UNION COLLEGE

Environmental Science, Policy & Engineering Program

Spring 2016

Waste Management and Recycling

ENS-208

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Lectures: TTH 9:00 AM- 10:45 AM, WOLD-028. Lab TH 1:55 - 4:45 PM, WOLD-028. Click HERE for class presentations.

COURSE DESCRIPTION

Introduction to various sources of hazardous, non-hazardous, biodegradable, and non-biodegradable waste materials. Focus areas are landfill systems, geosynthetics, geotextiles, geomembranes, geonets, single clay liner, single geomembrane liner, composite liner systems, leak detection and leachate collection, removal and treatment of leachate, and capping and closure systems. The recycling segment will explore natural resources of raw materials including origin and use, and potential and limitation for recycling of materials. Focus on various applications of recycling recyclable and non-recyclable materials. Discussion of methods of manufacture and compositions of such materials will concentrate on advanced industrial applications for the reuse of non-recyclable waste materials. Application areas include production of new materials, materials with superior qualities for special purposes, and materials with high level of resistance against certain environmental conditions. The course will also touch on the political aspect of recycling including consumer attitude and government incentives to encourage recycling. Three class hours and a weekly lab. Prerequisite ENS100 (Introduction to Environmental Studies) or GEO102 (Environmental Geology).

COURSE GRADE

- Assignments & Quizzes = 20%
- Laboratory Reports = 20%
- Term Test (6th week) = 20%
- Term Paper = 20%
- Final Examination = 20%

SCHEME OF FINAL GRADE								
90+ = A	85+ = A(-)	80+ = B(+)	75+ = B	70+ = B(-)	65+ = C(+)	60+ = C	55+ = C(-)	50+ = D

NOTES

- Assigned homework is due as will be arranged. Late submission results in partial grade loss. One week late submission results in total grad loss.
- Unannounced quizzes are probable to ensure students are keeping up with course work.

- If you must miss the midterm test due to extraordinary circumstances beyond your control (a letter from the Dean of Students will be required in this case), your 20 points of the midterm test will be automatically transferred to the final exam, i.e., your final will be graded out of 40 points. No makeup for the midterm test will be allowed for any reason. If you miss the midterm without a supporting letter from the Dean of Students, there will be 5 points penalty.
- If you must miss the final exam due to extraordinary circumstances beyond your control (a letter from the Dean of Students will be required in this case), your grade in the course will be prorated based on the components of your term work. No makeup for the final exam will be allowed for any reason.
- The academic performance of the students in this course will be held to the standards of Union College's Honor Code.

TEXTBOOK

Worrell, W., and Vesilind, P.A. (2012). "Solid Waste Engineering." 2nd Edition, Cengage Learning, ISBN 9781439062159.

COURSE SYLLABUS

INTEGRATED SOLID WASTE MANAGEMENT

- Solid waste in history
- Economics and solid waste
- Legislation and regulations
- Materials flow
- Reduction
- Reuse
- Recycling
- Recovery
- Disposal of solid waste in landfills
- Energy conversion
- The need for integrated solid waste management
- Special wastes

MUNICIPAL SOLID WASTE CHARACTERISTICS AND QUANTITIES

- Definitions
- Municipal solid waste generation
- Municipal solid waste characteristics
- Composition by identifiable items
- Moisture content
- Particle size
- Chemical composition
- Heat value
- Bulk and material density
- Mechanical properties
- Biodegradability
- Measuring particle size

COLLECTION

- Refuse collection systems
- Phase 1: house to can
- Phase 2: can to truck
- Phase 3: truck from house to house

- Phase 4: truck routing
- Phase 5: truck to disposal
- Commercial wastes
- Transfer stations
- Collection of recyclable materials
- Litter and street cleanliness
- Design of collection systems

LANDFILLS

- Planning, siting, and permitting of landfills
- Planning
- Siting
- Permitting
- Landfill processes
- Biological degradation
- Leachate production
- Gas production
- Landfill design
- Liners
- Leachate collection, treatment, and disposal
- Landfill gas collection and use
- Geotechnical aspects of landfill design
- Stormwater management
- Landfill cap
- Landfill operations
- Landfill equipment
- Filling sequences
- Daily cover
- Monitoring
- Post-closure care and use of old landfills
- Landfill mining

