Environmental Engineering
ABET Evaluation Summary
2018-2019

This document describes the evaluation of ABET Program Educational Objectives (PEOs) and Student Outcomes for the Environmental Engineering undergraduate program for 2018-19. Data were collected throughout the year and evaluated by the CEE Assessment Committee (Drs. Barr, Dupont, McNeill, Tullis, and Ball) in June 2019.

Program Educational Objectives
The Environmental Engineering (EnvE) Program Educational Objectives (PEOs) are reviewed by each of the program’s three constituencies (Table 1).

Table 1: PEO Review Process and Schedule for EnvE Program Constituency

<table>
<thead>
<tr>
<th>Constituency</th>
<th>Review opportunity</th>
<th>Frequency</th>
<th>Most recent reviews</th>
<th>Date of next review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>Freshman Orient. (CEE 1880)</td>
<td>Every freshman class (Fall and Spring)</td>
<td>Spring semester 2019</td>
<td>Fall semester 2019</td>
</tr>
<tr>
<td></td>
<td>Junior design course (CEE 3880)</td>
<td>Every junior class (Spring)</td>
<td>Spring 2019</td>
<td>Spring 2020</td>
</tr>
<tr>
<td></td>
<td>Senior exit interview</td>
<td>Every graduating class (Spring)</td>
<td>April 2019</td>
<td>April 2020</td>
</tr>
<tr>
<td>Employers</td>
<td>Advisory Board meeting</td>
<td>Annually (typically late Fall)</td>
<td>November 2018</td>
<td>November 2019</td>
</tr>
<tr>
<td>Faculty</td>
<td>CEE Faculty Retreat</td>
<td>Annually (August)</td>
<td>August 2018</td>
<td>August 2019</td>
</tr>
</tbody>
</table>

Students: The PEOs are introduced to the freshman class in CEE 1880 as part of a lecture on the accreditation and licensing processes (see the slides in Appendix A). PEOs are again shown to the juniors in CEE 3880. This reminds continuing students about the PEOs and allows transfer students (who may not take CEE 1880) to see the PEOs. Finally, as part of the senior exit interview process, graduating seniors are given an opportunity to review the PEOs in an effort to establish some big picture career goals. No comments were received from students related to the PEOs.

CEE Advisory Board: The CEE Advisory Board met on November 6, 2018 (see Appendix B for meeting minutes). The Advisory Board unanimously approved keeping the current PEOs. The PEOs will continue to be reviewed and discussed at all future annual Advisory Board Meetings.

Program Faculty: The PEOs are reviewed and discussed with the program faculty at the annual faculty retreat, which takes place every August just prior to the Fall semester. The faculty unanimously approved keeping the current PEOs during the 2018 faculty retreat (see Appendix C for meeting minutes). The PEOs will continue to be reviewed and discussed at all future annual faculty retreats.
**Student Outcomes**
Evaluation of the Student Outcome attainment is conducted by the CEE Assessment committee on a specified schedule with approximately half of the Student Outcomes assessed every year (Table 2). When deficiencies are identified, recommendations are made to fix specific problems and support continuous improvement. For the 2018-2019 school year, we changed to the new ABET Outcomes 1-7 instead of a-k so outcomes 1, 2, 3, and 4 were evaluated.

<table>
<thead>
<tr>
<th>Evaluation Date</th>
<th>School Year</th>
<th>Outcomes evaluated</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2015</td>
<td>2014-15</td>
<td>a, b, c, d</td>
</tr>
<tr>
<td>May 2016</td>
<td>2015-16</td>
<td>e, f, g</td>
</tr>
<tr>
<td>May 2017</td>
<td>2016-17</td>
<td>h, i, j, k</td>
</tr>
<tr>
<td>May 2018</td>
<td>2017-18</td>
<td>a, b, c, d</td>
</tr>
<tr>
<td><strong>May 2019</strong></td>
<td><strong>2018-19</strong></td>
<td><strong>1, 2, 3, 4</strong></td>
</tr>
<tr>
<td>May 2020</td>
<td>2019-20</td>
<td>5, 6, 7</td>
</tr>
</tbody>
</table>

The assessment process uses data from three sources: student coursework, FE Exam results, and senior exit interviews. The 2018-19 Assessment of Student Outcomes includes data from Fall 2018 and Spring 2019.

