Yes	☐ No
F. Conclusion. Did source water quality factors cause or contribute to the OEL exceedance(s)? If NO, proceed to evaluations of treatment systems.	☐ Yes ☐ No	☐ Possibly
If YES or POSSIBLY, explain below.		

Part 5: Treatment Process Evaluation Checklist

Note: Refer to Chapter 4 in the USEPA's Stage 2 D/DBPR Operational Evaluation Guidance Manual.

A. Review finished water data for the time period prior to the OEL exceedance(s) and compare to historical finished water data using the following questions:	☐ Yes	☐ No
Were DBP precursors (TOC, DOC, SUVA, bromide, etc.) higher than normal?	☐ Yes	☐ No
Was finished water pH higher or lower than normal?	☐ Yes	☐ No
Was the finished water temperature higher than normal?	☐ Yes	☐ No
Was finished water turbidity higher than normal?	☐ Yes	☐ No
Was the disinfectant concentration leaving the plant(s) higher than normal?	☐ Yes	☐ No
Were finished water TTHM/HAA5 levels higher than normal?	☐ Yes	☐ No
Were operational and water quality data available to the system operator for effective decision making?	☐ Yes	☐ No
B. Does the treatment process include predisinfection? If NO, proceed to item C. If YES, answer the following questions for the period in which an OEL exceedance occurred:	☐ Yes	☐ No
Was disinfected raw water stored for an unusually long time?	☐ Yes	☐ No
Were treatment plant flows lower than normal?	☐ Yes	☐ No
Were treatment plant flows equally distributed among different trains?	☐ Yes	☐ No
Were water temperatures high or warmer than usual?	☐ Yes	☐ No

	Were chlorine feed rates outside the normal range?	☐ Yes	☐ No
	Was a disinfectant residual present in the treatment train following predisinfection?	☐ Yes	☐ No
	Were online instruments utilized for process control?	☐ Yes	☐ No
	Did you switch to free chlorine as the oxidant?	☐ Yes	☐ No
	Was there a recent change (or addition) of pre-oxidant?	☐ Yes	☐ No
	Did you change the location of the predisinfection application?	☐ Yes	☐ No
	C. Does your treatment process include presedimentation? If NO, proceed to item D. If YES, answer the following questions for the period in which an OEL exceedance occurred:	☐ Yes	☐ No
	Were flows low?	☐ Yes	☐ No
	Were flows high?	☐ Yes	☐ No
	Were online instruments utilized for process control?	☐ Yes	☐ No
	Was sludge removed from the presedimentation basin?	☐ Yes	☐ No
	Was sludge allowed to accumulate for an excessively long time?	☐ Yes	☐ No
	Do you add a coagulant to your presedimentation basin?	☐ Yes	☐ No
	Was there a problem with the coagulant feed?	☐ Yes	☐ No
	D. Does your treatment process include coagulation and/or flocculation? If NO, proceed to item E. If YES, answer the following questions for the period in which an OEL exceedance occurred:	☐ Yes	☐ No
	Were there any feed pump failures or were feed pumps operating at improper feed rates?	☐ Yes	☐ No
	Were chemical feed systems controlled by flow pacing?	☐ Yes	☐ No
	Were there changes in coagulation practices or the feed point?	☐ Yes	☐ No
	Did you change the type or manufacturer of the coagulant?	☐ Yes	☐ No
	Do you suspect that the coagulant in use at the time of the OEL exceedance did not meet industry standards?	☐ Yes	☐ No
	Did the pH or alkalinity change at the point of coagulant addition?	☐ Yes	☐ No
	Were there broken or plugged mixers?	☐ Yes	☐ No
	Were flow rates above the design rate or was there short-circuiting?	☐ Yes	☐ No
	E. Does your treatment process include sedimentation or clarification? If NO, proceed to item F. If YES, answer the following questions for the period in which an OEL exceedance occurred:	☐ Yes	☐ No
	Were there changes in plant flow rate that may have resulted in a decrease in settling time or carry-over of process solids?	☐ Yes	☐ No
	Were settled water turbidities higher than normal?	☐ Yes	☐ No
	Was there any disruption in the sludge blanket that may have resulted in carryover to the point of disinfection?	☐ Yes	☐ No
	Was there any maintenance in the basin that may have stirred sludge from the bottom of the basin and caused it to carry over to the point of disinfectant addition?	☐ Yes	☐ No
	Was sludge allowed to accumulate for an excessively long time or was there a malfunction in the sludge removal equipment?	☐ Yes	☐ No
	F. Does your treatment process include filtration? If NO, proceed to item G. If YES, answer the following questions for the period in which an OEL exceedance occurred:	☐ Yes	☐ No
	Was disinfected raw water stored for an unusually long time?	☐ Yes	☐ No
	Were treatment plant flows lower than normal?	☐ Yes	☐ No
	Were treatment plant flows equally distributed among different trains?	☐ Yes	☐ No
	Were water temperatures high or warmer than usual?	☐ Yes	☐ No
	Were chlorine feed rates outside the normal range?	☐ Yes	☐ No
	Was a disinfectant residual present in the treatment train following predisinfection?	☐ Yes	☐ No
	Were online instruments utilized for process control?	☐ Yes	☐ No
	Did you switch to free chlorine as the oxidant?	☐ Yes	☐ No
	Was there a recent change (or addition) of pre-oxidant?	☐ Yes	☐ No
	Did you change the location of the predisinfection application?	☐ Yes	☐ No
	G. Does your treatment process include primary disinfection by injecting chlorine prior to a clearwell? If NO, proceed to item H. If YES, answer the following questions for the period in which an OEL exceedance occurred:	☐ Yes	☐ No
	Was there a sudden increase in the amount of chlorine fed or an increase in the chlorine residual?	☐ Yes	☐ No
	Was there an increase in clearwell holding time?	☐ Yes	☐ No
	Was the plant shut down or were plant flows low?	☐ Yes	☐ No
	Was there an increase in clearwell water temperature?	☐ Yes	☐ No
	Did you switch to free chlorine recently as the primary disinfectant?	☐ Yes	☐ No

