

**Western University - Faculty of Engineering
Department of Civil and Environmental Engineering**

**CEE 4465A: Environmental Design for Waste Disposal
Course Outline 2024/25**

This course is an advanced course in environmental design for waste disposal and includes a complete preliminary design of a landfill facility. The objectives of the course are for the students:

- To develop an understanding of modern waste management practice and the role of landfilling in this context.
- To recognize the wide range of technical and non-technical considerations associated with site selection, approval, design, construction and operation of a modern waste management facility and understand the impact of the engineering solution in a global and societal context.
- To develop an understanding of the sources and characteristics of municipal solid waste and the chemical and biological characteristics of landfill leachate.
- To understand the professional and ethical responsibility of an engineer with respect to waste management including consideration of social, economic, environmental, worker health and safety, and legislative and other regulatory issues.
- To use state-of-the-art computer techniques for assessing the impact of proposed waste disposal sites on groundwater quality.
- To apply mathematical, scientific, and engineering knowledge to the design of the preliminary design for a landfill facility to meet specified needs and legislative requirements.
- To improve communication skills by discussing current waste disposal issues and expressing and defending opinions before their peers.
- To obtain experience working as a member of a design team and hence prepare for the engineering workplace.
- To appreciate the rapidly changing nature of knowledge and technology in this field and the need for life-long learning

Calendar Copy:

Consideration of properties of solid waste, landfill covers, landfill gas, leachate, techniques for disposal, regulations, liner technology, contaminant transport, and impact assessment are examined in the context of the design of solid waste disposal facilities.

Prerequisites:

Completion of third year of either a B.E.Sc. or B.Sc. program.

Note: It is the student's responsibility to ensure that all Prerequisite and Corequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is

also the student's responsibility to ensure that they have not taken a course listed as an Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

Contact Hours:

3 lecture hours/week;

Lectures are organized into learning modules/units. Review of lecture material and attendance at lecture sessions should take approximately 6 hours per week.

3 tutorial hours/week;

A 3-hour tutorial session will be delivered each week during the scheduled tutorial hours. Students seeking assistance with assignments, project, or clarification on lecture material are strongly encouraged to attend these tutorials. Example problems will also be solved during some tutorial sessions.

Instructor:

Dr. Christopher Power

e-mail: cpower24@uwo.ca

Textbook:

Course notes (with gaps) will be provided. These should be downloaded from the course website in advance of the lecture. The gaps will be filled in during the lectures and should be done by the student in their own set of notes; this promotes active learning. Solutions to example problems will also be provided during the lectures and tutorials, and these, as well as the gap-filled notes, will **NOT** be posted on the course website.

Students are responsible for checking the course OWL Brightspace site (<http://westernu.brightspace.com>) on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class.

All course material will be posted to OWL Brightspace: [http:// westernu.brightspace.com](http://westernu.brightspace.com)

If students need assistance with the course OWL Brightspace site, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

Other References:

- Geotechnical Aspects of Landfill Design and Construction by Xuede Qian, Robert M. Koerner, Donald H. Gray, ISBN 0-13-012506-7. Published 2002 by Prentice-Hall, Inc. Upper Saddle River, New Jersey 07458
- Ontario Regulation 232/98 (key sections in course notes). Available in the Taylor Library and also on the internet at <http://www.canlii.org/on/laws/regu/1998r.232/20040802/whole.html>.

- Landfill Standards: a guideline on the regulatory and approval requirements of new or existing landfill sites, Ontario Ministry of the Environment and Energy (MOE), May 1998, Report PIBS365IE. Web link: <http://www.ene.gov.on.ca/envision/land/landfill/>
- Geotechnology of Waste Management by Oweis, I.S. and Khera, 2nd Edition, PWS Publ. Co., Boston, 1998.
- Solid Waste Landfill Engineering and Design by E.A. McBean, F. Rovers & G.J. Farquhar 1995.
- Barrier Systems for Waste Disposal Facilities by R.K. Rowe, R.M. Quigley & J.R. Booker 2004, Chapman & Hall.

Units:

Both SI and FPS unit systems may be used in lectures, laboratories, tutorials, and examinations.