**Student Coursework:** Outcomes 1, 2, 3, and 4 were reviewed in 2018-19 (Table 2). Assessment data are summarized in Table 3 and Figure 1; detailed evaluation of each outcome is presented in Appendix D. Student assignments are evaluated on a 0-1-2 scale, which corresponds to the student’s performance not meeting, partially meeting, and meeting the Outcome Objective, respectively. The EnvE program has two goals for student performance:
- Goal 1: a minimum of 70% of the students will perform at a 2 level
- Goal 2: a minimum of 80% of the students will perform at the 1 or 2 level.

Note the “sample size” in Table 3 refers to the number of individual examples of student work that were assessed for each outcome, not the number of students.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Sample size</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>Sum of 1&amp;2 ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>412</td>
<td>78%</td>
<td>14%</td>
<td>8%</td>
<td>92%</td>
</tr>
<tr>
<td>2</td>
<td>599</td>
<td>82%</td>
<td>11%</td>
<td>7%</td>
<td>93%</td>
</tr>
<tr>
<td>3</td>
<td>408</td>
<td>91%</td>
<td>8%</td>
<td>1%</td>
<td>99%</td>
</tr>
<tr>
<td>4</td>
<td>101</td>
<td>71%</td>
<td>14%</td>
<td>15%</td>
<td>85%</td>
</tr>
</tbody>
</table>

Both Goals 1 and 2 were met for Outcomes 1, 2, 3, and 4 (Figure 1). Last year (2017-18) the EnvE program did not meet the goals for the former Outcome c (“design within constraints”) but this year we are pleased that we did meet the goal for the new Outcome 2 which has similar...
content (“design with considerations”). The capstone design courses were also revised this year which should improve the design experience. Instructors will continue to expand assignments to include consideration of all six factors (public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors). We will also continue to emphasize “complex engineering problems” as part of Outcome 1 and include additional assessment of the ASCE Code of Ethics for Outcome 4 (see individual outcome reports in Appendix D).

Figure 1: Aggregated Assessment Results for EnvE Classes for Fall 2018 and Spring 2019
**Fe Exam:** Our goal is to have 100% pass rate on the FE exam; our minimum acceptable level of performance is a pass rate at or above the national average. Table 4 summarizes the FE results for the past six years, including the percentage of students who had passed the FE exam by the time of graduation. The USU EnvE pass rate has been either 100% or above the national average.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>USU EnvE graduates</td>
<td>5</td>
<td>2</td>
<td>9</td>
<td>5</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>USU EnvE pass rate at graduation</td>
<td>100%</td>
<td>100%</td>
<td>89%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>National EnvE pass rate*</td>
<td>84%</td>
<td>77%</td>
<td>76%</td>
<td>77%</td>
<td>78%</td>
<td>78%</td>
</tr>
</tbody>
</table>

*first time test-takers in that testing period

FE Exam performance by topic for first-time test takers is summarized in Figures 2 through 5. For Fall 2018 and Spring 2019, students performed at or above the national average (considering the error bars) on all fundamental engineering topics. The exception is the risk assessment section, where performance was below the national average (Figure 2). Over the past five years, student performance on this topic has been variable, ranging from slightly below average to significantly above average, so there does not seem to be a systemic problem with this content. Nevertheless, we will ensure there is adequate coverage of risk assessment in the curriculum. Overall, the fact that all EnvE students continue to pass the FE exam is a strong, independent, external indicator for meeting Student Outcomes 1 and 4. It is also an indication of a good foundation for life-long (independent) learning skills.

![Scaled Fe Exam results](image)

**Figure 2:** Scaled Fe Exam results (materials science, thermodynamics, environmental chemistry, risk assessment). Error bars represent uncertainty range for scaled scores.
Figure 3: Scaled FE Exam results (fluid mechanics, water resources, and water/wastewater). Error bars represent uncertainty range for scaled scores.

Figure 4: Scaled FE Exam results (air quality, solid/hazardous waste, groundwater/soils). Error bars represent uncertainty range for scaled scores.
Figure 5:  Scaled Fe Exam results (math, stats, ethics and professional practice, economics). Error bars represent uncertainty range for scaled scores.

