U.S. EPA Area Wide Optimization Program (AWOP): Goals and Operational Guidelines for those Pursuing Optimization

Performance and Monitoring Goals

Category	System/ Source Water Type	Treatment Type	Monitoring		Goal Type		References
			Location	Parameter(s)	Performance	Monitoring	
Source Water	Subpart H Systems – all public water systems (PWSs) that use surface water (SW) or that use groundwater (GW) under the influence of SW (GWUDI)	All	Raw water (prior to treatment)	Turbidity	• No specific performance goal (source water turbidity is largely beyond the control of the PWS); rather, results of this monitoring inform settled water turbidity goals (described below)	• Record maximum daily raw water turbidity (as a microbial surrogate)	U.S. Environmental Protection Agency (2004)[a]
Source Water	Subpart H Systems (SW and GWUDI systems)	Slow Sand Filtration (SSF)	Raw water (prior to treatment)	Total coliforms (TC)	• Results of source water monitoring inform SSF treatment goals (described below)	• Measure TC by Most-Probable Number or Colony-Forming Units methods at least once per month during normal operation • Increase raw water TC monitoring frequency to weekly with significant changes in raw water quality (e.g., after storms, wildfires, changes to the source/watershed, seasonal changes, etc.)	U.S. Environmental Protection Agency (2024)[b]
Source Water	GW systems	All	Raw water (prior to treatment)	TC	• No TC present (or, alternatively, no indicator organisms) at any wells	• Conduct microbial monitoring at each well. TC method generally used, or a reliable method for coliphage or other virus indicators can be used as a surrogate • Initially monitor all wells monthly and then reduce monitoring (e.g., quarterly) at	Primacy agency implementation experience

Category	System/ Source Water Type	Treatment Type	Monitoring		Goal Type		References
			Location	Parameter(s)	Performance	Monitoring	
						wells where there is no indication of microbial contamination	
Treatment Disinfection/ Inactivation	All	All	Finished Water	Disinfection/ CT parameters	• Meet primacy agency's CT requirements plus a system-specific factor of safety (e.g., ≥ 10%) for Giardia and virus inactivation • Note: GW systems may only be required to provide virus inactivation, unless concerns exist about microbial contamination in the source	• Record minimum disinfectant residual, minimum temperature, maximum pH, and maximum flow daily	U.S. Environmental Protection Agency (2004)[a] Primacy agency implementation experience
Treatment Microbial removal	Subpart H Systems	Rapid Rate Filtration	Sedimentation Basin Effluent (all applicable locations)	Turbidity	• 95th percentile settled water turbidity ≤ 2.0 NTU when the annual average raw turbidity is > 10 NTU • 95th percentile settled water turbidity ≤ 1.0 NTU when the annual average raw turbidity is ≤ 10 NTU	• Record individual sedimentation basin effluent turbidity readings at intervals of 4-hours or less if taking grab samples, or 15-minutes or less for continuous monitoring. • Performance is assessed based on the daily maximum values from all recorded readings.	U.S. Environmental Protection Agency (2004)[a]
Treatment Microbial removal	Subpart H Systems	Rapid Rate Filtration	Individual Filter Effluent (IFE) and Combined Filter Effluent (CFE)	Turbidity	• 95th percentile CFE turbidity ≤ 0.10 NTU • 95th percentile IFE turbidity ≤ 0.10 NTU (excluding 15-minute period following filter backwash) • Post backwash IFE turbidity for filters without filter-to-waste capability: Maximum IFE turbidity following backwash ≤ 0.30 NTU and achieve ≤ 0.10 NTU within 15 minutes	• Record IFE and CFE turbidity readings at intervals of 1-minute or less for continuous monitoring • Performance is assessed based on the daily maximum values recorded from all readings	U.S. Environmental Protection Agency (2004)[a]

