Microbial and Disinfection Byproducts
Rule Revisions Working Group

Meeting 7: March 9, 2023, 11:00am-6:00pm ET

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WELCOME

Rob Greenwood, Ross Strategic

Elizabeth Corr, DFO, U.S.EPA OGWDW

Eric Burneson, U.S. EPA OGWDW

OPENING REMARKS

Lisa Daniels & Andy Kricun, WG Co-Chairs

Segment 1: Agenda Review & Meeting Procedures

Rob Greenwood, Ross Strategic

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Today's Virtual Meeting: Zoom Controls

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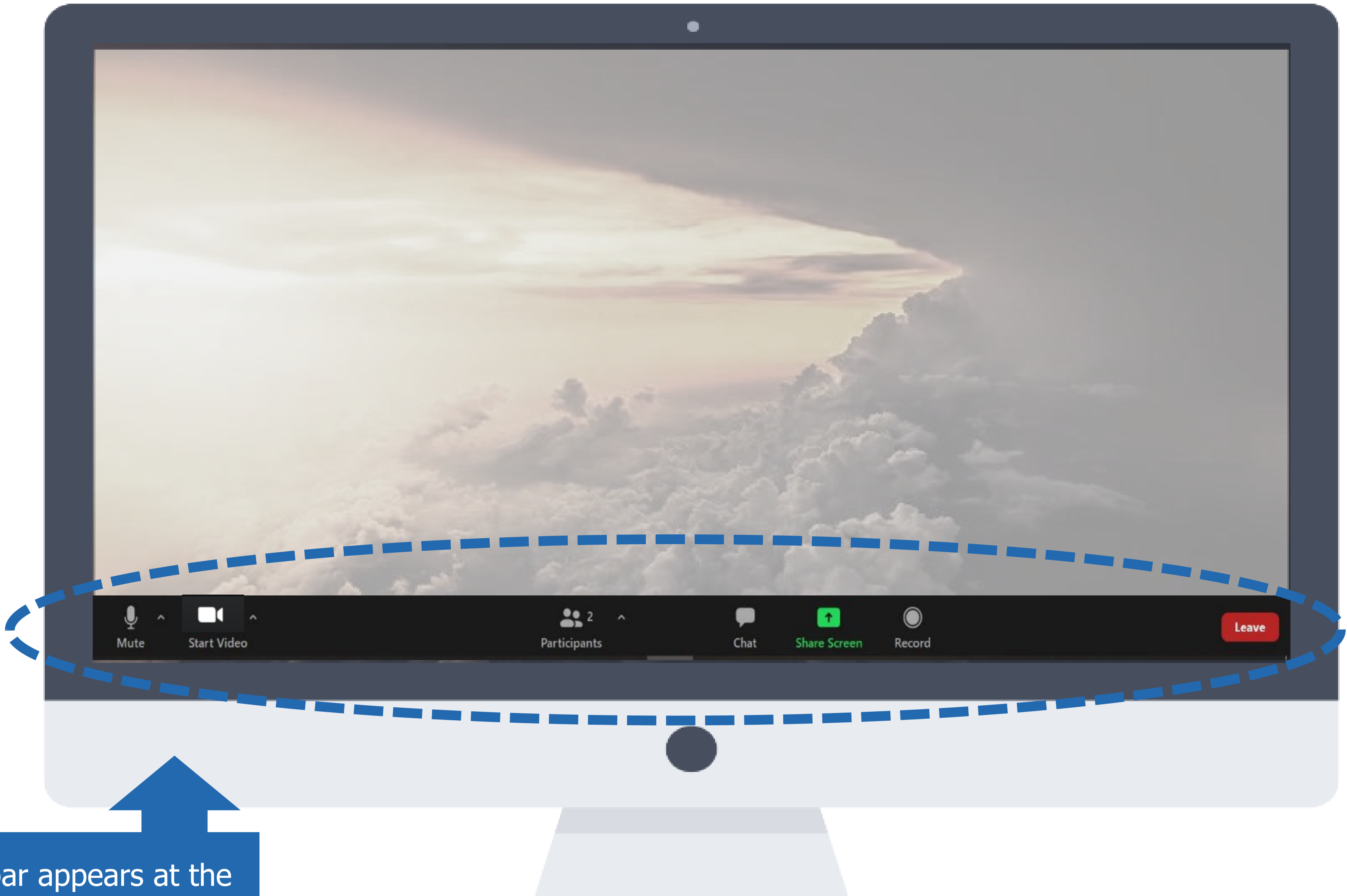

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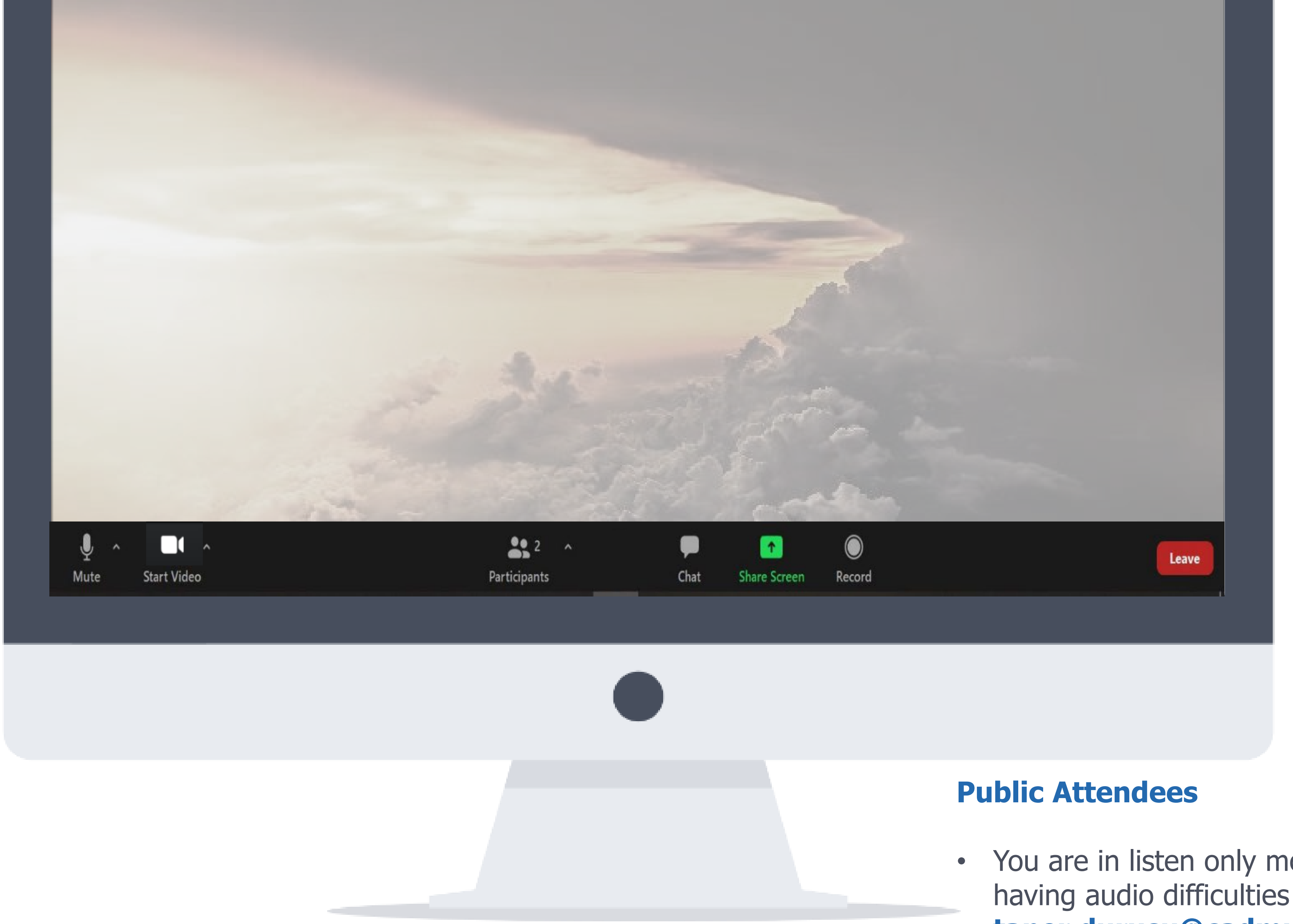