**Senior exit interview:** Graduating seniors complete an anonymous online exit interview to provide feedback about the EnvE program and rate their perceived progress in meeting each of the outcomes. The survey response rate was 9 of 11 students (82%). The performance goal is to have at least 80% of the students rating their attainment as “fully met” or “partly met”, which was achieved for all four outcomes (Figure 5). Acknowledging that this is a subjective self-evaluation, these exit interview results are taken as a general indication that students feel they are meeting the outcomes.

Figure 5: Student exit interview ratings of progress on Outcomes 1, 2, 3, and 4
Summary: The CEE Assessment Committee met in June 2019 and evaluated all of the assessment data presented herein. The evaluation of student work, FE Exam results, and senior exit interviews indicates that Outcomes 1, 2, 3, and 4 are being met. However, we need to ensure that all six considerations are addressed during design problems (Outcome 2) and make sure that students consider all four contexts for engineering solutions and that the ASCE Code of Ethics is specifically assessed (Outcome 4).

Recommendations
Evaluate outcomes 5, 6, and 7 as planned during the 2019-2020 school year, and evaluate Outcomes 1, 2, 3, and 4 in 2020-2021. In anticipation of our site visit in Fall 2020, collect additional data during the 2019-2020 school including material for course binders (samples of 0/1/2 rated work for each class) and other material needed for the self-study report (due July 2020) such as course syllabi and faculty CVs.
Appendix A
Slides from CEE 1880
(introducing freshmen students to ABET PEOs and outcomes)

ABET Accreditation
Why Should I Care?

Graduating Class 2018

The undergraduate Civil Engineering and Environmental Engineering programs are accredited by the Engineering Accreditation Commission of ABET

Students
Your degree is a significant achievement and perhaps the largest investment you will make toward your future. The quality of education you receive makes a big difference in your career success. ABET accreditation:

- Verifies that your educational experience meets the global standards for technical education in your profession.
- Enhances your employment opportunities—multinational corporations require graduation from an accredited program.
- Supports your entry to a technical profession through licensing, registration, and certification—all of which often require graduation from an ABET accredited program as a minimum qualification.
- Establishes your eligibility for many federal student loans, grants, and/or scholarships.
- Paves the way for you to work globally, because ABET accreditation is recognized worldwide through international agreements, and many other countries' national accrediting systems are based on the ABET model.

www.abet.org
Program Educational Objectives

Within five years of graduation:

**PEO 1:** Graduates will be successfully employed in Civil (Env) Engineering or related careers and will become independent thinkers and effective communicators, team members, and decision makers.

**PEO 2:** Graduates will incorporate economic, environmental, social, ethical, and sustainability considerations into the practice of civil (env) engineering and will promote public health and safety.

**PEO 3:** Graduates will engage in life-long learning by pursuing advanced degrees or additional educational opportunities through coursework, professional conferences and training, or participation in professional societies.

**PEO 4:** Graduates will pursue professional licensure or other appropriate certifications.

Student Outcomes

By the time of graduation, students will have:

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

ABET timeline

- ABET is a 6 year cycle
  - submit examples of your course work
  - fill out a survey about our programs
  - fill out a survey about summer and permanent jobs
  - meet with our industrial advisory board
- Next site visit: Fall 2020 semester
  - meet with the Program Evaluator
  - spruce up your lab/office/hallway
  - help with a tour

So what does it mean to have an accredited program?

https://dpul.utah.gov/eng/
Welcome and Introductions

- Mitch Dabbling
- Bruce Brothersen
- Paul Lindhart
- Brian Barton
- Marv Allen
- Zan Murray
- Shelley Dyer
- B Hall
- Larry Peterson
- Brandon Jones
- Brent White
- Todd Adams
- Cheryl Heying
- Shaun Dustin