Category	System/ Source Water Type	Treatment Type	Monitoring		Goal Type		References
			Location	Parameter(s)	Performance	Monitoring	
					• Post backwash IFE turbidity for filters with filter-to-waste capability: Minimize IFE turbidity during filter-to-waste period and record maximum value. Return the filter to service at ≤ 0.10 NTU		
Treatment Microbial removal	All	Low pressure membrane filtration (MF/UF)	IFE	Indirect Integrity (turbidity or particle counts)	• 95th percentile IFE turbidity ≤ 0.05 NTU OR • Particle counts (1.0 – 3.0 µm) ≤ 10 particles/mL	• Measured continuously (≤ 1-minute intervals)	U.S. Environmental Protection Agency (2005)[c]
Treatment Microbial removal	All	MF/UF	Log Removal Value (LRV) determined for each membrane unit	Several parameters affect LRV determination, including flow rate, trans-membrane pressure, direct integrity test pressure decay, and water temperature	• $LRV_{ambient}$ ≥ 4.0-log AND • $LRV_{ambient}$ ≥ Log Removal Credit awarded by regulating agency	• LRV is determined after each daily direct integrity test.	U.S. Environmental Protection Agency (2005)[c]
Treatment Microbial removal	Subpart H Systems	SSF	IFE and CFE	Turbidity	• 95th percentile IFE & CFE turbidity ≤ 1.0 NTU AND • Maximum daily IFE and CFE turbidity ≤ 5.0 NTU	• Measure IFE and CFE turbidity at intervals of 1-minute or less for continuous monitoring	U.S. Environmental Protection Agency (2024)[b]
Treatment Microbial removal	Subpart H Systems	SSF	IFE and CFE	Microbial	• When raw water TC most probable number or colony-forming units≥ 100 / 100 mL, then IFE TC Most Probable Number or colony-forming units ≤ 10 / 100 mL	• Measure IFE and CFE TC by either Most Probable Number or colony-forming unit methods at least once per month during normal operation. Increase frequency to weekly with significant changes in raw water quality	U.S. Environmental Protection Agency (2024)[b]

Category	System/ Source Water Type	Treatment Type	Monitoring		Goal Type		References
			Location	Parameter(s)	Performance	Monitoring	
					• When raw water TC Most Probable Number or colony-forming units < 100 / 100 mL, then IFE TC ≤ 5 / 100 mL	(e.g., after storms, wildfires, changes to the source/watershed, seasonal changes, etc.)	
Treatment Microbial removal	Subpart H Systems	SSF	Plant Effluent	Microbial	• TC absent, whenever IFE or CFE turbidity > 1.0 NTU	• Measure TC (presence/ absence) weekly when IFE or CFE turbidity > 1.0 NTU	U.S. Environmental Protection Agency (2024)[b]
Treatment Disinfection Byproduct (DBP) Control	All	All	Untreated raw water and treated water	Total Organic Carbon (TOC) Removal	• Meet Stage 1 Disinfection/ Disinfection Byproducts (D/DBP) Rule TOC removal requirements for enhanced coagulation, which are based on source water alkalinity and TOC levels, or an alternative compliance criterion, as a running annual average (RAA) of the performance ratio (PR, actual/required removal) plus a factor of safety of 10% (or PR ≥ 1.1)	• Collect monthly raw and treated water TOC samples • Collect source water alkalinity	Stage 1 D/DBP Rule (1998)[d] Primacy agency implementation experience
Treatment DBP Control	All	All	Plant Effluent	DBPs	• Adopt system specific goals for DBPs which are either a discrete value or range, based on an RAA. Suggested goals may be 30% to 50% of long term locational running annual average (LRAA) goals (e.g., 20-30 ppb for total trihalomethanes (TTHM), 15-20 ppb for haloacetic acids (HAA5)).	• Collect quarterly TTHM and HAA5 samples at the plant effluent on the same day as distribution system (DS) compliance sites.	Water Research Foundation (2010)[e]
Treatment Disinfectant Residual Stability	All	Chloramine Systems	Plant Effluent	Free Ammonia	• Maintain a detectable free ammonia residual in the plant effluent ≤ 0.10 mg/L as NH_3-N	• Monitor free ammonia in the plant effluent on a routine basis (daily, at a minimum; more frequently if needed)	American Water Works Association (2013)[f]

