Pipeline Engineering-Water – Body of Knowledge for Board Certification

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Pipeline Engineering-Water Body of Knowledge (PLWBOK)

Abstract

The Pipeline Engineering-Water Body of Knowledge (PLWBOK) describes the knowledge and core competencies integral to achieving expertise in the practice of Pipeline Engineering-Water as demonstrated through attainment of the credential. The objective of this document articulates the body of knowledge for the practice of Pipeline Engineering-Water. The PLWBOK describes the knowledge and skills required to practice Pipeline Engineering-Water at the expert level. The PLWBOK is based on and builds upon the American Society of Civil Engineers (ASCE) Body of Knowledge 3rd edition (CEBOK3) for the practice of Civil Engineering, of which Pipeline Engineering-Water is a part. The typical path to fulfill these outcomes is through a combination of bachelor's degree-level coursework, postgraduate level coursework, mentored professional experience, continued self-development, and adherence to the ASCE Code of Ethics (see detailed eligibility requirements on the "Eligibility" section of the program website). **The PLWBOK outlines the content included in the written exam for board-certification in Pipeline Engineering-Water (BC.PLW) and is utilized by the Utility Engineering & Surveying Certification Board (UESCB) to help evaluate candidates for board certification.**

Pipeline Engineering-Water BOK (PLWBOK)

The Pipeline Engineering-Water Body of Knowledge (PLWBOK) is to be used by certification applicants to help them understand the content of the written, computer-based exam for board-certification in Pipeline Engineering-Water (BC.PLW).This document will be used by the UESCB evaluation committee to evaluate a candidate's technical expertise, experience and education and determine if they qualify for certification upon passage of the written exam.

The intent of the PLWBOK is not to establish a checklist of requirements, but to provide a template by which the UESCB has developed examination content.

The American Society of Civil Engineers Civil Engineering Body of Knowledge, third edition, (CEBOK3), lists the outcomes necessary for professional licensing in 21 categories. The CEBOK3 outlines 21 foundational, technical, and professional practice learning outcomes for individuals entering responsible charge in the practice of civil engineering. Pipeline Engineering-Water Certification requires the same levels as the CEBOK3 plus mastery of at least one advanced technical outcome in Pipeline Engineering-Water under CEBOK3 outcomes 5 through 21.

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Table ES-1. *Civil Engineering Body of Knowledge* Outcomes.

Foundational	Engineering Fundamentals
Mathematics	Materials Science
Natural Sciences	Engineering Mechanics
Social Sciences	Experiment Methods and Data Analysis
Humanities	Critical Thinking and Problem Solving
Technical	**Professional**
Project Management	Communication
Engineering Economics	Teamwork and Leadership
Risk and Uncertainty	Lifelong Learning
Breadth in Civil Engineering Areas	Professional Attitudes
Design	Professional Responsibilities
Depth in a Civil Engineering Area	Ethical Responsibilities
Sustainability	

American Society of Civil Engineers. (2019). *Civil engineering body of knowledge for the 21st century: Preparing the future civil engineer* (3rd ed.). Table ES-1.

Mastery of an outcome means the engineer has reached the level of expertise such that more challenging, complex, and difficult problems may be solved than can be addressed by an ordinarily competent licensed engineer.

Mastery of an outcome can be demonstrated by planning, designing, constructing, operating, managing, regulating, or researching Pipeline Engineering-Water projects of geographic or type diversity at the expert level with increasing levels of responsibility and difficulty, teaching advanced courses on these outcomes, authoring or co-authoring papers and contributing to books, and developing the profession, such as through society committees, on these outcomes. Mastery may be manifested as exceptional expertise in a single area or as recognized expertise in multiple outcomes.

