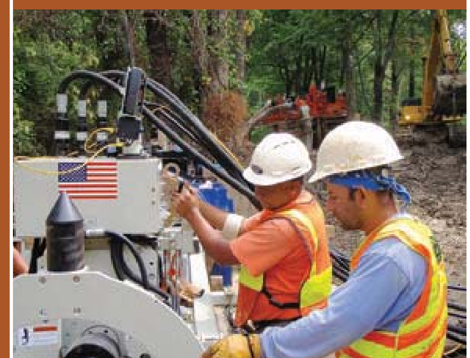
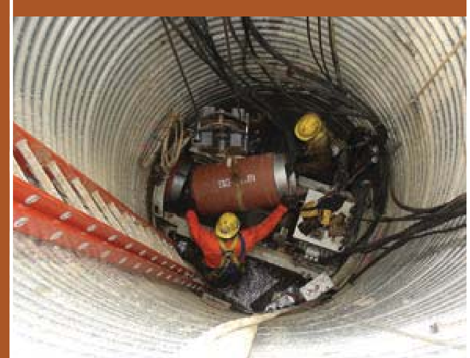
on Engineering Practice No. 133





Pilot Tube and Other Guided Boring Methods

PREPARED BY
Task Committee on Pilot Tube and Other Guided Boring Methods

ASCE

UTILITY ENGINEERING & SURVEYING INSTITUTE

ASCE Manuals and Reports on Engineering Practice No. 133

Pilot Tube and Other Guided Boring Methods

Prepared by
Task Committee on Pilot Tube and Other Guided Boring Methods of the
Committee on Trenchless Installations of Pipelines of the
Utility Engineering and Surveying Institute of the
American Society of Civil Engineers

Published by the American Society of Civil Engineers

Library of Congress Cataloging-in-Publication Data

Names: Utility Engineering and Surveying Institute (American Society of Civil Engineers). Task Committee on Pilot Tube and Other Guided Boring Methods, author.
Title: Pilot tube and other guided boring methods / prepared by Task Committee on Pilot Tube and Other Guided Boring Methods of the Committee on Trenchless Installations of Pipelines of the Utility Engineering and Surveying Institute of the American Society of Civil Engineers.
Description: Reston, Virginia : American Society of Civil Engineers, [2017] |
Series: ASCE manuals and reports on engineering practice ; no. 133 |
Includes bibliographical references and index.
Identifiers: LCCN 2017010889| ISBN 9780784414743 (paperback : alk. paper) |
ISBN 9780784480571 (PDF) | ISBN 9780784480663 (ePUB)|
Subjects: LCSH: Underground pipelines–Equipment and supplies. | Tubes. | Underground pipelines–Design and construction. | Directional drilling–Equipment and supplies. |
Trenchless construction. | Boring.
Classification: LCC TJ933 .P48 2017 | DDC 621.8/672–dc23 LC record available at https://lccn.loc.gov/2017010889

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

Errata: Errata, if any, can be found at http://dx.doi.org/10.1061/9780784414743

ISBN 978-0-7844-1474-3 (paper)
ISBN 978-0-7844-8057-1 (PDF)
ISBN 978-0-7844-8066-3 (ePUB)
Manufactured in the United States of America.

21 20 19 18 17 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, 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

This page intentionally left blank

PREFACE

This manual of practice was prepared by the Task Committee on Pilot Tube and Other Guided Boring Methods of the ASCE Committee on Trenchless Installation of Pipelines (TIPS), as part of the Utility Engineering & Surveying Institute (UESI). The manual describes the current pilot tube and other guided boring methods used by engineers and construction professionals in designing and installing pipelines to a design line and grade under roads, railroads, streets, and other constructed and natural structures and obstacles.

This manual of practice has been created by a group of engineers, owners, suppliers, manufacturers, and contractors fully knowledgeable of the method and its use. This manual takes into account many of the advances that have occurred over the years in the guiding of trenchless methods. Many of the sections provide a summary of the state of the industry as of 2016. The task committee acknowledges that the technology continues to change and that changes in construction continue to develop.

Sections have been written assuming the reader may be new to the various construction methods included in this manual. No document including this one can encompass all of the issues on a particular pilot tube or other guided boring project. Improvements in best practices and technology continue to evolve so quickly that consideration of this manual on any project must take into account not only the specific characteristics of the particular project but also further improvements in best practices and technology.

The engineer of a pipeline project is encouraged to consider all trenchless methods before concluding that the pilot tube and/or other guided boring methods are the most suitable construction methods available. Manuals and reports on engineering practice (known as *MOPs*) have been written by ASCE for different construction methods. A list of useful references is provided at the end of Chapter 1.

If the engineer responsible for the pipeline project does not have a strong background in trenchless design, an engineering firm that specializes in trenchless designs should be consulted to provide a peer review early in the planning/design process to help ensure good design choices are being made.