Public Attendees

- You are in listen only mode and will not be able to unmute. If you are having audio difficulties send an email to **taner.durusu@cadmusgroup.com**
- Any comments you may have can be sent to **MDBPRevisions@epa.gov** or to Public Docket: www.regulations.gov / Docket ID Number: EPA-HQ-OW-2020-0486

EPA AND FACILITATION TEAM

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Today's Agenda

11:00-12:30	• Segment 1: Agenda Review and Meeting Procedures
	• Segment 2: Continue Discussion of Working Group Understanding of OP and DBP Data and Analysis (Topics 1-5)
	15 Minute Break (12:30-12:45 pm ET)
12:45-1:45	• Segment 3: Synthesis of Source Water Conditions, Storage Tanks, Consecutive Systems, Environmental Justice, and Implementation Challenges Data and Analysis – Discussion of Working Group Understanding of These Topics (Topics 6-10)
	60 Minute Lunch Break (1:45-2:45 pm ET)
2:45-4:15	• Segment 3, continued
	15 Minute Break (4:15-4:30 pm ET)
4:30-6:00	• Segment 4: Introducing and Planning for MDBP Working Group Interventions Discussion
	• Segment 5: Next Steps

Segment 2:Continue Discussion of Working Group Understanding of OP and DBP Data and Analysis (Topics 1-5)

Facilitated Discussion

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Facilitated Discussion on OPs

- In your review of the draft summary Meeting 6 Segment 4, under OPs (Topics 1-3), what do you see as important common themes among WG members?
- Do you believe there is any important information from the Meeting 6 discussion not captured in the summary or is there additional perspective you would like to add during our discussions today?

Facilitated Discussion on DBPs

- In your review of the draft summary Meeting 6 Segment 4, under DBPs (Topics 4-5), what do you see as important common themes among WG members?
- Do you believe there is any important information from the Meeting 6 discussion not captured in the summary or is there additional perspective you would like to add during our discussions today?

15 Minute Break

12:30-12:45 pm ET

Segment 3: Synthesis of Storage Tanks, Consecutive Systems, Implementation Challenges, and Environmental Justice Data and Analysis – Discussion of Working Group Understanding of These Topics (Topics 6-10)

Presentation, Facilitated Discussion

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MDBP Problem Characterization (Topics 6-8)

[WORKING DRAFT]

Presented By Facilitators

March 9, 2023

MDBP WG Meeting 7

Meeting 7 Problem Characterization Topics
Topic 6: Source water conditions and related treatment requirements – evidence and root causes of challenges posed by source water quality. (NDWAC charge areas 1, 2)
Topic 7: Storage tanks – evidence and root causes related to negative water quality impacts resulting from contaminant entry, formation, or growth due to improper or inadequate storage tank maintenance, operations, and management. (NDWAC charge areas 1, 2)
Topic 8: Consecutive systems – evidence and root causes related to negative water quality impacts related to the unique circumstances of consecutive systems. (NDWAC Charge Areas 1, 2)
Topic 9: Environmental justice impacts related to drinking water system water quality, maintenance, operations, and management in the context of pathogens and DBP risks. (NDWAC charge area 6)
Topic 10: Areas that may introduce implementation or compliance challenges for drinking water systems/communities related to regulation and management of pathogens and DBPs (NDWAC charge area 3)

Topic 6: Source water conditions and related treatment requirements – evidence and root causes of challenges posed by source water quality . (NDWAC charge areas 1, 2)

- Key takeaways
  - Fecally contaminated source water and inadequate treatment (including GWUDI systems mischaracterized as GW systems), as well as the presence of DBP precursors and nutrients, create conditions for microbial growth and DBP formation.
  - Contributors to vulnerable source water conditions can include municipal or industrial wastewater effluents, saltwater intrusion, agricultural runoff, and cyanobacterial growth.
  - Public water systems often have limited control over source water conditions.
  - Source water contamination can increase challenges of treatment as well as DS operation/maintenance for effectively controlling M/DBPs (e.g., relatively high levels of TOC remain in treated water entering DS).
  - CT values for inactivation of fecal pathogens may need to be expanded for coverage to higher pH values.

Topic 6: Source water conditions and related treatment requirements – evidence and root causes of challenges posed by source water quality . (NDWAC charge areas 1, 2)

- Organic matter, algal matter, and nutrient levels (including from municipal, industrial, and agricultural sources)
    - Source water TOC varies spatially and temporally; high levels of source water TOC can be found in many areas of the country. (1)
    - Wastewater effluent organic matter is related to nitrogenated DBPs and their precursors. (2)
    - Organic-rich source waters can increase disinfectant demand, reduce disinfectant residuals, result in relatively high organic levels in treated water, increase biological activity, and increase DBP formation within the DS.
- High bromide in source water
    - Difficult to remove and may increase formation of brominated DBPs or bromate (if ozone treatment is used).
    - High bromide may result from saltwater intrusion (e.g., in CA and FL) and industrial activities (e.g., release of oil field brines and wastewater from coal-fired power plants).
- Fecal contaminants continue to be a focus of drinking water treatment requirements. Emerging contaminants are related to non-fecal pathogens, such as cyanobacterial toxins or OPs.
- PWSs often are not aware of water pollution sources and often lack control over upstream conditions (point and non-point sources).

Topic 6: Source water conditions and related treatment requirements – evidence and root causes of challenges posed by source water quality . (NDWAC charge areas 1, 2)

- Treatment deficiencies
  - Lack of guidance on CT implementation using modern equipment (e.g., online instruments).
  - Limited removal of organic matter and nutrients.
    - Finished water TOC from plants meeting 3x3 matrix could be high (31% and 10% of 3x3 matrix-compliant plants had TOC > 2 and 3 mg/L in finished water, respectively). (1)
    - Lack of requirement for TOC removal from plants other than conventional surface water, which could have high TOC in source water (including ground water), resulting in high TOC in finished water among these plants.
    - Overall, over 90% of SW conventional treatment met 3x3 matrix requirements for TOC removal. Commercially-available new coagulants/coagulant aids may further enhance TOC removal, with high costs.
  - CT tables that do not extend beyond pH 9, causing inconsistent CT calculations.

Facilitated Discussion

- For Source Water conditions, based on the presentations, resource material and discussions to date, what conclusions are emerging for you with respect to: impacts on drinking water quality and the primary root causes for those outcomes; and the degree of certainty we have for those conclusions?

Topic 7: Storage tanks – evidence and root causes related to negative water quality impacts resulting from contaminant entry, formation, or growth due to improper or inadequate storage tank maintenance, operations, and management. (NDWAC charge areas 1, 2)

- Key takeaways
  - Some finished water storage tanks can contribute to the presence of contaminants through breaches, high residence times, accumulation of sediments, and degrading infrastructure. (1)
  - Some conditions in finished water storage tanks can allow for opportunistic pathogen growth and/or DBP formation (elevated water age, presence of sediment, decreased residual, elevated temperature .(2)
  - High water age and stagnation in tanks can lead to a residual loss. (3)
  - Adequate maintenance and comprehensive inspections and cleaning activities are often lacking. (4)
  - Outbreaks of pathogenic disease have been associated with finished water storage tanks. (5)

Topic 7: Storage tanks – evidence and root causes related to negative water quality impacts resulting from contaminant entry, formation, or growth due to improper or inadequate storage tank maintenance, operations, and management. (NDWAC charge areas 1, 2)

- Design, operation, or management can lead to high water age and stagnation in some situations (based on volume, operation, design, and mixing conditions). (1)
  - Some inlet/outlet configurations can result in inadequate mixing, which can increase water age and affect water quality (e.g., decreased disinfectant residual levels, DBP formation). (2)
  - Tanks are often oversized for emergency use (e.g., fire flow) or the water may be used only to meet high demand, both of which can extend water age.
  - Above-ground tanks can have higher water temperatures, a conditions conducive to OP growth and DBP formation. (4)
  - Sediments and biofilms can accumulate in tanks and provide a habitat for OP growth. (5)
    - Sediments have been observed in finished water storage tanks with depths of 2 inches to more than 2 feet. (6)
    - Metal corrosion can contribute to the presence of sediment, and sediments overall can be made up of organic matter, iron particles, calcium deposits, and other inorganics, some of which may pose a stand-alone health risk. (7)
    - Exert a disinfectant residual demand, leading to decreased residual levels. (8)
    - Some tank sediment studies show the presence of DNA for *Legionella*, MAC, and *Pseudomonas aeruginosa* (Lu et al, 2015). (9)
  - Increased water ages and accumulation of sediments and biofilms can lead to elevated DBP levels in storage tanks as the residual levels are decreased (i.e., these conditions support storage tanks as an extended reactor for more formation of regulated and unregulated DBPs).(10)
  - Two legionellosis outbreaks were clustered around PWS storage tank. (11)

