

NORTHWESTERN UNIVERSITY
CIV_ENV 364 Syllabus
Sustainable Water Systems
Winter 2025

MWF 9-9:50 am, Tech M177
Th 1-1:50 pm (Discussion/ Office Hours), Tech M177

Instructor: Professor George Wells
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COURSE DESCRIPTION:

This course is designed to provide students with an overview of the engineered water cycle, an underappreciated yet critically important foundation for modern society that is in need of both immense investments to shore up existing infrastructure and innovative solutions to emerging problems. The emphasis in this course is on urban water infrastructure in industrialized countries, but we will also touch on the enormous challenges presented by the lack of sanitation and drinking water in developing countries. We will cover fundamental principles as well as design and assessment methods for physical, chemical and biological treatment unit processes for drinking water treatment, wastewater (“used water”) treatment and reuse, and water resource engineering. Regulatory drivers of water management will also be reviewed. Special attention will be paid to emerging issues, the energy-water nexus, and technological advances in the evolving engineered water cycle.

PREREQUISITES*: MECH_ENG 241 (Fluid Mechanics I) and CIV_ENV 260 (Environmental Systems and Processes)

REQUIRED TEXTS (Available in the NU bookstore):

Davis, Mackenzie L. (2019) *Water and Wastewater Engineering: Design Principles and Practice, 2nd edition*. McGraw-Hill, New York, NY.

WEBSITE: <http://www.mhprofessional.com/wwe2e>

→The first edition of this book (published in 2011) is also acceptable. Note that both a student edition and a professional edition of Davis 2011 are available. Only the student edition is necessary for the course.

We will also have a short discussion text for discussion sections. More information about this text will be provided in the first lecture.

These texts will be supplemented with in class handouts and online resources.

* Prerequisites for undergraduate students. Graduate student admission is subject to instructor permission.

OTHER REFERENCES:

Crittenden, J. C., Trussel, R. R., Hand, D. W., Howe, K. J., & Tschobanoglous, G. (2012) *MWH's Water Treatment: Principles and Design, 3rd Edition*. John Wiley & Sons, Hoboken, NJ.

Available to NU affiliates online at:

<https://onlinelibrary-wiley-com.turing.library.northwestern.edu/doi/book/10.1002/9781118131473>

Tschobanoglous, G., Stensel, H. D., Tsuchihashi, R., & Burton, F. L. (2013) *Wastewater Engineering: Treatment and Resource Recovery, 5th edition*. McGraw-Hill, New York, NY. (Also known simply as Metcalf & Eddy)

Rittmann, B. E. & McCarty, P. L. (2020) *Environmental Biotechnology: Principles and Applications, 2nd Edition*. McGraw-Hill, New York, NY.

EVALUATION:

- Six homework assignments – 30%
- Two exams - 40%
- Group project that will involve the conceptual design and/or analysis of a water resources solution - 25%: 15% report + 7.5% presentation + 2.5% teamwork (peer evaluation)
- Participation (class attendance and discussion) - 5%

OBJECTIVES:

By the end of this course, you should be able to:

Magnitude of the Problem

1. Explain current water resources issues and potential solutions
2. Identify typical and emerging water and wastewater contaminants
3. Describe the difficulties utilities face in eliminating combined sewer overflows

Regulations

4. Recognize what the regulations cover and where to find them
5. Indicate what performance characteristics are required
6. Interpret regulatory trends

The Major Technologies

7. Illustrate when and where they are used
8. Describe how the processes work and what performance can be achieved
9. Determine design parameters needed for conceptual and quantitative design

Innovative Technologies

10. Describe new and emerging technologies
11. Illustrate where they can be used and why they are improvements over older methods

How to Approach a Problem/Case Studies

12. Interpret the logic involved and decision processes commonly used

Resources

13. Locate and apply important information resources, including major professional journals, institutional websites, and professional organizations

Please note that the specifics of this course syllabus are subject to change in the case of unforeseen circumstances. Instructors will notify students of any changes as soon as possible. Students will be responsible for abiding by the changes.

OFFICE HOURS AND DISCUSSION SECTION:

- We will have 4 discussions about chapters from “The Big Thirst” (more information about this soon); these discussions will occur on January 23, January 30, February 13, and February 27 from 1-1:50 pm.
- We will take a tour of the Evanston Drinking Water Treatment Plant (Date TBA). The tour may last for more than 1 hour, so please reserve time for an extended class session if at all possible.
- On days without a formal discussion section, I will hold office hours (Thursdays 1-1:50 pm). Office hours will be by Zoom.

Chapter Conversion Chart between Student and Professional Editions in the first edition of Davis *Water and Wastewater Treatment*

Topic	Chapter in Student Ed.	Chapter in Prof. Ed.
The Design and Construction Process	1	1
General Water Supply Design Considerations	2	2
Coagulation and Flocculation	3	6
Lime-Soda Softening	4	7
Ion Exchange	5	8
Reverse Osmosis and Nanofiltration	6	9
Sedimentation	7	10
Granular Filtration	8	11
Disinfection	10	13
General Wastewater Treatment Design Consideration	12	18
Wastewater Microbiology	15	22
Secondary Treatment	16	23
Tertiary Treatment	19	26
Wastewater Treatment Plant Residuals	20	27

FORMAT AND PLATFORMS: I will use Canvas to distribute lecture slides, homeworks, readings outside of your textbook, grades, and supplemental articles/ readings. Lecture slides will be available through Canvas prior to each class. I'd encourage you to download these, and either annotate electronically or print and take notes during courses. In some classes, I will include whiteboard work (e.g. solving example problems).

Class sessions for this course will occur in person. Individual students will not be granted permission to attend remotely except as the result of an Americans with Disabilities Act (ADA) accommodation as determined by AccessibleNU. To provide flexibility to students, my office hours will be held via Zoom, or in person by appointment. To join Zoom office hours, please go to the calendar in Canvas, or go to the Canvas course homepage and scroll down to the appropriate date. You will need to be logged in to Zoom via your authenticated Northwestern account.

PROHIBITION OF RECORDING OF CLASS SESSIONS: Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact [AccessibleNU](#). Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University's [Copyright Policy](#), faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.

ACADEMIC SUPPORT AND LEARNING ADVANCEMENT (ASLA): If you are looking for help with a course or academic challenge, or if you would simply like to sharpen your study strategies and stay on track, check out [Academic Support & Learning Advancement](#). They offer drop-in tutoring, study groups, academic coaching, and individual consultations for all undergraduates. For more information: northwestern.edu/asla or asla@northwestern.edu.

For assistance in writing for the group project, I would also encourage you to explore consultations through [The Writing Place](#), Northwestern's peer writing center. You will work with juniors and seniors who have been trained to provide you feedback and assistance on any type of writing at any stage in the writing process. They will not edit your work. Rather, they will work with you to brainstorm ideas, organize or outline an essay, clarify your argument, document your sources correctly, or refine grammar and style. To book an appointment, register for an account at <https://northwestern.mywconline.com/>.

NORTHWESTERN UNIVERSITY SYLLABUS STANDARDS: This course follows the [Northwestern University Syllabus Standards](#). Students are responsible for familiarizing themselves with this information.

The following ABET learning outcomes will be addressed in this course:

O1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
(Course Objectives 2, 8, 9)

O2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

(Course Objectives 5, 7, 10, 11, 12)

O4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

(Course Objectives 1, 3, 4, 6, 13)