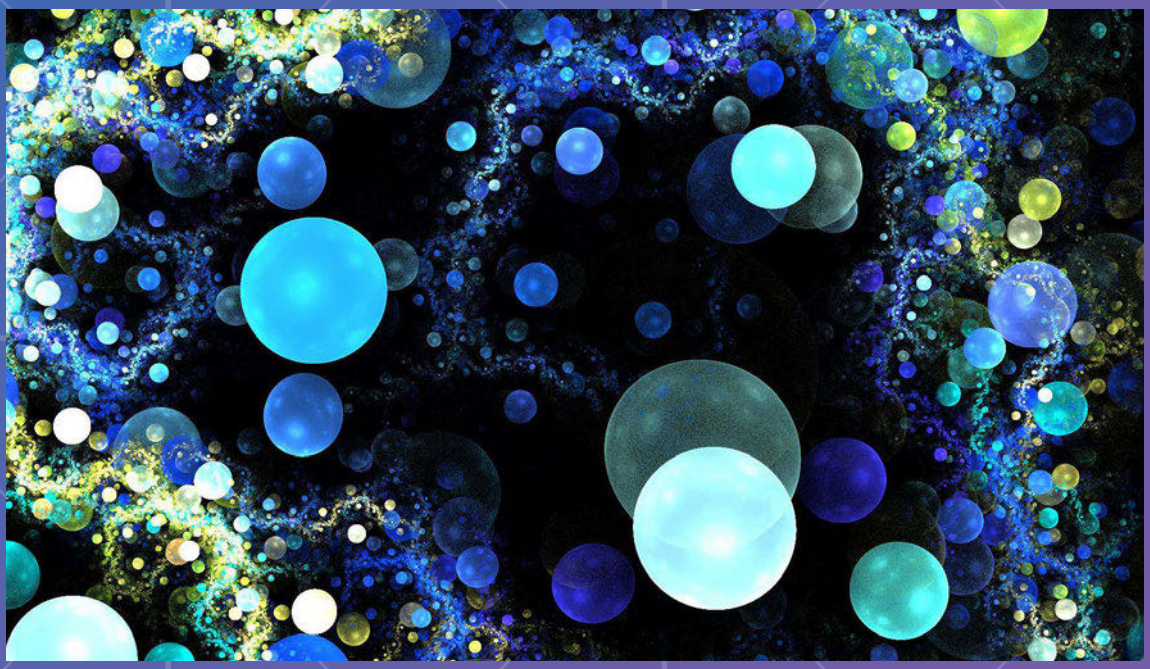
American Water Works Association

Manual of Water Supply Practices

M7

Fourth Edition



Nuisance Organisms in Water

Identification and Treatment

Manual of Water Supply Practices

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Nuisance Organisms in Water: Identification and Treatment

Fourth Edition

American Water Works Association®

Manual of Water Supply Practices—M7, Fourth Edition

Nuisance Organisms in Water: Identification and Treatment

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Preface

The drinking water community shares its water systems with a world of microscopic living creatures. Water professionals know that these organisms inhabit, grow, and potentially reproduce in source waters and throughout the treatment plant and distribution system. These creatures may contribute to numerous operational challenges, from problems in source water through finished water, including encrustation or corrosion within the water system and water quality problems at the customer's tap. This organism diversity makes it difficult for water treatment operators and water quality managers to be familiar with every organism. When problems arise, there is often no place for an operator and water quality manager to turn to for help. To address this gap, this manual provides information regarding nuisance organisms, the problems they cause, treatment options, and references to literature resources. It is intended to be a key reference for finding answers.

The third edition was a complete revision of AWWA Manual M7, which stemmed from the results of the 1989 AWWA Survey of Nuisance Organisms that demonstrated a need for information to help identify and control nuisance organisms. The difficulties identified in the survey were related to microorganisms that cause problems with plant operations or for customers because of undesirable tastes, odors, and color or their mere presence in what is supposedly a clean glass of water.

