

Sanitary Defects /Possible Cause(s) of TC+ and EC+	Conditions That May Point to Cause of TC+/EC+	Possible Corrective Action(s)
Biofilms	<ul style="list-style-type: none"> • Taste and odor complaints • Colored or turbid water that takes a long time to clear • Elevated HPC bacteria levels • Numerous isolates with similar genotypic profile 	<ul style="list-style-type: none"> • Conduct unidirectional flushing to remove biofilm and sediments from distribution system ensuring at least a 2.5 feet/second scouring velocity in the pipe being flushed. • Maintain adequate pressure in system to prevent sloughing of biofilm by installing booster pump stations, variable frequency drives (VFDs), elevated storage facilities, surge relief valves and surge tanks, and modifying high service pumps. Install automatic pressure monitoring and control. • Replace/rehabilitate pipe where biofilm sloughing is occurring. • Maintain disinfectant residuals in the distribution system. • Apply temporary disinfection, shock chlorination and/or booster disinfection in accordance with state guidelines. • Manage water age by looping dead ends; increasing volume turnover; and/or installing appropriate main sizes, automated flushing devices or mixing devices.
Contamination of water during main installation, repair or rehabilitation	<ul style="list-style-type: none"> • Break/repair activities that could have allowed entry of contaminants or dislodged accumulated pipe debris into water • Pressure loss associated with break • Low disinfectant residual Colored or turbid water 	<ul style="list-style-type: none"> • Apply temporary disinfection, shock chlorination and/or booster disinfection in accordance with state guidelines. • Review/enhance existing procedures for main installation, repair or rehabilitation procedures. Maintain adequate pressure in the system by installing booster pump stations, VFDs, elevated storage facilities, surge relief valves and surge tanks, and modifying high service pumps. Install automatic pressure monitoring and control.
Cross-connections	<ul style="list-style-type: none"> • Pressure loss event within a portion of the distribution system • Total coliform-positive samples occur at high elevation and/or low pressure location(s) Presence of a high-risk customer for backflow (e.g., industrial user) 	<ul style="list-style-type: none"> • Eliminate cross-connection. • Implement cross-connection control and backflow prevention (CCCBFP) program. Install adequate backflow prevention assemblies and devices. • Flush system (spot or routine). • Apply temporary disinfection, shock chlorination and/or booster disinfection in accordance with state guidelines. • Maintain adequate pressure in system to prevent backflow and backsiphonage by installing booster pump stations, VFDs, elevated storage facilities, surge relief valves and surge tanks, and modifying high service pumps. Install automatic pressure monitoring and control.

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Errors in the sampling protocol (i.e., proper sampling protocols were not followed – e.g., tap was not flushed, aerator was not removed, etc.)	<ul style="list-style-type: none"> Changes in sampler or protocol 	<ul style="list-style-type: none"> Review current protocol and if inadequate, identify alternate protocol. Enhance training on site preparation, flushing protocols and sanitary sample collection and transport procedures. Sanitize sample coolers and ice packs. Ensure that samples are shipped properly and securely (e.g., bottles do not tip or become contaminated during transport).
Inadequacies of the sample site (e.g., unsanitary conditions, leaks and breaches, unprotected access, improper construction, improper location)	<ul style="list-style-type: none"> Changes in sampling site use Presence of unsanitary conditions at the sampling site 	<ul style="list-style-type: none"> Develop a sample siting plan that is representative of the water quality in the distribution system. Install dedicated sampling taps. Correct leaks or other site deficiencies and breaches. Sanitize or replace sampling site.
Inadequate disinfectant residual levels in the distribution system	<ul style="list-style-type: none"> Variable raw and/or treated water quality conditions Inadequate disinfectant at entry point Inadequate disinfectant at booster stations Interruptions in disinfection processes Increases in temperature that lead to accelerated disinfectant decay 	<ul style="list-style-type: none"> Increase disinfectant feed at treatment plant. Manage water age by looping dead ends; increasing volume turnover; and/or installing appropriate main sizes, automated flushing devices or mixing devices. Install/upgrade on-line water quality monitoring and control. Flush system (spot or routine).
Intrusion through pipe leaks, pipeline fracture cracks, leaking joints, submerged air- vacuum/ air-release valves and deteriorating seals	<ul style="list-style-type: none"> Pressure loss or reduction in a portion of the distribution system Presence of leaks, cracks and other entry points High groundwater table and/or presence of sewers near the susceptible water main Numerous isolates with unique genotypic profile 	<ul style="list-style-type: none"> Repair/replace leaky component. Maintain adequate pressure in system by installing booster pump stations, VFDs, elevated storage facilities, surge relief valves and surge tanks, and modifying high service pumps. Install automatic pressure monitoring and control.
Pressure loss (can result from events such as flushing, main breaks, power outages, fires or improper operations and maintenance (O&M) practices	<ul style="list-style-type: none"> Recent maintenance activities, main breaks, power outages, fires Turbidity increase or fluctuations 	<ul style="list-style-type: none"> Flush distribution system (spot or routine). Increase disinfectant feed at treatment plant. Maintain adequate pressure by installing booster pump stations, VFDs, elevated storage facilities, surge relief valves and surge tanks, and modifying high service pumps. Improve O&M practices. Install automatic pressure monitoring and control.

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Sediment build-up in storage tank or reservoir	<ul style="list-style-type: none"> • Increased disinfectant demands • Increase in turbidity, particularly in water samples collected when tank is draining • Elevated HPC in samples from tank or reservoir • Low disinfectant residual in samples from tank or reservoir 	<ul style="list-style-type: none"> • Drain and flush tank or reservoir. Shock chlorination of tank or reservoir accordance with state guidelines.
Storage tank physical deficiencies like holes, inadequate screening, etc. (can allow entry of birds, animals, insects and other vectors that can fecally contaminate the water)	<ul style="list-style-type: none"> • Presence of physical deficiencies • Recent work on or near the tank • Recent vandalism, storm events or other events that could impact tank integrity 	<ul style="list-style-type: none"> • Repair broken parts of storage tank like the vent and hatch. • Repair / install screens. • Install / improve security measures.
Contamination during flushing/firefighting activities	<ul style="list-style-type: none"> • Turbidity increase or fluctuations • Color increase or fluctuations • Pressure fluctuations 	<ul style="list-style-type: none"> • Ensure unidirectional flushing approach is used for flushing program and that water quality objectives (i.e., chlorine, turbidity and iron) are met prior to terminating flushing.
Treatment breakthrough	<ul style="list-style-type: none"> • Variable raw and/or treated water quality conditions • Inadequate disinfectant at entry point • Elevated HPC bacteria levels occur throughout the distribution system 	<ul style="list-style-type: none"> • Increase disinfectant residual. • Flush system (spot or routine). • Assess performance of treatment processes and remedy cause of coliform breakthrough (e.g., replace filter, decrease particle loading, etc.).
Vandalism and/or unauthorized access to facilities	<ul style="list-style-type: none"> • Recent work or other events at a distribution system facility • Presence of broken or disabled security equipment 	<ul style="list-style-type: none"> • Flush system (spot or routine). • Install / improve security measures (e.g., install a fence, lock buildings, install alarms and cameras) • Develop and implement an operations plan. • Develop SOPs. • Develop emergency response plan.