

# WATER-RESOURCES ENGINEERING

*Fourth Edition*

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# Preface

Water-resources engineers design systems to control the quantity, quality, timing, and distribution of water to support human habitation and the needs of the environment. Water-supply and flood-control systems are commonly regarded as essential infrastructure for developed areas, and as such water-resources engineering is a core specialty area in civil engineering. Water-resources engineering is also a specialty area in environmental engineering, particularly with regard to the design of water-supply systems, wastewater-collection systems, and water-quality control in natural systems.

**Overview of book contents.** The technical and scientific bases for most water-resources applications are in the areas of hydraulics and hydrology, and this text covers these areas with depth and rigor. The fundamentals of closed-conduit flow, open-channel flow, surface-water hydrology, groundwater hydrology, and water-resources planning and management are all covered in detail. Applications of these fundamentals include the design of water-distribution systems, hydraulic structures, sanitary-sewer systems, stormwater-management systems, and water-supply wellfields. The design protocols for these systems are guided by the relevant ASCE, WEF, and AWWA manuals of practice, as well as USFHWA design guidelines for urban and transportation-related drainage structures, and USACE design guidelines for hydraulic structures. The topics covered in this book constitute the technical background expected of water-resources engineers. This text is appropriate for undergraduate and first-year graduate courses in hydraulics, hydrology, and water-resources engineering. Practitioners will also find the material in this book to be a useful reference on appropriate design protocols.

**Organization of book.** The book has been organized in such a way as to sequentially cover the theory and design applications in each of the key areas of water-resources engineering. The theory of flow in closed conduits is covered in Chapter 2, including applications of the continuity, momentum, and energy equations to flow in closed conduits, calculation of water-hammer pressures, flows in pipe networks, affinity laws for pumps, pump performance curves, and procedures for pump selection and assessing the performance of multi-pump systems. The design of public water-supply systems and building water-supply systems are covered in Chapter 3, which includes the estimation of water demand, design of pipelines, pipeline appurtenances, service reservoirs, performance criteria for water-distribution systems, and several practical design examples. The theory of flow in open channels is covered in Chapter 4, which includes applications of the continuity, momentum, and energy equations to flow in open channels, and computation of water-surface profiles. The design of drainage channels is covered in Chapter 5, which includes the application of design standards for determining the appropriate channel dimensions for various channel linings, including vegetative and nonvegetative linings. The design of sanitary-sewer systems is covered in Chapter 6, which includes design approaches for estimating the quantity of wastewater to be handled by sewers; sizing sewer pipes



based on self-cleansing and capacity using the ASCE-recommended tractive-force method; and the performance of manholes, force mains, pump stations, and hydrogen-sulfide control systems are also covered. Design of the most widely used hydraulic structures is covered in Chapter 7, which includes the design of culverts, gates, weirs, spillways, stilling basins, dams, and hydropower facilities. This chapter is particularly important since most water-resources projects rely on the performance of hydraulic structures to achieve their objectives. The bases for the design of water-resources systems are typically rainfall and/or surface runoff, which are random variables that must generally be specified probabilistically. Applications of probability and statistics in water-resources engineering are covered in detail in Chapter 8, with particular emphasis on the analysis of hydrologic data and uncertainty analysis in predicting hydrologic variables. The fundamentals of surface-water hydrology are covered in Chapters 9 and 10. These chapters cover the statistical characterization of rainfall for design applications, methodologies for estimating peak runoff rates and runoff hydrographs, methodologies for routing runoff hydrographs through detention basins, and methods for estimating the quality of surface runoff. The design of stormwater-collection systems is covered in Chapter 11, including the design of stormwater inlets and storm sewers. Stormwater-management systems are designed to treat stormwater prior to discharge into receiving waters, and the design of these systems is covered in Chapter 12. Several state-of-the-art design examples for the most commonly used stormwater-control measures, including green infrastructure, are provided. Coverage includes the design of infiltration basins, swales, filter strips, bioretention systems, green roofs, permeable pavements, exfiltration trenches, and drainage wells. The estimation of evapotranspiration, which is usually the dominant component of seasonal and annual water budgets in arid areas and a core component in the design of irrigation systems, is covered in Chapter 13. The fundamentals of groundwater hydrology are covered in Chapters 14 and 15, including an exposition on Darcy's law, derivation of the general groundwater flow equation, practical solutions to the groundwater flow equation, and methods to assess and control saltwater intrusion in coastal aquifers. Applications of groundwater hydrology to the design of wellfields, the delineation of wellhead protection areas, and the design of wells are all covered. Water-resources planning typically includes identifying alternatives and ranking the alternatives based on specified criteria. Chapter 17 covers the conventional approaches for identifying and ranking alternatives and the bases for the economic evaluation of these alternatives.