Pipeline Engineering-Water Job Role

Below is a description of the job role of Pipeline-Engineering Water for which this certification recognizes: Pipeline Engineers Water play a critical role in planning, designing, assessing, inspecting, constructing, and maintaining the conveyance of water-based liquids by pipeline systems, including related appurtenances. Water-based liquids include, but are not limited to, potable water, raw water, process water, reclaimed water, sanitary sewage, and surface drainage through storm sewers or culverts. This includes new construction by trenching methods or by trenchless technology and pipeline assessment and rehabilitation for both gravity and pressure pipelines.

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Pipeline Engineering-Water Technical Knowledge and Skills

PLWBOK Domains (Exam Topic Areas) and References

Pipeline engineers, depending on their specific expertise, shall have experience and responsibilities in the following domains (topic areas).

In addition, the references aligned with each domain contain information and guidance on the content of this exam. We recommend that you have general familiarity with key concepts outlined below.

1) **Pipeline System Planning**: This domain includes analyzing geospatial, Subsurface Utility Engineering data, operational, community and environmental effects to develop pipeline designs, assess risk tolerance, and coordinate regulatory compliance activities. Candidates should have the ability to demonstrate skills in conducting feasibility studies, alternative route analysis, selecting appropriate materials, installation methods analyzing system performance, and developing risk management strategies for sustainable water pipeline projects.

    a. Route Evaluation and Selection
    b. Determination of Design Flow
    c. Installation Methods
        i. Conventional Open Trench Methods
        ii. Trenchless Methods
            1. New Construction
            2. Rehabilitation
    d. Pipe Material Selection
    e. Pipe Connections
        i. Push Joints
        ii. Restrained Flexible Joints
        iii. Flanged Joints
        iv. Coupled Joints
        v. Welded Joints
    f. Pipeline Appurtenances
        i. Isolation Valves
        ii. Control Valves
        iii. Manholes
        iv. Junction Chambers
    g. Preliminary/Conceptual Design Reports
    h. Cost estimates
    i. Collaborate with geotechnical engineers for system routing.
    j. Identify environmental, cost, safety, schedule and hazard risks and develop risk management strategies.
    k. Assess the environmental footprint.
    l. Contribute to emergency response planning and procedures related to pipeline operations.
    m. Coordinate safety, regulatory, and code compliance activities.
    n. Work closely with stakeholders and authorities having jurisdiction during project planning.
    o. Analyze and utilize survey reports, maps, drawings, blueprints, aerial photography, or other geospatial data, topographical or geologic data.
    p. Find and evaluate all other utilities in conflict with the proposed alignment utilizing subsurface utility engineering (SUE).
    q. Plan surveys, land or bodies of water, to measure and determine features and to guide design.
    r. Analyze operational data to evaluate operations, processes or products.
    s. Develop system operations and maintenance manuals and specifications.

t. Plan construction surveying to lay out installations or establish reference points, grades, or elevations.
u. Use computational fluid dynamics software to analyze flow in pipelines and hydraulic structures.
v. Plan for pipeline maintenance and repair activities.
w. Determine risk tolerance of owner.
x. Evaluate system performance requirements to proposed design technical data to determine effect on designs.
y. Select appropriate materials for pipeline construction based on project requirements and environmental conditions.
z. Collaborate to develop reports & designs.
aa. Conduct concept and feasibility studies.

References:

- ASCE. 2022. Sustainable Design of Pipelines: Guidelines for Achieving Advanced Functionality. ASCE Manual of Practice 151. Reston, VA: ASCE.
- ASCE. 2017. Water Pipeline Condition Assessment. ASCE Manual of Practice 134. Reston, VA: ASCE.
- ASCE. 1996. Pipeline Crossings. ASCE Manual of Practice 89. New York, NY. ASCE
- Najafi, M. (2010). Trenchless technology Piping. McGraw Hill Professional.
- Najafi, M., & Gokhale, S. (2022). Trenchless technology: Pipeline and utility design, construction, and renewal.