Topic 7: Storage tanks – evidence and root causes related to negative water quality impacts resulting from contaminant entry, formation, or growth due to improper or inadequate storage tank maintenance, operations, and management. (NDWAC charge areas 1, 2)

- Storage tank breaches can allow contaminants to enter from outside of tanks. (1)
    - Inadequate or infrequent maintenance or management can lead to deteriorating infrastructure (e.g., cracks and holes). (2)
    - Inadequately screened openings can provide a pathway for vector or contaminant entry. (3)
    - Investigations of a salmonellosis outbreak in the Alamosa, CO municipal water supply concluded that the likely cause was the municipal water system and, specifically, a storage tank that had numerous cracks and entry points (Ailes et al., 2013; Falco and Williams, 2009). (4)
- Sanitary survey storage tank inspections may not be comprehensive.
- There is also a lack of standardized national requirements for inspection and cleaning. (5)

Facilitated Discussion

- For Storage Tanks, based on the presentations, resource material and discussions to date, what conclusions are emerging for you with respect to: impacts on drinking water quality and the primary root causes for those outcomes; and the degree of certainty we have for those conclusions?

Topic 8: Consecutive systems – evidence and root causes related to negative water quality impacts related to the unique circumstances of consecutive systems. (NDWAC charge areas 1, 2)

- Key takeaways
  - Consecutive water systems can extend water age, potentially leading to increased DBP formation, loss of residuals, and increased opportunistic pathogen growth.
  - Difficulties with coordination and communication between wholesale and consecutive systems, as well as a lack of water quality data at interconnections, can hinder provision of high-quality water.
  - Many consecutive systems are faced with, with technical, managerial, and financial challenges, and little control over the quality of the water they receive.
  - In some cases, consecutive systems may receive water barely meeting regulatory levels, leaving them vulnerable to exceedances.
  - Health-based DBP violations in consecutive systems are higher than in wholesale systems.

Topic 8: Consecutive systems – evidence and root causes related to negative water quality impacts related to the unique circumstances of consecutive systems. (NDWAC charge areas 1, 2)

- A consecutive water system receives some or all of its finished water from one or more wholesaler systems.
- The Stage 2 DBPR violation rate for consecutive Community Water Systems is 3.5 times greater than non-consecutive CWSs.
  - System-based (instead of plant-based) definition of DBP MCLs were extensively applied to consecutive systems under Stage 2 DBP rule. Consecutive systems having to comply with DBP MCLs drove up the number of systems in non-compliance.
  - Prolonged water age is a major issue, especially in the purchased water without sufficient TOC removal achieved by the wholesaler.
- Lack of federal level requirement for monitoring water quality at the master meter enables a gap in water quality understanding between the wholesale and retail systems.
- Contracts between wholesalers and retailers typically focus on the price per gallon of water sold, and less on water quality, such as residual level at delivery point and DBPs.
- Relationships between wholesalers and retailers vary:
  - Consecutive systems generally have minimal control over water quality coming from wholesale systems.
  - Local political and jurisdictional issues can affect relationships between wholesalers and retailers.

Topic 8: Consecutive systems – evidence and root causes related to negative water quality impacts related to the unique circumstances of consecutive systems. (NDWAC charge areas 1, 2)

- The number of consecutive systems have increased due to interest and pressure for system consolidation.
    - Leads to longer distribution systems and increased water age, consequently resulting in elevated levels of DBPs.
    - Disinfectant residual decay can also occur.
- Many consecutive systems generally don't have the space (or technical capacity) to add additional treatment at point of entry.
- Many consecutive systems are small systems with very limited technical/managerial/financial capacities for optimizing distribution management practices for simultaneous compliance with M/DBP rules.

Facilitated Discussion

- For Consecutive Systems, based on the presentations, resource material and discussions to date, what conclusions are emerging for you with respect to: impacts on drinking water quality and the primary root causes for those outcomes; and the degree of certainty we have for those conclusions?

Topic 9: Environmental justice impacts related to drinking water system water quality, maintenance, operations, and management in the context of pathogens and DBP risks. (NDWAC charge area 6)

Required EPA EJ Analyses

- Consistent with EO 12898 requirements, EPA will consider whether population groups of concern (e.g., minority and low-income populations) are disproportionately exposed to microbial contaminants and DBPs in drinking water. (A few examples exist in the published literature on small-scale analyses.)
- EPA's analysis is expected to also evaluate whether population groups of concern are disproportionately affected by potential regulatory options under the MDBP rule revisions.
- Affordability analyses are conducted separately as part of EPA's regulatory process, as per distinct SDWA statutory requirements.(1)

Aspects of Disproportionate Impact

- Social determinants of health (e.g., socioeconomic characteristics) include neighborhood and the built environment (e.g., drinking water infrastructure). (2) Water quality and water infrastructure are known to impact public health, and water quality is known to vary across a distribution system.
- Systems serving disadvantaged communities that may have declining populations and/or have lost large water-using entities (e.g., shrinking cities syndrome) can have water age problems in the DS, leading to associated water quality problems, including DBP formation and microbial growth. Loss of water customers and revenue also affect a system's technical, managerial, and financial capacity to manage water quality problems. (3)

Topic 9: Environmental justice impacts related to drinking water system water quality, maintenance, operations, and management in the context of pathogens and DBP risks. (NDWAC charge area 6)

Aspects of Disproportionate Impact (continued)

- The rate of Legionnaires' disease is over twice as high for Black populations as compared to other minority race/ethnicity groups and White populations. Many factors influence these disparities in health outcomes, including co-morbidities, poverty and education levels, professions, proximity to cooling towers and industries, urban settings, and home ownership. These factors likely stem from historic segregation policies/redlining housing practices. (1)
- New York City Legionnaires’ disease incidence in areas with higher rates of poverty was 2.5 times higher than in areas with lower rates of poverty.(2)
- Switzer and Teodoro, 2017 found that low-income communities that are predominantly Hispanic or Black are likely to experience worse SDWA health-based compliance than similarly poor communities that are predominantly non-Hispanic and White. “A move from 0% Black population to 80% Black population in a community with 40% of the population below the poverty line leads to a predicted […] 45% increase in the number of expected health violations.” (3)
- The disproportionately higher incidence of Legionnaires' disease among Black or African American persons and people with lower socioeconomic status suggests a need for public health action. (4)

Topic 9: Environmental justice impacts related to drinking water system water quality, maintenance, operations, and management in the context of pathogens and DBP risks. (NDWAC charge area 6)

MDBP Specific Root Causes

- Environmental justice raised as an issue for incidence of Legionnaires' disease. Data monitoring and collection measures may neglect known areas and at-risk and/or disadvantaged communities. Monitoring funded by various research and national monitoring strategies may miss those communities and therefore data gaps can exist. As a result, occurrence data collection may not be designed to characterize the extent of *Legionella* contamination in the most vulnerable communities. Greater focus can be placed on environmental justice in terms of selection of sampling locations. (1)
- For neighborhood and built environments, certain housing and facility conditions may create environments conducive to *Legionella* growth. This was shown in a study undertaken in New Jersey where the incidence of Legionnaires' disease showed increases associated with a higher percentage of vacant homes, rented homes, and older homes. Water age, water pipe material, water quality, and drinking water sources may influence the growth of *Legionella* and other opportunistic pathogens in these environments. (2)
- Scope and timing of OP and DBP-related public notification – insufficient capacity and communication channels in EJ communities can lead to the lack of timely notification hindering the ability of community members to take needed actions. (3)
- Compliance provision allowing for disinfectant residual to be undetectable in 5% or less of samples each month (for any two consecutive months), can create conditions where certain locations in distribution system lack disinfectant residual over an extended period of time. (4)

