

ENVE 5702: ENERGY DEVELOPMENT AND THE CRITICAL ZONE

Fall 2022

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Office Hours: Appointment by email (masks are **STRONGLY** encouraged when visiting office)

Lecture time: Tuesdays from 8:35 AM to 11:25 AM in ME 3174

Course Description (Calendar):

Quantification of the environmental impacts of current and future energy resource development including groundwater, surface water and soil contamination and greenhouse gas emissions. Application of relevant theory (multiphase flow, mass transfer, fate and transport) to describe key environmental processes, detection, monitoring, and mitigation.

Course Learning Outcomes (CLOs):

By the end of the course, students will be able to:

1. Identify the key environmental impacts of the current and future energy development landscape in Canada.
2. Define and distinguish the physical, chemical, and biological processes occurring in the critical zone.
3. Formulate a clear conceptual model of the physical, chemical, and biological processes which drive the environmental impacts of energy development in the critical zone.
4. Critique relevant literature on the study of processes in the critical zone.
5. Assemble process-based knowledge to define, describe, and assess the environmental impact of energy development on the critical zone.

Course Modality

In-person lectures

Course Communication:

All class-wide communications will be posted on the news page of BrightSpace. You are welcome to email me with any questions, but emails should be used for important and/or time sensitive matters. If your question can wait until class time, that would be preferred.

All notes and assignments will be posted to BrightSpace.

Outline of course topic (please know the approximate weeks are subject to change):

- 1) Introduction to critical zone and energy development (1.0 weeks)
 - What is the critical zone and why is it 'critical'?
 - The energy landscape of Canada.
 - Energy development approaches
 - Concern for the environment
 - Types of contaminants
- 2) Processes in the subsurface (4.0 weeks)
 - Groundwater flow and conservative transport
 - Multiphase flow (gases and non-aqueous phase liquids)
 - Phase partitioning
 - Multicomponent mass transfer
 - Diffusion in porous media
 - Vapour transport
 - Reactive transport
- 3) Environmental impacts of energy development on the critical zone (2.0 weeks)
 - Surface spills (fuels)
 - Stray gas migration
- 4) Detection, monitoring, management, and mitigation (1.5 weeks)
 - Signals to measure (dissolved gas, isotopes, composition)
 - Groundwater sampling techniques
 - Soil gas wells
 - Surface effluxes
 - Natural source zone depletion
 - Remedies for stray gas
- 5) Energy and environment into the future (0.5 weeks)
 - The end of oil and gas?
 - Hydrogen
 - Carbon sequestration

The remaining weeks will be used for journal critique and project presentations. Please note that I reserve the right to change the approximate time devoted to each course topic as the course progresses.

Textbooks (optional)

This course will refer to a variety of texts and journal papers throughout the course notes. For fundamental/seminal texts, please refer to (not required):

- Freeze, R.A., and Cherry J.A., 1979, Groundwater, Prentice-Hall
Available for free from Hydrogeologists without Borders.
- Dullien, 1992, Porous Media: fluid transport and pore structure, Academic Press, Inc., San Diego.
- Ho and Webb, 2006, Gas transport in porous media, Springer, The Netherlands.

Assessment

Assessment	Weight	Due dates (exact dates given in week 2)
1. Assignments (3)*	30 %	Weeks 4, 6, and 8
2. Paper Critique and discussion	20 %	Weeks 9-10 (we will schedule in week 2)
3. Active presence and engagement	10 %	All weeks we meet
4. Project presentation and slides*	40 %	Presentations: Weeks 11-12

*Please note that you cannot pass this course if you do not submit (within the required timeline), items 1 and 4 of the assessments.

Brief descriptions:

Assignments:

These will be take-home problem sets that will be numerical in nature (calculations, modeling, etc.). I encourage you to work together to solve these problems. However, I expect you to submit your own unique answers to the problems for grading. These will be marked using an answer key with part marks.

Paper critique and discussion:

You will each read three (3) research papers on topics presented in this course to augment your learning. During the critique weeks, you (as a collective group) will lead a discussion on the paper, and we will all participate in critiquing the methods, results, and overall conclusions. These discussions can include the approach to achieve the objectives of the study, good aspects, aspects which could be improved, or anything else you think is important to discuss. A rubric will be provided for grading.

Active presence and engagement:

As a result of no exam, I need to see that each of you is engaging with material and understanding course content. I expect each student to participate with questions, comments, and discussion each time we meet. No rubric required. If you contribute, you will get full marks. You can miss up to two classes and this will not affect your mark (please contact me if you have a valid reason for missing more than 2 classes, for 2 or less, no need to contact me. For example, being ill is a valid reason and I encourage you to stay home if you are ill).

Project presentation and slide deck:

You will each select a topic under the umbrella of energy development and the impacts to the critical zone (we will select these after the introductory lectures). You will then research and describe impacts in a presentation to the class. Additionally, you will submit your slide deck for grading. You will need to read 15 papers and include these in your presentation. Try to keep the papers as recent as possible (within the last 20 years). Rubrics will be provided.

Inclusivity in the classroom

We will strive to create an environment of mutual respect for all through equity, diversity, and inclusion within this course. The space which we work in will be safe for everyone. Please be considerate of everyone's personal beliefs, choices, and opinions.