2) Hydraulic Considerations

This domain includes tasks related to performing hydraulic calculations to determine pipe capacity and size, use modeling software to model piping and hydraulic structure flows, perform transient evaluations, and determine hydraulic gradelines, and contours. Candidates should have expertise in planning and implementing hydrostatic testing, use of modeling including, and utilizing computational fluid dynamics software for hydraulic analysis in pipelines, determine maximum pressures for pipeline design and develop transient mitigation methods.

a. Fluid Dynamics of Pipelines
b. Gravity Flow
    i. Manning Friction Factors
c. Pressurized Flow
    i. Friction Factors
    ii. Minor Losses (fittings, valves, etc.)
d. Hydraulic Grade Lines
e. Transients and Control Methods
f. Perform failure analysis and propose appropriate mitigation measures.
g. Evaluate system performance requirements to proposed design technical data to determine effect on designs.
h. Analyze and utilize survey reports, maps, drawings, blueprints, aerial photography, or other geospatial data, topographical or geologic data.
i. Find and evaluate all other utilities in conflict with the proposed alignment utilizing subsurface utility engineering (SUE).
j. Analyze operational data to evaluate operations, processes or products.
k. Develop system operations and maintenance manuals and specifications.
l. Use computational fluid dynamics software to analyze flow in pipelines and hydraulic structures.
m. Prepare technical reports.
n. Monitor and analyze pipeline performance data.
o. Plan and implement hydrostatic testing.

p. Perform analyses on pipelines subjected to internal, external and dynamic loads.
q. Identify methods and tools to evaluate the pipeline's condition.
r. Identify operational and maintenance constraints to perform pipeline cleaning and assessment.
s. Plan and design piping and hydraulic systems.
t. Select appropriate materials for pipeline construction based on project requirements and environmental conditions.

References:

- Walski, T. M. (1984). Analysis of Water Distribution Systems. Van Nostrand Reinhold, New York, NY.
- Walski, T. M., Chase, D. V., Savic, D. A., Grayman, W., Beckwith, S., & Koelle, E. (2003). Advanced Water Distribution Modeling and Management. Haestead Press, Waterbury, CT.

3) ***Design of Pipe and Pipeline Systems*:** This domain involves tasks related to assessing pipe material properties, performance characteristics and their incorporation into operations. Candidates should have knowledge in selecting appropriate materials, determining wall thickness, conducting construction and operational stress and stability analysis, collaborating with hydraulic, mechanical, corrosion and geotechnical engineers, establishing design criteria, determining needed appurtenances and utilizing hydraulic modeling software for flow analysis of the pipeline. Further, given the above, the candidates should be able to analyze if open cut or trenches less methods would be best for the conditions, and constructability. Then develop construction specifications.

a. Design Assumptions and Calculations
b. Pipe Material Mechanics
c. Pipe Material and Geometry Selection
d. Technical Specifications
e. Construction Drawings and Details
f. Contract Documents
g. Safety/Code/Standard Compliance
h. Inspection and Testing
i. Record Information.
    i. Drawings of Record
    ii. Equipment and Material Submittals
    iii. Operation and Maintenance Manuals
j. Resilience and Sustainability
k. Compute load and grade requirements and hydraulics.
l. Assess stress and stability analysis of pipeline systems and material stress factors to determine design specifications and comply with industry standards.
m. Plan and design piping and hydraulic systems.
n. Collaborate to develop reports & designs.
o. Collaborate with geotechnical engineers for system routing.
p. Contribute to emergency response planning and procedures related to pipeline operations.
q. Coordinate safety, regulatory, and code compliance activities.
r. Plan and coordinate pipeline construction activities, including procurement of equipment and materials.
s. Work closely with stakeholders and authorities having jurisdiction during project planning and execution.
t. Direct or participate in surveys, land or bodies of water, to measure and determine features and to guide design.

u. Plan and implement corrosion protection.
v. Analyze operational data to evaluate operations, processes or products.
w. Provide project requirements for emergency repair, including closures, short pipe sections, butt-straps, etc.
x. Direct or participate in construction surveying to lay out installations or establish reference points, grades, or elevations.
y. Use computational fluid dynamics software to analyze flow in pipelines and hydraulic structures.
z. Monitor and analyze pipeline performance data.
aa. Plan and implement hydrostatic testing.
bb. Provide technical advice regarding design, construction, program modifications, or structural repairs.
cc. Perform analyses on pipelines subjected to internal, external and dynamic loads.
dd. Assess pipeline constructability with graphical representations as needed.
ee. Evaluate system performance requirements to proposed design technical data to determine effect on designs.