ABET-Laurie McNeill

- timeline
  - Next submission is in 2020
  - We are in year 4 of the current 6-year cycle
  - Self-study report due July 1 2020
  - 2019-2020 school year is heavy on data collection
- PEO within 5 years of graduation
  - Be successfully employed
  - Will incorporate economic, environmental, social, ethical, and sustainability considerations
  - Will engage in life-long learning by pursuing advanced degrees
  - No suggested changes from the Board
- FE exam
  - Number of CE degrees has increased since 2012
  - National pass rate has stayed consistent
  - 100% pass rate is required for graduation
  - Subject areas of exam
    - Fluid mechanics: always at or above national average on performance
  - Our students scored at or above national average in all FE exam topics except probability/states (fall 2017)
  - Student outcomes (what we want students to be able to do when they graduate)
    - These have changed from A-K to 1-7
    - May 2019 outcomes 1,2,3, & 4
    - Complex engineering
  - How can the advisory board help?
    - Case studies and examples!
- Suggestions
  - List ABET goals so the students understand why you're doing these projects.
  - Add complexity by relating problems and projects to complex problems
  - The projects don't have to be number crunching, they can be general thought processes which can be done in any course with multiple components
Appendix C
CEE Annual Faculty/Staff Retreat Minutes
August 20, 2018

ABET (Laurie McNeill)
- [packet pages 8-13]
- ABET timeline
  - 6-year cycle
  - Next visit is Fall 2020
  - Self study report due July 1 2020
  - 2019-2020 school year is heavy on data collection
    - Course binders (syllabus, sample work)
    - Faculty info (cv, data tables)
    - Timely assessment data
2018-2019 school year is regular data collection

- Review program educational objectives (PEOs)
  - Look at these and be familiar with them
    - Information in packet
  - Students should be able to apply these within 5 years of graduation
  - No faculty comments or changes

- Evaluation of student outcomes (A-K)
  - What the students leave the program with
  - This prepares them for the PEOs
  - 2018-2019 evaluation schedule: e,f,g

- Course work
- FE exam
  - 100% pass rate is goal
  - Minimum acceptable is equal to or greater than national pass rate
  - National pass rate is for first-time test takers (70% 2017-2018)
    - Our students take the FE until they pass, so this number isn’t comparable
  - Subject areas within FE exam
    - Our students were at or above national average in all exam topics
      EXCEPT probability and statistics
    - Topics above national average:
      - Mechanics of materials, fluid mechanics, surveying, hydraulics and hydrologic systems, environmental engineering, geotechnical engineering

- Senior Exit Interviews
  - Collection of student feelings on how they learned the outcomes
  - Goals for exit interviews met, and are adding more software training to address student requests

- To-Do list for this year
  - Outcomes 1,2,3,& 4
  - Outcomes have changed from a-k to 1-7
  - See handout
  - Complex engineering problems
  - Engineering design definition
    - Designing within constraints
    - Are we appropriately doing engineering design
  - Assess at least two outcomes in all required UG classes
    - Preferably two different outcomes
      - Outcome 1: Ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
        - EVERYONE assess this!
      - Outcome 2: 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
        - All upper-division classes (not just senior design)
        - Electives, especially with “design” in the title
• Considerations other than environment or cost
  ▪ Outcome 3: ability to communicate effectively with a range of audiences
    • CEE 2890 and 5610-Joan
    • CEE 3165-Andrw
    • CEE 3610 and 3640/3650/3780/5860
    • Jr/Sr design-Austin
    • Any other class with written or oral report
  ▪ Outcome 4: 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
    • All upper-division classes
    • This may involve a writing assignment-help is available from the engineering writing center
  ▪ Other specific assignments
  ▪ Program criteria for civil engineering:
    • Apply probability and statistics to address uncertainty.
    • Include principles of sustainability in design; explain basic concepts in project management, business, public policy, and leadership
      o We don’t formally assess these, but we do have to discuss these items
Appendix D
Detailed Evaluation for Outcomes 1, 2, 3, and 4

See following pages
Outcome 1: an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

Student Course Work Assessment

Student work is rated on a 0 – 1 – 2 scale:

0 = student did not understand the fundamental principle or component
1 = student applied some but not all of the fundamental principles in their solution
2 = student applied the correct fundamental principles in their solution

The EnvE program has two goals for student performance for student course work assessment:

Goal 1: a minimum of 70% of the students will perform at a 2 level
Goal 2: a minimum of 80% of the students will perform at the 1 or 2 level.

