Environmental, Soil and Water Science (ESWS)

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ESWS Coordinator
115 Plant Science Building
479-575-5740

Opportunities for employment and post-graduate study are numerous for graduates of the Department of Crop, Soil, and Environmental Sciences. Environmental, Soil, and Water Science graduates find jobs with environmental consulting companies, environmental education organizations, state agencies (e.g., Extension Service, Department of Environmental Quality, Health Department), federal agencies (e.g., Environmental Protection Agency, Natural Resources Conservation Service), municipalities and local environmental services (e.g., waste management and recycling, water and wastewater treatment facilities, parks and tourism departments), a wide variety of private businesses, and environmental research.

The Environmental, Soil, and Water Science major includes courses in areas such as environmental science, water quality, soil science, soil and water conservation, and the sustainable productivity of natural resources.

Requirements for a Major in Environmental, Soil, and Water Science (ESWS)

State minimum core and discipline specific general education requirements:

(Course work that meets state minimum core requirements is in bold.)

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>ACTS Equivalency</th>
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<tr>
<td>BIOL 1543 &amp; BIOL 1541L</td>
<td>Principles of Biology</td>
<td>BIOL 1014 Lecture and Principles of Biology Laboratory</td>
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<tr>
<td>BIOL 2013 &amp; BIOL 2011L</td>
<td>General Microbiology</td>
<td>BIOL 2004 Lecture and General Microbiology Laboratory</td>
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<td>BIOL 3863 &amp; BIOL 3861L</td>
<td>General Ecology</td>
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<tr>
<td>or ENSC 3223 &amp; ENSC 3221L</td>
<td>Ecosystems Assessment</td>
<td>and Ecosystems Assessment Laboratory</td>
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<td>CSES 1203</td>
<td>Introduction to Plant Sciences</td>
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<tr>
<td>CHEM 1103 &amp; CHEM 1101L</td>
<td>University Chemistry I</td>
<td>CHEM 1414 Lecture and University Chemistry I Laboratory</td>
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<td>CHEM 1123 &amp; CHEM 1121L</td>
<td>University Chemistry II</td>
<td>CHEM 1424 Lecture and University Chemistry II Laboratory</td>
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<td>CHEM 2613 &amp; CHEM 2611L</td>
<td>Organic Physiological Chemistry</td>
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<td>or CHEM 3603 &amp; CHEM 3601L</td>
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<td>Environmental Science Core</td>
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<tr>
<td>CSES 2203</td>
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<td>CSES 3214</td>
<td>Soil Resources and Nutrient Cycles</td>
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<td>Soil Fertility (with Lab Component)</td>
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<td>CSES 4253</td>
<td>Soil Classification and Genesis</td>
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<td>ENSC 4263</td>
<td>Environmental Soil Science</td>
<td>(with Lab Component)</td>
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Environment, Soil and Water Science (ESWS)
Environmental, Soil, and Water Science (ESWS)

Natural Resources Core
Select 12 hours from the following two groups:

Environmental Science
AGME 3153 Surveying in Agriculture and Forestry
CSES 2013 Pest Management
CSES 355V Soil Profile Description (1 hour, may take twice)
CSES 462V Internship (1-6 credit hours)
CSES 4553 Wetland Soils
ENSC 3103 Plants and Environmental Restoration
ENSC 3263 Soil and Water Conservation
ENSC 4021L Water Quality Laboratory
ENSC 4034 Analysis of Environmental Contaminants
ENSC 4401 Professional Certification Preparation
GEOS 3043 Sustaining Earth
GEOS 3543 Geospatial Applications and Information Science

Environmental Studies (maximum of 6 hours)
AGEC 3413 Principles of Environmental Economics
AGEC 3503 Agricultural Law I
AGEC 3523 Environmental and Natural Resources Law
ENSC 3933 Environmental Ethics
SOCI 4603 Environmental Sociology

General Electives 16-17

Total Hours 120

Environmental, Soil, and Water Science B.S.A.
Eight-Semester Degree Program

Students wishing to follow the degree plan should see the Eight-Semester Degree Policy (http://catalog.uark.edu/undergraduatecatalog/academicregulations/eightsemesterdegreecompletionpolicy) for university requirements of the program.