Specific Learning Objectives [GA Indicator – **bold** denotes evaluated indicator]:

- 1) Waste Management - Diversion and Disposal. At the end of this section the student should be able to:
 - a) correctly use relevant terminology in hydrogeology and waste management [**KB4**]
 - b) incorporate the 3R's (Reduce, Reuse and Recycle) in the design of a waste management strategy and be familiar with the advantages and limitations of recycling [**KB4**]
 - c) describe alternative techniques for waste treatment (incineration and energy from waste; composting; bioconversion; waste processing and landfilling) [**KB4**]
 - d) describe the different landfilling techniques (trench method; area method) [**KB4**]
- 2) Solid Waste and Leachate Characteristics. At the end of this section the student should be able to:
 - a) describe the nature, sources and composition of solid waste [**KB4**]
 - b) describe the difference between in-place, apparent and total average density, at each of these and know when to use the different values [**KB4**]
 - c) describe the different solid waste bio-degradation processes and the characteristics of landfill leachate [**KB4**]
 - d) apply the Ontario "Reasonable Use" Guideline [**KB4**, PR1]
 - e) quantitatively estimate the contaminating life span of a landfill based on the size, infiltration and peak leachate characteristics [PA1]
- 3) Landfill Design. At the end of this section and after completion of the design project, the student should be able to:
 - a) describe the available design options for barrier systems [PA1, D2]
 - b) design barrier systems that comply with the Ontario Regulations 232 (§10) for both standard design and site-specific alternatives to the standard designs [**D3**, PR1]
 - c) design the base contours of a landfill [**D3**]
 - d) design the leachate collection system [**D3**]

- e) describe the general characteristics of the three main groups of clay liners (re-compacted active soil; soil-bentonite mixtures; geosynthetic clay liners) and their strengths and limitations [**KB4**]
 - f) describe the main types of geomembranes and the key design considerations associated with selection of a suitable geomembrane [**KB4, D2**]
 - g) describe the typical landfill development and operations consideration [EPM2]
- 4) Environmental Impact Assessment and Regulations. After completion of this section and the design project the student should be able to:
- a) discuss the different types of environmental regulatory systems, the requirements of a landfill approval process, and the advantages and limitations of prescriptive and performance-based regulations [PR1]
 - b) discuss the broad consideration of the Environmental Assessment Act [IESE3]
- 5) Advective-Diffusive Contaminant Transport. At the end of this section the student should be able to:
- a) describe the key contaminant transport and retardation mechanisms (advection, diffusion, dispersion, sorption and radioactive and biological decay) [**KB4**]
 - b) describe the governing differential equations and typical boundary conditions [**KB4**]
 - c) calculate the percolation through a landfill cover, based on the water balance method and estimate leachate volumes [**KB4, PA1**]
- 6) Landfill Gas. After completion of this section the student should be able to:
- a) estimate the quantity and composition of gas that will be generated by a MSW landfill [**KB4, PA1**]
 - b) describe and be familiar with typical gas recovery and migration control systems [KB4, PA1]
- 7) Design Project. As part of the Design Project, where students will design a landfill as part of a team, the student should be able to:
- a) classify the various phases of the design process and identify the key component of each phase, including the relevant legislation with which the design must comply [PA1]
 - b) describe the responsibility of a professional engineer with respect to long term health and safety issues and worker safety, education and training related to site investigation, construction and operation of a waste management facility [PR1]
 - c) describe, in general terms, what is involved in preparing for and obtaining approval of an undertaking under the Environmental Assessment Act of Ontario [PR1, IESE3]
 - d) describe the specific design considerations relevant to landfill design and be able to work as a member of a team that can develop a preliminary landfill design that is in compliance with Ontario Regulation 232/98, at a level that could be presented to the MOE for approval under the Environmental Protection Act of Ontario [D1, **D3**, D4, ITW2, ITW3, PR1, EPM2]

- e) prepare well-documented and consistent design calculations, a design and operations report, preliminary design drawings and cost estimates [D3, D4, CS2]
- f) provide an oral presentation of the design project and defend his/her work [CS3]

Instructor may expand or revise material presented in the course as appropriate.

