



University  
of Manitoba

University of Manitoba

Faculty of Agricultural and Food Sciences

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**Course Title:** Remediation of Contaminated Land

**Department:** Soil Science

**Credit Hours:** 3

**Course Number:** SOIL 4500

**Academic Session:** Winter 2024

**Prerequisite:** SOIL 3600 or instructor's permission

**Classroom Location:** AGRICULTURE BUILDING Rm: 343

**Meeting Days and Class Hours:** Tuesday 6:00 pm – 8:45 pm (NB: Agriculture Building entrances will automatically lock at 6:30 pm)

**Department Office location:** 362 Ellis Building

**Department email:** soiladmin@umanitoba.ca

### **Instructor Information**

**Name:** Clemence Muitire

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**Phone Number:** 432 275 7932

**Office Location:** 321 Ellis Building

**Office Hours:** By appointment. Book an appointment by sending an email to me.

### **LAND ACKNOWLEDGEMENT**

*The University of Manitoba campuses are located on original lands of Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene peoples, and on the homeland of the Métis Nation. We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.*

### **Course Philosophy**

#### **Students' Learning Responsibilities**

You should maintain a high attendance record in order to maximize your benefits from this course. If for any reason you are unable to attend a class, let me know ahead of the class. It is important that you keep up with assigned readings, participate in class discussions, and contribute to the group project. Your final grade will be based on class participation,

individual performance, and group work; it will be to your benefit to ensure that you optimize all three.

### **Why is this course useful?**

The course will increase the student's awareness of the factors controlling contaminant transport and fate in the environment, and how these affect the choice of remedial strategies for contaminated sites. Students will gain an understanding of the basis and mechanics of various established, emerging, and innovative remediation technologies.

### **Who should take this course?**

The course is designed for students who envisage a career in the environmental sector, particularly the sub-sector involved in environmental site assessments and site remediation.

### **Course Objectives**

In general, students should understand the significance of site and contaminant characteristics in the assessment and remediation of a contaminated site.

In particular, students should be able to:

1. Identify the important acts and regulations governing identification and cleanup of contaminated sites
2. Illustrate the major steps in the site assessment of a contaminated site
3. Recognize the major classes of contaminants and their attributes
4. Identify the properties of a site which influence the potential impact of contamination
5. Describe the risk of contaminants to impacting human and environmental health
6. Explain representative physical, chemical and biological approaches to remediation of contaminated land
7. Recognize the derivation of assessment and remediation endpoints and the regulatory framework within which land remediation must operate in Canada.

### **Course Evaluation**

Class participation/Quizzes	5%
Midterm	25%
Site Assessment/Term project	25%
Final Exam	45%

### **Assessment of grades**

A+	>89.4
A	79.5-89.4
B+	74.5-79.4
B	69.5-74.4
C+	64.5-69.4
C	59.5-64.4
D	49.5-59.4
F	<49.5

### **Description of assessments**

Students will be required to read assigned material ahead of class. A short quiz may be given at any time in class and may not be made up if missed.

Students will also conduct a Phase I Environmental Site Assessment group project during the term and prepare a report for submission at the end of the term.

**The group project is due on the last day of class (April 9, 2024).**

### **Description of Examinations**

One midterm (1 hour) and one final exam (2 hours) will be given. Both exams will include a short answer section and a long answer section. Students are expected to apply the concepts covered in class as well as understand the legislation governing contaminated site remediation.

### **Schedule for Term Examinations:**

Midterm: February 13

Final Exam: TBA

### **Texts, Readings, Materials**

#### **Textbooks**

*There are no required texts for the course. However, the following are good references:*

Barnhisel, R.I., R. D. Darmody, and W.L. Daniels (Eds.). 2000. Reclamation of Drastically Disturbed Lands. Agronomy No. 41. ASA-CSSA-SSSA, Madison, WI.

Suthersan, S.S. 2017. Remediation Engineering: Design Concepts. CRC-Lewis Publishers, Boca Raton, FL.

Swartjes, F. A. (Ed.) 2011. Dealing with contaminated sites: From Theory Towards Practical Application. Springer, Dordrecht, The Netherlands.

#### **Supplementary Reading**

CCME. 2006. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. 215 pp. CCME Publication No. PN1332. Available online:

<https://ccme.ca/en/res/a-protocol-for-the-derivation-of-environmental-and-human-health-soil-quality-guidelines-en.pdf>

CCME 1997. Guidance Document on the Management of Contaminated Sites in Canada 58 pp. CCME Publication Number PN1279. Available online:

[https://ccme.ca/en/res/guidance\\_management\\_cs\\_e.pdf](https://ccme.ca/en/res/guidance_management_cs_e.pdf) .