First Year

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<tr>
<th>Course</th>
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Second Year

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Third Year

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<td>CSES 2203</td>
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<td>General Microbiology Laboratory (ACTS Equivalency = BIO 2004 Lab)</td>
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Environmental, Soil and Water Science (ESWS)

Year Total: 14 14

Fourth Year

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<tr>
<td>CSES 3023 Crop, Soil, and Environmental Sciences Colloquium</td>
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<td>AGED 3143 Communicating Agriculture to the Public</td>
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<td>ENSC 3223 Ecosystems Assessment &amp; ENSC 3221L Ecosystems Assessment Laboratory</td>
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<td>BIOL 3863 General Ecology &amp; BIOL 3861L General Ecology Laboratory</td>
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<td>Soil Science or Natural Resources Core</td>
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<td>Natural Resources Core or General Elective</td>
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<td>Statistics or Natural Resources Core</td>
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Total Units in Sequence: 120

Minor in Natural Resources Management (NRMT-M)

A student planning to minor in Natural Resources Management must notify the program adviser for consultation and more detailed information. No more than 9 hours can be counted towards a Natural Resources Management minor with an ESWS major. The Natural Resources Management Minor consists of 18 hours to include the following:

Required courses

- ENSC 1003 Environmental Science
- ENSC 1001L Environmental Science Laboratory
- CSES 2203 Soil Science
- CSES 3214 Soil Resources and Nutrient Cycles
- AGEC 3413 Principles of Environmental Economics
- AGEC 3503 Agricultural Law I
- AGEC 3523 Environmental and Natural Resources Law
- BIOL 3863 General Ecology
- CSES 1203 Introduction to Plant Sciences
- CSES 2013 Pest Management
- CSES 2201L Soil Science Laboratory
- CSES 4013 Advanced Crop Science
- CSES 4133 Ecology Crop, Soil, and Environmental Sciences Colloquium
- CSES 4224 Soil Fertility
- CSES 4253 Soil Classification and Genesis
- CSES 4553 Wetland Soils
- CSES 462V Internship
- ENSC 3103 Plants and Environmental Restoration
- ENSC 3223 Ecosystems Assessment & ENSC 3221L Ecosystems Assessment Laboratory
- ENSC 3263 Soil and Water Conservation
- ENSC 3603 GIS for Environmental Science
- ENSC 4021L Water Quality Laboratory
- ENSC 4023 Water Quality
- ENSC 4034 Analysis of Environmental Contaminants
- ENSC 4263 Environmental Soil Science
- ENSC 4401 Professional Certification Preparation
- GEOS 3043 Sustaining Earth
- GEOS 3543 Geospatial Applications and Information Science

Total Hours: 18

Minor in Soil Science (SOIL-M)

A student planning to minor in Soil Science must notify the program adviser for consultation and more detailed information. The Soil Science minor will consist of a total of 18 hours comprising the following required and elective courses. No more than 9 hours can be counted towards a Soil Science minor with an Environmental Soil and Water Science major. Those students interested in obtaining certification in the area of soil science will need at least 15 soil science hours, preferably covering each of the sub-disciplines (i.e., fertility, genesis, morphology, and classification, chemistry, physics, soil biology and ecology, and land use and management).

Required Courses

- CSES 2203 Soil Science
- CSES 2201L Soil Science Laboratory

Elective Courses

Select the remaining 14 hours from the following courses:

Undergraduate Courses

- CSES 3214 Soil Resources and Nutrient Cycles
- CSES 355V Soil Profile Description (1 hour; may be taken for up to 2 hours credit)
- CSES 4224 Soil Fertility
- CSES 4253 Soil Classification and Genesis
- CSES 4553 Wetland Soils
- ENSC 3263 Soil and Water Conservation
- ENSC 4263 Environmental Soil Science
- ENSC 4401 Professional Certification Preparation (soils exam)

