

Notice of Intent
Bachelor of Science in Environmental Engineering
University of Wisconsin-Madison
May 2020
(Approved by CEE Faculty on May 5, 2020)

Name of Proposed Degree: Bachelor of Science in Environmental Engineering
Home Department: Department of Civil and Environmental Engineering
Home College: College of Engineering
Mode of Delivery: Face-to-face
Primary Faculty Contact Person: Gregory W. Harrington, Professor and Assoc. Dept. Chair
(608) 695-3380, gwharrin@wisc.edu

Program Description

General Overview

The degree program will prepare students for a career in environmental engineering, in which they will design, build, operate and manage the systems that will:^{1,2}

- sustainably supply food, water, and energy,
- curb climate change and adapt to its impacts,
- design a future without pollution or waste,
- create efficient, resilient, healthy cities,
- foster informed decisions and actions,
- prepare the field to address a new future,
- protect human populations from the effects of adverse environmental factors,
- protect environments, both local and global, from the potentially deleterious effects of natural and human activities,
- improve environmental quality

Required coursework is expected to include topics in environmental science and chemistry, risk assessment for public and environmental health, thermodynamics, materials science, fluid mechanics, soil mechanics, surface & groundwater resources engineering, water & wastewater treatment, air pollution control, solid & hazardous wastes engineering, engineering economics, decision making (including engineering economics and life-cycle assessment), professional & ethical practice, and multidisciplinary engineering design. Elective coursework is expected to include topics such as hydraulics, hydrology, coastal engineering, hydroclimatology, flood management practices, waste and remediation geotechnics, alternative energy systems (including wind, solar, geothermal, biofuels), smart infrastructure, green design/pollution prevention, alternative agricultural practices, non-point source pollution, manure management, agricultural water management and environmental systems optimization. Sustainability and resiliency considerations will be integrated into the required and elective coursework.

The program will require successful completion of at least 120 credits for graduation. Of the total credits required, a minimum of 30 credits will include mathematics and basic sciences and a minimum of 45 credits will include engineering topics. Consistent with other degree programs within the College of Engineering and with the general education expectations of UW-Madison, the program will also require a minimum of 16 credits carrying Social Sciences Breadth, Humanities Breadth, or Literature Breadth. Also consistent with professional and institutional expectations, the program will require 7 credits of coursework focused on the development of written and oral communication skills.

Learning Outcomes

The program will be developed for accreditation by ABET Inc., which is the accrediting body for engineering degree programs in the United States. To meet the minimum criteria established by ABET, students in the UW-Madison BS Environmental Engineering program will attain the following by the time of graduation:³

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Program Content and Relationship to Other UW-Madison Programs

To meet minimum criteria for accreditation, the mathematics and basic sciences component of the curriculum will include “mathematics through differential equations, probability and statistics, calculus-based physics, chemistry (including stoichiometry, equilibrium, and kinetics), an earth science, a biological science, and fluid mechanics.”³

Similarly, the engineering component of the curriculum will need to include courses that prepare our students to “formulate material and energy balances, and analyze the fate and transport of substances in and between air, water, and soil phases; conduct laboratory experiments, and analyze and interpret the resulting data in more than one major environmental engineering focus area (e.g., air, water, land, environmental health); design environmental engineering systems that include considerations of risk, uncertainty, sustainability, life-cycle principles, and environmental impacts; and apply advanced principles and practice relevant to the program objectives.”³

Required coursework in public policy and business practices will prepare our students to “understand concepts of professional practice, project management, and the roles and responsibilities of public institutions and private organizations pertaining to environmental policy and regulations.”³

This degree program will provide a central administrative locus for undergraduate environmental engineering education at UW-Madison with multidisciplinary collaboration from the campus units that are connected to the domain. The proposed program will be administratively housed in the Department of Civil and Environmental Engineering, and will replace the Environmental Engineering option in the BS Civil Engineering degree program. Other BS degree programs with published environmental engineering tracks are Biological Systems Engineering, Chemical Engineering, and Geological Engineering. We consider these programs to be complementary to the proposed program, providing coursework breadth that helps deliver a comprehensive environmental engineering education. Environmental engineering also includes the application of environmental science, and the BS Environmental Science programs in L&S and CALS have courses of interest to students in the proposed program.

