GEOL 470 Environmental Hydrogeology : Course Outline for Fall, 2021

Instructor: Professor Hammond ZHS 325E, x05837, dhammond@usc.edu;
Office hrs by appointment (many options)
TA: Abra Atwood ZHS 325D, aatwood@usc.edu, Office hrs: W 1-3pm
Meetings: Lectures: MW 9:00-10:20 Lab: F 10:00-11:50 Exercises and trips
Field Trip scheduling may require times other than hours above.

Course Description: The course presents principles of hydrogeology and contaminant behavior, illustrating their applications to environmental problems. Instruction will include several lectures by practicing environmental geologists. Case studies will be integrated into the discussion. In addition to scheduled lectures, lab time will be allocated to practical exercises, discussion of problem sets, term projects, field trips and issues in the news.

Topic	Time
1. Introduction	1 week
a) Scope of hydrogeology	
b) Water Resources and the Water Cycle	
c) Common Contaminants and their Sources	
d) Key physical and chemical properties of contaminants	
2. Principles of Hydrology	4 weeks
a) Surface hydrology: Precipitation, runoff, and floods	
b) Darcy's Law and the water table	
c) Aquifers: Stratigraphy and physical characteristics	
d) Drilling and Well Logging techniques	
e) Well construction and aquifer testing	
f) Groundwater tracers and age dating	
3. Groundwater Chemistry	3 weeks
a) Review of chemical equilibria	
b) Chemical evolution of natural waters: Rainfall to seawater	
c) Organic nomenclature	
d) Sampling and Analytical techniques	
e) Statistical considerations	
4. Mass Transport Phenomena and Modeling	2 weeks
a) Advection, diffusion, and dispersion	
b) Adsorption and retardation; Complexing, chelation, and colloids	
c) Reaction Kinetics and Transport	
d) Vadose Zone Transport; Vapors and solutions	
5. Remediation, regulations, and case studies	3 weeks
a) Environmental investigations and Regulations	
b) Remediation techniques	
c) LA Basin hydrodrogeology and contamination issues	
d) Other examples & Project presentations	

Optional Text: C. W. Fetter, T. Boving, D.Kreamer (2019), *Contaminant Hydrogeology, 3rd ed.*, Waveland Press.

Grading:		
	Midterm Exam	35%
	Term Project/Paper/Presentation	30%
	Lab Exercises, Trips, and Problem Sets	35%

Learning Objectives: The class is designed to familiarize students with:

- *Conceptual thinking about water dynamics and its chemistry in the surface and subsurface*
- *Some of the practical problems faced by environmental hydrogeologists*
- *Tools for understanding these problems and possibly remediating them.*
- *Relevant equations that are developed and applied to describe flow in the surface and subsurface*

Term Project: Each student will identify a problem of interest and carry out an independent investigation of this problem. This could involve making observations in the field, laboratory studies, doing literature research, mathematical modeling, or a combination of these efforts. A topic of interest should be selected by mid-way through the course and outlined in a paragraph that will be submitted by Oct. 8. The selection of this topic should include discussions with your instructors about its objective and scope. A brief progress report (about 2 pages) is due on Nov. 5. The progress report should outline the objectives and what has been accomplished, including a bit of relevant data. The final report is due on Dec. 14 and should be written in the format of a research article, including an abstract, introduction, methodology, results and discussion, conclusions and references. In addition, each student will make a 15 minute oral presentation summarizing the project. Presentations will take place during the last scheduled lab or during the final exam period.

Attendance: ESSENTIAL. Reading in the recommended texts, articles or on line will augment, but not replace, class meetings and exercises—a missed class meeting is hard to make up. Please prearrange excused absences or let us know before class (via email) if you are going to be out with an illness. The same applies for exams. They cannot be made up if absence is not excused.

Academic Honesty: You are expected to observe the rules of academic conduct outlined in the Student Handbook (available online). We do encourage you to work together on labs and assignments; however, you must always turn in your own work (describe results in your own words). This helps you better learn the material and helps us see your individual progress.