Graduate Courses

- CSES 5033 Advanced Soil Fertility and Plant Nutrition
- CSES 5224 Soil Physics
- CSES 5264 Microbial Ecology
Crop, Soil and Environmental Sciences Courses

CSES 1011. Introduction to Crop, Soil, and Environmental Science. 1 Hour.
An introduction to the CSES department and majors in Environmental Soil and Water Sciences and Crop Management. Emphasis will be placed on issues and opportunities within these disciplines and orienting students to the department and University of Arkansas. Required of all department majors with less than 24 semester credit hours. Recitation 1 hour 20 minutes per week for the first eight weeks of the semester. Prerequisite: Freshman and sophomore standing only.

CSES 1203. Introduction to Plant Sciences. 3 Hours.
An introduction to basics of agricultural crop plant structure, growth, and production.

CSES 2003. Introduction to Weed Science. 3 Hours.
Fundamental, practical concepts of weed control and weed biology; equipment and techniques used in modern weed control practices; and basic recommendations and systems for specific agronomic and horticultural crops. Lecture 2 hours, laboratory 2 hours per week. Corequisite: Lab component. Prerequisite: CSES 1203 or CSES 2103 or HORT 2003.

CSES 2012. Introduction to Organic Crop Production. 2 Hours.
An introduction to the principles of organic agriculture and ecology and the regulations defining organic production and certification. Additional topics include crop rotations for pest management and for increasing soil organic matter, feeding the soil and plant nutrition, soil health, and green manuring, corporate agriculture and genetically modified organisms.

CSES 2013. Pest Management. 3 Hours.
Introduction to basic principles of pest management as they relate to vertebrate animals, insects, plant disease and weeds. Selected pests are studied with emphasis on current management approaches and alternative pest control.

CSES 2101L. Crop Science Laboratory. 1 Hour.
A series of laboratory experiments designed to reinforce principles of plant growth and development, reproduction, classification, and the utilization of plant products. Emphasis is placed on major crop plant species. Experiments are conducted by individuals or by teams. Laboratory consists of a single, 2-hour period each week. Required for Crop Management majors. Corequisite: CSES 2103.

CSES 2103. Crop Science. 3 Hours.
Principles of crop growth, development, and utilization and how these principles relate to production. Emphasis on major agronomic crop species. Lecture 3 hours per week.

CSES 2201L. Soil Science Laboratory. 1 Hour.
Field and laboratory exercises related to the study of the physical, chemical, and biological properties of soils. Laboratory mandatory for all crop management and environmental, soil, and water science majors and optional for others. Laboratory 2 hours per week. Pre- or Corequisite: CSES 2203.

CSES 2203. Soil Science. 3 Hours.
Origin, classification, and physical, chemical, and biological properties of soils. Lecture 3 hours, discussion 1 hour per week. Corequisite: Drill component. Prerequisite: MATH 1203 and CHM 1103 or CHM 1073.

CSES 3023. Crop, Soil, and Environmental Sciences Colloquium. 3 Hours.
A communication-intensive course covering topics in agronomy and environmental, soil, and water science with particular emphasis on spoken communication but also including written communication, group activities, professionalism, ethics, problem solving, and information retrieval. A student-oriented class with collaborative participation. Colloquium workshop: 3 hours per week. Prerequisite: COMM 1313 and Junior or Senior standing only.

CSES 3112. Forage Management. 2 Hours.
Forage crops for pasture, hay, and silage with reference to growth and development, production, nutritional quality, and grazing systems. Lecture 2 hours per week. Prerequisite: CSES 1203 or CSES 2103.

CSES 3214. Soil Resources and Nutrient Cycles. 4 Hours.
Integration of the fundamental concepts of the biological, chemical, and physical properties of soil systems and their roles in managing soil resources. Lecture 3 hours, laboratory 3 hours per week. Pre- or Corequisite: BIOL 2013 and BIOL 2011L. Corequisite: Lab component. Prerequisite: CSES 2203.

CSES 3312. Cotton Production. 2 Hours.
Principles and techniques associated with production of cotton. Recitation 2 hours per week. Prerequisite: CSES 1203 or CSES 2103.

