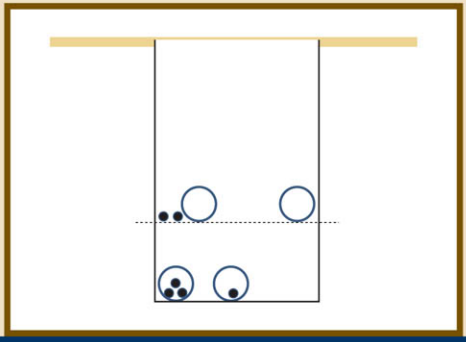
ASCE Manuals and Reports on Engineering Practice No. 118

Belowground Pipeline Networks for Utility Cables



ASCE

ASCE Manuals and Reports on Engineering Practice No. 118

Belowground Pipeline Networks for Utility Cables

Prepared by
the Pipeline Planning and Design Committee and
the Underground Pipeline Asset Management Committee of
the Pipeline Division of
the American Society of Civil Engineers

Edited by
Lawrence M. Slavin, Ph.D.

ASCE American Society of Civil Engineers

Library of Congress Cataloging-in-Publication Data

Belowground pipeline networks for utility cables / prepared by the Pipeline Planning and Design Committee and the Underground Pipeline Asset Management Committee of the Pipeline Division of the American Society of Civil Engineers; edited by Lawrence M. Slavin.
p. cm.—(ASCE manuals and reports on engineering practice; no. 118)
Includes bibliographical references and index.
ISBN 978-0-7844-1055-4
1. Electric conduits. 2. Underground pipelines. 3. Underground utility lines. 4. Underground electric lines. I. Slavin, Lawrence M. II. American Society of Civil Engineers. Pipeline Planning and Design Committee. III. American Society of Civil Engineers. Underground Pipeline Asset Management Committee. IV. Title: Below ground pipeline networks for utility cables.
TK3261.B45 2009
621.319′23—dc22

2009025132

Published by American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia 20191

www.pubs.asce.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. This information should not be used without first securing competent advice with respect to its suitability for any general or specific application. Anyone utilizing this 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 reprints. You can obtain instant permission to photocopy ASCE publications by using ASCE's online permission service (http://pubs.asce.org/permissions/requests/). Requests for 100 copies or more should be submitted to the Reprints Department, Publications Division, ASCE (address above); e-mail: permissions@asce.org. A reprint order form can be found at http://pubs.asce.org/support/reprints/.

Copyright © 2009 by the American Society of Civil Engineers.
All Rights Reserved.
ISBN 978-0-7844-1055-4
Manufactured in the United States of America.

16 15 14 13 12 11 10 09 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 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, in order that its merit may be definitely understood.

In February 1962 (and revised in April 1982) the Board of Direction voted to establish a series entitled "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 reports of joint committees, bypassing of Journal publications may be authorized.