Existing Resources and Anticipated Resource Needs

Human Resources

The nationally recognized Environmental Engineering Program at UW-Madison is part of the Department of Civil and Environmental Engineering (CEE). Of the 34 tenured/tenure track faculty within CEE, 17 teach and conduct research in environmental engineering. Six of these 17 tenured/tenure track faculty are affiliated with the Geological Engineering program in CEE and form the environmental engineering nucleus of that program. Expertise in the department includes drinking water and wastewater treatment, surface and ground water resources, pollutant dynamics

in the environment, atmospheric chemistry, environmental geotechnics, renewable energy, and sustainability. Additionally, the CEE Department has 14 adjunct professors with ties to the local environmental engineering community of practice. The BSE Department has an additional group of 8 faculty who engage in research and instruction in areas of environmental engineering that include water resources management, small-scale waste and wastewater management, manure management, and renewable energy systems. This group of CEE and BSE faculty already teach courses that will be an integral part of program requirements and elective offerings – no reallocation of human or financial resources is needed to keep offering these courses.

Most of the courses needed for the program are already offered by faculty affiliated with the proposed degree program. We expect to create two new courses to offer the program – one in Environmental Engineering Thermodynamics and one in Materials for Environmental Engineering. We have sufficient faculty numbers to create and cover both of these courses on an annual basis. The proposals for these courses will be submitted early in the 2020-21 academic year.

To cover sabbatical and administrative leave, the program may need to hire instructors on a periodic basis. We anticipate no more than 2 instructors will be needed in any given year. CEE already hires one instructor per year to deliver a course in air pollution control, to cover the administrative leave for Professor Schauer.

Student services staff in the College of Engineering will serve as advisors for the program. We anticipate an increased load of about 10% over current load, based on our evaluations of peer institutions that have implemented their own programs. Most of the initial enrollment will be from currently enrolled civil engineering students who transfer to the environmental engineering program, and these students would require minimal additional effort.

Accreditation of the program will require additional administrative support above that already needed for accreditation of the BS Civil Engineering and BS Geological Engineering programs. Most of the data collection needed for this effort already occurs in the senior capstone design course. This course is multidisciplinary and will include the students in the new degree program, so this will not substantively change resource needs for data collection. Additional resources will be needed for data interpretation and report writing, estimated to be a 25% increase over the amount currently needed for accreditation of the two existing degree programs in CEE (BSCE and BSGLE).

Reallocation of some TA resources will be likely due to shifts in enrollment from some courses currently required by the BSCE program to courses newly required by the BS Environmental Engineering program.

Capital Resources

Instructional laboratory and classroom spaces are already available to cover curriculum needs. The laboratories already require upgrades to equipment and space. The new program will not change the expected costs or scheduling of these upgrades.

Additional Approvals Required Beyond the UW System Board of Regents

We intend to accredit the program with ABET, which accredits engineering degree programs in the United States. Accreditation of the program is essential to our students' ability to attain professional engineering licensure, a critical need for this discipline. The curriculum will be partly driven by this need. ABET requires us to produce graduates of the program prior to accreditation. Accreditation is then applied retroactively to the year in which the first graduate attained their degree. Our next accreditation review is in AY 2024-25, and we expect our first graduates in either Spring 2022 or Fall 2022 – these will almost certainly be transfers from the BSCE program. More information can be found at www.abet.org.

Alignment with Institutional Mission, Strategic Plan, and Existing Degree Program Array

With respect to the institutional mission, the proposed program clearly fits within the primary purpose of UW-Madison, which “is to provide a learning environment in which faculty, staff and students can discover, examine critically, preserve and transmit the knowledge, wisdom and values that will help ensure the survival of this and future generations and improve the quality of life for all.” As noted earlier, the presence of complementary programs on campus allows the program to be “broad and balanced” and one that is “mutually reinforcing” with other programs at the undergraduate level.

Considering the university's 2020-25 strategic framework, this program will "expand educational programming in areas of high student demand, while maintaining the broad-based strength of our educational enterprise." Considering the 2015-19 UW-Madison strategic plan, the proposed program is expected to thrive with UW-Madison's distinctive "scale and breadth" and the "premium we place on our relevance to society." The program will incorporate established high-impact experiences that meet the goals of the Wisconsin Experience, including a community-based capstone experience, a cooperative education program, research experiences, community service in co-curricular experiences, and collaborative projects in both curricular and co-curricular environments.