PROCESSING OF MUNICIPAL SOLID WASTE

- Refuse physical characteristics
- Storing MSW
- Conveying
- Compacting
- Shredding
- Use of shredders in solid waste processing
- Types of shredders used for solid waste processing
- Describing shredder performance by changes in particle size distribution
- Power requirements of shredders
- Health and safety
- Hammer wear and maintenance
- Shredder design
- Pulping
- Roll crushing
- Granulating
- The pi breakage theorem

MATERIALS SEPARATION

- General expressions for materials separation
- Binary separators
- Polynary separators

- Effectiveness of separation
- Picking (hand sorting)
- Screens
- Trommel screens
- Reciprocating and disc screens
- Float/sink separators
- Theory of operation
- Jigs
- Air classifiers
- Other float/sink devices
- Magnets and electromechanical separators
- Magnets
- Eddy current separators
- Electrostatic separation processes
- Other devices for materials separation
- Materials separation systems
- Performance of materials recovery facilities

COMBUSTION AND ENERGY RECOVERY

- Heat value of refuse
- Ultimate analysis
- Compositional analysis
- Proximate analysis
- Calorimetry
- Materials and thermal balances
- Combustion air
- Efficiency
- Thermal balance on a waste-to-energy combustor
- Combustion hardware used for MSW
- Waste-to-energy combustors
- Modular starved air combustors
- Pyrolysis
- Mass burn versus RDF
- Undesirable effects of combustion
- Waste heat
- Ash
- Air pollutants
- Dioxin

BIOCHEMICAL PROCESSES

- Methane generation by anaerobic digestion
- Anaerobic decomposition in mixed digesters
- Potential for application of anaerobic digesters
- Methane extraction from landfills
- Potential for the application of methane extraction from landfills
- Composting
- Fundamentals of composting
- Composting municipal solid waste
- Potential for composting municipal solid waste
- Composting wastes other than refuse
- Other biochemical processes
- Glucose production by acid and enzymatic hydrolysis
- Other bacterial fermentation processes

CURRENT ISSUES IN SOLID WASTE MANAGEMENT

- Life cycle analysis and management
- Life cycle analysis
- Life cycle management
- Flow control
- Public or private ownership and operation
- Contracting for solid waste services
- Financing solid waste facilities
- Calculating annual cost
- Calculating present worth
- Calculating sinking funds
- Calculating capital plus O&M costs
- Comparing alternatives
- Hazardous materials
- The role of the solid waste manager

LABORATORY SCHEDULE

Lab (1): Field trip

- Schenectady County composting facility & household waste sorting facility, and Colonie landfill facility, Colonie

Lab (2): Field trip

- WTE Recycling Corp.

Lab (3): Field trip

- Paper and cardboard recycling facility, Albany.

Lab (4): Field trip

- Metal salvage and recovering facility, Green Island.

Lab (5): Field trip

- Waste tires conversion and recycling facility, Niskayuna.

Lab (6): Field trip

- Waste-to-energy facility, Hudson Falls.

Lab (7): Field trip

- Schenectady County wastewater treatment and sludge composting facility, Schenectady.

Lab (8): Field trip

- Hazardous and electronic waste recycling facility, Scotia.

Lab (9)

- Direct shear test demonstration using geosynthetics.

Lab (10)

- Project Presentation.

SPECIFICATIONS OF LAB REPORT

The sites of field trips are selected to show the students a wide variety of facilities involved in waste management, recycling, treatment, and waste-to-energy production. These visits are intended to be educational and informative. To get the most out of these field trips, students are expected to document every visit in a site-visit report. Students are encouraged to ask tour guides questions, inquire about details of operation, learn about the advantages and disadvantages of shown processes, and seek explanation for how various functions work. The report should contain all technical and non-technical information related to the visited facility: name, location, function, capacity, operation, products, by-products, and any information deemed necessary for a comprehensive report. In addition to written text, students may include in their reports tables, graphs, charts, figures, and site photos and video clips. All submissions will be electronic (more details will be given).

