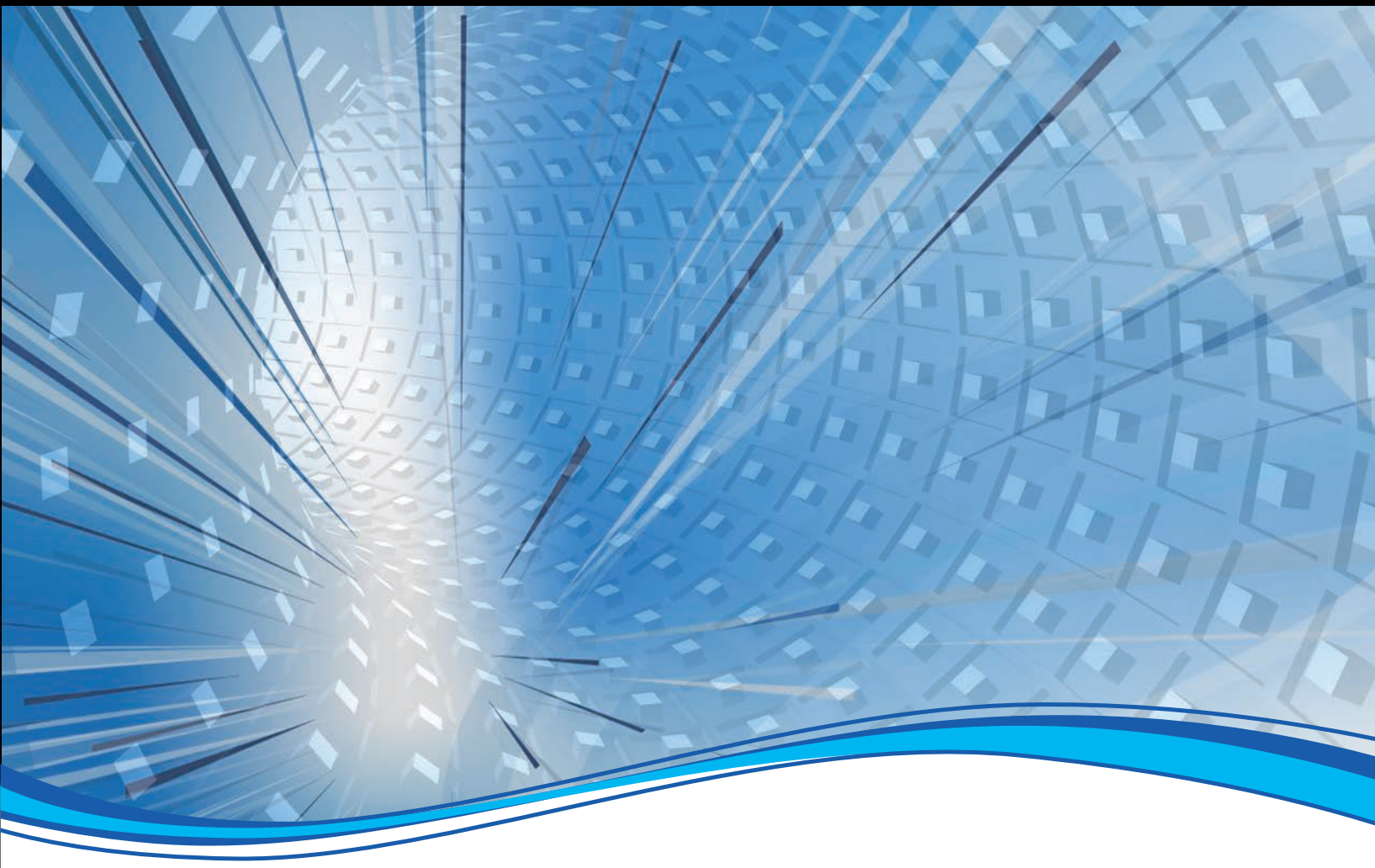
Manual of Water Supply Practices

M68

Water Quality in Distribution Systems



American Water Works Association

Manual of Water Supply Practices

M68

Water Quality in Distribution Systems

American Water Works Association

Manual of Water Supply Practices—M68

Water Quality in Distribution Systems

If you find errors in this manual, please email books@awwa.org. Possible errata will be posted at www.awwa.org/resources-tools/resource.development.groups/manuals-program.aspx.