CSES 3322. Soybean Production. 2 Hours.
An overview of the history and utilization of soybean as well as the physiological and environmental basis for the development of economical soybean production practices. Recitation 2 hours per week. Prerequisite: CSES 1203 or CSES 2103.

CSES 3332. Rice Production. 2 Hours.
A study of the principles and practices involved in rice culture worldwide with major emphasis on the United States. Recitation 2 hours per week. Prerequisite: CSES 1203 or CSES 2103.

CSES 3342. Cereal Grain Production. 2 Hours.
An overview of the botany, production, cultural practices, soil & climatic adaptation and utilization of the major cereal grain crops. Prerequisite: CSES 1203 or CSES 2103.

CSES 355V. Soil Profile Description. 1-2 Hour.
Training for soil profile description writing and membership of judging teams. May be repeated for up to 8 hours of degree credit.

CSES 3603. Metrics for Sustainable Agricultural Systems. 3 Hours.
Analysis of productive agricultural systems necessary to meet expanding demand worldwide for food, feed, fiber and fuel while preserving critical ecosystem services to avoid future catastrophic failures of the biosphere. Characterization of sustainable systems using well-defined metrics, indicators and indices, including reference to sustainability certifications. Metrics for soil, water, atmosphere and biodiversity. Applications in crop and animal production with scales from field to watershed to eco-region. Examining the process and methodologies of integrating metrics into indices to support sustainable supply chain decisions. Discussion of life cycle analyses and current initiatives toward approaching agricultural systems sustainability. Technical course intended for students in agriculture, biology, business, engineering, and environmental sciences. This course is cross-listed with BENG 3603.

CSES 400V. Special Problems. 1-6 Hour.
Work on special problems in crop, soil and environmental sciences or related field. May be repeated for up to 6 hours of degree credit.

CSES 4013. Advanced Crop Science. 3 Hours.
Fundamental concepts of crop physiology, crop improvement, seed science, and crop production systems. Recitation 3 hours per week. Prerequisite: CSES 2103 and CSES 2203.

CSES 402V. Special Topics. 1-3 Hour.
Studies of selected topics in crop, soil and environmental sciences not available in other courses. May be repeated for up to 12 hours of degree credit.

CSES 4103. Plant Breeding. 3 Hours.
Basic principles involved in plant breeding programs to improve crop plants and seed programs. Lecture 2 hours, laboratory 2 hours per week. Corequisite: Lab component. Prerequisite: ANSC 3123 or BIOL 2323.
CSES 4133. Ecology and Morphology of Weedy and Invasive Plants. 3 Hours.
Study of weeds as economic pests occurring in both agricultural and nonagricultural situations and including poisonous plants and other specific weed problems. Gross morphological plant family characteristics which aid identification, habitat of growth and distribution, ecology, competition, and allelopathy are discussed. Lecture 2 hours, laboratory 2 hours a week. Corequisite: Lab component. Prerequisite: CSES 2103 or HORT 2003.

CSES 4143. Principles of Weed Control. 3 Hours.
Advanced concepts and technology used in modern weed control practices and study of the chemistry and specific activity of herbicides in current usage. Lecture 2 hours, laboratory 2 hours per week. Corequisite: Lab component. Prerequisite: CHEM 1073 and CHEM 1071L.

CSES 4224. Soil Fertility. 4 Hours.
Study of the soil's chemical, biological and physical properties, and human modification of these properties, as they influence the uptake and utilization of the essential nutrients by plants. Lecture 3 hours, laboratory 2 hours per week. Pre- or Corequisite: CHEM 1123 and CHEM 1121L or (CHEM 1073 and CHEM 1071L and CHEM 2613 and CHEM 2611L). Corequisite: Lab component. Prerequisite: CSES 2201L and CSES 2203.

CSES 4253. Soil Classification and Genesis. 3 Hours.
Lecture and field evaluation of soil properties and their relation to soil genesis and soil classification with emphasis on soils of Arkansas. Lecture 2 hours, laboratory 2 hours per week. Corequisite: Lab component. Prerequisite: CSES 2203 and CSES 2201L.