ACKNOWLEDGMENTS

The American Society of Civil Engineers (ASCE) and the Utility Engineering & Surveying Institute (UESI) acknowledge the work of the Task Committee on Pilot Tube and Other Guided Boring Methods. This group comprises individuals from many backgrounds, including design and consulting engineering, the construction industry, equipment and pipe manufacturing, academia, and government.

Principal authors:

Jeffrey J. Boschert, P.E., *Task Committee Secretary*
Glenn M. Boyce, Ph.D., P.E.
Dennis J. Doherty, P.E.
Andrew Finney, P.E., G.E., P.Eng.
Mohammad Najafi, Ph.D., P.E., *Task Committee Chair*
Richard Palmer, P.E.
Troy Stokes
Nick Strater, P.G.

Other individuals who served and contributed:

Don Bergman
Richard Botteicher
Mark Bruce
Ralph Carpenter
David Crandall
Brian Dorwart, P.E.
Jason Holden, P.E.
Daniel L. Liotti, P.E.
Shah Rahman
Rick Turkopp, P.E.
Camille Rubeiz

Thank you to the Blue Ribbon Review Committee who reviewed the finished document and provided their comments:

Jason Lueke, Ph.D., P.Eng., *Chair*
Maynard Akkerman
Alan Atalah, Ph.D., P.E.
Lester M. Bradshaw Jr.
Craig Camp

Thank you to Julie McCullough for providing technical editing, Niloofar Rezaei and Nader Mavaddat for editorial review, and Laura Anderson, Yovani Zelaya, and Jon Clugston for graphic support.

The task committee would like to acknowledge the support provided by the following companies, association, and university:

Akkerman
Brierley Associates
CUIRE at the University of Texas at Arlington
CH2M
Haley & Aldrich
McMillen Jacobs Associates
National Clay Pipe Institute
Northeast Remsco Construction, Inc.

ASCE Committee on Trenchless Installation of Pipelines (TIPS):

Chair: Jeffrey J. Boschert, P.E.
ExCom Liaison: Tennyson Muindi, P.E.

ABBREVIATIONS AND ACRONYMS

AAA	American Arbitration Association
ADR	alternative dispute resolution
AIME	American Institute of Mining, Metallurgical and Petroleum Engineers
ANSI	American National Standards Institute
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BVR	boulder volume ratio
CCTV	closed-circuit television
CFR	Code of Federal Regulations
CPT	cone penetration testing
CVR	cobble volume ratio
DI	ductile iron
DM	design memoranda
DMP	deformation monitoring points
DRB	dispute review boards
DIN	Deutsches Institut für Normung; in English, the German Institute for Standardization
DSC	differing site conditions
EBR	environmental baseline report
EN	European Norme; in English, European Standard
EPDM	ethylene propylene diene monomer
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FRPM	fiberglass-reinforced polymer mortar
GBR	geotechnical baseline report

GDM	geotechnical design memorandum
GDR	geotechnical data report
GDSR	geotechnical design summary report
GIR	geotechnical interpretative report
GSI	geological strength index
HDD	horizontal directional drilling
HDPE	high-density polyethylene
ID	inside diameter
IJS	intermediate jacking stations
ISRM	International Society for Rock Mechanics
LED	light-emitting diode
MOP	Manual and Report on Engineering Practice
MSDS	material safety data sheets
MUTCD	Manual of Uniform Traffic Control Devices
NASTT	North American Society for Trenchless Technology
NSF	National Sanitation Foundation
OD	outside diameter
OSHA	Occupational Safety and Health Administration
PC	polymer concrete
PCH	powered cutterhead
PPE	personal protective equipment
PRH	powered reamer head
PVC	polyvinyl chloride
Q	flow capacity or system for classification of rock mass
QA	quality assurance
QC	quality control
QLA	Quality Level A
QLB	Quality Level B
QLC	Quality Level C
QLD	Quality Level D
RC	reinforced concrete
RDA	rock drill adapter
RMR	rock mass rating
RQD	rock quality designation
SAT	soil abrasion test
SDS	safety data sheets
SI	International System of Units
SMP	structural monitoring points
SPT	standard penetration test
TBM	tunnel boring machine
TM	technical memoranda
UCS	unconfined compressive strength
UMP	utility monitoring points
VC	vitrified clay

CHAPTER 1
INTRODUCTION

Utilities of various types, sizes, and purposes are installed below the surface routinely in every community around the world. The pipelines are the infrastructure that provides our homes, our office buildings, our schools, and other structures with waste removal via sanitary sewers, stormwater drainage, potable water, gas, recycled water, irrigation, electricity, communication, and cable TV (as listed in order of most common current usage).