UW-Madison has several named options and published degree tracks that are affiliated with environmental engineering:

- BS Civil Engineering: Degree program has a named option in Environmental Engineering, which would be replaced by the proposed degree program. The degree program also has a track in water resources engineering that would be absorbed into the new degree program.
- BS Biological Systems Engineering: Degree program has a named option in Natural Resources and Environmental Engineering.
- BS Geological Engineering: Degree program has a technical electives requirement with five specialty tracks. "Students may select courses within these tracks to focus their coursework in a particular area. However, students may complete the technical electives requirement using courses listed in multiple tracks." The five listed tracks are (1) Energy, Minerals, and Mining; (2) Sustainability and Environment; (3) Geohazards; (4) Groundwater and Surface Water; and (5) Infrastructure.
- BS Chemical Engineering: Degree program has suggested courses for specialization in Energy and Sustainability, and in Environmental Engineering.

As noted earlier, we view these programs as complementary, allowing for a curriculum with substantive breadth. As noted below, the full proposal for the program will be developed by a governance committee consisting of representatives from three of the above programs. We expect this group to be retained for program governance once the program is approved.

Link to Institution's Academic Strategic Plan

- UW-Madison's Educational Experience in the 2015-19 Strategic Plan: https://chancellor.wisc.edu/strategicplan2/ed_experience.html
- UW-Madison's Strategic Framework for 2020-25: https://strategicframework.wisc.edu/content/uploads/2020/02/Strat-framework_web.pdf

Need for the Program

Market demand was assessed by reviewing the Occupational Outlook Handbook, published by the U.S. Bureau of Labor Statistics.⁵ In 2018, there were 55,400 environmental engineers in the nation with a projection to grow by 5% over the next 10 years (matches the national average). Median wage for environmental engineers was \$87,620 per year. The Wisconsin Department of Workforce Development⁶ indicated statewide employment of 715 environmental engineers in Year 2016 with projections to grow to 774 in Year 2026. Annual total job openings on a statewide basis from 2016 to 2026 were projected to be 53.

To date, our approach has successfully placed graduates into the national and statewide job markets (including graduate degree programs at peer institutions around the nation). However, the recruitment of these students to our program has become increasingly difficult as our peer institutions have shifted from civil engineering option programs to BS Environmental Engineering degree programs. Professional licensure in environmental engineering has been available for some time now and prospective environmental engineering students now expect to have a degree title that matches their discipline of emphasis. We need to better serve the forthcoming generations of students.

Institutions in the Big Ten Conference now have accredited BS Environmental Engineering programs at Northwestern (first accredited in 1976), Penn State (2000), Rutgers (2007), Ohio State (2010), Michigan State (2011), Purdue (2012),

Michigan (2013), and Minnesota (2016). Iowa opened a BS Environmental Engineering program in Fall 2017 and will have this reviewed for accreditation in 2021-22. Other notable public peer institutions with a BS Environmental Engineering program include the University of Texas at Austin and Georgia Tech.

For those Big Ten peers that have a BS Environmental Engineering degree, enrollments are in the range of 80 to 160 students. Most of the initial students transferred into the program from a BS Civil Engineering degree upon program implementation, representing 20% to 40% of the civil engineering enrollment. Our BS Civil Engineering program currently has 400 students and approximately 1/4 to 1/3 of these students pursue the named option or tracks in environmental engineering, consistent with the peer institution data. Thus, we expect the BS Environmental Engineering program to have an official enrollment of 100 to 130 students and the BS Civil Engineering program to drop to an official enrollment of 270 to 300 students within three years of implementation. We also expect to capture an increased number of freshmen enrollees who currently choose to attend one of our peer institutions. Based on the implementation numbers we have seen at our peer institutions, we think this will be about a 10% increase.

We also expect the increased number of freshmen enrollees to enhance gender diversity in the program's home department. Data from our Big Ten peers reveals that women account for 35% to 55% of enrollment in BS Environmental Engineering degree programs, compared to 15% to 40% for BS Civil Engineering degree programs.