References:

- AWWA. 2008. *Concrete Pressure Pipe*. *AWWA Manual M9*. *3rd ed*. Denver, CO: AWWA.
- AWWA. 2017. *Steel Pipe – A Guide for Design and Installation*. *AWWA Manual M11*. *5th ed*. Denver, CO: AWWA.
- AWWA. 2020. *PVC Pipe – Design and Installation*. *AWWA Manual M23*. *2nd ed*. Denver, CO: AWWA.
- AWWA. 2009. *Ductile-Iron Pipe and Fittings*. *AWWA Manual M41*. *3rd ed*. Denver, CO: AWWA.
- AWWA. *Fiberglass Pipe Design*. *AWWA Manual M45*. *3rd ed*. Denver, CO: AWWA.
- AWWA. 2020. *PE Pipe – Design and Installation*. *AWWA Manual M55*. *2nd ed*. Denver, CO: AWWA
- ASCE. 2021. Design of Close-Fit Liners for the Rehabilitation of Gravity Pipes. ASCE Manual of Practice 145. Reston, VA: ASCE.
- Skousen, P. L. (1998). *Valve Handbook*. McGraw-Hill, New York, NY.
- ASCE. 2007. Gravity Sanitary Sewer Design and Construction. *2nd ed*. ASCE Manual of Practice 60. Reston, VA: ASCE.
- ASCE. 2017. Pilot Tube and Other Guided Boring Methods. ASCE Manual of Practice 133. Reston, VA: ASCE.
- DIPRA. 2016. *Thrust Restraint Design for Ductile Iron Pipe*. *7th ed*. Birmingham, AL. https://dipra.org/docs/thrust-restraint-design-for-ductile-iron-pipe-english.

4) **Corrosion Monitoring and Mitigation:** This domain focuses on evaluating pipeline operations, conducting inspections, designing monitoring and protection systems, managing risks, and overseeing maintenance activities to prevent corrosion in water pipelines. Candidates should have the ability to analyze data, implement protection systems, conduct inspections, manage leaks, and propose mitigation measures to ensure pipeline integrity.
   a. Identify environmental, cost, safety, schedule and hazard risks and develop risk management strategies.
   b. Perform failure analysis and propose appropriate mitigation measures.

c. Plan and implement corrosion protection.
d. Analyze operational data to evaluate operations, processes or products.
e. Develop system operations and maintenance manuals and specifications.
f. Conduct site inspections and surveys to assess existing pipeline conditions and identify potential risks or issues.
g. Prepare technical reports.
h. Implement systems for detecting and managing leaks or failures.
i. Oversee pipeline maintenance and repair activities.
j. Recognize the need for cathodic protection, determine system continuity, and evaluate area for possible stray current sources.

References:

- AWWA. 2014. External Corrosion Control for Infrastructure Sustainability. *AWWA Manual M27. 3rd ed.* Denver, CO: AWWA.
- AWWA. 2014. Rehabilitation of Water Mains. *AWWA Manual M28. 3rd ed.* Denver, CO: AWWA.
- ASCE. 2012. Steel Penstocks. ASCE Manual of Practice 79. *2nd ed.* Reston, VA: ASCE.