Lateness

Accommodation may be made for valid reasons, requirements for which are outlined below. Without a valid or recognized accommodation, a penalty of 10% per day will be given for all assessments. If you think an extra day or two will enhance the work you submit, I understand this. I will give you a total of **FIVE** "grace days" for assignments, only. I will track the total used. If it exceeds five, the late policy of 10% per

day applies. This includes all days of the week. The exception is the Paper Critique and discussion and the Project presentation, you must present on your assigned day. If missed without a valid reason, you will receive a 0.

Appeals

Please bring any grading appeals to my attention within 10 days of grades being posted. Please write a brief description of your concern and submit to me. I will then review and discuss with you, if needed.

Course Material Copyright

Classroom teaching and learning activities, including lectures, discussions, presentations, etc., by both instructors, guest lecturers and students, are copyright protected and remain the intellectual property of their respective author(s). All course materials, including PowerPoint presentations, outlines, and other materials, are also protected by copyright and remain the intellectual property of their respective author(s).

Students registered in the course may take notes and make copies of course materials for their own educational use only. Students are not permitted to reproduce or distribute lecture notes and course materials publicly for commercial or non-commercial purposes without express written consent from the copyright holder(s).

Academic Integrity

The University Academic Integrity Policy defines plagiarism as “presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one’s own.” This includes reproducing or paraphrasing portions of someone else’s published or unpublished material, regardless of the source, and presenting these as one’s own without proper citation or reference to the original source. Examples of sources from which the ideas, expressions of ideas or works of others may be drawn from include but are not limited to: books, articles, papers, literary compositions and phrases, performance compositions, chemical compounds, art works, laboratory reports, research results, calculations and the results of calculations, diagrams, constructions, computer reports, computer code/software, material on the internet and/or conversations.

Examples of plagiarism include, but are not limited to:

- any submission prepared in whole or in part, by someone else;
- using ideas or direct, verbatim quotations, paraphrased material, algorithms, formulae, scientific or mathematical concepts, or ideas without appropriate acknowledgment in any academic assignment;
- using another’s data or research findings without appropriate acknowledgement;
- submitting a computer program developed in whole or in part by someone else, with or without modifications, as one’s own; and
- failing to acknowledge sources through the use of proper citations when using another’s work and/or failing to use quotations marks.

Plagiarism is a serious offence that cannot be resolved directly by the course’s instructor. The Associate Dean of the Faculty conducts a rigorous investigation, including an interview with the student, when an instructor suspects a piece of work has been plagiarized. Penalties are not trivial. They can include a final grade of “F” for the course or even suspension or expulsion from the University.

Final Grades

Standing in a course is determined by the course instructor subject to the approval of the Faculty Dean. This means that grades submitted by the instructor may be subject to revision. No grades are final until they have been approved by the Dean.

Course Completion

Please take careful note of Section 5.1 of the Academic Regulations in the Undergraduate Calendar (<https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/grading/#credit>): *“To obtain credit in a course, students must satisfy the course requirements as published in the course outline.”* As per the note (*) in the assessment section of this document, you will fail the entire course if you do not complete the assignments and project presentation and annotated bibliography in a timely manner (as per late policy).

Academic Accommodation

Students with diverse learning styles and needs are welcome in this course. You may need special arrangements to meet your academic obligations during the term. For an accommodation request, the processes are as follows. For more information, please consult: <http://students.carleton.ca/course-outline>

Pregnancy Obligation

Please contact the instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please consult: <http://students.carleton.ca/course-outline>

Religious Obligation

Please contact the instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please consult: <http://students.carleton.ca/course-outline>

Accommodations for Students with Disabilities

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613- 520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your *Letter of Accommodation* at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). *Requests made within two weeks will be reviewed on a case-by-case basis.* After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (<http://www.carleton.ca/pmc>) for the deadline to request accommodations for the formally scheduled exam (if applicable).

Survivors of Sexual Violence

As a community, Carleton University is committed to maintaining a positive learning, working, and living environment where sexual violence will not be tolerated, and survivors are supported through academic accommodations as per Carleton’s Sexual Violence Policy. For more

information about the services available and to obtain information about sexual violence and/or support, please visit: <http://www.carleton.ca/sexual-violence-support>

Accommodation for Student Activities

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact the instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more information, please consult: <http://students.carleton.ca/course-outline>

COVID-19

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are [a number of actions you can take](#) to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

Feeling sick? Remaining vigilant and not attending work or school when sick or with symptoms is critically important. If you feel ill or exhibit COVID-19 symptoms do not come to class or campus. If you feel ill or exhibit symptoms while on campus or in class, please leave campus immediately. In all situations, you must follow Carleton's [symptom reporting protocols](#).

Masks: Carleton has paused the [COVID-19 Mask Policy](#), but continues to **strongly** recommend masking when indoors, particularly if physical distancing cannot be maintained. It may become necessary to quickly reinstate the mask requirement if pandemic circumstances were to change.

Vaccines: Further, while proof of vaccination is no longer required as of May 1 to attend campus or in-person activity, it may become necessary for the University to bring back proof of vaccination requirements on short notice if the situation and public health advice changes. Students are strongly encouraged to get a full course of vaccination, including booster doses as soon as they are eligible, and submit their booster dose information in [cuScreen](#) as soon as possible. Please note that Carleton cannot guarantee that it will be able to offer virtual or hybrid learning options for those who are unable to attend the campus.

All members of the Carleton community are required to follow requirements and guidelines regarding health and safety which may change from time to time. For the most recent information about Carleton's COVID-19 response and health and safety requirements please see the [University's COVID-19 website](#) and review the [Frequently Asked Questions \(FAQs\)](#). Should you have additional questions after reviewing, please contact covidinfo@carleton.ca.