This outcome was assessed in 10 classes, ranging from a 2000-level sophomore course to 5000-level upper-division classes, using 412 samples of student work including homework, exams, and lab exercises; see Table 1-1 on the next page. Instructors endeavored to use assignments that met the new ABET definition of “complex problems,” such as problems that are open-ended, have conflicting constraints, or involve multiple steps or disciplines. Student performance met both goals, with 78% of students rating a 2 and 92% rating a 1 or 2 (Figure 1-1).
<table>
<thead>
<tr>
<th>Class</th>
<th>Name</th>
<th>Instructor</th>
<th>Term</th>
<th>Enrol</th>
<th>Method</th>
<th>Description</th>
<th>Assessment score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE</td>
<td>Env Microbiology</td>
<td>Dupont</td>
<td>Sp 2019</td>
<td>10</td>
<td>exam question</td>
<td>evaluate eng systems to protect against waterborne disease</td>
<td>78%  22%  0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Engineering Hydrology</td>
<td>Neilson</td>
<td>Sp 2019</td>
<td>73</td>
<td>HW</td>
<td>unit hydograph problem</td>
<td>93%  4%  3%</td>
</tr>
<tr>
<td>CEE</td>
<td>Fluid Mechanics</td>
<td>Urroz</td>
<td>F 2018</td>
<td>80</td>
<td>HW</td>
<td>pipeline flow analysis</td>
<td>78%  13%  10%</td>
</tr>
<tr>
<td>CEE</td>
<td>Environmental Management</td>
<td>McNeill</td>
<td>F 2018</td>
<td>83</td>
<td>HW</td>
<td>risk assessment from chemical exposure</td>
<td>72%  12%  16%</td>
</tr>
<tr>
<td>CEE</td>
<td>Environmental Management</td>
<td>McNeill</td>
<td>F 2018</td>
<td>83</td>
<td>HW</td>
<td>mass balance - phosphorus control strategies in lake</td>
<td>71%  18%  11%</td>
</tr>
<tr>
<td>CEE</td>
<td>Solid and Haz Waste Mgmt</td>
<td>Dupont</td>
<td>F 2018</td>
<td>41</td>
<td>HW</td>
<td>optimize container based on statistical dese of variable w</td>
<td>88%  10%  2%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2018</td>
<td>12</td>
<td>lab exercise</td>
<td>evaluate BMP for phos control in a river - env relevance</td>
<td>82%  18%  0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2018</td>
<td>12</td>
<td>lab exercise</td>
<td>evaluate BMP for phos control in a river - use of previous</td>
<td>45%  55%  0%</td>
</tr>
<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2018</td>
<td>12</td>
<td>lab exercise</td>
<td>evaluate BMP for phos control in a river - impacts of BM</td>
<td>64%  36%  0%</td>
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<tr>
<td>CEE</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2018</td>
<td>12</td>
<td>lab exercise</td>
<td>evaluate BMP for phos control in a river - sources of P</td>
<td>90%  10%  0%</td>
</tr>
</tbody>
</table>
**FE Exam Results**

Our goal is to have 100% pass rate on the FE exam; our minimum acceptable level of performance is a pass rate at or above the national average. Table 1-2 summarizes the FE results for the past six years, including the percentage of students who had passed the FE exam by the time of graduation. The USU EnvE pass rate has been 100% except in 2016 when one student (of 9 graduates) did not pass the exam.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>USU EnvE graduates</td>
<td>5</td>
<td>2</td>
<td>9</td>
<td>5</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>USU EnvE pass rate at graduation</td>
<td>100%</td>
<td>100%</td>
<td>89%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>National EnvE pass rate*</td>
<td>84%</td>
<td>77%</td>
<td>76%</td>
<td>77%</td>
<td>78%</td>
<td>78%</td>
</tr>
</tbody>
</table>

*for first-time test takers

FE Exam performance by topic for first-time test takers is summarized in Figures 1-2 through 1-5. For Fall 2018 and Spring 2019, students performed at or above the national average (considering the error bars) on all fundamental engineering topics. The exception is risk assessment section, where performance was below the national average (Figure 1-2). Over the past five years, student performance on this topic has been variable, ranging from slightly below average to significantly above average, so there does not seem to be a systemic problem with this content. Nevertheless, we will ensure there is adequate coverage of risk assessment in the curriculum.