Topic 9: Environmental justice impacts related to drinking water system water quality, maintenance, operations, and management in the context of pathogens and DBP risks. (NDWAC charge area 6)

Systemic Root Causes (note, the points below derive from Meeting 5 and 6 discussions)

- Different challenges may exist in cases where the entire system serves disadvantaged populations versus a system where a relatively small proportion of the system serves a disadvantaged community. (1)
- In areas experiencing significant economic changes (e.g., population decline and/or loss of large water users) and/or where community trust in their public water systems may be lacking, it can be hard to find reliable access to monitoring water utilities may not utilize sampling sites across all neighborhoods served by the system.(2)
- Some disadvantaged communities may lack financial resources to make capital improvements and hire additional staff. As a result, they may not be able to meet regulatory requirements and locate sample sites as well as collect samples that appropriately represent the full distribution system.(3)
- Water systems are not homogenous and disproportionate impacts may persist if monitoring site selection does not account for the underlying variability in a given system. (3)

Topic 9: Environmental justice impacts related to drinking water system water quality, maintenance, operations, and management in the context of pathogens and DBP risks. (NDWAC charge area 6)

Systemic Root Causes (cont.) (note, the points below derive from Meeting 5 and 6 discussions)

- Lack of access to adequate funding through the local rate base.
- Lack of access to technical knowledge (e.g., local workforce limitations).
- Location and size of systems (e.g., rural, small systems with low density customer base).
- Fragile public trust in the system based on previous experiences.
- Disproportionate burdens (e.g., cumulative health impacts, lack of or poor-quality health care) that create underlying health disparities across demographic groups.
- Lack of basic technical, managerial, and financial capacity to implement regulations.
- Barriers to apply for and administer federal and state funding.

Facilitated Discussion

- Are you aware of any additional examples or research that can add to our understanding of Environmental Justice (EJ) conditions related to MDBP rules?

- Are there additional EJ considerations within the specific context of the MDBP rules that are important to acknowledge?

Topic 10: Areas that may introduce implementation or compliance challenges for drinking water systems/communities related to regulation and management of pathogens and DBPs (NDWAC charge area 3)

- MDBP Compliance Context
  - Compliance records data from SDWIS shows violations for MDBP rules.
  - Over the past 6 years, the number of systems in violation has been decreasing.
  - For FY 2021 (Compliance Period Date), SDWIS reported approximately 3,000 health-based violations of the D/DBPRs for CWSs comprising the following approximate number of violations – MCL: 2,641; TT: 264; and MRDL: 22. Most D/DBPR violations occur at surface water systems.
    - A relatively larger number of systems were found to be in violation of the D/DBPRs than the SWTRs.
    - Most violations occurred among small and/or consecutive systems.
    - The Stage 2 D/DBPR violation rate for consecutive CWSs is about 3.5 times higher than non-consecutive systems.
- SDWA Public Notification Challenges
  - WG members have raised questions about the effectiveness of existing processes like CCR for informing communities about health-based violations.
  - Public notification requirements don’t consider some means of modern communication. Examples were noted for WG members (Meeting #6).

Topic 10: Areas that may introduce implementation or compliance challenges for drinking water systems/communities related to regulation and management of pathogens and DBPs(NDWAC charge area 3)

- System Characteristic Challenges – Can Apply to Large, Medium, Small and Urban-Rural Systems to Varying Degrees
  - Level of organic matter in water entering the distribution system.
  - Low customer density and prolonged water ages (e.g., in consecutive systems).
  - Multiple water sources (differences in water chemistry).
  - Branched distribution system (long water age and related problems).
  - Consecutive systems (water quality at and beyond POE, compliance challenges).
  - Economically disadvantaged communities (limited economic base).
  - Low customer population (balance of infrastructure and O&M costs relative to rate/revenue base).
  - Deteriorating infrastructure (increased susceptibility to breakage or leakage, intrusion, disinfectant demand).
  - Certified operator recruitment/retention (O&M deficiencies, sampling/reporting challenges).
  - System designs to serve historically larger customer demands/populations or anticipating/supporting future demand (and related difficulty/inability to right size retroactively).

Topic 10: Areas that may introduce implementation or compliance challenges for drinking water systems/communities related to regulation and management of pathogens and DBPs(NDWAC charge area 3)

- Competing Priority Challenges – Context for Understanding Relative Risk Benefit of Additional Requirements and Implications for System Capacity
  - Risk and Resilience Investments: natural hazards (e.g., climate change, earthquake); cyber security; physical security; asset management.
  - Staffing: recruitment; retention; and competency.
  - Feasibility Studies (e.g., full life-cycle cost analyses).
  - Supply Chain Issues: treatment chemicals; replacement parts; equipment not supported (includes unique small/rural system challenges).
  - Emergent and existing regulations (e.g., PFAS Rule Proposal, Lead and Copper Rule revisions and upcoming LCRI, Lead in Schools and Childcare Facilities).

Topic 10: Areas that may introduce implementation or compliance challenges for drinking water systems/communities related to regulation and management of pathogens and DBPs(NDWAC charge area 3)

- MDBP Specific Implementation Challenges
  - Microbial growth and continued DBP formation can occur in distribution systems.
  - Simultaneous compliance: water chemistry is complicated; treatment changes can lead to changes in water chemistry. DBP reduction can place pressure on pathogen reduction and vice versa.
  - Design requirements: Similar unit treatment processes used for the same or different purposes and on different compliance schedules (e.g., GAC for PFAS or DBP precursor reduction).
  - BATs for disinfection or organic removal can have a high relative cost.
  - Chloramination may be difficult for small systems to successfully implement – maintaining the proper chlorine/ammonia balance requires ongoing tailoring to system conditions, as well as implications for changes to the DBP mix.
  - Water quality challenges from DBP treatment techniques - chloramination (e.g., less effective disinfection, nitrification which can cause biofilm growth, disinfectant depletion, coliform occurrences, and nitrite/nitrate formation depressing pH and causing corrosion, unregulated DBPs).
  - CxT value calculations don't consider modern measurement methods.
  - Flushing to reduce water age has cost (lost revenue), conservation, and consumptive use permit (water quantity) implications.
  - Reduced finished water storage capacity has fire demand and emergency operations implications.

Topic 10: Areas that may introduce implementation or compliance challenges for drinking water systems/communities related to regulation and management of pathogens and DBPs(NDWAC charge area 3)

- MDBP Specific Implementation Challenges (cont.)
  - More consecutive systems due to increased interest/pressure for system consolidation.
  - Variable building owner water quality management understanding and actions.
  - Differing state and federal regulations.
  - Regulatory compliance schedules – time for design, construction, implementation, and stakeholder communications.
  - Consecutive systems – Point of Entry water quality management - many consecutive systems are small; D/DBPR rule compliance remains a challenge for such systems.
- Sanitary Survey Challenges
  - Lack of adequate follow-up actions correcting identified deficiencies.
  - Knowledge gap for inspectors/surveyors given retirements and turnover.
  - Increased regulatory requirements without commensurate increases in state resources and funding.
  - Does not break down silos within water system related to risk management.
  - More complex regulation leads to increase in state workload.

Facilitated Discussion

- Have we captured a well-rounded characterization of MDBP-related implementation challenges faced by drinking water systems? If not, what needs to be added?