Senior Managing Editor/Project Manager: Melissa Valentine
Cover art: Melanie Yamamoto
Production: Janice Benight
Manuals Specialist: Sue Bach

Library of Congress Cataloging-in-Publication Data

Names: Smith, Kira S., author. | Slabaugh, Rebecca, author. | American Water Works Association, issuing body.
Title: Water quality in distribution systems / by Kira S. Smith, Rebecca Slabaugh.
Other titles: AWWA manual ; M68.
Description: First edition. | Denver, CO : American Water Works Association, [2017] | Series: AWWA ; M68 | Includes bibliographical references and index.
Identifiers: LCCN 2017028391 | ISBN 9781625762269
Subjects: LCSH: Water quality management. | Water--Distribution.
Classification: LCC TD365 .S62 2017 | DDC 628.1/44--dc23 LC record available at https://lccn.loc.gov/2017028391

Printed in the United States of America

ISBN 978-1-62576-226-9 eISBN-13 978-1-61300-423-4

American Water Works Association

American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235-3098
awwa.org

Contents

This page intentionally blank.

Figures

This page intentionally blank.

Tables

This page intentionally blank.

Acknowledgments

The AWWA Manual M68 was written through the persistent and dedicated work of the following authors:

Kira S. Smith, *Manual Chair,*
City of Houston Drinking Water Operations, Houston, Texas

Nick Ashbolt, University of Alberta, Edmonton, Alb., Canada
Hélène Baribeau, AQUAlity Engineering, Arcadia, Calif.
Patrick Cole, H2M Architects and Engineers, Brielle, N.J.
Ricard Devesa, Aigues de Barcelona (Agbar), Barcelona, Spain
Andrea Dietrich, Virginia Tech, Blacksburg, Vir.
John Dyksen, SUEZ Water NA, North Haledon, N.J.
Kevin Fisher, Southern Nevada Water District, Las Vegas, Nev.
Peter Fiske, Lawrence Berkeley National Laboratory, Berkeley, Calif.
Melinda Friedman, Confluence Engineering Group LLC, Seattle, Wash.
Rich Giani, CH2M, Lees Summit, Mo.
Amlan Ghosh, Corona Environmental Consulting, Austin, Texas
Alex Gorzalski, US Army Corp of Engineers, Washington, D.C.
John Graham, California Water Service Co, Chico, Calif.
Ellen Hall, Hazen and Sawyer, Fairfax, Vir.
Amie Hanson, Confluence Engineering Group LLC, Seattle, Wash.
Adam Jacoby, Hatch Mott MacDonald, New York, N.Y.
Aneta King, Halton Regional Municipality, Oakville, Ont., Canada
Mark LeChevallier, American Water, Voorhees, N.J.
Dave MacNevin, Tetra Tech, Tampa, Fla.
Yvonne Mazza, CH2M, Lakewood, Colo.
Laura Meteer, Regional Municipality of York, Newmarket, Ont., Canada
Jack W. Moyer, AECOM Technical Services, Morrisville, N.C.
Andrew Ohrt, Arcadis, Minneapolis, Minn.
Susan Rivera, Central Washington University, Ellensburg, Wash.
Meg Roberts, Hazen and Sawyer, Greensboro, N.C.
Caroline Russell, Carollo Engineers, Austin, Texas
Janice Skadsen, Ann Arbor, Mich. (formerly with CDM Smith)
Rebecca Slabaugh, Arcadis, Indianapolis, Ind.
Justin Sutherland, Carollo Engineers, Inc., Austin, Texas
Alejandro Ureta, Asesoramiento a la Gestión de los Sistemas de Agua (AGeSA), Montevideo, Uruguay
Raj Vaidya, Chastain Skillman, Lakeland, Fla.
Francesc Ventura, IDAEA-CSIC, Barcelona, Spain
Jennifer Wade, Wachs Water Services, Buffalo Grove, Ill.

David Wahman, US Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio

Carol Walczyk, Hatch Mott MacDonald, Iselin, N.J.

Thomas M. Walski, Bentley Systems, Nanticoke, Pa.

Jian Yang, American Water–Engineering, Voorhees, N.J.

The following individuals provided peer review of this manual. Their knowledge and efforts are gratefully appreciated:

Colleen M. Arnold, Aqua America, Inc., Bryn Mawr, Pa.

Alicia Diehl, Texas Commission on Environmental Quality, Austin, Texas

Michelle De Haan, Park City MCWD, Park City, Utah

Tarrah Henrie, Corona Environmental, Fremont, Calif.

Randy Moore, Tnemic Company, Saint Louis, Mo.

Lauren Wasserstrom, AWWA, Denver, Colo.

The authors would also like to acknowledge the following individuals who provided editorial and technical comments:

Mike Duer, Tideflex, Carnegie, Penn.

Laith Furation, University of British Columbia, Vancouver, B.C., Canada

Mark Graves, HDR, Austin, Texas

Paul Handke, TideFlex, Venetia, Penn.