Within the UW System, UW-Platteville has the only accredited BS Environmental Engineering degree program in the UW System. The program has been accredited by ABET since 1999. In June 2019, the UW System Board of Regents approved a BSE Environmental Engineering program at UW-Milwaukee. This program was begun in Spring 2020 and will be considered for accreditation in the next ABET cycle for UW-Milwaukee. Prior to this, UW-Milwaukee included environmental engineering as part of a civil engineering degree program. We believe the environmental engineering community in Wisconsin and the Upper Midwest have been well served by the complementary programs offered at Madison, Platteville, and Milwaukee. Our program differs from these programs by giving undergraduate students access to a greater number of faculty with expertise in many areas of environmental engineering as well as connections to faculty in the College of Agricultural and Life Sciences and the Nelson Institute for Environmental Studies.

Program Faculty

The full proposal for the BS Environmental Engineering program will be developed by:

- Greg Harrington, Dept of Civil and Environmental Engineering
- Paul Block, Dept of Civil and Environmental Engineering (with Dan Wright as alternate)
- Christy Remucal, Dept of Civil and Environmental Engineering (with Matt Ginder-Vogel as alternate)
- Mike Cardiff, Dept of Civil and Environmental Engineering (GLE Representative)
- Krishnapuram Karthikeyan, Dept of Biological Systems Engineering (with Troy Runge as alternate)

Implementation and sustained operation of the program will be performed by faculty in the Department of Civil and Environmental Engineering. Governance will be provided by a 5-person committee consisting of faculty from CEE (including GLE) and BSE. A complete listing of the 20+ program faculty will be provided in our full proposal. Curriculum development during the proposal will also be supported by a group of CEE adjunct professors who can provide the perspective of professional practice in the field of environmental engineering.

Letters of Support

Letters of support are provided from the Department of Biological Systems Engineering, the Department of Chemical and Biological Engineering, and the Geological Engineering Program.

References

1. National Academies of Sciences, Engineering, and Medicine (NASEM). 2019. *Environmental Engineering for the 21st Century: Addressing Grand Challenges*. Washington DC: The National Academies Press.
2. American Academy of Environmental Engineers (AAEE). 2009. *Environmental Engineering Body of Knowledge*. Annapolis MD: AAEE.

3. ABET Engineering Accreditation Commission (ABET EAC). 2018. *Criteria for Accrediting Engineering Programs, 2019-2020*. Baltimore MD: ABET
4. UW-Madison Office of the Provost. <https://assessment.provost.wisc.edu/uw-madison-essential-learning-outcomes/>
5. U.S. Bureau of Labor Statistics. Occupational Outlook Handbook. <https://www.bls.gov/ooh/architecture-and-engineering/environmental-engineers.htm>
6. Wisconsin Department of Workforce Development. Labor Market Information. Retrieved from <http://worknet.wisconsin.gov/worknet/daocprj.aspx?menuselection=da>

Memorandum of Understanding
Shared Governance of the Proposed BS Environmental Engineering Degree Program
May 5, 2020

Parties

This Memorandum of Understanding (hereinafter referred to as “MOU”) is made and entered into by and between the Department of Civil and Environmental Engineering (CEE) and the Department of Biological Systems Engineering (BSE).

Purpose

The aim of shared governance between CEE and BSE is to ensure the proposed program takes advantage of the complementary programs already on campus, giving the program substantive breadth and mutually reinforcing depth in the environmental engineering field.

Cooperation

The activities and services for shared governance shall include participation on a program governance committee that will:

- Develop curriculum requirements and program learning outcomes
- Participate in assessment and evaluation of learning outcomes attainment
- Develop advising materials that help students make informed decisions about undergraduate degree choices (e.g., BS Environmental Engineering versus BS Civil Engineering, BS Geological Engineering, and BS Biological Systems Engineering)
- Develop curriculum pathways that allow for straightforward transfer between the above degree programs at the freshman and sophomore level

Governance Committee Composition

The BS Environmental Engineering governance committee will be composed of the following representatives:

- 1 representative of the environmental process engineering faculty in CEE
- 1 representative of the water resources engineering faculty in CEE
- 1 representative of the environmental chemistry and technology faculty in CEE
- 1 representative of the Geological Engineering program faculty in CEE
- 1 representative of the natural resources and environmental engineering faculty in BSE

Responsibilities

CEE will serve as the home department for the BS Environmental Engineering program and will be responsible for administrative functions, including appointment of a program director. The program director will be responsible for oversight of administrative and governance functions, including service as chair of the governance committee. Once each semester, the program director will convene a meeting of the governance committee to cover the items listed in the “cooperation” section above.