60 Minute Lunch Break

1:45-2:45 pm ET

Segment 3, cont.: Synthesis of Storage Tanks, Consecutive Systems, Implementation Challenges, and Environmental Justice Data and Analysis – Discussion of Working Group Understanding of These Topics (Topics 6-10)

Presentation, Facilitated Discussion

March 9, 2023

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15 Minute Break

4:15-4:30 pm ET

Segment 4: Introducing and Planning for MDBP Working Group Interventions Discussion

Presentation, Facilitated Discussion

March 9, 2023

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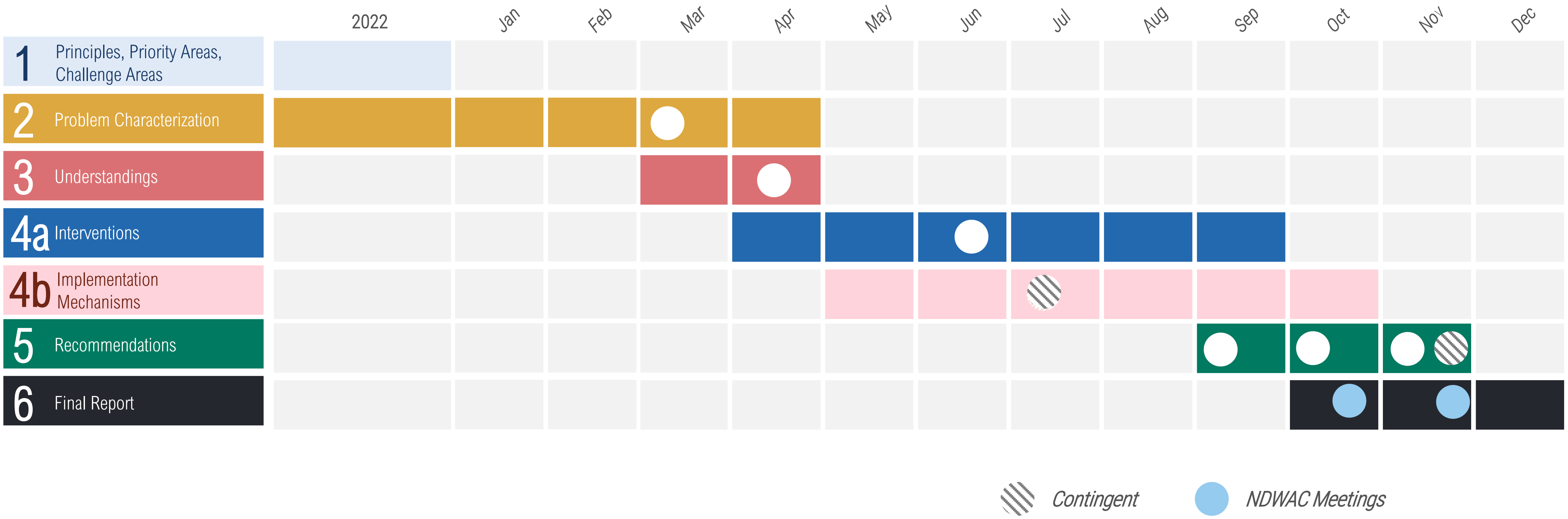
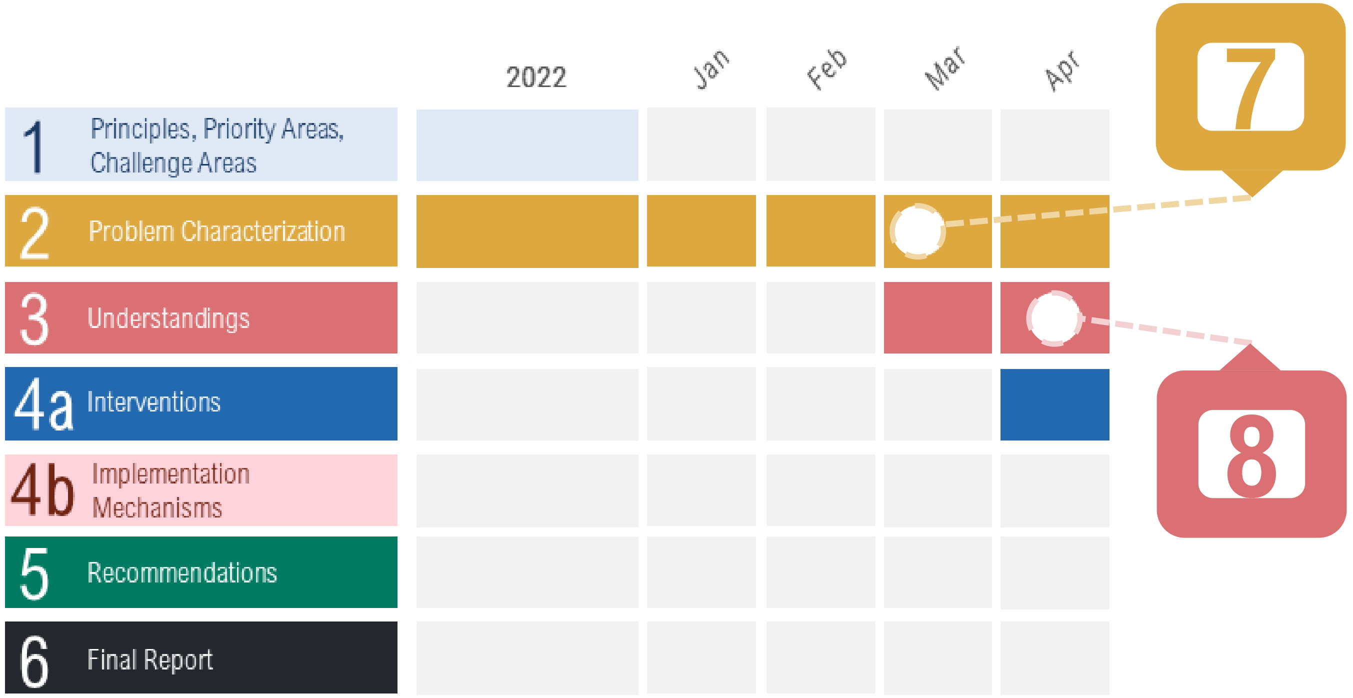
Meeting Topics & Timeline



Meeting Topics & Timeline



March 9 (Today)

- Problem characterization for topics 1-10
- Introduction to Interventions phase of WG discussions

April 19

- Brainstorm and scoping of intervention opportunities
- Exchange of ideas and perspectives

Getting from Meeting 7 to 8

7

8

- Review of Table 3: compilation of interventions & implementation mechanisms
- Interim engagement between facilitation team & Working Group members to check in on initial ideas on interventions
- Facilitation team compilation & sharing of initial ideas

Reference Tables

Table 1: Existing Requirements

	Microbials	Interdependence	DBPs
Source Water	**IESWTR 1998 (63 FR 9478) - Applies to all public water systems using surface water, or ground water under the direct influence of surface water (GWUDI), that serve 10,000 or more persons.** • Requires that watershed protection programs address *Cryptosporidium* for systems that are not required to provide filtration. **LT1ESWTR 2002 (67 FR 1812) - Applies to all public water systems using surface water, or GWUDI, serving fewer than 10,000 persons.** • Requires that watershed protection programs address *Cryptosporidium* for systems that are not required to provide filtration.		**Stage 1 DBPR 1998 (63 FR 69390) - Applies to all surface water (including GWUDI) treatment plants using a conventional filtration treatment process.** • Requires monitoring source water for Total Organic Carbon (TOC) and Alkalinity.
Treatment	**SWTR 1989 (54 FR 27486) - Applies to all public water systems using surface water sources or GWUDI.** • Includes treatment technique (TT) requirements for removal or inactivation of at least 99.9% (3 log) of *Giardia lamblia* and 99.99% (4 log) of viruses for all PWSs using surface water or GWUDI as a source (i.e., Subpart H systems). Presumed that if sufficient treatment is provided to control for *G. lamblia* and viruses, then *Legionella* risks will also be removed or inactivated. • Includes TT requirements for filtered and unfiltered systems to protect against adverse health effects of exposure to pathogens, including specific numeric requirements for turbidity and disinfection/CTs (at EP). • Requires certain public water systems to meet strengthened filtration requirements, including lower turbidity levels. **IESWTR 1998 (63 FR 9478) - Applies to all public water systems using surface water, or GWUDI, that serve 10,000 or more persons.** • Sets a minimum 2-log *Cryptosporidium* removal requirement for systems that provide filtration. • Requires certain public water systems to meet strengthened filtration requirements, including lower turbidity levels. • For filtered systems using conventional treatment or direct filtration, must meet a turbidity performance standard.[1] • Perform continuous (every 15 minutes) individual filter effluent (IFE) monitoring to assist treatment plant operators in understanding and assessing filter performance. • Individual filter effluent continuous turbidity monitoring requirements can trigger requirements to complete a filter profile, a self-assessment of the filter, and a Comprehensive Performance Evaluation (CPE). • Filtration avoidance requirements include meeting source water quality conditions and site-specific conditions. **LT1ESWTR 2002 (67 FR 1812) - Applies to all public water systems using surface water, or GWUDI, serving fewer than 10,000 persons.** • Sets a minimum 2-log *Cryptosporidium* removal requirement for systems that provide filtration.	**IESWTR 1998 (63 FR 9478) - Applies to all public water systems using surface water, or GWUDI, that serve 10,000 or more persons.** Public water systems must evaluate impacts on microbial risk before changing disinfection practices to ensure adequate protection is maintained. The three major steps are: • Determine if a public water system needs to profile based on TTHM and HAA5 levels (applicability monitoring). • Develop a disinfection profile that reflects daily *Giardia lamblia* inactivation for at least a year (systems using ozone or chloramines must also calculate inactivation of viruses). • Calculate a disinfection benchmark (lowest monthly inactivation) based on the profile and consult with the state prior to making a significant change to disinfection practices. **LT1ESWTR 2002 (67 FR 1812) - Applies to all public water systems using surface water, or GWUDI, serving fewer than 10,000 persons.** If a system that was required to profile subsequently wishes to make a significant change to its disinfection practices, it must establish a disinfection benchmark and consult with the state for approval prior to implementing such modifications.	**Stage 1 DBPR 1998 (63 FR 69390) - Applies to all community and non-transient noncommunity water systems that add a chemical disinfectant in any part of the drinking water treatment process and transient noncommunity water systems using chlorine dioxide.** • Based on levels of TOC/Alkalinity in source water, requires meeting specified percentage of TOC removal before disinfecting and delivering the water to distribution system, unless meeting alternative criteria (treatment technique (TT) requirement).