5) ***Condition Assessment*:** This domain involves evaluating the existing condition of pipelines through site inspections, selection of test equipment and procedures, soil testing, and analyzing operational loads to identify risks and potential issues. Candidates should demonstrate knowledge of leak detection systems, tools for assessing pipeline conditions, pipe structural design, oversight of maintenance and repair activities, and asset management strategies.

a. Feasibility studies
b. Work closely with stakeholders and authorities having jurisdiction during project planning and execution.
c. Plan and implement corrosion protection.
d. Analyze operational data to evaluate operations, processes or products.
e. Develop system operations and maintenance manuals and specifications.
f. Conduct site inspections and surveys to assess existing pipeline conditions and identify potential risks or issues.
g. Prepare technical reports.
h. Test soils or materials along alignment to determine the respective conditions and risks.
i. Implement systems for detecting and managing leaks or failures.
j. Provide technical advice regarding design, construction, program modifications, or structural repairs.
k. Perform analyses on pipelines subjected to internal, external and dynamic loads.
l. Oversee pipeline maintenance and repair activities.
m. Identify methods and tools to evaluate the pipeline's condition.
n. Identify operational and maintenance constraints to perform pipeline cleaning and assessment.
o. Conduct asset management to determine critical ranking of individual portions of the pipeline.
p. Identify environmental, cost, safety, schedule and hazard risks and develop risk management strategies.

q. Perform failure analysis and propose appropriate mitigation measures.
r. Inspect facilities or sites to determine if they meet specifications and standards.
s. Contribute to emergency response planning and procedures related to pipeline operations.
t. Coordinate safety, regulatory, and code compliance activities.
u. Develop Opinions of Cost.

References:

- AWWA. 2019. Condition Assessment of Water Mains. *AWWA Manual M77. 1st ed.* Denver, CO: AWWA.
- ASCE. 2017. Standard Guidelines for the Design, Installation, and Operation and Maintenance of Stormwater Impoundments. ASCE Manual of Practice 62. Reston, VA: ASCE.
- ASCE. 2017. Water Pipeline Condition Assessment. ASCE Manual of Practice 134. Reston, VA: ASCE.
- Higgins, M. S., Galleher, J., Norton, J., & Bell, G. WRF 5069: Management of PCCP to Extend Asset Life. In Pipelines 2022 (pp. 188-195), Denver, CO, United States.
- NAASCO and WEF. 2018. *Manual of Practice Trenchless Technologies and Asset Management*. 3rd ed. Alexandria, VA. WEF. ISBN-10: 1572783516.

6) **Project Management:** This domain involves coordinating various aspects of pipeline projects, such as environmental assessment, cost, stakeholder collaboration, regulatory compliance, and risk management throughout the design and construction of the project lifecycle. Candidates should demonstrate their ability to manage project planning, feasibility studies, construction activities, operational maintenance, repair, and rehabilitation tasks effectively.

a. Contract Administration
b. Concept & feasibility studies
c. Cost estimates
d. Identify environmental, cost, safety, schedule and hazard risks and develop risk management strategies.
e. Perform failure analysis and propose appropriate mitigation measures.
f. Assess the environmental footprint.
g. Contribute to emergency response planning and procedures related to pipeline operations.
h. Coordinate safety, regulatory, and code compliance activities.
i. Plan and coordinate pipeline construction activities, including procurement of equipment and materials.
j. Work closely with stakeholders and authorities having jurisdiction during project planning and execution.
k. Inspect facilities or sites to determine if they meet specifications and standards.
l. Monitor surveys, land or bodies of water, to measure and determine features and to guide design.
m. Plan and implement corrosion protection.
n. Develop system operations and maintenance manuals and specifications.
o. Prepare technical reports.
p. Test soils or materials along alignment to determine the respective conditions and risks.
q. Plan and implement hydrostatic testing.
r. Provide technical advice regarding design, construction, program modifications, or structural repairs.

s. Monitor pipeline maintenance and repair activities.
t. Determine risk tolerance of owner.
u. Identify operational and maintenance constraints to perform pipeline cleaning and assessment.
v. Monitor asset management to determine critical ranking of individual portions of the pipeline.
w. Communicate through the owner to the public related to pipeline topics.
x. Prepare technical specifications and assemble the contract documents.
y. Monitor pipeline system construction or installation activities.
z. Perform contract bidding and construction administration for pipeline system construction or installation activities.
aa. Collaborate to develop reports & designs.