MANUALS AND REPORTS ON ENGINEERING PRACTICE CURRENTLY AVAILABLE

No.	*Title*
40	Ground Water Management
45	Consulting Engineering: A Guide for the Engagement of Engineering Services
49	Urban Planning Guide
50	Planning and Design Guidelines for Small Craft Harbors
54	Sedimentation Engineering
57	Management, Operation and Maintenance of Irrigation and Drainage Systems
60	Gravity Sanitary Sewer Design and Construction, Second Edition
62	Existing Sewer Evaluation and Rehabilitation
66	Structural Plastics Selection Manual
67	Wind Tunnel Studies of Buildings and Structures
68	Aeration: A Wastewater Treatment Process
71	Agricultural Salinity Assessment and Management
73	Quality in the Constructed Project: A Guide for Owners, Designers, and Constructors
77	Design and Construction of Urban Stormwater Management Systems
80	Ship Channel Design
81	Guidelines for Cloud Seeding to Augment Precipitation
82	Odor Control in Wastewater Treatment Plants
84	Mechanical Connections in Wood Structures
85	Quality of Ground Water
91	Design of Guyed Electrical Transmission Structures
92	Manhole Inspection and Rehabilitation, Second Edition
93	Crane Safety on Construction Sites
94	Inland Navigation: Locks, Dams, and Channels
95	Urban Subsurface Drainage
97	Hydraulic Modeling: Concepts and Practice
98	Conveyance of Residuals from Water and Wastewater Treatment
100	Groundwater Contamination by Organic Pollutants: Analysis and Remediation
101	Underwater Investigations
103	Guide to Hiring and Retaining Great Civil Engineers
104	Recommended Practice for Fiber-Reinforced Polymer Products for Overhead Utility Line Structures
105	Animal Waste Containment in Lagoons
106	Horizontal Auger Boring Projects
107	Ship Channel Design and Operation
108	Pipeline Design for Installation by Horizontal Directional Drilling
109	Biological Nutrient Removal (BNR) Operation in Wastewater Treatment Plants
110	Sedimentation Engineering: Processes, Measurements, Modeling, and Practice
111	Reliability-Based Design of Utility Pole Structures
112	Pipe Bursting Projects
113	Substation Structure Design Guide
114	Performance-Based Design of Structural Steel for Fire Conditions
115	Pipe Ramming Projects
116	Navigation Engineering Practice and Ethical Standards
117	Inspecting Pipeline Inatallation
118	Belowground Pipeline Networks for Utility Cables

PREFACE

This manual was prepared by the Task Committee on Belowground Pipeline Networks for Utility Cables of the ASCE Pipeline Planning and Design Committee and of the ASCE Underground Pipeline Asset Management Committee, in a cooperative effort, under supervision of the Pipeline Division. The manual provides a general overview of methods for placing utility cables belowground, including formal underground conduit systems and relatively low-cost direct-buried facilities, with emphasis on a belowground cable network that represents a cost-effective and space-efficient installation. The Pipeline Planning and Design Committee, under the leadership of Chairman Sam A. Arnaout, in cooperation with the Underground Pipeline Asset Management Committee, under the leadership of Chairman Thomas D. Iseley, are responsible for the efforts leading to this publication. The committees would like to thank contributors, task committee members, and reviewers, whose names follow, for their support, time, and effort. The Task Committee chairmen greatly appreciate the support and guidance provided by the U.S. Department of Transportation and the FHWA Turner–Fairbank Highway Research Center.

Lawrence M. Slavin, Task Committee Chair
Oleh Kinash, Task Committee Co-Chair
ASCE Belowground Pipeline Networks for Utility Cables

ACKNOWLEDGMENTS

CONTRIBUTORS

Lawrence M. Slavin, Ph.D., Chair
Outside Plant Consulting Services, Inc.

Oleh Kinash, Ph.D., Co-Chair
IUPUI—Purdue School of Engineering & Technology

Mohammad Najafi, Ph.D., P.E., Vice Chair
The University of Texas at Arlington

Samir A. Arnaout, P.E.
Hanson Pressure Pipe

Tom Iseley, Ph.D., P.E.
IUPUI—Purdue School of Engineering & Technology

Stephen Boros
Plastics Pipe Institute

Thomas Marti, P.E.
Underground Solutions, Inc.

BLUE RIBBON REVIEWERS

James Anspach, P.G., Chair, ASCE Construction Institute Construction Standards Council
Terry McArthur, HDR
Tom Stewart, A-D Technologies

PIPELINE DIVISION EXECUTIVE COMMITTEE

Mohammad Najafi, Ph.D., P.E., *Chair*
John D. Hair, P.E., *Vice Chair*
Michael T. Stift, P.E., *Past Chair*
Terry McArthur, P.E., *Secretary*
Tim Stinson, P.E.
Joe Castronovo, P.E., *Senior Advisor*