Reference Tables

Table 2: Problem Characterization

Microbials	Interdependence	DBPs
Source Water Conditions: • Potential consequences of organic-rich source water conditions include increasing disinfectant demand and increasing nutrient levels within the distribution system. • Source water nutrients, if not removed by the treatment process, can increase the growth potential of opportunistic pathogens (e.g., *Legionella*) within distribution and premise plumbing systems. The types of nutrients that may drive the growth of organisms in distribution systems vary by location, as well as by organism, and can include carbon, nitrogen, phosphorus, and iron. Exposure to elevated levels of such pathogens is associated with acute health risks such as legionellosis and *Pseudomonas* pneumonia.	**Microbial Contamination and DBP Formation:** • Organic matter present in source water can react with chemical disinfectants to deplete disinfectant residuals, form potentially harmful disinfection byproducts (DBPs), and provide nutrients for microbial growth within the distribution system or premise plumbing. • Considering source water quality in determining microbial and DBP risks is important, especially noting the increased risks of drinking water treatment systems that are downstream of critical organic sources, such as wastewater treatment plants. **Variable Requirements and Conditions:**	**Source Water Conditions:** • Source water quality conditions, such as the concentration of organic precursors, composition of the organic or algal material present, and presence of inorganic precursors (e.g., iodide and bromide), can influence the species and concentration of DBPs formed (Young et al., 2020) • In recent years there has been increased concerns about source water bromide including from anthropogenic sources. Elevated levels of bromide in source water have been shown to shift the distribution of haloacetic acids (HAAs) and other DBP groups toward more brominated species, which may have greater relative toxicity than their chlorinated analogs. As source water bromide concentrations increase, the overall HAA5 proportions could decrease while the unregulated brominated HAAs increase due to this shift. In these instances, potential risk associated with the brominated HAA exposure to consumers would remain even while there is continued HAA5 maximum contaminant level (MCL) compliance. • The nitrogen-containing organics present in source water, including those from the municipal wastewater effluent, agricultural runoff, and harmful algal blooms, can be precursors for nitrogenated DBPs including N-nitrosodimethylamine (NDMA). • Data show that TOC as a surrogate for the organic precursors may not adequately capture the reactivity of the organics in the water in the context of DBP formation. A given concentration of TOC may have a wide range of DBP formation potentials and biological availability, depending upon the source water and the treatment processes used.
		Chlorate and Chlorite: • The occurrence of chlorate and chlorite in treated water are largely attributable to certain chemical disinfection practices (when chlorine dioxide and/or hypochlorite are used as disinfectants and oxidants, also on-site generation of chlorine). Elevated levels of chlorate are found when hypochlorite is stored for long periods of time and/or under warmer conditions. • Some strong oxidants (such as ozone and free chlorine) can convert chlorite to chlorate in water. • Common health endpoints associated with exposure to chlorite and chlorate include hematological and thyroid effects. **TOC:** • Compliance with the "3x3 matrix" can result in substantial variability in treated water quality both across and within systems. Significant differences in source water may result in substantial disparities in finished water TOC. **System Operations:** • From the operational perspective, some systems may take advantage of relatively long residence time in coagulation/sedimentation basins and apply chemical disinfectants there to obtain disinfection credits prior to the targeted TOC removal being achieved. Such a practice

Table 1: Existing Requirements

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Reference Tables

Table 3: Interventions - DRAFT

Drinking Water Value Chain	Microbials	Interdependence	DBPs
		• Periodic source water assessments (e.g., DBP formation potential, nutrient contributions, seasonal changes). • Triggered source water assessments based on events or monitoring results and work with relevant authorities to reduce source water contamination. • Enhanced and continuous source water monitoring for specific parameters	• Identify source specific water parameters and monitoring tools to evaluate issues with DBP formation potential. o Consider bromide, iodide, DOC, DBP precursors, wastewater reuse, algal matter, and UV254 o Conduct source water monitoring using above methods • Work with your primacy agency and local government to find the potential sources contributing to elevated levels of monitored water quality parameters and explore measures to improve source water quality • Seek to control bromide in source waters (e.g., power plant effluent control).
			• Develop routine filter media profiles to: o Modify existing filter operations and maintenance practices to maximize AOC removal (If the filters are operated at a biological mode. If not, consider converting to this mode) • Across PWS treatment operations and management focus approaches on decreasing entry point TOC/DOC by: o Considering a broad range of DBPs not limited to volatile DBPs when making treatment decisions. o Setting specific finished water precursor target goals ahead of distribution based on initial raw water levels. Describe a methodology to determine appropriate numbers for a given system? o Utilizing UV254 for advanced monitoring of TOC. • Utilize direct treatment methods to control TOC/DOC levels by: o Increasing filtration of AOC to reduce chlorine requirements. o Using pre-disinfection treatment with granular activated carbon (GAC) media or other technologies.

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Reference Table 3

Table 3: Map of Potential Interventions for Consideration

This table describes actions that can be taken by water utilities to reduce the impacts of problems described in the Problem Characterization table (Table 2). Before undertaking any of these interventions utilities should consider the potential effects on simultaneous compliance with other drinking water regulations. The footnotes contain areas that cross-cut from source to tap, suggested areas for EPA to consider for addressing these problems nationally (e.g., regulations, guidance), and data and research needs. Prioritization and commentary on the interventions and the EPA implementation suggestions can be provided in comment bubbles – factors to consider include health risks addressed, effectiveness, costs, implementability, feasibility, overall need across a range of systems, and competing objectives. Uncertainty regarding any of the factors should be included as well. Consideration should be added on what will most increase the value of water for the consumers.

