

Prepared by the Task Committee on Water Pipeline Condition Assessment



# Water Pipeline Condition Assessment

Prepared by the Task Committee on Water Pipeline Condition Assessment

> Edited by George F. Ruchti Jr.

Sponsored by the Pipeline Division of the Utility Engineering and Surveying Institute of the American Society of Civil Engineers



Published by the American Society of Civil Engineers Reston, Virginia

#### Library of Congress Cataloging-in-Publication Data

Names: Ruchti, George F., editor. | Utility Engineering and Surveying Institute (American Society of Civil Engineers). Task Committee on Water Pipeline Condition Assessment, author. | Utility Engineering and Surveying Institute (American Society of Civil Engineers). Pipeline Division, sponsoring body. Title: Water pipeline condition assessment / prepared by the Task Committee on Water Pipeline Condition Assessment ; edited by George F. Ruchti Jr. ; sponsored by the Pipeline Division of the Utility Engineering and Surveying Institute of the American Society of Civil Engineers. Description: Reston, Virginia : The American Society of Civil Engineers, [2017] | Series: ASCE manuals and reports on engineering practice ; no. 134 | Includes index. Identifiers: LCCN 2017015211 | ISBN 9780784414750 (soft cover : alk. paper) | ISBN 9780784480588 (PDF) | ISBN 9780784480656 (ePUB) Subjects: LCSH: Water-pipes–Testing. | Water-pipes–Evaluation. Classification: LCC TD491.W378 2017 | DDC 621.8/672–dc23 LC record available at https:// lccn.loc.gov/2017015211

Published by American Society of Civil Engineers 1801 Alexander Bell Drive Reston, Virginia 20191-4382 www.asce.org/bookstore | ascelibrary.org

Any statements expressed in these materials are those of the individual authors and do not necessarily represent the views of ASCE, which takes no responsibility for any statement made herein. No reference made in this publication to any specific method, product, process, or service constitutes or implies an endorsement, recommendation, or warranty thereof by ASCE. The materials are for general information only and do not represent a standard of ASCE, nor are they intended as a reference in purchase specifications, contracts, regulations, statutes, or any other legal document. ASCE makes no representation or warranty of any kind, whether express or implied, concerning the accuracy, completeness, suitability, or utility of any information, apparatus, product, or process discussed in this publication, and assumes no liability therefor. The information contained in these materials should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing such information assumes all liability arising from such use, including but not limited to infringement of any patent or patents.

ASCE and American Society of Civil Engineers—Registered in U.S. Patent and Trademark Office.

*Photocopies and permissions.* Permission to photocopy or reproduce material from ASCE publications can be requested by sending an e-mail to permissions@asce.org or by locating a title in the ASCE Library (http://ascelibrary.org) and using the "Permissions" link.

Errata: Errata, if any, can be found at https://doi.org/10.1061/9780784414750.

Copyright © 2017 by the American Society of Civil Engineers. All Rights Reserved. ISBN 978-0-7844-1475-0 (print) ISBN 978-0-7844-8058-8 (PDF) ISBN 978-0-7844-8065-6 (ePUB) Manufactured in the United States of America.

24 23 22 21 20 19 18 17 1 2 3 4 5

Cover photo: Courtesy of Pure Technologies U.S.

## MANUALS AND REPORTS ON ENGINEERING PRACTICE

(As developed by the ASCE Technical Procedures Committee, July 1930, and revised March 1935, February 1962, and April 1982)

A manual or report in this series consists of an orderly presentation of facts on a particular subject, supplemented by an analysis of limitations and applications of these facts. It contains information useful to the average engineer in his or her everyday work, rather than findings that may be useful only occasionally or rarely. It is not in any sense a "standard," however; nor is it so elementary or so conclusive as to provide a "rule of thumb" for nonengineers.

Furthermore, material in this series, in distinction from a paper (which expresses only one person's observations or opinions), is the work of a committee or group selected to assemble and express information on a specific topic. As often as practicable the committee is under the direction of one or more of the Technical Divisions and Councils, and the product evolved has been subjected to review by the Executive Committee of the Division or Council. As a step in the process of this review, proposed manuscripts are often brought before the members of the Technical Divisions and Councils for comment, which may serve as the basis for improvement. When published, each work shows the names of the committees by which it was compiled and indicates clearly the several processes through which it has passed in review, so that its merit may be definitely understood.

In February 1962 (and revised in April 1982), the Board of Direction voted to establish a series titled "Manuals and Reports on Engineering Practice," to include the Manuals published and authorized to date, future Manuals of Professional Practice, and Reports on Engineering Practice. All such Manual or Report material of the Society would have been refereed in a manner approved by the Board Committee on Publications and would be bound, with applicable discussion, in books similar to past Manuals. Numbering would be consecutive and would be a continuation of present Manual numbers. In some cases of joint committee reports, bypassing of Journal publications may be authorized.

A list of available Manuals of Practice can be found at http://www.asce.org/ bookstore.