**Summary.** In summary, this book provides an in-depth coverage of the subject areas that are fundamental to the practice of water-resources engineering. A firm grasp of the material covered in this book along with complementary practical experience are the foundations on which water-resources engineering is practiced at the highest level. Throughout the entire textbook, equations contained within boxes represent derived equations that are particularly useful in engineering applications. In contrast, equations without boxes are typically intermediate equations within an analysis leading to a derived useful equation.

**Philosophy.** This book is a reflection of the author's belief that water-resources engineers must gain a firm understanding of the depth and breadth of the technical areas that are fundamental to their discipline, and by so doing will be more innovative, view water-resource systems holistically, and be technically prepared for a lifetime of learning. On the basis of this vision, the material contained in this book is presented mostly from first principles, is rigorous, is relevant to the practice of water-resources engineering, and is reinforced by detailed presentations of design applications.

## What's New in the Fourth Edition

The fourth edition of this book contains much new and updated material relative to the previous edition. The most notable changes are as follows:

- Most figures have been enhanced to provide greater clarity in presentation and to facilitate understanding by the reader. The original versions of most figures are now available in color, and these color images can be presented using PowerPoint presentations that are available to instructors.
- The text presentation in the book has been significantly enhanced by using paragraph headings, which provides much greater clarity in the presented material.
- All design protocols reflect the latest design guidelines from the appropriate manuals of practice, and the material content reflects the latest advances as reported in professional journals.
- Many sections have been rewritten and updated, new sections have been added, and obsolete sections have been deleted. Notable changes are as follows:
  - A new section on pump-station design for sanitary sewers has been added.
  - The section on culvert design has been reorganized and rewritten to be consistent with the state-of-the-art practice.
  - The section relating to the estimation of intensity-duration-frequency (IDF) functions has been completely rewritten to reflect the emergence of Atlas 14 as the primary source of IDF functions in the United States.
  - The section relating to the design rainfall hyetographs has been updated to reflect the discontinuation of NRCS Type distributions in favor of more accurate local and regional synthetic rainfall distributions.
- The chapters on stormwater management (Chapter 12) and evapotranspiration (Chapter 13) have been almost completely updated in content. Chapter 12 now has increased coverage of removal capabilities of various stormwater control measures, including green infrastructure.
- More than 220 new end-of-chapter problems have been added, and these end-of-chapter problems have been segregated into groups that correspond to specific sections in the chapter.

This new edition reflects the state-of-the-art of water-resources engineering and is intended to provide the necessary competencies expected by the profession.

## Instructor Resources

The following resources are available to instructors for download at [www.pearsonhighered.com/irc](http://www.pearsonhighered.com/irc). If you are in need of a login and password for this site, please contact your local Pearson representative.

- An Instructor Solution Manual contains solutions to the end-of-chapter problems.
- All figures from the text are available in PowerPoint presentations.

Water resource engineering is the field that is primarily responsible for water and tackles the planning, development, and management of water resources. It also covers the estimation of water resource in a region and the water inflow so that new structures can be built.

Water Resource Engineering Sub Disciplines. Water Resource Engineering has been divided into the following; Water and Wastewater treatment plant design. Water Distribution, Wastewater and Storm water Sewer Systems. Irrigation Engineering. Water resources engineering includes hydrologic, groundwater and hydraulic analysis of the planning and design of remediation, flood control, and water supply. It also includes different types of hydraulic structures, surface and ground water flow, environmental impacts and quality monitoring. The engineering discipline also includes fluid mechanics, open channel hydraulics, sediment transport, and water supply systems. View. Show abstract. Water-Resources Engineering. Article. Jan 1992. Water resources engineering is the processes that are used to help plan and build infrastructures that maintain safe drinking...Â Category: Science Technology Industry Internet Environment Education Business Food Beauty Language Miscellaneous Anatomy Health Crafts Cars Home Finance Medicine Fashion Fitness Art United States Travel History People World Law Hobbies. What Is Water Resources Engineering? Join the Community. Follow @wiseGEEK. resources engineering. Water in a wetland, lake or a river is called surface water, and is lost by evaporation, seepage in sub-surface and discharge to the oceans. The total quantity of water available in any system is dependent upon the storage capacity of the reservoirs, the permeability of the soil below the storage reservoirs, the overflow characteristics of the watershed, precipitation, and the rate of evaporation.