	Was the inactivation of *Giardia* and/or viruses exceptionally high?	☐ Yes	☐ No
	Was there a change in the mixing strategy (i.e. mixers not used, adjustment of tank level)?	☐ Yes	☐ No
	H. Does your plant recycle spent filter backwash or other streams? If NO, proceed to item I. If YES, answer the following questions for the period in which an OEL exceedance occurred:	☐ Yes	☐ No
	Did a change in the recycle stream quality contribute to increased DBP precursor loading that was not addressed by treatment plant processes?	☐ Yes	☐ No
	Did a recycle event result in flows in excess of typical or design flows?	☐ Yes	☐ No
	I. Do you inject a disinfectant after your clearwell to maintain a distribution system residual? If NO, proceed to item J. If YES, answer the following questions for the period in which an OEL exceedance occurred:	☐ Yes	☐ No
	Was there a sudden increase in the amount of chlorine fed or an increase in the chlorine residual?	☐ Yes	☐ No
	Was there an increase in clearwell holding time?	☐ Yes	☐ No
	Was the plant shut down or were plant flows low?	☐ Yes	☐ No
	Was there an increase in clearwell water temperature?	☐ Yes	☐ No
	J. Did concern about complying with a rule other than Stage 2 DBPR, such as the Lead and Copper rule, the LT2ESWTR, or any other rule constrain your options to reduce the DBP levels at this site? For example, are you limited by other treatment targets/requirements in your ability to control precursors in coagulation/flocculation? If NO, proceed to item K.	☐ Yes	☐ No
	If YES, explain below and consult EPA's Simultaneous Compliance Guidance Manual for alternative compliance approaches.		
	K. Conclusion. Did treatment factors and/or variations in the plant performance contribute to the OEL exceedance(s)?	☐ Yes ☐ No	☐ Possibly
	If YES or POSSIBLY, explain below.		

Part 6: Submission of Operational Evaluation Reporting Forms

I certify that all of the above is correct to the best of my knowledge.