General Learning Objectives:

E=Evaluate, T=Teach, I=Introduce

Problem Analysis	T	Teamwork	T	Ethics and Equity	I
Investigation	I	Communication	T	Economics and Project Management	T
Design	E(A)	Professionalism	T	Life-Long Learning	I
Engineering Tools	I	Impact on Society	T	Knowledge Base	E(A)

Accreditation Units:

Engineering Science: 50% (23 AUs)

Engineering Design: 25% (12 AUs)

Complementary Studies: 25% (12 AUs)

Evaluation:

The final course mark will be determined as follows:

Participation	10%
Assignments	15%
Design Project	20%
Quizzes	15%
Final Examination	40%

Total	100%

1. Quizzes and Examinations:

Two 50-minute quizzes will be held during lecture hours. These quizzes are tentatively scheduled for Wednesday, October 9 and Wednesday, November 13.

A three-hour written final examination will be held during the regular examination period.

2. Assignments

Four assignments will be completed during the course. The purpose of the assignments is to help students in their assimilation and synthesis of the material, to develop their communication skills, and to prepare for the midterm and final exam. Assignment questions will consist of a mix of short answer and problem-based computational questions.

Assignments will be due electronically as a PDF through the course website; if completed by hand, then the assignment must be converted to a **very clear and legible PDF** for submission (instructions will be provided). Completion using software (Word, OneNote, Excel, etc.) is ideal for easy conversion to PDF. Submission in any format other than a single PDF (unless otherwise indicated in the cover page of the assignment) will be assigned a mark of zero.

All written submissions will be passed through Turnitin to ensure no copying or plagiarism. You may discuss the assignments with colleagues but the work you turn in must be yours alone. Assignments are to be submitted prior to **11:55 pm on the due date**. Late assignments will be assessed a penalty of 10% per day, to a maximum of 4 days, after which they will receive a mark of zero. Request for extensions for legitimate reasons (e.g., sickness) must follow appropriate procedures; see “**Academic Consideration for Student Absence**” section below. **The maximum number of missed assignments for each student will be one;** if more than one assignment is missed a student may be barred from writing the final exam.

3. Design Project

The design project is a major component of the course. You will be asked to form “design teams” of 4 or 5 students (the actual number will be specified when the number of students in the course is known). You will be assigned a site that has previously been considered for landfilling during or following an extensive EAA investigation. You will have access to key hydrogeologic data arising from these studies. The site boundaries of the area investigated will be shown on the drawing, however, you may select your own footprint subject to the requirement that the landfill must be located within the boundaries shown. You are to design the landfill subject to a number of constraints that will be specified (in addition to those arising from the Environmental Assessment Act, the Environmental Protection Act, 1998 Landfill Standard Guidelines (Ontario Regulation 232/98) MOE and MOE Guidelines for EPA Submissions and Government waste diversion targets).

Although basic information concerning the site is provided for your assistance, this information is not complete, and it will be necessary for you to obtain additional information. The submission should be sufficiently detailed such that it could be presented to the MOE for review and approval of the undertaking.

Your submission should clearly indicate the name of the individual who undertook prime responsibility for each aspect of the work and the name of the individual who reviewed that aspect of the work. All hand calculations are to be on squared paper and must be organized and presented in a neat, clear and professional manner. All pages of calculations must have the date, initials of the originator and initials of the checking engineer. All calculations are to be checked. All drawings are to be of professional quality with the name of originator and checking individual shown.

Your group will be required to make an oral presentation of your design and will be expected to defend your design (which will be reviewed by the instructor, teaching assistant, and a peer review group).

Of the marks assigned for the oral presentation and defence of your project, 10% will be assigned for your critical review of the other groups' submissions and 80% will be assigned for the final design submission. Each student will be required to submit a written and signed assessment (with reasons) of how, in their opinion, the marks for the design project should be divided between team members (the instructor will make the final allocation after considering the opinion of all group members and reviewing the work done by each student).

4. Participation

Participation is an important component of this course. It will be assessed in primarily three ways:

- a) Attendance and verbal contribution during lectures and student presentations
- b) Participation in the "test-your-learning" quizzes and polls using iClicker
- c) Posting relevant, original, constructive material to the Discussions page on the OWL Brightspace website (both original posts and replies)

Attendance:

Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Information regarding iClicker Cloud:

Classroom Polling: We will be using iClicker Cloud, a cloud-based student response software, in class this semester. This will help me understand what you know, give everyone a chance to participate in class, and provide more interaction on concepts and example questions. We will also use this software to keep track of attendance. At the start of every class, you will register your attendance; only after you do this will you be able to answer any poll questions posted. You are required to bring a device connected to the university Wi-Fi to participate in iClicker Cloud during class, including a smartphone, tablet, laptop or iClicker remote. You will need to create an iClicker Reef Student account to participate in class.