CCME 1996. Guidance Manual for Developing Site-specific Soil Quality Remediation Objectives for Contaminated Sites in Canada. 30 pp. Available online:

<https://ccme.ca/en/res/guidance-manual-for-developing-site-specific-soil-quality-remediation-objectives-for-contaminated-sites-in-canada-en.pdf>

CCME 2020. Ecological Risk Assessment Guidance Document. CCME Publication Number PN1585. Available online: [https://ccme.ca/en/res/eraguidance\\_e.pdf](https://ccme.ca/en/res/eraguidance_e.pdf)

Manitoba Sustainable Development. 2016. Guideline for the Designation of Contaminated and Impacted Sites in Manitoba. Available online:

[https://www.gov.mb.ca/sd/////envprograms/contams/pdf/guidlines/designation\\_of\\_contaminated\\_and\\_impacted\\_sites\\_in\\_manitoba\\_e.pdf](https://www.gov.mb.ca/sd/////envprograms/contams/pdf/guidlines/designation_of_contaminated_and_impacted_sites_in_manitoba_e.pdf)

Manitoba Sustainable Development 2016. Environmental Site Assessments in Manitoba.

Available online:[https://www.gov.mb.ca/sd/envprograms/contams/pdf/guidlines/environmental\\_site\\_assessments\\_in\\_manitoba\\_e.pdf](https://www.gov.mb.ca/sd/envprograms/contams/pdf/guidlines/environmental_site_assessments_in_manitoba_e.pdf)

## **Course Policies**

### **Late submissions**

A 10% penalty will be assessed for late submissions. No points (0%) will be awarded for submissions received after the quiz is returned to the rest of the class.

### **Missed Exams**

Make-up exams will not be granted except in the case of a documented emergency.

### **Attendance**

Students will not be penalized for not attending class however, they are highly encouraged to attend and participate in class activities to be able to successfully complete this course. Notify the instructor by email if you are not able to attend class. NB: Make-up exams and quizzes will not be granted except in the case of a documented emergency.

### **Academic Integrity**

Plagiarism or any other form of cheating in examinations, term tests or academic work is subject to serious academic penalty (e.g., suspension or expulsion from the faculty or university). Cheating in examinations or tests may take the form of copying from another student or bringing unauthorized materials into the exam room (e.g., crib notes, pagers or cell phones), also copying from online sources verbatim without giving credit. Exam cheating can also include exam personation. (Please see Exam Personation, found in the Examination Regulations section of the General Academic Regulations). A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty. Students should acquaint themselves with the University's policy on plagiarism, cheating, exam impersonation and duplicate submission (<https://umanitoba.ca/student-supports/academic-supports/academic-integrity>; See Student Academic Misconduct Procedures in the Undergraduate Calendar 21/22 p.91).

Take Academic Integrity and Student Conduct Tutorial [here](#)

### **Respectful Work and Learning Environment Policy**

The university prohibits harassment and discriminatory practices. Each individual has a right to learn in an inclusive and respectful environment, hence no disrespectful and discriminatory activity towards the instructor or other students will be allowed in this course (See the University's policy of RWLE : <https://umanitoba.ca/about-um/respectful-work-and-learning-environment-policy>).

## **Accessibility**

The University of Manitoba is committed to providing an accessible academic community. [Students Accessibility Services \(SAS\)](#) offers academic accommodation supports and services such as note-taking, interpreting, assistive technology, and exam accommodations. Students who have, or think they may have, a disability (e.g., mental illness, learning, medical, hearing, injury-related, visual) are invited to contact SAS to arrange a confidential consultation.

520 University Centre

(204) 474-7423

[Student\\_accessibility@umanitoba.ca](mailto:Student_accessibility@umanitoba.ca)

## **LEARNER SUPPORT & RESOURCES**

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### **Writing and Learning Support**

The Academic Learning Centre (ALC) offers writing and learning support to help you throughout your academic program. You have access to a writing tutor who can give you feedback at any stage of the writing process. The tutor is available by appointment. Students can also get the services of an English as an Additional Language (EAL) specialist from the ALC. The EAL is available to work with students on improving their English-language academic writing skills.

Consult an ALC learning specialist or attend an academic skills workshop to improve your time management, learning strategies and test-taking strategies. Get support in selecting courses by making an appointment with an ALC content tutor. The ALC also offers peer-facilitated study groups called Supplemental Instruction (SI) for certain courses that students have typically found difficult. In SI study groups, students ask questions, compare notes, discuss content, solve practice problems, and develop new study strategies in a group-learning format.

In addition to one-to-one and group sessions, you can also find writing and study tip sheets and videos on the ALC website.

Academic Learning Centre services are free for U of M students. For more information, please visit the Academic Learning Centre website at: <http://umanitoba.ca/student/academiclearning/>

Contact the Academic Learning Centre by calling 204-480-1481 or emailing [academic\\_learning@umanitoba.ca](mailto:academic_learning@umanitoba.ca).

## Course Outline

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### **Module 1 - Introduction**

#### **Introduction**

- Terminology and definitions
- What does the remediation worker need to know?