References:

- AWWA. 2010. Capital Project Delivery. *AWWA Manual M47. 2nd ed.* Denver, CO: AWWA.
- ASCE. 2007. Gravity Sanitary Sewer Design and Construction. *2nd ed.* ASCE Manual of Practice 60. Reston, VA: ASCE.
- ASCE. 2012. Quality in the Constructed Project: A Guide for Owners, Designers, and Constructors. *3rd ed.* ASCE Manual of Practice 73. Reston, VA: ASCE.
- American Society of Civil Engineers. *Pilot Tube and Other Guided Boring Methods.* ASCE Manual of Practice No. 133. Reston, VA:ASCE, 2017.
- Project Management Institute. *A Guide to the Project Management Body of Knowledge (PMBOK Guide).* 7th ed. Newtown Square, PA: Project Management Institute, 2021.

7. **Geotechnical Considerations:** This domain involves analyzing geotechnical investigations, collaborating with geotechnical engineers, and selecting materials based on project requirements to ensure the integrity of the pipe/soil system. Candidates should demonstrate skills in assessing pipeline constructability, preparing technical reports, soil materials and mechanics, and testing procedures along the alignment. Includes trenching, bedding, and backfill.

a. Material Properties Along the Route
b. Pipe to Soil Interaction
c. Pipe Bedding and Embedment Zone
d. Constructability
e. Collaborate with system designers.
f. Identify environmental, cost, safety, schedule and hazard risks and develop risk management strategies.
g. Inspect facilities or sites to determine if they meet specifications and standards.
h. Analyze and utilize survey reports, maps, drawings, blueprints, aerial photography, or other geospatial data, topographical or geologic data.
i. Find and evaluate all other utilities in conflict with the proposed alignment utilizing subsurface utility engineering (SUE).
j. Plan and implement corrosion protection.
k. Conduct site inspections and surveys to assess existing pipeline conditions and identify potential risks or issues.
l. Prepare technical reports.

m. Test soils or materials along alignment to determine the respective conditions and risks.
n. Assess pipeline constructability with graphical representations as needed.
o. Prepare technical specifications and assemble the contract documents.
p. Select appropriate materials for pipeline construction based on project requirements and environmental conditions.
q. Collaborate to develop reports & designs.

References:

- ASCE. 2022. Geotechnical Baseline Reports: Suggested Guidelines. ASCE Manual of Practice 154. Reston, VA: ASCE
- ASCE. 2024. Pipeline Design for Installation by Horizontal Directional Drilling. *3rd ed.* ASCE Manual of Practice 108. Reston, VA: ASCE.
- AWWA. 2024. "Installation of Buried Steel Water Pipe - 4 In. (100 mm) and Larger". *ANSI/AWWA C604.* Denver, CO: AWWA.
- AWWA. 2008. *Concrete Pressure Pipe*. *AWWA Manual M9. 3rd ed.* Denver, CO: AWWA.
- AWWA. 2017. *Steel Pipe – A Guide for Design and Installation*. *AWWA Manual M11. 5th ed.* Denver, CO: AWWA.
- AWWA. 2020. *PVC Pipe – Design and Installation*. *AWWA Manual M23. 2nd ed.* Denver, CO: AWWA.
- AWWA. 2009. *Ductile-Iron Pipe and Fittings*. *AWWA Manual M41. 3rd ed.* Denver, CO: AWWA.
- AWWA. *Fiberglass Pipe Design*. *AWWA Manual M45. 3rd ed.* Denver, CO: AWWA.
- AWWA. 2020. *PE Pipe – Design and Installation*. *AWWA Manual M55. 2nd ed.* Denver, CO: AWWA
- Bennett, D., Ariaratnam, A. Neher, M., Wallin, M., Wallin, K.2024. *NASTT Horizontal Directional Drilling (HDD) Good Practices Guidelines. 5th ed.* NASTT, Bothell, WA. ISBN- 978-1-928984-10-8.