Academic Accommodations: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to Prof. Hammond as early in the semester as possible. DSP can be reached at ability@usc.edu and is open 8:30am-5:00pm Monday through Friday. The phone number for DSP is 213-740-0776. dsp.usc.edu

Support Systems:

- *Student Health Counseling Services - (213) 740-7711 – 24/7 on call.* Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling
- *National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call.* Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.
- suicidepreventionlifeline.org
- *Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 – 24/7 on call.* Free and confidential therapy services, workshops, and training for situations related to gender-based harm. engemannshc.usc.edu/rsvp
- *Office of Equity and Diversity (OED) | Title IX - (213) 740-5086.* Information about how to get help or help a survivor of harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations. equity.usc.edu, titleix.usc.edu
- *Bias Assessment Response and Support - (213) 740-2421.* Avenue to report incidents of bias, hate crimes, and microaggressions for appropriate investigation and response.
- studentaffairs.usc.edu/bias-assessment-response-support
- *USC Support and Advocacy - (213) 821-4710.* Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

- *Diversity at USC - (213) 740-2101.* Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students. diversity.usc.edu
- *USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call.* Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu
- *USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call .* Non-emergency assistance or information. dps.usc.edu

GEOL 470 Schedule (Tentative, as of 8/3/21)		
Date	**Topic**	**Reading (F=Fetter)**
23-Aug	Water Cycle, Rainfall, Water Quality & Resources	Notes
25-Aug	Geology & Geomorph: Drainage Basins, Rivers, Surf Runoff	Notes
27-Aug	Lab 1: Surface Hydrol: Rainfall, Runoff, Floods, Recurr. Int.	Notes
30-Aug	Floods, Dams, Hazards	
1-Sep	Subsurface Flow; Aquifers & Darcy's Law	F: p 42-51
3-Sep	Lab 2: Porosity, Permeability, Darcy's Law, Falling Head Permeameter	
6-Sep	Labor Day - No class	
8-Sep	Groundwater Hydrology: Aquifers, Stratigraphy & Structure	Notes
10-Sep	Lab 3:Groundwater Problem Set; Finish Lab 2	
13-Sep	Applications of Darcy's Law: Inhomogeneity, Theis Eq.	Notes
15-Sep	Inorganic solutes and Measurements (Cond., pH, O2)	
17-Sep	Lab 4: Trip to San Gabriel Basin (maybe on Sun 9/19)	
20-Sep	Organic Contaminants	F: Ch 7, p376-428
22-Sep	Sources of Contaminants/Behaviors	F: Ch 1, p1-44
24-Sep	Lab 5: Work on Organic Chem Prob Set	
27-Sep	Local Examples of Contamination; inlude Burbank	
29-Sep	Legislation, Environmental Assessment, Remediation	Notes
1-Oct	Lab 6: Field Trip to Burbank Remediation Site	
4-Oct	Inorganic Contaminants/ Behaviors, Equilibria & Redox	F: Ch 6, p316-343
6-Oct	Inorganics/ Behaviors, Equilibria & Redox; Computer Codes	Notes
8-Oct	Lab 7: Problem Set on Equilibria and Redox	Term Project Topic Due
11-Oct	Sewage Treatment; Review for Exam	
13-Oct	**Mid-term Exam**	
15-Oct	Fall Recess - No Class	
18-Oct	Age Tracers: Gases and radioisotopes	Phillips&Castro 2003 TreatiseGeoch v5
20-Oct	Tracers: stable isotopes as tracers	handout
22-Oct	Lab 8: Hyperion Field Trip	
25-Oct	Using Stable Isotopes and Mixing	Langmuir chapter
27-Oct	Sampling, Analytical Techniques and Basic Statistics	Handout
29-Oct	Lab 9: Solving Problems: Isotopes, Tracers and Stats	
1-Nov	Evolution of Natural Waters: Rainfall to Rivers	Langmuir chapter
3-Nov	Hydrograph Separation and Watershed Mass Balances	
5-Nov	Lab 10: Chesapeake Bay Nutrients	Paper Intro due;
8-Nov	Reactions and Transport Modeling	F: p56-97
10-Nov	Transport Models and Sorption	F: p133-187
12-Nov	Lab 11: Prob. Set on Reaction-Transport (Wooster & others)	
15-Nov	Guest Lecture	
17-Nov	GIS Intro (Abra)	
19-Nov	Lab12: GIS Exercise on Drainage Basins	
22-Nov	Guest Lecture	
24-Nov	Turkey Prep - No Class	
26-Nov	Turkey Digestion - No Class	
29-Nov	Drilling Wells and Well Logs	F: Ch 8; Handout
1-Dec	Solid Waste & Landfills, Radioactive Waste	
3-Dec	Student Presentations	
13-Dec	Final Exam Period 11-1pm: Student Presentations	
Additional Topics (if time permits)		
	Transport Models and U Series Isotopes	