#### **Regulatory Framework**

- The context of public and environmental safety: The Love Canal Jolt
- Canadian Council of the Ministers of the Environment (CCME)
- Contaminated Sites Remediation Act
- Dangerous Goods Transportation Act
- Other sorts of liability

#### **Quantifying Contamination Risk**

- Defining contamination
- The source-pathway-receptor pollutant linkage concept
- Establishing assessment criteria and remediation end-points
- Risk assessment and risk-based end-points
- Site specific risk assessment (risk based corrective action)
- Environmental Impact Assessment (EIA)
- Environmental Site Assessments (Phase I/II ESA)

### **Module 2 – Contaminant Characteristics and Partitioning**

Understanding contaminant dynamics in the environment key to remediation efforts

#### **Fate and Transport of Contaminants**

- Classification of contaminants
- Examples of contaminated lands in Manitoba and Canada
- Interaction with water
- Interaction with the gas phase
- Interaction with the solid phase
- Equations of transfer
- Contaminant degradation
- Inorganic contaminants
- Mechanisms of contaminant injury to humans and the environment

### **Module 3- Remediation Approaches**

Choosing the right remediation and reclamation approach

- Remedial Standards - Tier 1, II, III CCME
- Biological approaches to remediation (Bioremediation)
  - Intrinsic remediation (natural attenuation)
  - Bioenhancement
  - Bioventing
  - Bioslurping
  - Biosparging

- Bioslurry systems (Bioreactors)
- Biopiles
- Landfarming
- Phytoremediation
- Physical & chemical approaches
  - Soil washing
  - Encapsulation
  - Soil vapor extraction (SVE)
  - In situ air sparging
  - Dual phase extraction
  - Surfactant and solvent flushing
  - LNAPL/DNAPL
  - Low temperature thermal desorption
  - Incineration
  - Vitrification
  - Solidification/stabilization
  - Nanoremediation

### **Site Assessment Projects**

Each group will prepare a site assessment of your case study as if you were a consultant hired to do so. The group will be asked to provide a report including:

- i) A discussion of the regulatory framework and site assessment process as they would pertain to the site,
- ii) a description of the site,
- iii) a description of the contaminant,
- iv) a proposal for a site assessment,
- v) an assessment of the potential fate of the contaminant,
- vi) an assessment of the potential impact of the contaminant, and
- vii) a discussion of remediation approaches, where applicable.

Each group will present a summary of their report to the class on the last day of class.

## **University of Manitoba's COVID Syllabus message**

The University of Manitoba (the "UM") is committed to maintaining a safe learning environment for all students, faculty, and staff. Should campus operations change because of health concerns related to the COVID-19 pandemic or other campus-wide emergency, it is possible that this course will move to a fully remote delivery format. Should the instructor be required to stay at home for an extended period and an alternate instructor not be available, the course may move temporarily to a remote delivery format. In that instance, you may be provided with an asynchronous option to minimize the impact the change may have on your schedule.

### **PPE and Mask Wearing**

In a face-to-face environment, our commitment to safety requires students to observe all public health and safety guidelines set by the University (<https://umanitoba.ca/coronavirus>). Students are discouraged to come to class if they suspect or test positive for covid-19.

Medical-grade 3-ply masks are available at many locations on campus, including specific classroom locations, designated by your unit, the Elizabeth Dafoe Library (Fort Garry Campus) and the Brodie Centre main doors (Bannatyne Campus). Additional PPE, if necessary for a specific learning environment, will be provided to you by the teaching unit.

### **Illness**

Remember: **STAY HOME IF YOU HAVE SYMPTOMS OR ARE ILL.** If you become sick or are required to self-isolate, you should notify your instructor by email so you can develop a plan to complete the course learning outcomes while you are absent.

What to do if you become ill while at UM:

1. Leave the classroom, lab, or workspace immediately. Wear a mask while leaving the premises and/or while waiting for transportation.
2. Perform hand hygiene (soap and water or hand sanitizer) and avoid contact with others and minimize contact with the physical environment.
3. Once at home, complete the [MB self-assessment](#) and follow the directions that are provided.
4. Inform your supervisor(s), instructor(s) or, if in residence, the appropriate individual.
5. You must remain off campus and all UM facilities until cleared to return in accordance with self-assessment, testing results, or MB Health requirements.

### **Recommended transportation options (in order):**

1. Drive yourself home.
2. Pick-up by family or friend – remember to keep your mask on and to distance as much as possible, and where possible, open a window to improve ventilation.



3. Pickup by taxi/Uber:

- Remain masked and perform hand hygiene before entering the vehicle.
  - Avoid touching the inside of the vehicle
  - Keep your mask on for the duration of the ride
  - Where possible, open a window to improve ventilation.

4. Winnipeg Transit buses - Winnipeg Transit has indicated that individuals that are ill **must not use Transit.**