8. **Construction Activities*:*** This domain involves overseeing and coordinating aspects of pipeline system construction and installation activities. Candidates should demonstrate expertise in assessing constructability, directing surveying, inspecting facilities, monitoring construction activities, interpreting design intent and supervising construction activities while working closely with stakeholders and authorities.

a. Plan and coordinate pipeline construction activities, including procurement of equipment and materials.
b. Work closely with stakeholders and authorities having jurisdiction during project planning and execution.
c. Direct or participate in construction surveying to lay out installations or establish reference points, grades, or elevations.
d. Provide technical advice regarding design, construction, program modifications, or structural repair.
e. Assess pipeline constructability with graphical representations as needed.
f. Supervise pipeline system construction or installation activities.
g. Monitor pipeline system construction or installation activities.
h. Observe pipeline system construction or installation activities.
i. Perform contract bidding and construction administration for pipeline system construction or installation activities.

References:

- Amster H., (2015). Pipeline Installation 2nd Ed., Relativity Publishing, Lakewood, CO.
- ASTM International, ASTM F1417-92 (Reapproved 1998). Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air. West Conshohocken, PA.

Pipeline Engineering-Water - Additional References

This list of additional references does not necessarily reflect exam content but rather informed the development of the PLWBOK and the exam development process. References directly aligned with exam questions are listed with their corresponding domains above (exam content areas).

- MOP 46 Pipeline Route Selection in Rural and Urban Areas
- MOP 60 Gravity Sewer Design and Construction
- MOP 92 Manhole Inspection and Rehabilitation
- MOP 106 Horizontal Auger Boring Projects
- MOP 112 Pipe Bursting Projects
- MOP 115 Pipe Ramming
- MOP 117 Inspection Pipeline Installation
- MOP 118 Belowground Networks for Utility Cables
- MOP 119 Buried Flexible Steel Pipe
- MOP 120 Trenchless Renewal of Culverts and Storm Sewers
- MOP 132 Renewal of Potable Water Pipes
- ASCE 15 Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)
- ASCE 26 Standard Practice for Direct Design of Buried Precast Concrete Box Sections
- ASCE 27 Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction
- ASCE 28 Standard Practice for Direct Design of Precast Concrete Box Sections for Jacking in Trenchless Construction
- ASCE 36 Standard Design and Construction Guidelines for Microtunneling
- ASCE 38 Standard Guideline for Investigation and Documenting Existing Utilities
- ASCE 75 Standard Guideline for Recording and Exchanging Utility Infrastructure Data
- ASCE Guided Online Course: Pipeline Installation
- ASTM C76 on Reinforced Concrete Pipe
- Howard, A. Pipeline Installation 2.0. 2015. https://amsterhoward.com/product/book/ASTM C76 on Reinforced Concrete Pipe
- AWWA M81 – Rehabilitation of Water Mains (Large Diameter)
- AWWA C604 – Installation of Buried Steel Water Pipe – 4 In. (100 mm) and Larger
- AWWA M17 - Fire Hydrants: Installation, Field Testing, and Maintenance
- AWWA M 31 – Distribution System Requirements for Fire Protection
- NACE SP0169 - Control of External Corrosion on Underground or Submerged Metallic Piping Systems
- Najafi, M., and Gokhale, S. (2022). Trenchless technology: pipeline and utility design, construction, and renewal. McGraw-Hill, New York, NY.
- Najafi, M. (2010). Trenchless Technology Piping, McGraw-Hill, New York, NY.

- Najafi, M. (2013). Trenchless technology: Planning, equipment, and methods. McGraw-Hill Education, McGraw-Hill, New York, NY.
- Watkins, Reynold King, and Loren Rumar Anderson. (1999) *Structural Mechanics of Buried Pipes*. Boca Raton, FL.

**MOP## = ASCE Manuals of Practice (MOPs)*
** ASCE## = ASCE Standard*