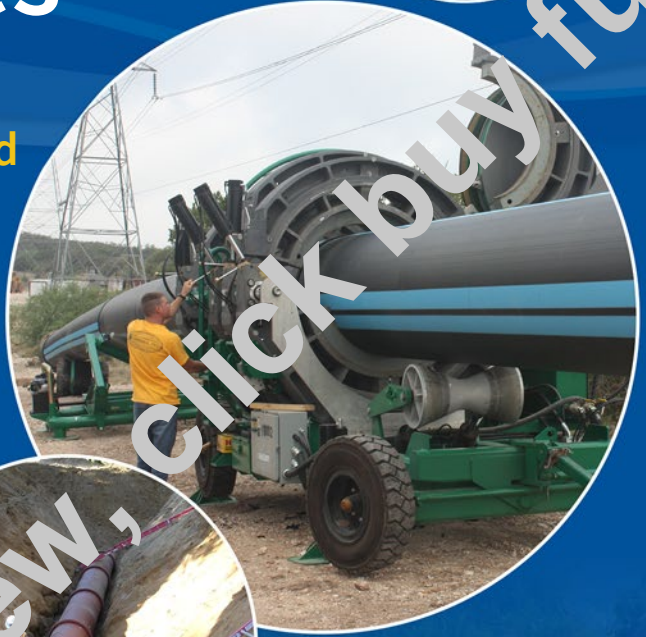


Sustainable Design of Pipelines

Guidelines for Achieving Advanced Functionality



Task Committee on the Sustainable Design of Pipelines

EDITED BY

Walt Schwarz, P.E.
Patrick White, P.E., ENV SP
Mark S. Mihm, P.E., ENV SP



UTILITY ENGINEERING
& SURVEYING
INSTITUTE

Sustainable Design of Pipelines

fully in preview, click buy full

Other Titles of Interest

Design of Close-Fit Liners for the Rehabilitation of Gravity Pipes, edited by Norman E. “Ed” Kampbell, P.E. and Jadranka Simicevic (ASCE/UESI 2021). MOP 145 provides a comprehensive explanation of the design of flexible, close-fit linings for the renewal or rehabilitation of pipes designed for gravity flow such as sanitary sewers, culverts, and storm sewers (978-0-7844-1580-1).

Pipe Ramming: Second Edition, by the Pipe Ramming Task Force of the Trenchless Installation of Pipelines (TIP) Committee of the Utility Engineering and Surveying Institute; edited by Glenn M. Boyce (ASCE/UESI 2020). MOP 115 presents the latest and best practices for the design and construction of road and railroad crossings using pipe ramming technologies (978-0-7844-1560-3).

Hazard-Resilient Infrastructure: Analysis and Design, edited by Bilal M. Ayyub (ASCE/IRD 2021). MOP 144 provides guidance and underlying framework for creating consistency across hazards, systems, and sectors in the design of new infrastructure systems and in enhancing the resilience of existing ones (978-0-7844-1575-7).

Sustainable Procurement for Infrastructure, edited by Nancy Kralik and Jeremy Chrzan (ASCE 2020). This report presents an overview of the implementation of sustainability principles in the procurement process (978-0-7844-8310-7).

Engineering for Sustainable Communities: Principles and Practices, edited by William E. Kelly, Barbara Luce, and Richard N. Wright (ASCE 2017). *Engineering for Sustainable Communities: Principles and Practices* defines and outlines sustainable engineering methods for real-world engineering projects (978-0-7844-1811-1).

Sustainable Design of Pipelines

Guidelines for Achieving Advanced Functionality

Edited by
Walt Schwarz, P.E.
Patrick J. White, P.E., ENV SP
Mark S. Mihm, P.E., ENV SP

Prepared by the
Task Committee on the Sustainable Design of Pipelines

Sponsored by the
Pipelines Division of the Utility Engineering and Surveying Institute



UTILITY ENGINEERING
& SURVEYING
INSTITUTE

Library of Congress Cataloging-in-Publication Data

Names: Utility Engineering and Surveying Institute (American Society of Civil Engineers). Task Committee on the Sustainable Design of Pipelines, author. | Schwarz, Walt, editor. | White, Patrick (Civil engineer), editor. | Mihm, Mark S, editor. | Utility Engineering and Surveying Institute (American Society of Civil Engineers). Pipeline Division, sponsoring body.

Title: Sustainable design of pipelines : guidelines for achieving advanced functionality / edited by Walt Schwarz, P.E., Patrick White, P.E., and Mark S. Mihm, P.E. ; prepared by the Task Committee on the Sustainable Design of Pipelines ; sponsored by the Pipelines Division of the Utility Engineering and Surveying Institute.