Category	System/ Source Water Type	Treatment Type	Monitoring		Goal Type		References
			Location	Parameter(s)	Performance	Monitoring	
Distribution System (DS)	All	All	DS	Disinfectant Residual	At all monitoring sites: • 95th percentile ≥ 0.20 mg/L free chlorine residual in systems that use free chlorine as a secondary disinfectant OR • 95th percentile ≥ 1.50 mg/L monochloramine residual in systems that use chloramines as a secondary disinfectant	• Monitor disinfectant residual at bacteriological and DBP compliance sites, all active EPTDS, all storage tanks (preferably while draining), and at a minimum of four critical sites (one in each quadrant of the system) identified by investigative sampling. • Conduct monitoring at least monthly and more frequently during elevated water temperature.	American Water Works Association (2013)[f] American Water Works Association (2017)[g]
Distribution System (DS)	All	All	DS	DBPs	• Individual Site Goal: Quarterly maximum LRAA TTHM/HAA5 values not to exceed 70/50 ppb • Long-Term System Goal: Average of maximum LRAA TTHM/HAA5 values not to exceed 60/40 ppb (the average of the last 8 quarters cannot exceed 60/40 ppb)	• Collect quarterly DBP samples at all compliance locations at systems in compliance with the Stage 2 D/DBP Rule • Collect monthly DBP samples at all compliance locations at system not in compliance with the Stage 2 D/DBP Rule	Stage 2 D/DBP Rule (2006)[h] U.S. Environmental Protection Agency (2006)[i] U.S. Environmental Protection Agency (2019)[j]

Operational Guidelines

Type	System/ Source Water Type	Treatment Type	Monitoring		Goal Type		References
			Location	Parameter(s)	Performance	Monitoring	
Source	All	All	Raw Water	Assess potential oxidant demand	• Results of monitoring informs disinfection practices and related goals (below)	• Measure parameters that may exert an oxidant demand (e.g., manganese, iron, free ammonia, natural organic matter). May be done on a routine basis (e.g., weekly), or seasonally, as appropriate for the source.	Primacy agency implementation experience
Treatment	All	MF/UF	Filter influent and IFE	Recovery after cleaning as indicated by post clean-in-place (CIP) normalized permeability	• Post-CIP normalized permeability (or specific flux, M20) ≥ 90% of the Reference Permeability	• Determined after each CIP	U.S. Environmental Protection Agency (2005)[c]
Treatment	Subpart H Systems	SSF	IFE	Ripening as indicated by IFE TC, *E. coli*, and turbidity	• Filter-to-waste at least 24 hours AND until sampling demonstrates the following: ○ IFE TC Most Probable Number or colony-forming units ≤ 5 / 100 mL ○ IFE E. coli Most Probable Number or colony-forming unit absent (0/100 mL) • IFE turbidity ≤ 1.0 NTU	• Sample no earlier than 24 hours after the start of filtering to waste	U.S. Environmental Protection Agency (2024)[b]
Treatment	All	Chloramine Systems	Plant Effluent	Chlorine dose and residual, ammonia concentration	• Maintain a chlorine-to-nitrogen mass ratio between 4.5:1 and 5.0:1 (or chlorine-to-ammonia mass ratio between 3.7:1 and 4.1:1), which should result in a detectable free ammonia in the plant effluent that is ≤ 0.10 mg/L as NH3-N.	• Monitor applicable parameters on a daily (at a minimum) basis to ensure this is met	American Water Works Association (2013)[f]
Distribution System (DS)	All	Chloramine Systems	EPTDS and DS	Nitrification Indicators	• Maintain ≥ 1.50 mg/L monochloramine residual at all monitoring sites	• At a minimum, monitor at all active EPTDS and in the DS (see Disinfectant Residual Monitoring	American Water Works Association (2013)[f]