This page intentionally left blank

## **CONTENTS**

PR	EFACE		ix
AC	CKNOV	VLEDGMENTS	xi
1.	INTR	ODUCTION	1
	1.1	Condition Assessment	2
	1.2	Pertinent Websites	6
	1.3	Related Documents	7
	1.4	Acronyms	7
2.	DATA COLLECTION AND MANAGEMENT		
	2.1	Data Management	11
	2.2	Historical Documents	12
	2.3	Condition Assessment Reports	12
3.	PLANNING		
	3.1	Documentation of Pipeline Assets	20
	3.2	Prioritization and Scheduling	21
	3.3	Planning Condition Assessment Logistics	27
4.	PIPE MATERIALS: CAST IRON AND DUCTILE IRON		
	4.1	History	30
	4.2	Condition Issues	32
	4.3	Condition Assessment Techniques	37
	4.4	Condition Determination	38
	4.5	Rehabilitation Practices	39
		References	41
5.	PIPE MATERIALS: CONCRETE		
	5.1	History	43
	5.2	Condition Issues	49

### CONTENTS

	5.3	Inspection Procedures	52
	5.4	Condition Assessment	53
	5.5	Rehabilitation Practices	54
		References	56
6.	PIPE I	MATERIALS: STEEL	57
	6.1	History	58
	6.2	Condition Issues	61
	6.3	Inspection Procedures	63
	6.4	Condition Determination	64
	6.5	Rehabilitation Practices	65
		References	66
7.	PIPE I	MATERIALS: FIBERGLASS	67
	7.1	History	67
	7.2	Condition Issues	69
	7.3	Inspection Procedures	71
	7.4	Condition Determination	72
	7.5	Repair Practices	73
		References	77
8.	PIPE I	MATERIALS: POLYVINYL CHLORIDE	79
	8.1	Introduction	79
	8.2	History	83
	8.3	Condition Issues	84
	8.4	Inspection Procedures	87
	8.5	Condition Determination	87
	8.6	Rehabilitation Practices	87
		References	88
9.	PIPE I	MATERIALS: ASBESTOS CEMENT	89
	9.1	History	90
	9.2	Condition Issues	92
	9.3	Inspection Procedures	96
	9.4	Rehabilitation Practices and Repair Mechanisms	100
		References	101
10.	PIPE	INSPECTION TOOLS	103
	10.1	Inspection Techniques for Low Risk Pipelines	103
	10.2	Inspection Techniques for Medium Risk Pipelines	114
	10.3	Inspection Techniques for High Risk Pipelines	121
	10.4	Recent Developments in Condition Assessment Tools	
		and Technologies	131
		References	133
11.	CON	DITION ASSESSMENT REPORT	135
	11 1	Introduction	135

### CONTENTS

	11.2	Summary of Field Testing Program	137
	11.3	Data Analysis	138
	11.4	Structural Analysis	139
	11.5	Risk Ranking Analysis	142
	11.6	Using the Condition Assessment Report	145
12.	CASE STUDIES		149
	12.1	Weber Basin Water Conservancy District, Utah:	
		Water Supply Aqueducts Condition Assessment	
		Using Multiple Inspection Technologies	150
	12.2	Miami-Dade Water and Sewer Department, Florida:	
		Pipediver Inspection	157
	12.3	Tarrant Regional Water District, Texas: Condition-Based	
		Maintenance of a Water Transmission System	159
	12.4	San Diego County Water Authority, California:	
		Magnetic Flux Leakage Inspection	170
	12.5	Pinellas County Utilities, Florida: Subaqueous Pipeline	
		Inspection	173
	12.6	Dallas Water Utilities, Texas: Water Management	
		Program	186
	12.7	City of Houston Department of Public Works and	
		Engineering, Texas: Rehabilitation of 60-Year-Old	
		Cast Iron Water Line	189
IND	<b>DEX</b>		199

vii

This page intentionally left blank

## PREFACE

This Manual of Practice provides an investigator with an appropriate path to adequately determine the structural status of an individual pipeline or pipeline system. The manual provides recommendations and information to assist in a detailed approach to prioritize a program and develop an accurate determination of the condition of the individual pipelines. With an understanding of the structure of such a program, understanding the nature of the materials to be evaluated, the tools available for the evaluation, and what information the findings should provide, the Water Pipeline Condition Assessment report can and should provide critical input to an asset management program.

The "Introduction" walks the reader through the steps to achieve this goal and provides the framework for this manual. The next chapters provide information on the type of reporting that utilities should be implementing and the planning that then goes into the structure of the condition assessment. Six chapters, written by experts in each material, discuss pipeline materials including cast iron, ductile iron, concrete (all variations), steel, fiberglass, PVC, and asbestos cement pipe. Although repair, rehabilitation, or replacement of the individual materials is not a function of the condition assessment, they are an important part of an asset management program; therefore, information on each product has been provided for assistance. "Pipe Inspection Tools" deals with the various tools available for the assessment, for which materials they can be used, and what they can and cannot accomplish. The Condition Assesment Report chapter provides an understanding of the results that should be expected, and the "Case Studies" provide guidance from actual projects covering the majority of the pipe products that have been available.