Overall, the fact that all EnvE students continue to pass the FE exam is a strong, independent, external indicator for meeting Student Outcomes 1 and 4. It is also an indication of a good foundation for life-long (independent) learning skills.
Figure 1-2: Scaled FE Exam results (math, probability/statistics, ethics, and economics). Error bars represent uncertainty range for scaled scores.

Figure 1-3: Scaled FE Exam results (materials science, thermodynamics, environmental chemistry, risk assessment). Error bars represent uncertainty range for scaled scores.
Figure 1-4: Scaled FE Exam results (fluids, water resources, water/wastewater). Error bars represent uncertainty range for scaled scores.

Figure 1-5: Scaled FE Exam results (air quality, solid/haz waste, groundwater/soils). Error bars represent uncertainty range for scaled scores.
Senior Exit Interviews
Graduating seniors complete an anonymous online exit interview to provide feedback about the EnvE program and rate their perceived progress in meeting each of the outcomes. The survey response rate was 9 of 11 students (82%). The performance goal is to have at least 80% of the students rating their attainment as “fully met” or “partly met”, which was achieved with 100% of students rating Outcome 1 as “fully met” or “partly met” (Figure 1-6). Acknowledging that this is a subjective self-evaluation, these exit interview results are taken as a general indication that students feel they are meeting the outcome.

Figure 1-6: Student exit interview ratings of progress on Outcome 1

Summary
The evaluation of student work, FE Exam results, and senior exit interviews indicates that Outcome 1 is being met.

Recommendations
Evaluate Outcome 1 as planned during the 2020-2021 school year. Continue to emphasize complex engineering problems in course assignments.
Outcome 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

Student Course Work Assessment

Student work is rated on a 0 – 1 – 2 scale:

0 = student did not understand the fundamental principle or component
1 = student applied some but not all of the fundamental principles in their solution
2 = student applied the correct fundamental principles in their solution

The EnvE program has two goals for student performance for student course work assessment:

Goal 1: a minimum of 70% of the students will perform at a 2 level
Goal 2: a minimum of 80% of the students will perform at the 1 or 2 level.

This outcome was assessed in 11 courses (see Table 2-1 on the next page), using 599 samples of student work. Goal 1 was met with 82% of student work rating a 2 and Goal 2 was met with 93% of student work rating a 1 or 2 (Figure 2-1). However, not all assessed assignments required students to consider all six factors listed in the outcome. We will continue to educate faculty members that all six factors don’t have to be relevant to a particular design problem, but students still need to consider all of them and state which factors are not applicable.

Figure 2-1: Summary of ratings of student work on Outcome 2
### Table 2-1: List of student work assessed for Outcome 2