CSES 4303. Bioenergy Feedstock Production. 3 Hours.
Overview of production and characteristics of cultivated crops, perennial grasses, and woody species as feedstocks for bioenergy. Fundamentals of plant growth factors, culture, harvest and storage, quality and improvement, and introduction to environmental impact, modeling, and resource utilization. Prerequisite: MATH 1203 and BIOL 1543 or CSES 1203. Courses in introductory chemistry or soil science are preferred.

CSES 4533. Wetland Soils. 3 Hours.
This course explains the chemical, physical, and morphological characteristics of wetland soils and describes the techniques for identifying wetland soils using field indicators and monitoring equipment. This course also explains principles of wetland creation, restoration, and mitigation - all key components in assuring the sustainability of valuable wetland resources. Prerequisite: CSES 2203 and CSES 2201L or CSES 355V.

CSES 462V. Internship. 1-6 Hour.
Supervised practical work experience in agronomy and environmental science to develop and demonstrate professional competence. Faculty approval of project proposal prior to enrollment and written and oral reports after the project is complete are required. Prerequisite: Instructor consent. May be repeated for up to 6 hours of degree credit.

Environmental Science Courses

ENSC 1001L. Environmental Science Laboratory. 1 Hour.
Laboratory, field trip, and discussion sessions covering the concepts and information allowing students to critically evaluate environmental issues. Topics will include: laboratory safety, recycling, composting, geographic information systems, soil testing, water quality, hazardous wastes, waste disposal, wetlands, wastewater treatment, and sustainable food systems. Laboratory 2 hours/week. Corequisite: ENSC 1003. This course is cross-listed with BIOL 1001L.

ENSC 1003. Environmental Science. 3 Hours.
Series of lectures and discussions introducing the topic of environmental science including factors related to water, soil, and air quality. Corequisite: ENSC 1001L. This course is cross-listed with BIOL 1003.

ENSC 1003H. Honors Environmental Science. 3 Hours.
Series of lectures and discussions introducing the topic of environmental science including factors related to water, soil, and air quality. If taking course for University core Natural Science credit, ENSC 1001L is a co-requisite. Corequisite: ENSC 1001L. This course is cross-listed with BIOL 1003.

ENSC 1833. Soils and Civilization. 3 Hours.
Humankind's use of and dependence on soil from the Neolithic Revolution to the present day. The composition and basic properties of soils. The importance of soils as components of ecosystems, and ecosystem services provided by soils. The nature and causes of soil degradation. The need for conservation of soils. Soil as a key factor in sustaining life on Earth.

ENSC 3003. Introduction to Water Science. 3 Hours.
Properties, occurrence, and description of the types, functions, quality and quantity, potential contaminants, uses, and guiding policies and regulations of the various water resources in the environment. Prerequisite: MATH 1203 AND (ENSC 1003 OR CHEM 1053 (or higher) OR GEOS 1113 (or higher) OR BIOL 1543).

ENSC 3103. Plants and Environmental Restoration. 3 Hours.
Selection, establishment, and use of plants to promote soil stabilization, water quality, and wildlife habitat. Principles and practices of managing plants for soil remediation, nutrient and sediment trapping, and restoration of plant communities. Prerequisite: CSES 1203 or HORT 2003 or BIOL 1613.

ENSC 3103H. Honors Plants and Environmental Restoration. 3 Hours.
Selection, establishment, and use of plants to promote soil stabilization, water quality, and wildlife habitat. Principles and practices of managing plants for soil remediation, nutrient and sediment trapping, and restoration of plant communities. Prerequisite: CSES 1203 or HORT 2003 or BIOL 1613 and honors standing. This course is equivalent to ENSC 3103.

ENSC 3221L. Ecosystems Assessment Laboratory. 1 Hour.
The purpose of this laboratory is to complement concepts learned in lecture by carrying out experiments that familiarize students with methods used in soil and aquatic ecology. Students will collect samples, analyze and interpret data obtained from soil and water samples. Lab will meet once per week for 3 hours. Corequisite: ENSC 3223.