Contaminants of Concern

Drinking Water Value Chain	Microbials	Interdependence	DBPs
Source Water	• Monitor source waters for specified parameters, including assimilable organic carbon (AOC), nitrogen, phosphorous, and other nutrients that could enhance opportunistic pathogens or cyanobacterial growth. • Work with your primacy agency and local government to find the potential sources contributing to elevated levels of monitored water quality parameters and explore measures to improve source water quality RG Input – Table 2 has GWUDI characterization as a problem. Is there in intervention to capture here?	• Periodic source water assessments (e.g., DBP formation potential, nutrient contributions, seasonal changes). • Triggered source water assessments based on events or monitoring results and work with relevant authorities to reduce source water contamination. • Enhanced and continuous source water monitoring for specific parameters o Monitor for changes in upstream discharges o Use as a basis for treatment and operational decisions o Use following heavy rainfall events • Improve source water protection and management to control nutrients and DBP pre-cursors: o Create or refine, and implementing source water protection plans; o Source water reservoir design and maintenance for physical or operational protective measures o Integrate watershed planning o Modify land development activities in areas that would negatively impact drinking water sources o Limit land use in areas under utility control o Employ riparian buffers o Divert runoff (e.g., agricultural, urban) o Evaluate wastewater impacts to source water • Long-term climate resiliency utility planning (impacted by drought or natural disasters)	• Identify source specific water parameters and monitoring tools to evaluate issues with DBP formation potential. o Consider bromide, iodide, DOC, DBP precursors, wastewater reuse, [illegible] o Conduct source water monitoring using above methods • Work with your primacy agency and local government to find the potential sources contributing to elevated levels of monitored water quality parameters and explore measures to improve source water quality • Seek to control bromide in source waters (e.g., power plant effluent control).
	• Develop routine filter media profiles to: o Determine microbial growth in filters o Modify existing filter operations and maintenance practices to maximize turbidity removal with consistency • Establish pre-treatment (such as riverbank filtration or pre-sedimentation) ahead of primary treatment train to control for microbial loads • Sample media beds for disinfectant levels at treatment plant: o Consider presence of host amoeba in treatment regimens o Verify CT calculations for treatment of regulated pathogens (e.g., *Giardia*, viruses) under specific operating conditions	• Create or optimize treatment for removal of organic matter and solids: o Pilot treatment studies specific to the source water to assess and address water quality conditions o Employ pre-treatment to improve disinfection efficacy o Monitor for simultaneous reductions microbial and DBP formations across treatment o Improve filtration performance o Consider biofiltration to reduce DBP precursors, remove AOC, and improve the persistence of a disinfectant residual in the distribution system while	• Develop routine filter media profiles to: o Modify existing filter operations and maintenance practices to maximize AOC removal (If the filters are operated at a biological mode. If not, consider converting to this mode) • Across PWS treatment operations and management focus approaches on decreasing entry point TOC/DOC by: o Considering a broad range of DBPs not limited to volatile DBPs when making treatment decisions. o Setting specific finished water precursor target goals

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Four Sections:

- Map of Potential Interventions
- Cross-Cutting Considerations
- Implementation Mechanisms
- Additional Data Needs

Reference Table 3

Section 1: Map of Potential Interventions

Actions needed to address MDBP-related identified public health, administrative, implementation, or environmental justice challenges while considering unintended consequences

Table 3: Map of Potential Interventions for Consideration

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	Contaminants of Concern		
Drinking Water Value Chain	**Microbials**	**Interdependence**	**DBPs**
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Reference Table 3

Section 2: Cross-Cutting Considerations

Actions that have the potential to work equally across two or more components of the value chain

systems that includes water quality considerations.
- Establish communication channels between buyer and seller.
- Monitor for disinfection residuals and DBPs at interconnections.
- Hold water suppliers accountable for sold water.
- Coordination between parent/consecutive to control water age entering and in consecutive system?

- Gather the information of quality of water entering the service buildings (if necessary, conduct monitoring)
- Consider Opportunistic Pathogen growth potential when making decisions about pipe and other materials and design
- Implement building systems maintenance:
  - Monitoring point-of-entry treatment
  - [illegible]
- Require building water management programs under non-SDWA authority (e.g., plumbing codes, local codes for fire storage, water mains)
- Pilot studies to better understanding building water systems from different designs, age, and size
- Promote and educate, and support premise owners/managers
- See comment

See Distribution Systems

See Distribution Systems

Cross-Cutting

1. **Water Safety Plans** (WSPs) were developed to ensure the safety of drinking water through the use of a comprehensive risk assessment and risk management approach from the source to the tap. There may be an opportunity to use them in whole or in part to address emerging contaminants that may be specific to that system and potentially to identify how a system can ensure compliance with existing regulations. While WSP weren't developed for specific use on Opportunistic Pathogens or DBPs, there may be benefits from their use to control these contaminants, while minimizing unintended consequences. Implementing a WSP entails looking at water systems more holistically.
   a. Could adopt only certain elements of the WSP for some systems (e.g., distribution system), rather than adopting the entire framework.
   b. Implement only certain elements of a WSP to address small system concerns. The water industry in Iceland produced a separate, "Hazard Analysis Critical Control Point (HACCP)-light" set of requirements involving a reduced number of steps for small systems.
   c. Consider risk registries and WSP applications. Identify how priority risks can be identified and how WSP applications can be applied.
   d. Utilize WSPs as a complementary approach focusing on an opportunity to educate since many violations are related to a lack of understanding.
   e. Incorporate the WSP approach into operator and management training to promote a preventative-minded culture.
2. **Sanitary Surveys:**
   a. Consider in response to potential water quality problems
   b. Promote conversations and information sharing between sanitarians and water utility staff. This is important for understanding the challenges of a water system and where weaknesses may exist. Standard sanitary survey inspection checklists may not allow for this sharing.
   c. Push the technical assistance angle of sanitary surveys (e.g., large system assistance to small systems).
   d. Provide more timely responses to significant deficiencies.
   e. Improved communication between utilities and their communities.
   f. Consider an increased frequency of sanitary surveys for systems with repeated violations.

Implementation for EPA: Regulatory Requirements/Oversight/Guidance

1. **Consider a Find and Fix Approach**
   a. Implement the use of a toolbox with corrective actions to address problems identified [illegible]PA develo[illegible] dis[illegible] system toolbox to be used by systems to respond to low disinfectant residuals. Toolbox to include flushing, booster disinfection, water age management, optimizing corrosion control, and other measures.
      i. Development of an online guidance tool for distribution systems for improvi[illegible] water [illegible].
      ii. Consider a staged response based on the levels found, as well as a separate response for [illegible]eate[illegible] problems.
   b. Require distribution system operation and management plan for systems in violation of disinfecta[illegible] residu[illegible] maintenan[illegible] re[illegible]irement[illegible] times in a rolling 12-month period. Plan would use elements of the toolbox.
   c. Integrate additional testing, data analysis, and data management. Can better identify trends in water quality[illegible]
   d. If systems fail to meet the minimum disinfectant residuals require them to conduct repeat monitoring and Legi[illegible]a test[illegible] amon[illegible] other actions.
   e. Response to high disinfectant residuals measurements.
   f. EPA develop DBP reduction toolbox to be used by systems with DBP levels exceeding MCLs.
2. **Finished water storage**
   a. Minimum disinfectant residuals in storage tanks, including storage tank outlets as monitoring locations. Could be done in guidance or regulati[illegible] Define sampling practices.
   b. Federal requirements for routine storage facility maintenance, inspection and cleaning (both internal and external).
      i. Specify frequencies.
      ii. Qualified personnel.
      iii. Require corrective action based on problems identified during inspections.
   c. Identify an appropriate trigger level for taking action.
   d. Set maximum water age in tanks as tank turnover expectation with regular evaluation of turnover using tracers.
   e. Consider different requirements or guidance for different climates; local codes on fire storage, etc.
   f. Provide a toolbox for tank management/water quality.
3. **Require minimum numerical disinfectant residuals in distribution systems**
   a. Evaluate measurement accuracy and variation - as measured in the field (not just ideal conditions)
   b. Minimum free and total chlorine levels throughout the DS TBD based on evaluation. May also consider variation in the numerical limit. Specify total chlorine as being for monochloramine, requiring use of monochloramine method.
   c. Consider a national disinfectant residual reporting limit.
   d. Clarify requirements to maintaining residual when a utility has source blending.
   e. Use chlorine not chloramines.
   f. Provide guidance on practical ways to maintain a numerical residual throughout the distribution system.
   g. Develop training to improved residual measurements.
   h. Testing to measure for both total and free chlorine especially when using chloramine disinfection.
   i. Consider regulating chloramines differently than free chlorine as distribution system residual. Chloramines have issues with dichloramine, organic chloramines, both greatly affect regulated and unregulated DBP formation and residual efficacy and decay.