<table>
<thead>
<tr>
<th>Class</th>
<th>Name</th>
<th>Instructor</th>
<th>Term</th>
<th>Enrol</th>
<th>Method</th>
<th>Description</th>
<th>Assessment score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE 2890</td>
<td>EnvE Sophomore Seminar</td>
<td>McLean</td>
<td>Sp</td>
<td>17</td>
<td>team design pro</td>
<td>design with considerations</td>
<td>100% 0% 0%</td>
</tr>
<tr>
<td>CEE 3430</td>
<td>Engineering Hydrology</td>
<td>Neilson</td>
<td>Sp</td>
<td>73</td>
<td>HW</td>
<td>detention basin design using HEC-HMS - consider all 6 factors</td>
<td>82% 11% 7%</td>
</tr>
<tr>
<td>CEE 3500</td>
<td>Fluid Mechanics</td>
<td>Urroz</td>
<td>F</td>
<td>80</td>
<td>HW</td>
<td>design freeboard for channel considering flood (safety)</td>
<td>93% 1% 6%</td>
</tr>
<tr>
<td>CEE 3510</td>
<td>Hydraulics</td>
<td>Crookston</td>
<td>Sp</td>
<td>75</td>
<td>team design pro</td>
<td>design various hydraulics topics</td>
<td>100% 0% 0%</td>
</tr>
<tr>
<td>CEE 3640</td>
<td>Drinking Water Engineering</td>
<td>McNeill</td>
<td>Sp</td>
<td>35</td>
<td>mini-design</td>
<td>mini-design of water treatment processes #1 - technical considerations</td>
<td>86% 11% 3%</td>
</tr>
<tr>
<td>CEE 3640</td>
<td>Drinking Water Engineering</td>
<td>McNeill</td>
<td>Sp</td>
<td>35</td>
<td>mini-design</td>
<td>mini-design of water treatment processes #1 - consider all factors</td>
<td>69% 17% 14%</td>
</tr>
<tr>
<td>CEE 3640</td>
<td>Drinking Water Engineering</td>
<td>McNeill</td>
<td>Sp</td>
<td>35</td>
<td>mini-design</td>
<td>mini-design of water treatment processes #2 - technical considerations</td>
<td>80% 14% 6%</td>
</tr>
<tr>
<td>CEE 3880</td>
<td>CEE Design I</td>
<td>Ball</td>
<td>Sp</td>
<td>71</td>
<td>capstone design</td>
<td>design proposal - consider all 6 factors</td>
<td>82% 18% 0%</td>
</tr>
<tr>
<td>CEE 4200</td>
<td>Engineering Economics</td>
<td>Stevens</td>
<td>F</td>
<td>86</td>
<td>exam</td>
<td>design economic analysis for equipment depreciation and</td>
<td>59% 20% 21%</td>
</tr>
<tr>
<td>CEE 4870</td>
<td>CEE Design II</td>
<td>Ball</td>
<td>F</td>
<td>74</td>
<td>capstone design</td>
<td>concept report - consider all 6 factors</td>
<td>85% 12% 3%</td>
</tr>
<tr>
<td>CEE 5190</td>
<td>GIS for CEE</td>
<td>Horsburgh</td>
<td>Sp</td>
<td>18</td>
<td>exam</td>
<td>determine parcels that meet criteria for development - considerations</td>
<td>72% 22% 6%</td>
</tr>
</tbody>
</table>
**FE Exam Results**
Not applicable to this outcome.

**Senior Exit Interviews**
Graduating seniors complete an anonymous online exit interview to provide feedback about the EnvE program and rate their perceived progress in meeting each of the outcomes. The survey response rate was 9 of 11 students (82%). The performance goal is to have at least 80% of the students rating their attainment as “fully met” or “partly met”, which was achieved in 2018-2019 with 100% of students rating Outcome 2 as “fully met” (Figure 2-2). Acknowledging that this is a subjective self-evaluation, these exit interview results are taken as a general indication that students feel they are meeting the outcome.

![Outcome 2](image)

Figure 2-2: Student exit interview ratings of progress on Outcome 2

**Summary**
The evaluation of student work and exit interviews indicates that goals related to Outcome 2 are being met.

**Recommendations**
Evaluate Outcome 2 during the 2020-2021 school year as planned. Course assessment will require students to specifically consider all six factors (public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors).
**Environmental Engineering**  
**ABET Outcome Summary**  
**2018-19**

**Outcome 3: an ability to communicate effectively with a range of audiences**

**Student Course Work Assessment**

Student work is rated on a 0 – 1 – 2 scale:

- 0 = student did not understand the fundamental principle or component
- 1 = student applied some but not all of the fundamental principles in their solution
- 2 = student applied the correct fundamental principles in their solution

The EnvE program has two goals for student performance for student course work assessment:

- **Goal 1**: a minimum of 70% of the students will perform at a 2 level  
- **Goal 2**: a minimum of 80% of the students will perform at the 1 or 2 level.

This outcome was assessed in ten upper-level classes using 408 samples of student work (see Table 3-1 on the next page). Students had to communicate both orally and in written form to a range of audiences (lay-person, a client such as a municipality, and technical audiences such as student colleagues, faculty, or an engineering supervisor). Both goals were met, with 91% of students rating a ‘2’ and 99% of students rating a 1 or 2 (Figure 3-1).

