Stanford University

Department of Civil & Environmental Engineering

CEE 273F **Urban Water Use Efficiency and Conservation**

Summer 2017

2 units; Letter or Credit/No Credit

Instructor: Martin Reinhard, Research Professor (Emeritus)

Lecture: Fridays 1:30 pm – 4:20 pm, Y2E2 101

Course description: Growing water shortages force cities large and small to increase the efficiency with which water is used and to promote water conservation in industry, commerce and the general population. The course covers technologies, infrastructure modifications and management measures that are available to achieve these goals, mainly water recycling, runoff collection and treatment, and minimizing losses to the environment. Key technologies include advanced water treatment encompassing membrane treatment, advanced oxidation processes, disinfection, and groundwater infiltration. Infrastructure modifications range from efficient runoff collection systems, impaired water recovery, installation of artificial turf fields, and improving industrial and private and appliances. Management options include substituting potable water with impaired water such as brackish and seawater. Basic biological, chemical and physicochemical principles underlying these technologies and their limitations will be discussed, as will potential public-health consequences. Students will analyze and summarize in a technical report and oral presentations the technical, economic and societal challenges encountered in implementing specific water-saving technologies.

Prerequisites: The course focuses on technological aspects and knowledge of basic chemical, biological and physical principles relevant environmental engineering and science are expected.

Expected workload and grading: Approximately 8 hours per week. Weekly written 1-page vignettes, a 5-page technical report and a 10 min oral presentation.

Learning objectives: This course is an opportunity for students to familiarize themselves with technologies designed to increase the water use efficiency in urban settings (rather than in agriculture) and to understand the barriers that hinder facile implementation. The course covers projects the instructor encountered first-hand in Singapore, Berlin and California. Studying technologies from a fundamental viewpoint offers students an opportunity to refresh chemical principles encountered in environmental engineering practice.

This is a Graduate-Level course. Undergraduate students interested in enrolling should seek consent of instructor.

SCHEDULE (subject to change)

June 30. Lecture 1.

Course Overview: Supplying mega cities with water: four case studies, Shanghai, Singapore, Berlin, Southern California

Water use in California by area and sector

The urban water cycle

Terminology: water conservation, water efficiency, water reuse, water recovery, water security.

Economic incentives for implementing water conservation strategies

Technologies used: groundwater recharge, desalination, advanced water treatment, urban stormwater runoff management, artificial turf.

July 7. Lecture 2.

Drinking water regulations

Emerging contaminants

Water quality issues in water supplies

Groundwater: conjunctive use and groundwater recharge

Natural and artificial groundwater recharge with impaired waters

Contaminant attenuation during groundwater transport

Case studies: California, Arizona, Berlin

July 14. Lecture 3.

Storm water harvesting

Sources and sinks of organic contaminants

Water quality challenges related to eutrophication

Natural attenuation processes in urban watersheds by sorption and biotransformation in water columns and aquifers

Fundamentals of contaminant sorption to sediments

Case study: Singapore

July 21. Lecture 4.

Seawater desalination

Membrane technologies

Fundamentals of reverse osmosis desalination

Limits and efficiency: passage of contaminants through membranes, fouling, osmotic pressure limitations, brine-disposal

Pre- and post-treatment: filtration, disinfection, remineralization.

Case studies: Israel

July 28. Lecture 5.

Water reuse by advanced technologies

Case study: Orange County Water District groundwater replenishment system.

Basics: disinfection and advanced oxidation processes

Water quality challenges related to disinfection

August 4. Lecture 6.

Urban irrigation: artificial turf as a means to save irrigation water. Producing irrigation water from secondary effluent by desalination.

Health considerations.

August 11. Lecture 7.

Wrap-up

Student presentations

Student papers due (date tba)

Accessibility

Students who may need an academic accommodation based on the impact of a disability must initiate the request with the Office of Accessible Education (OAE). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty dated in the current quarter in which the request is being made. Students should contact the OAE as soon as possible since timely notice is needed to coordinate accommodations. The OAE is located at 563 Salvatierra Walk; phone: 650-723-1066; web site: http://studentaffairs.stanford.edu/oae.

Honor Code

The Honor Code applies to both instructors and students. The text is reproduced below; for more information, see http://studentaffairs.stanford.edu/communitystandards/policy/honor-code. Violations of the Honor Code will be taken extremely seriously in this class.

I. The Honor Code is an undertaking of the students, individually and collectively:
   A. that they will not give or receive aid in examinations; that they will not give or receive unpermitted aid in class work, in the preparation of reports, or in any other work that is to be used by the instructor as the basis of grading;
   B. that they will do their share and take an active part in seeing to it that others as well as themselves uphold the spirit and letter of the Honor Code.

II. The faculty on its part manifests its confidence in the honor of its students by refraining from proctoring examinations and from taking unusual and unreasonable precautions to prevent the forms of dishonesty mentioned above. The faculty will also avoid, as far as practicable, academic procedures that create temptations to violate the Honor Code.

III. While the faculty alone has the right and obligation to set academic requirements, the students and faculty will work together to establish optimal conditions for honorable academic work.