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Reference Table 3

Section 3: Implementation Mechanisms

the regulatory and non-regulatory mechanisms available to implement recommended interventions

Implementation for EPA: Regulatory Requirements/Oversight/Guidance

1. Consider a Find and Fix Approach
   a. Implement the use of a toolbox with corrective actions to address problems identified. EPA develop a distribution system toolbox to be used by systems to respond to low disinfectant residuals. Toolbox to include flushing, booster disinfection, water age management, optimizing corrosion control, and other measures.
      i. Development of an online guidance tool for distribution systems for improving system water quality.
      ii. Consider a staged response based on the levels found, as well as a separate response for repeated problems.
   b. Require distribution system operation and management plan for systems in violation of disinfectant residual maintenance requirement two times in a rolling 12-month period. Plan would use elements of the toolbox.
   c. Integrate additional testing, data analysis, and data management. Can better identify trends in water quality.
   d. If systems fail to meet the minimum disinfectant residuals require them to conduct repeat monitoring and *Legionella* testing, among other actions.
   e. Response to high disinfectant residuals measurements.
   f. EPA develop DBP reduction toolbox to be used by systems with DBP levels exceeding MCLs.
2. Finished water storage
   a. Minimum disinfectant residuals in storage tanks, including storage tank outlets as monitoring locations. Could be done in guidance or regulation. Define sampling practices.
   b. Federal requirements for routine storage facility maintenance, inspection and cleaning (both internal and external).
      i. Specify frequencies.
      ii. Qualified personnel.
      iii. Require corrective action based on problems identified during inspections.
   c. Identify an appropriate trigger level for taking action.
   d. Set maximum water age in tanks as tank turnover expectation with regular evaluation of turnover using tracers.
   e. Consider different requirements or guidance for different climates; local codes on fire storage, etc.
   f. Provide a toolbox for tank management/water quality.
3. **Require minimum numerical disinfectant residuals in distribution systems**
   a. Evaluate measurement accuracy and variation - as measured in the field (not just ideal conditions)
   b. Minimum free and total chlorine levels throughout the DS TBD based on evaluation. May also consider variation in the numerical limit. Specify total chlorine as being for monochloramine, requiring use of monochloramine method.
   c. Consider a national disinfectant residual reporting limit.
   d. Clarify requirements to maintaining residual when a utility has source blending.
   e. Use chlorine not chloramines.
   f. Provide guidance on practical ways to maintain a numerical residual throughout the distribution system.
   g. Develop training to improved residual measurements.
   h. Testing to measure for both total and free chlorine especially when using chloramine disinfection.
   i. Consider regulating chloramines differently than free chlorine as distribution system residual. Chloramines have issues with dichloramine, organic chloramines, both greatly affect regulated and unregulated DBP formation and residual efficacy and decay.
   j. Compliance determined when 95% of monthly disinfectant residual samples are maintained at required levels (as opposed to two consecutive months).
   k. Amend required disinfectant residual levels entering the distribution system to consider those throughout the distribution system.
4. Monitoring locations and timing
   a. Additional emphasis on accurate monitoring at target locations conducted frequently enough to capture variations.
   b. Monitoring at RTCR locations as in the current SWTR.
   c. Continuous monitoring of disinfectant residuals in the distribution system for at least some system sizes.
   d. Require monitoring for *Legionella* or other opportunistic pathogens in distribution systems and biofilms, especially during warm-water conditions. Require corrective actions based on the results.
   e. Develop guidance on how to respond and communicate for *Legionella* (and OPs) is distribution system. Need to be concentration driven.
   f. Monitoring plan to include a combination of representative and maximum residence time locations, at interconnections to consecutive systems, DBP monitoring locations, at or near service connections with vulnerable populations, and in areas of the distribution system that have historically been prone to a difficulty in maintaining residuals or high DBP levels.
   g. Define DBP monitoring frequencies and locations based on source, treatment, and distribution system evaluations.
   h. Reduced DBP monitoring if running annual average concentrations are less than half the MCL.
5. **Water quality monitoring by qualified personnel.**
6. **Consider seasonal chlorination requirements, including monitoring for disinfectant residuals, DBPs, and related parameters during this time.**
7. CT Values:
   a. Update CT tables in accordance with new research.
   b. Establish frequency for reporting CT calculations

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28. Support development of Water Management Plans to include monitoring approaches and data collection for large buildings and high-risk building settings to minimize water-related risks including opportunistic pathogens.
29. Establish a monitoring and data collection effort for distribution systems and premise plumbing to develop a national database (to include MAC and *Pseudomonas*)
30. Educate the public (including building managers and owners) on strategies to reduce *Legionella* growth in premise plumbing.
    a. Provide additional guidance to states about treatment in building water systems.

Reference Table 3

Section 4: Additional Data Needs

Data and analysis needs suggested by WG and technical analysis during the course of WG discussions – to receive further consideration during Interventions discussion

1. **Data and Research Needs**
    a. *Legionella*
        i. National occurrence data in drinking water distribution systems.
            1. Additional investment in distribution system monitoring for *Legionella* and other opportunistic pathogens could provide data in support of a revised rulemaking.
            2. This could provide greater insight into the relationship between distribution systems and building water systems.
            3. Lack of data on the relationship between disinfectant residual and *Legionella*.
            4. Data to show when *Legionella* occurs in the distribution system.
        ii. Relationship between *Legionella* in distribution and building systems.
        iii. Identifying factors leading to microbial regrowth in the distribution system.
        iv. Amoeba co-occurrence and protection of *Legionella* relationship.
        v. How to measure biostability?
    b. Factors Affecting DBP Variation (in distribution systems)
        i. Need EPA guidance on how to perform DBP formation potential studies.
        ii. Need to better understand the implications of maintaining a minimum residual at all points in the distribution system on DBP levels.
    c. Relative Risks of Different DBPs
        i. Determine relative risks of nitrogenous, iodinated, and brominated DBPs, since some toxicity information suggests these compounds may be more problematic than regulated DBPs.
        ii. Better understand benefits from further control of HAAs, considering the potential [illegible] toxicity driver in DBP mixtures.
    d. Source Water Quality Impacts to Utilities
        i. Unknown quantification of the costs to utilities from recurring pollution events and the long-term impacts on their source water quality.
        ii. Review research on impacts of point and non-point source pollution on source water quality.
        iii. Impacts from algal blooms on chlorine demand.
        iv. Better identification of DBP precursors vs. bulk parameters like TOC.
        v. The bromide to TOC ratio is important and should be evaluated.
        vi. Development of more cost-effective ways to identify and remove precursors.
        vii. Is there a need to know more specifics about types of TOC or DOC to focus on removal techniques or is it the same on either the operational control or technique side?
    e. Costs
        i. A better understanding of life cycle costs of increased treatment vs. managing through distribution system operations and maintenance especially considering drought.
        ii. Quantify removal costs vs. source protection.
        iii. How can costs be brought down for GAC, membranes, and other precursor removal technologies?
        iv. Life cycle costs of treatment for precursor removal vs. need for 24/7/365 operations & maintenance (O&M) management, water use for flushing, booster disinfection, etc. in the distribution system.
        v. Identify the key cost factors.
    f. Health Risks
        i. Establish a clearer relationship between occurrence and health risk.
        ii. There needs to be more epidemiological evidence of pathogenicity and health risks.
        iii. Role of distribution system water quality in influencing building water quality.
    g. Treatment Technology: Precursor Removal Technology Non-GAC solutions to natural organic matter (NOM) removal.
    h. Focus on the multiple benefits of precursor removal with GAC, membranes, or other technologies on reducing microbial and DBP risks, as well as other synthetic organic chemicals (SOCs) and volatile organic chemicals (VOCs).
    i. Simultaneous compliance issues with precursor removal.
    j. Sanitary Survey: Support for technologies and approaches to inspect 'hard to reach' aspects, such as water sources, sub-surface infrastructure, high-level water tanks – these are very hard to inspect
    k. Easy on-site methods that are informative for precursor control.
    l. Analytical methods with adequate detection limits needed (e.g., minimum accuracy for disinfectant residual instrumentation).
    m. On-line monitoring methods that are usable by small utilities and not resource-intensive to do QA/QC requirements for use.
    n. Variability of disinfectant residual measurements.

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Facilitated Discussion

- Do you have additions or refinements to the proposed approach?
- What background materials, presentations, or other resources will be helpful to you to prepare for the Meeting 8 discussions?

Segment 5: Next Steps

Co-Chairs Andy Kricun & Lisa Daniels
Rob Greenwood, Ross Strategic

Next Steps

- Prepare summary for meeting 7.
- Share Reference Table 3 with Working Group members for review.
- Schedule interim check-ins.
- Scheduling the Working Group meetings for the remainder of the year.

CLOSING REMARKS

CO-CHAIRS LISA DANIELS AND ANDY KRICUN

MEETING CLOSURE

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