Creating Your iClicker Reef Student Account: Go to iclicker.com/students or download the iClicker Reef Student app for your Apple or Android device to sign up for a Reef account. You should use your university email address and your University ID (e.g., "cpower24" for student cpower24@uwo.ca) in the Student ID field. You can edit your email address, password, or student ID from your account profile. Do not create and use more than one Reef account as you will only receive credit from a single account.

You do not need to purchase anything – iClicker Cloud is fully supported by Western and is free to all its students. Make sure you choose Western University Ontario when signing up.

Add This Course to Your Reef Account

Institution: Western University Ontario

Course: CEE 4465A F24 - Enviro Design for Waste

Academic Integrity Information: iClicker activities fall under the provisions of our campus academic honesty policy. Students must not engage in academic dishonesty while participating in iClicker activities. This includes but is not limited to:

- Checking in while not physically in class
- Having another student check you into class
- Answering polling questions while not physically in class
- Looking at other students' devices while answering live questions
- Using more than one iClicker remote or account at a time

Any student found to be in violation of these rules will lose polling points for the entire term and may be reported to the Dean of Engineering.

General Regulations and Procedures:

I. Missed/Late Accommodation Policy:

1. Students missing an assignment or examination will report the absence by submitting Academic Consideration Request form through [STUDENT ABSENCE PORTAL](#).
2. Documentation must be provided as soon as possible.

II. Exam Accommodation:

1. If you are unable to write a final examination, report your absence using the Academic Consideration Request Form through [STUDENT ABSENCE PORTAL](#).
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, misreading timetable, and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department and the Associate Dean and in order to apply you must submit an the Academic Consideration Request Form through [STUDENT ABSENCE PORTAL](#). PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.

III. Late Assignments:

1. Students must advise the course instructor if they are having difficulty completing an assignment on time (prior to the due date of the assignment).
2. Students should be prepared to submit the Academic Consideration Request Form and provide documentation if requested to do so by the course instructor (see reverse side for information on documentation).
3. If granted an extension, a revised due date should be established with the course instructor. The approval of the Chair of your Department (or the Assistant Dean, First Year Studies, if you are in first year) is not required if assignments are completed prior to the last day of classes.
4. This course has 3 assignments with each assignment counted towards your final course grade. Academic consideration will not be granted for missed assignments. The maximum number of missed assignments for each student will be one; if more than one assignment is missed a student may be barred from writing the final exam.

5. The assignment deadlines can be found above in the course outline. For each assignment, students are expected to submit the assignment by the deadline listed. Late assignments will be assessed a penalty of 10% per day, to a maximum of 4 days, after which they will receive a mark of zero. If you have a long-term academic consideration or an accommodation for disability that allows greater flexibility than provided here, please reach out to your instructor at least one week prior to the posted deadline.
6. Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

IV. Medical Accommodation:

1. Requests for Academic Consideration Request Form through [STUDENT ABSENCE PORTAL](#).
2. Requests for academic consideration must include the following components:
 - a. Self-attestation signed by the student (*This is only accepted for the first/one absence*)
 - b. Medical note
 - c. Indication of the course(s) and assessment(s) affected by the request
 - d. Supporting documentation as relevant
3. Requests without supporting documentation are limited to one per term per course.
4. **Students must request academic consideration as soon as possible and no later than 48 hours after the missed assessment.**
5. Once the request and supporting documents have been received and reviewed, appropriate academic consideration, if granted, shall be determined by the instructor in consultation with the academic advisor, in a manner consistent with the course outline. Academic consideration may include extension of deadlines, waiver of attendance requirements for classes/labs/tutorials, or re-weighting of course requirements. Some forms of academic consideration, such as arranging Special Examinations, assigning a grade of Incomplete, or granting late withdrawals without academic penalty, may only be granted by the Academic Advising office of the Faculty of Engineering.