Contents

1 INTRODUCTION....1

1.1 Scope....1
1.2 Background....2

2 UNDERGROUND CONDUIT SYSTEMS....7

2.1 General....7
2.2 Design and Construction Requirments....9
2.3 Operation and Maintenance....24
2.4 Issues....28

3 DIRECT-BURIED SYSTEMS....31

3.1 General....31
3.2 Design and Construction Requirments....34
3.3 Operation and Maintenance....54
3.4 Issues....54

4 CABLE INSTALLATION METHODS IN DUCT....57

4.1 Pulling....57
4.2 Pushing....64
4.3 Blown Cable....65

5 HYBRID BELOWGROUND CABLE NETWORKS....71

5.1 Background....71
5.2 Description of the Example BCN....72

5.3 Duct Installation....82
5.4 BCN Hardware Requirments....85
5.5 BCN Management and Operations....91

6 STATUS OF BELOWGROUND CABLE NETWORKS 95

6.1 Description....95
6.2 Field-Fused PVC Pipe....97
6.3 HDD Operation....97
6.4 Mitchell Street....102
6.5 South Davis Drive....104
6.6 Intersection of Mitchell Street and South Davis Drive....106
6.7 Completion....107

GLOSSARY....109

REFERENCES....115

INDEX....119

1
INTRODUCTION

1.1 SCOPE

Underground pipes, or conduits, represent a routine means of installing and protecting cables, including telephone, cable television (CATV), and electric power supply lines. An array of such pipes, often encased in concrete, is typically part of a formal conduit network, including manholes placed at access points along the route, and is commonly used in urban areas and other locations for which the periodic placement of such cables is planned or anticipated. In contrast, the use of individual pipes or ducts placed in a trench, similar to direct-buried[1] cables is less common, but has occasionally been used by individual utilities to provide a degree of upgrade capability not otherwise provided by conventional, low-cost, direct-buried construction methods. Such applications have not been used on a routine or coordinated basis among the utilities, although such utility companies may be sharing a single, joint-use trench. In the present context, *joint-use* refers to the sharing of aboveground or belowground facilities by several utilities or organizations using cables, such as electric power and communication (telephone or CATV) companies.

The objective of this book is to present a brief description of present and past practices for the placement of utility cables belowground, including conventional underground conduit systems and direct-buried methods, as well as more recent techniques in which individual pipes or ducts may be advantageously deployed in conjunction with direct-buried cables. Related design, construction, and operational requirements and

[1]See the Glossary for the definition of terms used throughout this book.

guidelines are also provided. Finally, specific design and implementation information is provided for a cost-effective, space efficient hybrid joint-use system for utility cables that provides many advantages relative to previous or existing methods of belowground construction. In general, however, it is not the intention of this book to provide or duplicate existing detailed design, construction, or installation specifications and information as currently used by the various utilities for their belowground cable facilities. Such information is available within the individual utilities or their representative organizations. Although much of the information in this book is applicable to a variety of applications, some of the information tends to be more appropriate for specific portions of the power and communication networks, e.g., the local distribution system toward the customer end of the network.

The book is divided into six chapters. This chapter includes a description of the general categories of construction methods relevant to utility cables. Chapter 2 provides a description of underground conduit systems, including an overview of installation, operation, and maintenance procedures. Chapter 3 provides analogous information for direct-buried systems, including the limited use of pipes or ducts. A description of various methods for installing cables within ducts is contained in Chapter 4, which also includes an explanation of basic engineering principles governing such installations. Chapter 5 presents a detailed description of a particular example of a belowground cable network (BCN), including related planning, design, maintenance, and management rules for this hybrid system, which combines the advantages of direct-buried and underground conduit construction methods. Chapter 6 reviews the status of the described BCN, including the results of recent field applications and anticipated future introduction into industrial applications. A glossary of terms and a list of references are provided at the end of the book. This manual is useful for new and experienced engineers alike in road and community construction, as well as utility owners, contractors, municipalities, other project owners, and other industry professionals. It provides both introductory and specific design and construction information to support the implementation of the proposed hybrid belowground cable network.

1.2 BACKGROUND

There are basically three modes of construction for outside plant facilities for communication and electric power supply lines. These are the following:

1. aerial or overhead plant in which the cables are individually suspended between utility poles placed on the order of 100 to 300 ft apart,