This fourth edition includes two new chapters, "Free-Living Protozoa" and "Invasive Aquatic Plant Species," as well as a new Taxonomy Overview. The protozoa chapter in previous editions focused on pathogenic protozoa. Because pathogenic protozoa are covered in AWWA's M48 Waterborne Pathogens manual, the chapter in Manual M7 was revised to focus on non-pathogenic or free-living protozoa. The addition of the "Invasive Aquatic Plant Species" chapter increases the Manual's applicability to source water protection and improvement. The Taxonomy Overview is designed to help operators and other water professionals recognize the relationships of organisms, which can provide a better understanding of the significance and control of the organisms in water supplies. This edition also clarifies "algae" by refocusing and expanding Chapter 10 to "Algae and Cyanobacteria." However, Chapter 10 is an introduction to the biology, ecology, and water treatment problems potentially caused by algae and cyanobacteria; readers are referred to M57 Algae: Source to Tap, which provides in-depth information and a comprehensive review of algae and cyanobacteria with respect to water treatment.

This edition of Manual M7 provides more robust information to operators and water quality managers by incorporating current taxonomic structure based on molecular studies; updated information on the significance to water supplies and control strategies; expanded references for each chapter; a new, detailed glossary; and a user-friendly troubleshooting guide (Appendix A).

Each chapter focuses on a type or category of nuisance organism that can impact drinking water in varying capacities. The chapters contain the environmental conditions, biology and ecology, identification, and characterization of the organism. In addition, significance to water supplies specific to each organism is covered with control strategies.

An outline of the nuisance organisms addressed and their respective significance to the water supply can be seen in FM-1.

Chapter	Nuisance Organism	Significance to Water Supply									
		T&O Issues	Fouling	Frothing	Corrosion	Physical Obstruction	WQ Issues	Harbor Pathogens	Visible Organisms	HABs	Indicator Organism
1	Actinomycetes	●									
2	Iron-oxidizing Bacteria	●	●	●	●	●	●				
3	Sulfur-related Bacteria	●	●		●	●	●				
4	Ammonia-oxidizing Bacteria				●		●				
5	Nematodes	●						●	●		
6	Bloodworms or Midges (Chironmid larvae)								●		
7	Crustacea						●	●	●		
8	Rotifers							●	●		●
9	Invasive Mussels	●				●			●		●
10	Algae & Cyanobacteria	●				●	●		●	●	●
11	Free-living Protozoa						●	●			
12	Invasive Aquatic Plant Species	●	●			●	●		●	●	

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Chapter 1

Actinomycetes

Beryl Zaitlin and Sue B. Watson

Actinomycetes are a diverse group of bacteria that are widespread in terrestrial and aquatic environments. A few actinomycetes are human pathogens, some produce antibiotics, and many play a major role in organic decomposition and nutrient recycling in the environment. Some actinomycetes—notably species of *Streptomyces*—produce taste and odor (T&O) compounds, especially geosmin and 2-methylisoborneol (2-MIB). These compounds have an earthy–muddy odor that can affect drinking water supplies and taint wild and farmed fish with off flavor. Effective control of actinomycetes and their effects on drinking water depend on accurate identification of these organisms and a basic understanding of their occurrence, biology, and odor production.

BIOLOGY AND ECOLOGY

Actinomycetes tolerate environmental extremes of temperature, pH, and salinity (Goodfellow and Williams 1983). Cold-tolerant forms are found in Arctic snow, lake ice, and permafrost. Alkali-tolerant, salt-loving, or salt-tolerant types have been isolated from sand dunes, alkaline soil, saline lakes, and salt marshes. Other actinomycetes are found in acidic environments including sediments, bogs, and peat lands. This tolerance of environmental extremes enables many actinomycetes to resist chemical treatment, biocides, and irradiation. Their wide tolerance and geographical range also mean that they can potentially affect drinking water sources in many regions and often occur within water treatment plants as part of the microbes associated with sand and carbon filters and distribution system biofilms.

Most actinomycetes can exist under low-oxygen environments but grow best under oxygenated conditions. The collective scientific literature indicates that actinomycetes are widely distributed within drinking water supplies from source to tap, but differences in methods used to enumerate and identify these bacteria make it difficult to resolve consistent patterns in their abundance and activity. Early studies using plate methods