Printed Name, Title	Signature	Date

If you have any questions, contact your County Compliance Assistance Coordinator: azdeq.gov/DWcomplianceassistance
Submit completed evaluation to: EMAIL: DBPR@azdeq.gov **-or- MAIL**: ADEQ Drinking Water Monitoring and Protection Unit (MC 5415B-2), 1110 W. Washington St., Phoenix, AZ 85007

Notes

Source Water

1. Collecting and evaluating raw water quality data and comparing to historical data may help identify causes of DBP formation and actions that may be taken to minimize exceedances. Systems that do not currently monitor raw water quality may wish to incorporate the listed parameters into regular monitoring.
2. Water temperature may affect DBP formation. Low flow in rivers or lakes, extended raw water storage time, and/or decreased water usage can increase water temperature.
3. Changes in total organic carbon (TOC) and analysis of specific ultraviolet absorbance (SUVA) can indicate changes in levels of organic matter and makeup. SUVA analysis indicates if the organic content in the water is more hydrophilic or hydrophobic which can affect removal rates. If treatment processes do not change in response to organic matter changes, organic content may not be removed as expected and could lead to increased DBP formation.
4. Increased turbidity levels can serve as an indicator of a watershed event that may result in increased DBP precursors in the source water.
5. Coagulation salts, which help remove DBP-forming TOC, and chlorine are sensitive to changes in pH. At a higher pH, you may need to use more chlorine to make up for the decrease in efficacy, but this could increase DBP formation.
6. Bromide is an inorganic DBP precursor that reacts with chlorine and organic DBP precursors to form TTHM and HAA5. Bromine has also been shown to accelerate chloramine decay, causing disinfectant residual loss.
7. Watershed events such as heavy rain, drought, logging, fires, industrial spills, and lake/reservoir turnover can alter organic matter levels in water sources impacting DBP formation.
8. Different water sources may have different TOC levels depending on climate and watershed characteristics. Seasonal use of sources may impact TOC levels and DBP formation; adjustments may need to be made to the treatment process as a result.

Disinfection and Treatment Process

1. Collecting and evaluating finished (treated) water quality data and comparing to historical data may help identify causes of DBP formation and actions that may be taken to minimize exceedances. Systems that do not currently monitor water quality may wish to incorporate the listed parameters into regular monitoring. Comparing finished water quality data to historical data and to raw water quality data may indicate causes of DBP formation.
2. Systems may need to adjust treatment processes in response to water quality changes to avoid formation of DBPs.
3. Entry point TTHM constituent results, bromoform, chloroform, dibromochloromethane, and bromodichloromethane can be found in DWW.
4. Free chlorine tends to form more DBPs than chloramines or other disinfectants.
5. An increase in free chlorine levels or contact times may increase DBP levels. For systems using chloramines, the absence or decrease in ammonia may drastically increase DBP levels.
6. Elevated disinfectant residuals may indicate high chlorine feed rates which can increase DBP levels. Alternatively, lower than usual disinfectant residuals may indicate elevated chlorine demand due to increased levels of DBP precursors.
7. Systems that use chloramines should maintain a chlorine to ammonia ratio of 3:1 to 5:1. Anything more than 5:1 will decrease the chloramine residual and will also lead to dichloramine formation. Small amounts of dichloramine create taste and odors that are noticeable to customers. DBP formation can also increase.
8. Changes or failures in a treatment unit may cause DBP precursor removal to be ineffective.
9. Spikes in turbidity levels may overload the treatment process and result in decreased removal of DBP precursors.

Distribution System

1. Tank circulation, turnover, maintenance records, and drawdown level should be evaluated. Storage tanks may contain stagnant zones which may be high in DBPs.
2. When tanks operate in "last in, first out" mode, the freshest water in the tank may be drained first. As a result, the tank may contain older water which may be high in DBPs due to prolonged contact time (age). When system demand is high, aged water is more likely to be discharged from the tank.
3. Sediment at the bottom of the tank may be high in DBP precursors.
4. Storage of significantly more water than normal water use may lead to high water age due to low water turnover. Aged water in the tank may cause increased DBP levels.
5. Oversized inlet piping can lead to low flow rates, resulting in improper mixing. In-tank mixing may reduce DBP formation.
6. Low water demand may increase water age in the distribution system.
7. Dead-end piping leads to increased water age which may result in increased DBP formation.
8. The rate of reaction between disinfectants and DBP precursors increases as water temperature increases. As a result, TTHM and HAA5 concentrations may increase with increasing temperature.
9. High chlorine residuals may indicate an increase in chlorine feed rates, which could increase DBP formation. Low residuals may indicate higher chlorine demand due to increased levels of DBP precursors.
10. HAA5 formation increases at lower pH while TTHM formation increases at higher pH. Also at higher pH, the efficacy of chlorine decreases.
11. When line breaks occur, older water in the distribution system can be drawn into high use areas because of flow pattern changes. Aged water may have higher DBP levels. If water pipes are disinfected using high chlorine levels and the chlorine is not flushed from the pipes, DBP levels may increase.
12. High chlorine levels present during a chlorine conversion may increase DBP formation. Systems should notify ADEQ before conducting a chlorine conversion to delay DBP sampling.
13. To effectively booster disinfectant, free chlorine and/or total chlorine must be measured in order to add the correct amount of chemical.