BSE will be responsible for appointing a member to serve on the governance committee.

Term

The term of this MOU is indefinite but the participants agree to review the agreement on an annual basis. Termination of the MOU must be given in writing with at least 6 months advance notice, directed to both department chairs.

Amendment

This MOU may be amended or supplemented in writing, based on the annual review described above. Both departments must sign the amended agreement.

Understanding

It is mutually agreed upon and understood by CEE and BSE that:

- Each department will work together in a coordinated fashion for the fulfillment of the shared governance.
- This MOU will be effective upon the signature of both departments.

Signatories

William Likos
Professor and Chair, Civil and Environmental Engineering



Troy Runge
Associate Professor and Chair Biological Systems Engineering

This Agreement shall be effective as of the date first written above.



University of Wisconsin- Madison
College of Agriculture and Life Sciences
Department of Biological Systems Engineering
<https://bse.wisc.edu/>

April 28, 2020

The Department of Biological Systems Engineering offers its strong support for the Notice of Intent for a BS Degree Program in Environmental Engineering at UW-Madison. Current and future UW-Madison students will greatly benefit from this opportunity, which will provide a critical service to Wisconsin and the nation in training students to solve the environmental and public health challenges that our world will face. We look forward to a program that brings together the complementary programs already on campus, giving the program substantive breadth and mutually reinforcing depth in the environmental engineering field. We are eager to contribute to the program and look forward to participating in planning, course development, governance, and teaching associated with the program.

Sincerely,

Troy Runge
Professor and Chair
Biological Systems Engineering
115E Ag Engineering | 460 Henry Mall | Madison, WI 53706



**Department of Chemical
and Biological Engineering**
UNIVERSITY OF WISCONSIN-MADISON

Regina M. Murphy
Kreuz Bascom Professor & R. Byron Bird Department Chair
Department of Chemical & Biological Engineering
Engineering Hall, Room 2020
1415 Engineering Drive
Madison WI 53706-1607
Phone: 608-262-1092
E-mail: regina.murphy@wisc.edu

To: Prof. Harrington
Re: BS Environmental Engineering
Date: May 4, 2020

The Department of Chemical and Biological Engineering (CBE) supports the Notice of Intent for a new BS degree program in Environmental Engineering. We do not anticipate substantive negative impacts of the new degree program on our CBE undergraduate program. Environmental engineering courses are of interest to many of our students and an expansion of environmental engineering elective course options would be attractive to CBE majors. Conversely, some CBE undergraduate courses will be of interest to students in the Environmental Engineering degree program. We are happy to coordinate with the Department of Civil and Environmental Engineering in supporting their degree program and in managing any impacts of the new degree on our undergraduate students.

Regina M Murphy
Kreuz- Bascom Professor
R. Byron Bird Department Chair



Geological Engineering
COLLEGE OF ENGINEERING
UNIVERSITY OF WISCONSIN-MADISON

May 08, 2020

RE: Letter of Support from Geological Engineering Program for BS Degree Program in Environmental Engineering

To: Professor Greg Harrington
Department of Civil and Environmental Engineering

The Geological Engineering Program offers its support for the Notice of Intent for a BS Degree Program in Environmental Engineering at UW-Madison. UW-Madison students will greatly benefit from this opportunity, which will provide a critical service to Wisconsin and the nation in training students to solve the environmental, sustainability, and public health challenges that our world will face. We look forward to a program that brings together the complementary programs already on campus—such as Geological Engineering—giving the program substantive breadth and mutually reinforcing depth in the environmental engineering field. We are eager to contribute to the program and look forward to participating in planning, course development, governance, and teaching associated with the program

Sincerely,

James Tinjum, PE, PhD, F.ASCE

Director, Geological Engineering Program
Department of Civil and Environmental Engineering
jmtinjum@wisc.edu