The lab sessions that will be conducted in the college lab are designed to study some of the specifications of the American Society for Testing and Materials (ASTM) related to waste materials and containment systems. The lab report should include a cover page with the name of the student(s), course and standard specification titles, and date. The report itself shall contain the objective of the standard and procedure. The report should emphasize the technical aspect of the standard. Emphasis of grading will be placed on the technical content of the report as well as clarity, creativity, and correctness of writing.

PROJECT COME CLEAN

Introduction

Come Clean is a research-based project with focus on waste management systems and recycling techniques. The goal in this project is to research in depth one of the subjects listed below. Students can also research a subject not listed below but the instructor's approval is required in this case. Students may survey case studies that document effective and economical methods of waste containment as well as successful projects of recycling that resulted in a reduction in waste that goes into landfill. The project may also offer a study of environmental compliance of a site with the standard specifications of the American Society for Testing and Materials (ASTM, see specifications cited below) and/or the regulations of the Environmental Protection Agency (EPA). This project is for the students registered in the Waste Management & Recycling course.

Suggested Topics

- Acid Rain
- Agriculture waste
- Asbestos
- Ash (waste of waste)
- Brownfields
- Carbon emissions
- Chemical and biochemical treatment
- Clean Air Act and Clean Water Act
- Cleanup
- Composting and biological treatment
- Construction and demolition wastes
- Containment systems
- Energy recovery and thermal treatment
- Environmental impacts
- Facility siting and transfer stations
- Final landfill post-closure use
- Groundwater contamination
- Hazardous (nuclear/radioactive) waste

- Household hazardous (electronic/lead/mercury/cadmium) waste
- Incinerators
- Industrial waste
- Integrated waste management
- Landfills
- Liners, caps, gas, and leachate
- Medical waste
- Metal recovery
- Mining and mineral waste
- Municipal waste
- Ozone depletion
- Paper and pulp
- Pesticides
- Recycling
- Recycling of waste in new materials
- Risk Assessment
- Scrap tires
- Environmental site assessment
- Settlement of landfills
- Sludge
- Solid waste dust
- Superfund
- Toxins and dioxins
- Waste collection
- Waste composition
- Waste generation
- Waste reduction
- Waste to energy
- Wetland

Project Subject

Each student is free to choose the project subject they like to research but any given subject may not be selected by more than one student. Students in this course come from many departments and some may wish to address in their project a problem that is closely related to their major since the problems of waste containment and recycling techniques have many environmental dimensions. Students may also wish to explore a new field of interest or use a theme or a subject that has intrigued them (policy, regulations, environmental law, economics, politics, ethics and environmental justice, public perception, attitude, and opinion, etc.). All selected subjects must be approved by the instructor.

This Waste Management & Recycling course covers a wide variety of topics. Whether it is a containment system or a recycling project, the requirement for an in-depth technical study is always present. Furthermore, one should also ensure the sensibility and foundational premise of the project in order to gain public acceptance.

The literature is rich with examples of projects that transformed the public's perception of waste and the general attitude towards recycling. Recycling is no longer a choice; it is a necessity for an enduring and sustainable environment. Students are to report in depth on their selected subject and offer a careful analysis of the all involved factors. Students may also wish to concentrate on how recyclable materials can be used in the manufacture of conventional products or to impart certain properties that can improve traditional materials.

Resources

Students may collect the scientific and technical information for their chosen project from one or more of the following sources: the Internet, technical publications, professional journals, magazines, textbooks, movies, documentaries, and all other credible sources including interviews with knowledgeable individuals.

Students are required to cite in their report all the sources they used in their research. Internet sites are cited using the address (URL) of those sites. All other references are to be cited with the name of author, year, title of paper or book, page, and publisher.

Progress Report

In the sixth week of the term, each student is required to submit a progress report. This should include the name of the student, title of the project, and a statement describing the subject. The instructor will provide feedback and approve the project subject if it involves the expected level of rigor. If more than one student selected the same subject, the instructor will advise these students that different projects are required.