These pipelines can be installed by a variety of construction methods, with the most common being open trench excavation. The pipelines can be found anywhere, but are typically installed within the rights-of-way of our roads, streets, and highways. As new pipelines are installed below the surface and more utilities are abandoned, the density of the underground infrastructure increases. As the amount of traffic increases on the road surfaces, access to the subsurface also decreases. Installing new infrastructure and pipelines within an existing right-of-way has become more difficult. However, not all pipelines can be installed by open trench excavation. The pipeline industry has adopted and now offers increasingly sophisticated solutions to meet the challenges of installing pipelines in congested, urban environments around the world. Because these new construction solutions/methods do not rely on digging a trench, the methods are known as trenchless methods.

Some of the more widely used trenchless methods for new utility installations are (as listed alphabetically)

- Guided boring through nondisplaceable soils or rock;
- Guided boring using a pilot tube;
- Horizontal auger boring;
- Horizontal directional drilling (HDD);

- Impact moling;
- Microtunneling;
- Pipe jacking;
- Pipe ramming; and
- Utility tunneling.

Trenchless methods are often attractive to project owners and often required by regulatory agencies and property owners because they generally result in fewer impacts to the surface, existing structures, and infrastructure than do traditional open trench excavations. Aboveground effects are reduced because only shafts, pits, or portals have to be excavated rather than a continuous trench. Underground impacts are reduced because the pipe can be installed without excavating the otherwise conflicting underground utilities or surface structures. The application of certain trenchless methods enables alignment control in established corridors and rights-of-way that are becoming more congested. In general, the benefits of trenchless construction methods can be summarized as follows:

- Safer for the public;
- Lowers social and economic effects;
- Minimizes environmental effects including carbon footprint;
- Reduces traffic effects;
- Allows for deeper installations without significant increases in the cost;
- Mitigates impacts to existing surface and subsurface infrastructure;
- Addresses potentially challenging subsurface conditions such as soft or loose soil, rock, or the groundwater table;
- Allows more freedom in alignment selection within or outside of established rights-of-way; and
- Reduces project duration or work content.

Trenchless design is much more sensitive to subsurface conditions than open trench excavation. It is usually more difficult, costly, and time-consuming to adapt trenchless methods to unexpected ground conditions than it is to adapt open trench excavations; primarily because when trenchless methods are used, the material being excavated is not visible or directly accessible. When using trenchless methods, it is critical to conduct a thorough geotechnical and subsurface investigation to determine, among other things, geology, ground type and anticipated behavior, groundwater, and the presence of buried objects placed naturally or as a remnant of past construction. The anticipated conditions affect the selection of the trenchless method, the design layout, and even the contract provisions.

The basic design process for a trenchless project should include identifying and understanding project requirements, owner design requirements, third-party requirements, ground conditions, and risks and risk tolerance. This information is then used in the design phase to select the most suitable trenchless method; provide a well-thought-out design that minimizes the risks; mitigate the controllable risks; identify potential claims and address them; and prepare contract clauses that help allocate risks and manage disputes.

The decision to use a trenchless method, and the selection of a particular method from those available, should be made methodically and systematically and be based on project requirements. Trenchless methods, equipment, and guidance systems have improved and changed over time, and contractors have continued to apply innovative new techniques to construction. Therefore, it is important for design engineers to remain current with all available trenchless methods to systematically evaluate options. Regardless of the trenchless method selected, adherence to the following guidelines can reduce project cost, schedule, and risk:

- Use uniform outside diameters (ODs) to the extent possible;
- Use similar drive lengths to the extent possible;
- Keep drive lengths within practical limits;
- Minimize the number of shafts;
- Locate shafts at typical maintenance access points; and
- Evaluate alternative alignments.

As noted already, there are a number of different trenchless methods available to engineers and contractors. These trenchless methods use different means to excavate and support the ground and install the pipeline, offering different capabilities on pipe size, pipe material, or need for a casing; drive length; installation above or below the groundwater table; installation at a precise line and grade for gravity flow within the pipeline; and installation of the pipeline directly (one-pass process) or with a casing (two-pass process).

Table 1-1 summarizes the typical pipe sizes, installation lengths, ability to install pipelines above or below the groundwater table, ability to install pipelines at a precise line and grade, and ability to install the carrier pipe directly for the more common trenchless methods. The pipe sizes and drive lengths reflect increases that have occurred as the industry has matured. However, it is important to remember that the emphasis should always be placed on managing risk first, not matching or exceeding lengths accomplished in the past. Actual and perceived risks directly increase an owner's cost.

This manual and report on engineering practice (MOP) focuses specifically on the pilot tube and other guided boring methods. The chapters in this manual will describe the following:

- Chapter 2: The pilot tube and other guided boring methods in detail;
- Chapter 3: Planning;