Katherine D. Martel, The Cadmus Group, Inc., Steep Falls, Me.

Dennis O'Connor, Philadelphia Water Department, Philadelphia, Pa.

The following individuals provided peer review of this manual. Their knowledge and efforts are greatly appreciated:

Tim Brown, Albermarle County Service Authority, Charlottesville, Vir.

Gary Burlingame, City of Philadelphia, Philadelphia, Pa.

Anne Camper, Montana State University, Bozeman, Mont.

Alan Degnan, Wisconsin State Lab of Hygiene, Sun Prairie, Wisc.

Paul Handke, TideFlex, Venetia, Penn.

Tarrah Henrie, Corona Environmental, Fremont, Calif.

Simon Horsley, Stantec, York, Ont., Canada

Kathy Martel, Cadmus Group, Steep Falls, Me.

Mark Pinkney, Ontario WaterMarks, Midland, Ont., Canada

Ravi Ravisangar, Brown and Caldwell, Atlanta, Ga.

Camille George Rubeiz, Plastics Pipe Institute, Irving, Texas

Robert Ryder, Kennedy/Jenks, San Francisco, Calif.

Charlotte Smith, Charlotte Smith and Associates, Berkley, Calif.

Tom M. Walski, Bentley Systems, Nanticoke, Penn.

Linda Wojcicka, Associated Engineering, Burnaby, B.C., Canada

Don Wood, KYPipe, Carrollton, Texas

This new manual was reviewed and approved by the Distribution System Water Quality Committee. Special thanks to the following committee members during the time of development and for review comments:

Rich Giani, Chair, CH2M, Kansas City, Mo.

Paul R. Easley, Central Arkansas Water, Little Rock, Ark.

Peter Fiske, Lawrence Berkeley National Laboratory, Berkeley, Calif.

Stewart Husband, Sheffield Water Centre, Western Bank, Sheffield, U.K.

Quirien Muylwyk, Toronto, Ont., Canada

Meg Roberts, former Chair, Hazen and Sawyer, Greensboro, N.C.

Susan Teefy, East Bay Municipal Utility District, Oakland, Calif.

Thomas M. Walski, Bentley Systems, Nanticoke, Pa.

This manual was also reviewed and approved by the Water Quality Technology Division under the Technical and Educational Council and included the following personnel at the time of approval:

Brent Alspach, Arcadis, Oceanside, Calif.

Glen Boyd, The Cadmus Group, Seattle, Wash.

George Di Giovanni, Metropolitan Water District of Southern California, La Verne, Calif.

Kimberly Kunihiro, Orange County Utilities-Water Division, Orlando, Fla.

Kerry Meyer, CH2M, Englewood, Colo.

Meg Roberts, Hazen and Sawyer, Greensboro, N.C.

Richard Sakaji, El Cerrito, Calif.

Jeff Swertfeger, Greater Cincinnati Water Works, Cincinnati, Ohio

David Wahman, US Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio

This page intentionally blank.

Chapter 1

Introduction

Kira S. Smith, City of Houston Drinking Water Operations, Houston, Texas

Rebecca Slabaugh, Arcadis, Indianapolis, Ind.

A drinking water distribution system is a system of pipes that carry potable water from treatment plants or water sources to consumers. It is also the last barrier available to water systems to maintain safe and high-quality water. This manual presents typical distribution system water quality challenges, providing summaries of typical responses and best practices as a "first stop" for drinking water system professionals.

Since each distribution system is unique, this manual is not intended to be all inclusive. Rather, it is a guide that summarizes the issues and actions to be taken when distribution system issues arise and provides references to other industry standards and publications that provide more detail. Additionally, this manual does not delve into treatment process or source water changes that can affect the quality of water that enters the distribution system. Readers are encouraged to familiarize themselves with the American Water Works Association (AWWA) standards and manuals of practice related to water source and treatment. These manuals are available for purchase online at http://www.awwa.org/publications/manuals-of-practice.aspx (accessed May 16, 2016).

For purposes of this manual, distribution systems include pump stations, ground and elevated storage tanks, potable water mains, potable water service lines, and all associated valves, fittings, and meters. Potable water customer service lines are excluded (Texas Commission on Environmental Quality 2015).

The chapters in this manual are organized based on the most common distribution system challenges that water systems face today. These are listed in Table 1-1.

Each chapter provides an introduction and description of a Distribution System Water Quality (DSWQ) Challenge, followed by:

- Discussion and description of the factors associated with each challenge. See text box(es) in each chapter for a summary of Characterizing the DSWQ Challenge;