Submittals

At noon on the Saturday that precedes the tenth week of the term, the final electronic report of the project is due. The report should be equivalent to at least 10 pages of text (double-spaced type, Times font with one inch margin on all sides). In addition to the 10 pages of text, students may add pictures, tables, graphs, charts, figures, and any other supplementing materials. The total length of the report, however, may not exceed the equivalent of 20 pages.

Grading Criteria

In addition to the written report, students are required to make 8-10 minutes class presentation. The presentations will take place during the lab time in the tenth week of the term.

The grade in this project will be assigned based on the quality and organization of the report, relevance of content to the subject under consideration, understanding, clarity of presentation, organization, and demonstration of ability to address questions with comprehension.

SUGGESTED REFERENCES

- Ackerman, Frank. (1997). Why do we recycle: markets, values, and public policy. Washington, D.C.: Island Press.
- Albertsson, Anne-Christine. (1995). Degradable Polymers, Recycling, and Plastics Waste Management. CRC.
- Curlee, Randall T. (1994). Waste-to-energy in the United States: a social and economic assessment. Westport, Conn: Quorum Books.
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- Farrelly, E. M. (2008). Blubberland: the dangers of happiness. Cambridge, Mass.: MIT Press.
- Gandy, Matthew. (1994). Recycling and the politics of urban waste. New York: St. Martin's Press.
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- Kanti L. Shah (2000). Basics of Solid and Hazardous Waste Management Technology. Prentice Hall.
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- Lund, H.F. (2001). The McGraw-Hill Recycling Handbook. Second Edition, McGraw-Hill.
- Luton, Larry S. (1996). The politics of garbage: a community perspective on solid waste policy making. Pittsburgh, Pa: University of Pittsburgh Press.
- Porter, Richard C. (2002). The economics of waste. Washington, DC: Resources for the Future.
- Rathje, William L. and Murphy, Cullen. (2001). Rubbish!: the archaeology of garbage. Tucson, AZ: University of Arizona Press.
- Rogers, Heather. (2005). Gone tomorrow: the hidden life of garbage. New York; London: New Press: Distributed by W.W. Norton & Company.
- Tchobanoglous, George, Theisen, Hilary, and Vigil, Samuel A. (1993). Integrated Solid Waste Management. McGraw-Hill Publishing Co.; International edition.
- Williams, Paul T. (2006). Waste treatment and disposal, Chichester, West Sussex, England; Hoboken, NJ, USA: Wiley, 2nd ed.
- Young, Mitchell (ed.). (2007). Garbage and recycling. Detroit: Greenhaven Press.

Standard American Society for Testing and Materials (ASTM) Specifications

- D6008-96(2005) Standard Practice for Conducting Environmental Baseline Surveys.
- E1527-05 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.
- E1528-06 Standard Practice for Limited Environmental Due Diligence: Transaction Screen Process.
- E1609-01 Standard Guide for Development and Implementation of a Pollution Prevention Program.
- E1903-97(2002) Standard Guide for Environmental Site Assessments: Phase II Environmental Site Assessment Process.
- E1984-03 Standard Guide for Process of Sustainable Brownfields Redevelopment.
- E2018-01 Standard Guide for Property Condition Assessments: Baseline Property Condition Assessment Process.

- E2060-06 Standard Guide for Use of Coal Combustion Products for Solidification/Stabilization of Inorganic Wastes.
- E2081-00(2004)e1 Standard Guide for Risk-Based Corrective Action.
- E2091-05 Standard Guide for Use of Activity and Use Limitations, Including Institutional and Engineering Controls.
- E2107-06 Standard Practice for Environmental Regulatory Compliance Audits.
- E2137-06 Standard Guide for Estimating Monetary Costs and Liabilities for Environmental Matters.
- E2173-07 Standard Guide for Disclosure of Environmental Liabilities.
- E2201-02a Standard Terminology for Coal Combustion Products.
- E2205-02 Standard Guide for Risk-Based Corrective Action for Protection of Ecological Resources.
- E2247-02 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process for Forestland or Rural Property.
- E2277-03 Standard Guide for Design and Construction of Coal Ash Structural Fills.
- E2365-05 Standard Guide for Environmental Compliance Performance Assessment.

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