V. Religious Accommodation:

When scheduling unavoidably conflicts with religious holidays, which (a) require an absence from the University or (b) prohibit or require certain activities (i.e., activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), no student will be penalized for absence because of religious reasons, and alternative means will be sought for satisfying the academic requirements involved. If a suitable arrangement cannot be worked out between the student and instructor involved, they should consult the appropriate Department Chair and, if necessary, the student's Dean.

It is the responsibility of such students to inform themselves concerning the work done in classes from which they are absent and to take appropriate action.

VI. Academic Integrity:

In the Faculty of Engineering, we encourage students to create a culture of honesty, trust, fairness, respect, responsibility, and courage, befitting the professional degree you are pursuing.

Please visit [Academic Integrity Western Engineering](#) for more information.

VII. Academic Offences:

Plagiarism means using another's work without giving credit. The university has rules against plagiarism and other scholastic offences. Western Engineering has a zero-tolerance policy on plagiarism. The minimum penalty is zero on the course work and a repeat offence will earn you zero on the course. A third offence may lead to expulsion from the university.

[Scholastic Discipline for Undergraduate Students](#) & [Cheating, Plagiarism and Unauthorized Collaboration: What Students Need to Know](#)

Students must write their reports, essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (<http://www.turnitin.com>). Scholastic offences are taken seriously, and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

VIII. Faculty of Engineering AI Policy:

The use of generative Artificial intelligence (GenAI) tools won't be discouraged in the Faculty of Engineering. As we pride ourselves on building the future we can't hide from the use of GenAI tools to contribute to the understanding of the course materials. However, the use of GenAI tools in any assignment or contribution during the course will have to be disclosed, as a resource.

GenAI tools use won't be permitted in any type of examination or other assessments where the faculty have prohibited their use. If use of GenAI tools is detected by the instructor in these instances, academic offences penalties might be imposed against the student.

IX. Use of English Policy:

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work except for the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

X. Accessibility:

Western is committed to achieving barrier free accessibility for persons with disabilities studying, visiting and working at Western. As part of this commitment, there are a variety of services, groups and committees on campus devoted to promoting accessibility and to ensuring that individuals have equitable access to services and facilities. To help provide the best experience to all members of the campus community, please visit the [Accessibility Western University](#) for information on accessibility-related resources available at Western.

Students with disabilities may arrange for academic accommodation at Western. For a more detailed explanation, please visit [Academic Support & Engagement -Academic Accommodation](#).

XI. Inclusivity, Diversity, and Respect:

The Faculty of Engineering at Western University is committed to creating equitable and inclusive learning environments that value diverse perspectives and experiences. We recognize that university courses often marginalize students based on social identity characteristics such as, but not limited to, Indigeneity, race, ethnicity, nationality, ability, gender identity, gender expression, sexuality, age, language, religion, and socioeconomic status. Understanding this, we strive to facilitate equitable experiences and inclusion within the classroom by respecting and integrating multiple ways of knowing, being, and doing. Please visit the [Office of Equity, Diversity and Inclusion](#).

XII. Health and Well-Being:

- [Health & Wellness Services – Students](#) - Offers appointment-based medical clinic for all registered part-time and full-time students.
- [Mental Health Support](#) - Provides professional and confidential services, free of charge, to students needing assistance to meet their personal, social and academic goals. Services include consultation, referral, groups and workshops, as well as brief, change-oriented psychotherapy.
- [Crisis Support](#) - For immediate assistance, please visit Thames Hall Room 2170 or call 519-661-3030. The crisis clinic operates between 11:00 am - 4:30 pm. For after-hours crisis support, click [here](#).
- [Gender-Based Violence and Survivor Support](#) - Western [is committed to reducing incidents of gender-based and sexual violence](#) and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, [here](#). To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Important Contacts:

Engineering Undergraduate Services	SEB 2097	519-661-2130	engugrad@uwo.ca
Civil & Environmental Engineering	SEB 3005	519-661-2139	civil@uwo.ca
Office of the Registrar/Student Central	WSSB 1120	519-661-2100	

Important Links:

- [WESTERN ACADEMIC CALENDAR](#)
- [ACADEMIC RIGHTS AND RESPONSIBILITIES](#)