Type	System/ Source Water Type	Treatment Type	Monitoring		Goal Type		References
			Location	Parameter(s)	Performance	Monitoring	
						Goals for locations and frequency) for: ○ Monochloramine and free ammonia at sample locations where monochloramine is ≤ 1.50 mg/L; nitrate may also be monitored to further assess nitrification. ○ Consider additional Nitrification Monitoring Plan requirements	U.S. Environmental Protection Agency (2023)[k] See examples from Primacy agency implementation experience (refer to Illinois[l], Louisiana[m], Pennsylvania[n], and Texas[o])
Distribution System (DS)	Consecutive Systems	All	EPTDS	Disinfectant Residual and DBPs	• Establish disinfectant residual and DBP goals at EPTDS for consecutive systems, which provide water quality at levels that could meet disinfectant residual goals and the Long-Term System Goals for TTHM and HAA5.	• On a routine basis, monitor appropriate disinfectant residuals (e.g., free chlorine; or monochloramine and free ammonia for chloramine systems) and collect DBP samples. Refer to the Disinfectant Monitoring Goals and DBP Monitoring Goals for additional guidance.	U.S. Environmental Protection Agency (2019)[j] Primacy agency implementation experience
Distribution System (DS)	All	All	Storage tanks	Storage Tank level data, generally from PWS's SCADA	• Maintain an average turnover time < 5 days; or establish and maintain an acceptable water turnover rate at each storage facility to maintain water quality. • Maintain good mixing (i.e., PR* ≥ 1) at all times; for tanks where the PR cannot be calculated, adequate mixing (i.e., uniform water quality) should be confirmed by alternate means (e.g., tank profiling/water quality sampling).	• Establish a baseline and then assess tank turnover and mixing PR. Additional assessments should be done when tank demand changes, which may impact the frequency or span (i.e., minimum and maximum tank levels).	American Water Works Association Research Foundation (2000)[p] American Water Works Association Research Foundation (1999)[q]

Type	System/ Source Water Type	Treatment Type	Monitoring		Goal Type		References
			Location	Parameter(s)	Performance	Monitoring	
Distribution System	All	All	Distribution System	Pressure Management	• Minimum pressure: 20 psi for 99.5% of daily minimum daily readings • Maximum pressure: less that utility-set maximum for 95% of measurements • Pressure fluctuation range: less than utility-set pressure fluctuation range for 95% of measurements	• Permanent continuous pressure monitors should be installed at minimum and maximum pressure locations within each pressure zone.	Water Research Foundation (2010)[e]
Distribution System	All	All	Distribution System	Main Breaks Frequency	• ≤ 15 breaks and/or leaks per 100 miles of distribution system mains per year (excluding service lines and private mains). • Systems not meeting the ≤ 15 breaks per 100 miles of main per year are considered optimized if they have a 5-year declining trend.	• Maintain and track main break data to assess performance.	Water Research Foundation (2010)[e]

Acronym List (listed by appearance)

AWOP – Area-Wide Optimization Program
PWS – public water system
SW – surface water
GW – groundwater
GWUDI – groundwater under the influence of surface water
SSF – slow sand filtration
TC – total coliform
IFE – individual filter effluent
CFE – combined filter effluent
MF/UF – low pressure membrane filtration
LRV – log removal value
DBP – disinfection byproduct
TOC – total organic carbon
D/DBP – Disinfection/Disinfection Byproduct
RAA – running annual average
PR – performance ratio
LRAA – locational running annual average
TTHM – total trihalomethanes
HAA5 – haloacetic acids
DS – distribution system
EPTDS – entry point to the distribution system
CIP – clean-in-place

References

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[c] U.S. Environmental Protection Agency. (2005). *Membrane Filtration Guidance Manual.* Cincinnati, Ohio: U.S. Environmental Protection Agency. doi:EPA 815-R-06-009
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[f] American Water Works Association. (2013). *Manual of Water Supply Practices M56: Nitrification Prevention and Control in Drinking Water* (2nd ed.). Denver, Colorado: AWWA. doi:978-1-58321-935-5

[g] American Water Works Association. (2017). *Manual of Water Supply Practices M68: Water Quality in Distribution Systems* (1st ed.). Denver, Colorado: AWWA. doi:978-1-62576-226-9

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