Description: Reston, Virginia : American Society of Civil Engineers, [2022] | Series: ASCE manuals and reports on engineering practice no. 151 | Includes bibliographical references and index. | Summary: "MOP 151 details the sustainable design and construction of pipelines and presents methods, practices, and decisions that influence and guide sustainable planning, design, construction, and operation, including the Envision infrastructure sustainability rating system"-- Provided by publisher.

Identifiers: LCCN 2021048139 | ISBN 9780784415979 (print) | ISBN 9780784483862 (PDF)

Subjects: LCSH: Pipelines--Design and construction. | Sustainable construction.

Classification: LCC TJ930 .U855 2022 | DDC 621.8/672--dc23/eng/2021112

LC record available at <https://lcn.loc.gov/2021048139>

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 informational only and do not represent a standard of ASCE, nor are they intended as a reference for 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, method, 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 US Patent and Trademark Office.

Photocopying and permissions. Permission to photocopy or reproduce material from ASCE publications can be requested by sending an email to permissions@asce.org or by locating a title in the ASCE Library (<https://ascelibrary.org>) and using the "Permissions" link.

Errata: Errata, if any, can be found at <https://doi.org/10.1061/9780784415979>.

Copyright © 2022 by the American Society of Civil Engineers.

All Rights Reserved.

ISBN 978-0-7844-1597-9 (print)

ISBN 978-0-7844-8386-2 (PDF)

ISBN 978-0-7844-8424-1 (ePub)

Manufactured in the United States of America.

27 26 25 24 23 22 1 2 3 4 5

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 manual 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>.

Full text in preview, click buy full

CONTENTS

PREFACE	x
ACKNOWLEDGMENTS	xiii
1. INTRODUCTION AND BACKGROUND	1
1.1 Background.....	1
1.2 Manual of Practice Organization.....	2
1.3 Concept of Sustainability.....	5
1.4 Sustainability and Practice	12
1.5 Manual of Practice General Objectives.....	13
References	16
2. PIPELINE PRODUCTS	17
2.1 Scope Limitations and Purpose	18
2.2 Product Sustainability Assessment	19
2.3 Installation	29
2.4 End of Life	30
2.5 Summary.....	30
References	30
3. OWNER BEST PRACTICES	33
3.1 Introduction.....	34
3.2 Project Definition and Scoping	35
3.3 Community/Social Sustainability Leadership.....	37
3.4 Project Leadership Management.....	38
3.5 Long-Term Planning.....	39
3.6 Procurement Management	39
3.7 Design/Construction Leadership	40
3.8 Conclusions	41

4. PLANNING AND DESIGN BEST PRACTICES.....	43
4.1 Introduction.....	43
4.2 Planning Considerations	45
4.3 Project Influencers	46
4.4 Owner Goals.....	47
4.5 Higher Levels of Sustainable Achievement.....	53
4.6 Conclusion	56
References.....	56
5. SUSTAINABLE CONSTRUCTION.....	57
5.1 Introduction.....	57
5.2 Designer-Influenced Practices	58
5.3 Contractor-Influenced Practices	60
5.4 Sustainable Construction Methods.....	60
5.5 Summary.....	79
References.....	79
6. BEST PRACTICES—OPERATION AND MAINTENANCE.....	81
6.1 Introduction.....	81
6.2 Testing	81
6.3 Maintenance	82
6.4 General Maintenance Activities.....	83
6.5 Rehabilitation	84
6.6 Monitoring.....	85
6.7 Asset Management.....	85
6.8 Data Collection.....	86
6.9 Condition Assessment Methods.....	87
6.10 Pipeline Inspections.....	88
6.11 Determining Cathodic Protection Performance.....	88
6.12 System Optimization.....	89
6.13 Reduce Third-Party Damage	90
6.14 Reduce Outages and Catastrophic Failures.....	91
6.15 Summary.....	91
7. LIFE CYCLE INVENTORY/LIFE CYCLE ANALYSIS: ACHIEVING SUSTAINABLE FUNCTIONALITY IN PIPELINE DESIGN AND MANUFACTURING.....	93
7.1 Introduction.....	93
7.2 Standard History and Methodology.....	93
7.3 Cradle to Grave.....	94
7.4 Water/Wastewater Infrastructure	95
7.5 Social and Environmental Costs.....	96
7.6 Pipe Diameter.....	96

