
WATER-RESOURCES ENGINEERING

Third Edition

David A. Chin

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To Andrew and Stephanie.

“But those who hope in the Lord will renew their strength. They will soar on wings like eagles; they will run and not grow weary, they will walk and not be faint.”

Isaiah 40:31

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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.

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.

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 non vegetative 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, and dams. 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 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 are provided, including the design of infiltration basins, swales, filter strips, bioretention systems, and exfiltration trenches. 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, aquifer pumping tests, slug tests, and exfiltration trenches 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.

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.

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.

Many persons have contributed in various ways to this book and to my understanding of water-resources engineering, and to recognize all of those who have helped me along the way would be a book onto itself. However, special recognition is deserved by Professor LaVere Merritt of Brigham Young University for his expert advice and detailed review of the chapter on design of sanitary sewers and Professor Dixie Griffin of Louisiana Tech for his extensive feedback and constructive comments throughout the years on the present and previous editions of this book. I am also grateful to Professors John Miknis of Pennsylvania State University, Jacob Ogaard of the University of Iowa, Francisco Olivera of Texas A&M University, and Ken Lee of the University of Massachusetts Lowell, for reviewing this book.

What's New in the Third Edition

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

- The book contains 17 chapters compared to 7 chapters in the previous edition. In the previous edition, most of the chapters were quite long and contained both theory and practical examples. In the present edition, theory-oriented chapters have been separated from practice-oriented chapters. The material in all chapters has been revised and updated, with some chapters being almost entirely rewritten as described below.
- Coverage of the design of drainage channels (Chapter 5) has been completely rewritten. Subsequent to the previous edition of the book, the Federal Highway Administration thoroughly revised their urban drainage design manual, Hydraulic Engineering Circular No.22 (HEC-22), which provides the primary design guidelines for the design of drainage channels in the United States. The updated chapter in this book is consistent with the latest edition of HEC-22. Appendix F describing the unified soil classification system has been added to support the design applications contained in this chapter.

- Coverage of the design of sanitary-sewers (Chapter 6) has been completely rewritten to be consistent with the latest version of the ASCE Manual of Practice No.60 (MOP 60) on the design of sanitary sewers. The latest version of MOP 60 is a significant departure from previous versions of MOP 60 in that the tractive-force design approach is now recommended as the preferred approach for designing sanitary sewers. The updated chapter emphasizes the tractive-force approach and contains the key design aids provided in ASCE Manual of Practice No.60.
- Coverage of the design of stormwater-management systems (Chapter 12) has been significantly revised and updated. Over the past several years, much has been learned about the performance and design of various stormwater control measures (SCMs) and the latest design approaches to these systems are incorporated in the revised chapter. These design approaches are consistent with the latest version of ASCE Manual of Practice No.87.
- In addition to updating the coverage on most topics covered in the book, several new topics have been added. For example, coverage of water hammer, variable-speed pumps, water-surface profiles across bridges, design of dams and reservoirs, and uncertainty analysis have all been added.
- Many new end-of-chapter problems have been added to support the revised coverage in the book, and several problems from the previous edition have been removed or modified.

In summary, this new edition reflects the state-of-the-art of water-resources engineering and is intended provide the necessary competencies expected by the profession. The redesigned chapters, which are shorter in length than previous chapters, are intended to provide a more focused treatment of individual cognate topics and hence contribute to more effective learning by those using this textbook.

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Water Resources Engineering - Free ebook download as PDF File (.pdf), Text File (.txt) or read book online for free.Â Module 1 Principles of Water Resources Engineering 4 Lesson 1 Surface and Ground Water Resources Water Resources Development Act of 1986 â€” The Water Resources Development Act of 1986 (WRDA 1986) is part of USPL|99|662, a series of acts enacted by Congress of the United States on November 17, 1986. [[http://thomas.loc.gov/cgi bin/bdquery/D?d099:1:./temp/ bdVNjS:@@@D summ2=mâ€| â€| Wikipedia.Â GIS and Geocomputation for Water Resource Science and Engineering, Barnali Dixon. Water resources engineering is the processes that are used to help plan and build infrastructures that maintain safe drinking...Â Hydraulic water resources engineering is primarily concerned with flow and conveyance of fluids, as well as fluids at rest. Engineers make use of gravity and other physics properties to design canals, sluice gates, irrigation projects, and cooling-water facilities in nuclear plants.