ENSC 3223. Ecosystems Assessment. 3 Hours.
Application of basic ecological principles to gain an appreciation for ecosystem assessment and management. Lecture 3 hours per week. Prerequisite: BIOL 1543.

ENSC 3263. Soil and Water Conservation. 3 Hours.
Effect of land use on water quality. Major sources of agricultural nonpoint pollutants. Best management practices used to minimize water quality impacts. Prerequisite: CSES 2203.
ENSC 3413. Principles of Environmental Economics. 3 Hours.
An introductory, issues-oriented course in the economics of the environment. What
is involved in society making decisions about environmental quality will be studied.
Environmental issues important to the State of Arkansas and the United States will
be emphasized. Prerequisite: AGEC 1103 or ECON 2023.
This course is cross-listed with AGEC 3413.

ENSC 3603. GIS for Environmental Science. 3 Hours.
Provide instruction on the uses of GIS techniques in solving practical environmental
and agricultural land use problems. Areas include: 1) an introduction to spatial
variability in soils with an emphasis on the application of GIS techniques to map and
understand spatial parameters important to different land uses, and 2) development
of individual experience in the use of GIS in solving environmental and agricultural
problems using an oral and written term project. Prerequisite: CSES 2203.

ENSC 3933. Environmental Ethics. 3 Hours.
The course addresses ethical questions about nature and the natural environment.
Topics of discussion include anthropocentric and biocentric ethics, population
control, obligations to future generations, animal rights, moral considerability,
Leopold's land ethic, deep ecology, and ecofeminism. Lecture/discussions 3 hours
per week. Prerequisite: ENSC 1003 or PHIL 2003 or PHIL 2103.
This course is cross-listed with PHIL 3113.

ENSC 400V. Special Problems. 1-3 Hour.
Work on special problems in environmental science or related fields. May be
repeated for up to 8 hours of degree credit.

ENSC 4021L. Water Quality Laboratory. 1 Hour.
Field and laboratory experience in physical, chemical, and biological characteristics
of natural waters (rain, river, lake, soil, ground, etc.). Laboratory experiments in
water sampling, measurement of water quality parameters such as pH, alkalinity
and acidity, redox, hardness, BOD, TSS, etc., and instrumentation. Prerequisite or
Corequisite: ENSC 4023

ENSC 4023. Water Quality. 3 Hours.
Physical, chemical, and biological characteristics of natural waters (rain, river, lake,
soil, ground, etc.). Discussion of water quality parameters such as pH, alkalinity
and acidity, redox, hardness, BOD, TSS, etc. Aquatic processes of pollutants and
principles of modeling. Prerequisite: CHEM 1123 and CHEM 1121L and BIOL 1543
and BIOL 1541L.

ENSC 4034. Analysis of Environmental Contaminants. 4 Hours.
Methods of analysis for inorganic and organic contaminants, radionuclides and
microorganisms in soil and water. Quality assurance and quality control, sampling
protocols, sample handling, instrumentation and data analysis. Lecture 2 hours
and laboratory 4 hours per week. Corequisite: Lab component. Pre- or Corequisite:
CHEM 2613 and CHEM 2611L or CHEM 3603 and CHEM 3601L.

ENSC 404V. Special Topics. 1-3 Hour.
Studies of selected topics in environmental sciences not available in other
courses. May be repeated for up to 12 hours of degree credit.

ENSC 4263. Environmental Soil Science. 3 Hours.
Study of the behavior of pesticides, toxic organic compounds, metals, nutrients, and
pathogenic microorganisms in the soil/plant/water continuum. Lecture 3 hours per
week. Pre- or Corequisite: PHYS 2013 and PHYS 2011L. Prerequisite: CSES 3214.

ENSC 4401. Professional Certification Preparation. 1 Hour.
This class is meant to reinforce concepts and skills already learned in other soil
and environmental science and related courses and to provide the opportunity to
prepare to take a national certification examination. If so chosen, students may
pursue certification as soil or environmental science professionals. Prerequisite:
Senior standing.