7.7	Owner Costs	96
7.8	Environmental Costs—The Envision Rating System	97
7.9	Social Costs	98
7.10	Life-Cycle Cost Analysis	98
7.11	Reducing Social Costs	98
7.12	Conclusions	99
8.	ENVISION PROJECT RATING SYSTEM.....	101
8.1	Background and Development	101
8.2	Rating System Purpose and Goals	102
8.3	Organization and Structure	102
8.4	Project Scoring and Guidance	105
8.5	Envision Implementation	113
8.6	Applicable Features for Pipeline Design and Construction	119
8.7	Summary	121
	Reference	122
	APPENDIX A: PIPE STANDARDS, DESIGN MANUALS, AND GUIDELINES.....	123
A.1	Relevant Standard Development Organizations	123
A.2	Concrete Pipe	123
A.3	Ductile Iron Pipe	124
A.4	Fiber-Reinforced Thermosetting Resin Pipe	125
A.5	Polyethylene Pipe	125
A.6	Polyvinyl Chloride (PVC) Pipe	126
A.7	Steel Pipe	127
A.8	Vitrified Clay Pipe	128
	APPENDIX B: PIPE MATERIALS RESOURCE INFORMATION.....	129
B.1	Polyvinyl Chloride Pipe	129
B.2	Concrete Pipe	135
B.3	Vitrified Clay Pipe	142
B.4	Fiberglass Pipe (AWWA C950).....	148
B.5	Cast Iron Water Pipe	153
B.6	Polyethylene Pipes (AWWA C906).....	158
B.7	Ductile Iron Pipe (ANSI/AWWA C151/A21.51)	162
	References	169
	APPENDIX C: ENVISION PIPELINE PROJECT EXAMPLE.....	171
C.1	Envision Project Example	171
C.2	Benefits from Using Envision	177
C.3	Methodology to Prepare an Envision Application	178
C.4	Strategy to Achieve an Envision Award.....	182

C.5 Lessons Learned from Preparing and Envision	
Application	184
C.6 Conclusion	186
Reference.....	186
INDEX	187

PREFACE

This Manual of Practice (MOP) was developed for sustainable design and construction of pipelines and presents methods, practices, and decisions that influence and guide sustainable planning, design, construction, and operation. The contents of the MOP are based on the principles of sound engineering practice but use the framework of an infrastructure sustainability rating system, Envision, to provide a more quantitative decision-making process and to include focus on potential project considerations that may not be typically considered. Envision® is a product of the Institute for Sustainable Infrastructure (ISI), an independent entity formed as a result of joint cooperation among ASCE, the American Public Works Association (APWA) and the American Council of Engineering Companies (ACEC).

Envision was discussed and its applicability and features appropriate to pipeline design and construction evaluated. The Task Committee on the Sustainable Design of Pipelines (SDP) recognized the value of the already developed Envision rating system and used it as a framework for developing the process and methodology of sustainable pipeline design. The MOP goes beyond what Envision currently includes related to pipelines and develops chapters as listed in the Table of Contents.

VISION

This manual is intended to be a resource guideline for those interested promoting sustainability in the development, construction, and operation of pipeline projects and was developed as an MOP for project proponents, consultants, government agencies, and others who are not familiar with sustainability practices as they may be applied to pipeline technologies and for those who engage in the practice of pipeline development on a daily basis.

It is not the purpose of this MOP to promote the development of pipeline projects that will “save the world” or debate the causes or the potential effects of climate change. Rather the goal is to provide guidance for those in the pipeline industry, such as engineers, contractors, and particularly pipeline owners, to promote the inclusion of project considerations that go beyond the typical domain of what can be a relatively mundane, single-purpose project to include components that reduce life-cycle costs, as well as adverse impacts to society and the environment. In some cases, a pipeline project may be able to be planned and developed to include benefits beyond the basic purpose of the pipeline.

It is important to not only develop a pipeline project with sustainable components that serve to maintain or enhance economic, social, and environmental considerations but also develop a pipeline project that has increased resilience to the potentially damaging impacts of climate change. Without considering the cause or duration of climate change, there is little doubt that the planet is currently in a cycle of increasing sea-level rise and the associated potential for flooding as well as an increase in storm intensity that can affect the long-term performance of the constructed project if they are not considered as part of the system design. As discussed later in this MOP, such considerations are a crucial factor for the overall life-cycle cost of a project.

This MOP will provide the pipeline professional with guidance and processes that allow for the considerations and trade-offs necessary to produce the most-sustainable overall project design. For the most part, the processes are not prescriptive, but rather serve to provide the resources needed to balance the project requirements that result in the least overall impact for the functional life cycle of the project. The purpose of the MOP is not to describe how to successfully rate a project under Envision but rather to take the concepts of the Envision system and incorporate them into the design process. The MOP uses the concept of Life-Cycle Analysis (LCA) to develop project life-cycle costs in a more rigorous evaluation of a project’s total carbon footprint and impact of the triple bottom line. The ability to successfully rate a project under Envision is a value added that project proponents can use to promote their efforts.

