Preface

Since completion of the fourth edition of this textbook, the field of wastewater engineering has evolved at a rapid pace. Some of the more significant changes include:

1. A new view of wastewater as a source of energy, nutrients, and potable water.
2. More stringent discharge requirements related to nitrogen and phosphorus;
3. Enhanced understanding of the fundamental microbiology and physiology of the microorganisms responsible for the removal of nitrogen and phosphorus and other constituents;
4. An appreciation of the importance of the separate treatment of return flows with respect to meeting more stringent standards for nitrogen removal and opportunities for nutrient recovery,
5. Increased emphasis on the treatment of sludge and the management of biosolids; and
6. Increased awareness of carbon footprint impacts and greenhouse gas emissions, and an emphasis on the development of energy-neutral or energy-positive wastewater plants through more efficient use of chemical and heat energy in wastewater.

The 5th edition of this textbook has been prepared to address the significant changes cited above. Increased understanding of the importance of pre-treatment processes is addressed in Chap. 5. Advances in biological treatment are addressed in Chaps. 7 through 10. New developments in disinfection are considered in Chap. 12. The management of sludge and biosolids is now covered in Chaps. 13 and 14. Return flow treatment is considered in Chap. 15. Energy management is considered in Chap. 17. An emphasis of this fifth edition is to present practical design and operational data, while maintaining a solid theoretical discussion of the technologies and applications. Input from AECOM's process engineers and outside reviewers was sought to provide the user with a source of real-world practical information, the likes of which is not available in any single source.

IMPORTANT FEATURES OF THIS BOOK

In the 4th edition of this book, a separate chapter was devoted to the fundamentals of process analysis, including an introduction to the preparation of mass balances and reaction kinetics. Because introductory courses on process analysis and modeling are now taught at most colleges and universities, the material on the fundamentals of process analysis from the 4th edition has been condensed and is now included in Secs. 1–7 through 1–11 in Chap. 1. The material on process analysis has been retained as a reference source for students that have already had a separate course on modeling and as an introduction to the subject for students who may not have had an introductory course.

Following the practice in the 4th edition, more than 150 example problems have been worked out in detail to enhance the readers' understanding of the basic concepts presented in the text. To aid in the planning, analysis, and design of wastewater management systems, design data and information are summarized and presented in more than 400 tables, most of which are new. To illustrate the principles and facilities involved in the field of wastewater management, over 850 individual illustrations, graphs, diagrams, and

photographs are included. An additional 120 drawings are included in tables. More than 375 homework problems and discussion topics are included to help the readers of this textbook hone their analytical skills and enhance their mastery of the material. Extensive references are also provided for each chapter.

The International System (SI) of Units is used in the 5th edition. The use of SI units is consistent with teaching practice in most US universities and in most countries throughout the world. In general, dual sets of units (i.e., SI and US customary) have been used for the data tables. Where the use of double units was not possible, conversion factors are included as a footnote to the table.

To further increase the utility of this textbook, several appendixes have been included. Conversion factors from International System (SI) of Units to US Customary Units and the reverse are presented in Appendixes A–1 and A–2, respectively. Conversion factors used commonly for the analysis and design of wastewater management systems are presented in Appendix A–3. Abbreviations for SI and US customary units are presented in Appendixes A–4 and A–5, respectively. Physical characteristics of air and selected gases and water are presented in Appendixes B and C, respectively. The statistical analysis is reviewed in Appendix D. Dissolved oxygen concentrations in water as a function of temperature are presented in Appendix E. Carbonate equilibrium is considered in Appendix F. Moody diagrams for the analysis of flow in pipes are presented in Appendix G. The analysis of nonideal flow in reactors is considered in Appendix H. Modeling nonideal flow in reactors is addressed in Appendix I.

USE OF THIS BOOK

Enough material is presented in this textbook to support a variety of courses for one or two semesters, or three quarters at either the undergraduate or graduate level. The book can be used both as a class textbook or class reference to supplement instructors' notes. The specific topics to be covered will depend on the time available and the course objectives. Suggested course outlines are presented below.

For a one semester introductory course on wastewater treatment, the following material is suggested.

Topic	Chapter	Sections
Introduction to wastewater treatment	1	1–1 to1–6
Wastewater characteristics	2	All
Wastewater flowrates and constituent loadings	3	All
Physical unit processes	5	5–1 to 5–8
Chemical unit processes	6	6–1 to 6–3
Introduction to biological treatment of wastewater	7	All
Disinfection	12	12–1 to 12–5, 12–9
Biosolids management	13, 14	All
Process selection, design, and implementation	4	All
Advanced treatment processes (optional)	6, 11	6–7, 6–8, 11–5 to 11–7

For a two semester course on wastewater treatment, the following material is suggested.

Topic	Chapter	Sections
Introduction to wastewater treatment	1	1–1 to1–6
Wastewater characteristics	2	All
Wastewater flowrates and constituent loadings	3	All
Process selection, design, and implementation	4	4–1 to 4–5
Physical unit operations	5	All
Chemical unit operations	6	All
Introduction to biological treatment of wastewater	7	All
Suspended growth biological treatment processes	8	All
Attached growth and combined biological treatment processes	9	9–1 to 9–5
Anaerobic treatment processes	10	10–1 to 10–5
Disinfection	12	All
Sludge Management	13	All
Biosolids management	14	All
Treatment of return flows	15	All

For a one semester course on biological wastewater treatment, the following material is suggested.

Topic	Chapter	Sections
Introduction to wastewater treatment	1	1–1 to1–6
Wastewater characteristics	2	All
Process selection, design, and implementation	4	4–2, 4–4, 4–5
Introduction to biological treatment of wastewater	7	7–1 to 7–8
Suspended growth processes	8	8–1 to 8–3
Attached growth biological treatment processes	9	All
Anaerobic treatment processes	10	10–1 to 10–5
Anaerobic sludge treatment	13	13–9, 13–10

For a one semester course on physical and chemical unit processes, the following material is suggested. It should be noted that material listed below could be supplemented with additional examples from water treatment.

Topic	Chapter	Sections
Process selection, design, and implementation	4	4–1 to 4–4
Introduction to physical unit processes		
Mixing and flocculation	5	5–3
Sedimentation	5	5–4, 5–6, 5–7,
Gas transfer	5	5–10, 5–11
Filtration (conventional depth filtration)	11	11–3, 11–4, 11–6
Membrane filtration	11	11–7
Adsorption	11	11–9
Gas stripping	11	11–10
UV disinfection	12	12–9
Introduction to chemical unit processes		6–2
Coagulation	6	6–2
Chemical precipitation	6	6–3, 6–4, 6–6
Ion exchange	11	11–11
Water stabilization	6	6–10
Chemical oxidation (conventional)	6	6–7
Advanced oxidation processes	6	6–8
Photolysis	6	6–9