Adding too much chlorine can increase DBP, dichloramine, or trichloramine formation. Adding too much ammonia can increase chances of nitrification. Disinfectant levels should be monitored before and after booster disinfection to ensure residuals are as expected and within range of ADEQ requirements.
14. Flushing reduces water age and helps maintain disinfectant residual levels.
15. Customer complaints of low pressure may indicate that water age is increasing within the distribution system. Customer complaints of color and/or odor may indicate pipe scaling or sediment, which may contain DBP precursors. In a chloraminated system, odor could indicate the formation of dichloramine or trichloramine which are typically accompanied by DBP formation.

Actions to Minimize Future Exceedances

1. Blending water can decrease DBP formation in finished water. Review water quality characteristics such as organic content, temperature, pH, corrosion potential, and loss of disinfectant residual to determine the correct blending ratio.
2. Monitoring source water can identify changes in water quality conditions that may impact DBP levels and organic content removal. Helpful parameters to monitor include TOC, SUVA, temperature, bromide, alkalinity, pH, and turbidity. Treatment processes may need to be adjusted based on changes in the source water.
3. Changing sources seasonally can help avoid issues such as temperature changes, algal blooms, and turnover that could significantly increase DBP formation.
4. Watershed management can help reduce organic content in the source water. Sources of organic matter will need to be identified and cooperation from local officials will be needed. Groups that could assist include soil and water conservation districts, conservation groups, farming organizations, fish and game commissions, and officials from local municipalities.
5. Optimizing treatment processes can increase removal of DBP precursors and decrease levels of chlorine.
6. Switching oxidants may increase or decrease DBP levels. Potassium permanganate does not form DBPs, chlorine may increase DBPs, and chlorine dioxide may decrease DBPs.
7. Temperature and chlorine dosage increases, and changes in NOM characteristics affect DBP formation. Treatment processes may need to be adjusted based on changes in the source water.
8. A sudden decrease in plant flow may increase chlorine contact time.
9. Adjusting disinfectant dosage or moving the point of injection can decrease the amount of DBPs that form in distribution.
10. When used appropriately chloramines form significantly less DBPs than chlorine.
11. Actions to improve water quality in storage tanks include increasing the amount of water flowing into and out of a tank, optimizing inlet pipe location and orientation, decreasing residence time, and improving maintenance.
12. TTHMs are more volatile than HAA5s and are more likely to decrease with aeration. Chloroform is the most volatile of the TTHM constituents.
13. Water distribution models can be an effective tool to determine water residence time in distribution system pipes. Creating a comprehensive valve inventory includes locating and verifying valve position can also prevent any issues that could lead to increased DBP formation. Physical improvements may include looping dead ends, installing blow-offs at dead ends or stagnant zones, and replacing oversize mains.
14. Aging pipes can exert high disinfection demand due to the presence of corrosion byproducts, biofilms, and sediment deposits. Disinfectant demand can be reduced by replacing, cleaning, or lining pipes as well as periodic flushing. The use of booster disinfection may allow the system to use a lower chlorine dosage at the treatment plant.
15. Periodic flushing can help control DBP levels by purging stagnant water to reduce water age and clean pipes that exert chlorine demand. Conventional flushing removes water by opening hydrants in the affected area. Unidirectional flushing involves closing valves and opening hydrants in a specific sequence to increase water velocity which will scour the pipe and remove biofilm and any debris attached to the pipe.