ACKNOWLEDGMENTS

ASCE and the Utility Engineering and Surveying Institute (UESI) acknowledge the work of the Task Committee on the Sustainable Design of Pipelines. This committee was formed from a diverse group of municipal government utility engineers, design and consulting engineers, pipe manufacturers, and academia and research associations. This manual was prepared by a committee as part of the following organizational structure:

Task Committee on the Sustainable Design of Pipelines

Walt Schwarz, P.E., F.ASCE, Jacobs (retired), *Chair*

Patrick J. White, P.E., ENV SP, F.ASCE, Jacobs, *Vice Chair*

Mark S. Mihm, P.E., ENV SP, M.ASCE, Dallas Water Utilities, *Secretary*

Lead Chapter Contributors

Chapter 1: Introduction and Background—Walt Schwarz, P.E., F.ASCE, Jacobs (retired)

Chapter 2: Pipeline Products—Bob Walker, P.E., L.ASCE, Underground Solutions, and Gregg Horn, P.E., M.ASCE, DIPRA

Chapter 3: Owner Best Practices—Matt Gaughan, P.E., M.ASCE, Plus Six Engineering

Chapter 4: Planning and Design Best Practices—Patrick J. White, P.E., ENV SP, F.ASCE, Jacobs, and Randall C. Hill, P.E., F.ASCE, Consultant

Chapter 5: Sustainable Construction—Mark S. Mihm, P.E., ENV SP, M.ASCE, Dallas Water Utilities, and Dr. Mohammad Najafi, Ph.D., P.E., M.ASCE, CUIRE/University of Texas Arlington

Chapter 6: Best Practices—Operations and Maintenance—Mike Leathers, Pipeline Plastics, LLC and Richard Mueller, P.E., F.ASCE, ACPPA

Chapter 7: Life Cycle Inventory/Life-Cycle Analysis: Achieving Sustainable Functionality in Pipeline Design and Manufacturing—Richard Mueller, P.E., F.ASCE, ACPPA, and Mike Leathers, Pipeline Plastics, LLC

Chapter 8: Envision Project Rating System—Alan Hutson, P.E., ENV SP, M.ASCE, Freese & Nichols

Appendix A: Pipe Standards, Design Manuals, and Guidelines

Appendix B: Pipe Materials Resource Information

Appendix C: Envision Project Example—Elizabeth Blackwelder, P.E. ENV SP, M.ASCE, Black and Veatch Corp.

Members

Sam Arnaout	Shelly Hattan	Mohammad Najafi
Ron Bishop	Randy Hill	Kim Paggioli
Elizabeth Blackwelder	Gregg Horn	Sri Rajah
Joe Castronovo	Alan Hutson	Shah Rahman
Allen Cox	Jeff LeBlanc	Camille Rubeiz
Vic Degrande	Mike Leathers	Walt Schwarz
Peter Dyke	Karen Lively	Larry G. Tolby
Matt Gaughan	Mark Mihm	Robert Walker
Wayne Geyer	Richard Mueller	Patrick J. White
Sharon Hamilton		

Internal Committee Reviewers

Shelly Hattan, Sharon Hamilton, Shah Rahman, and Larry G. Tolby

Blue Ribbon Review Committee

Dave Reardon, P.E., ENV SP, M.ASCE, HDR (retired), *Chair*
 William (Bill) Wallace, Wallace Futures, Inc.
 William (Bill) Bertera, ISI (retired)
 Fran Eide, P.E., ENV SP, City of Olympia

Pipeline Location and Installation Technical Committee

Sri Rajah, Ph.D., P.E., ENV SP, F.ASCE, CDM Smith, *Chair*
 Walt Schwarz, P.E., F.ASCE, Jacobs (retired), *Vice Chair*

CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1 BACKGROUND

In recent years, the idea that development and building construction could continue without regard to available resources and impacts on the environment and society has rapidly given way to an increased understanding that we cannot continue to consume resources both locally and globally without regard to their replacement. These considerations apply to the primary raw materials required to complete a construction or development project, as well as secondary and tertiary considerations such as impacts on the environment, displacement of other functionalities, or changes in the quality of life for those in close proximity to the project. For better or worse, the concepts of “green” living and sustainable growth have become popular buzzwords around the world and have assumed a political tone that often detracts from the ability to do the right thing.

The groundwork for these concepts dates back several decades. In the United States, the 1970 National Environmental Policy Act formally established as a national goal the creation and maintenance of conditions under which humans and nature “can exist in productive harmony, and fulfill the social, economic and other requirements of present and future generations of Americans.”

Globally, the concept of sustainable design and construction is attributed to a report prepared for the United Nations by the Brundtland Commission in 1987, which states, “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Over the last 30 to 40 years, the concept of sustainability has evolved to reflect the differing and not always compatible perspectives of the public