![Outcome 3 chart](image)

**Figure 3-1**: Summary of ratings of student work on Outcome 3
<table>
<thead>
<tr>
<th>Class</th>
<th>Name</th>
<th>Instructor</th>
<th>Term</th>
<th>Enrol</th>
<th>Method</th>
<th>Description</th>
<th>Assessment score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Course</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CEE 3610</td>
<td>Environmental Management</td>
<td>McNeill</td>
<td>F 2018</td>
<td>83</td>
<td>HW</td>
<td>written summary of an EIS for a lay-person</td>
<td>86%  12%  2%</td>
</tr>
<tr>
<td>CEE 3640</td>
<td>Drinking Water Engineering</td>
<td>McNeill</td>
<td>Sp 2019</td>
<td>35</td>
<td>HW</td>
<td>written essay on Flint MI - technical audience</td>
<td>80%  11%  9%</td>
</tr>
<tr>
<td>CEE 3650</td>
<td>Wastewater Engineering</td>
<td>Dupont</td>
<td>Sp 2019</td>
<td>18</td>
<td>team project</td>
<td>WWTP design for effluent discharge to meet use - written</td>
<td>78%  22%  0%</td>
</tr>
<tr>
<td>CEE 3650</td>
<td>Wastewater Engineering</td>
<td>Dupont</td>
<td>Sp 2019</td>
<td>18</td>
<td>team project</td>
<td>WWTP design for effluent discharge to meet use - oral</td>
<td>100%  0%  0%</td>
</tr>
<tr>
<td>CEE 3780</td>
<td>Solid and Haz Waste Mgmt</td>
<td>Dupont</td>
<td>F 2018</td>
<td>41</td>
<td>report</td>
<td>written report for team project</td>
<td>100%  0%  0%</td>
</tr>
<tr>
<td>CEE 3780</td>
<td>Solid and Haz Waste Mgmt</td>
<td>Dupont</td>
<td>F 2018</td>
<td>41</td>
<td>poster</td>
<td>oral presentation using poster for team project</td>
<td>100%  0%  0%</td>
</tr>
<tr>
<td>CEE 3880</td>
<td>CEE Design I</td>
<td>Ball</td>
<td>Sp 2019</td>
<td>71</td>
<td>team design pro</td>
<td>written design proposal - audience is the client</td>
<td>82%  18%  0%</td>
</tr>
<tr>
<td>CEE 4880</td>
<td>CEE Design III</td>
<td>Ball</td>
<td>Sp 2019</td>
<td>74</td>
<td>team design pro</td>
<td>poster presentation for general and technical audiences</td>
<td>100%  0%  0%</td>
</tr>
<tr>
<td>CEE 5610</td>
<td>Env. Quality Analysis</td>
<td>McLean</td>
<td>F 2018</td>
<td>12</td>
<td>lab exercise</td>
<td>written report for technical audience</td>
<td>91%   9%  0%</td>
</tr>
<tr>
<td>CEE 5860</td>
<td>Air Quality Management</td>
<td>Martin</td>
<td>F 2018</td>
<td>14</td>
<td>team design pro</td>
<td>oral presentation for technical audience</td>
<td>100%  0%  0%</td>
</tr>
</tbody>
</table>
**FE Exam Results**
Not applicable to this outcome.

**Senior Exit Interviews**
Graduating seniors complete an anonymous online exit interview to provide feedback about the EnvE program and rate their perceived progress in meeting each of the outcomes. The survey response rate was 9 of 11 students (82%). The performance goal is to have at least 80% of the students rating their attainment as “fully met” or “partly met”, which was achieved in 2018-2019 with 89% of students rating Outcome 3 as “fully met” and 11% as “partly met” for a total of 100% (Figure 3-2). Acknowledging that this is a subjective self-evaluation, these exit interview results are taken as a general indication that students feel they are meeting the outcome.

![Outcome 3 Chart]

**Summary**
The evaluation of student work and exit interviews indicates that goals related to Outcome 3 are being met.

**Recommendations**
Evaluate Outcome 3 during the 2020-2021 school year as planned. Continue emphasizing communication to a range of audiences.
Outcome 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

**Student Course Work Assessment**

Student work is rated on a 0 – 1 – 2 scale:

0 = student did not understand the fundamental principle or component
1 = student applied some but not all of the fundamental principles in their solution
2 = student applied the correct fundamental principles in their solution

The EnvE program has two goals for student performance for student course work assessment:

Goal 1: a minimum of 70% of the students will perform at a 2 level
Goal 2: a minimum of 80% of the students will perform at the 1 or 2 level.

Outcome 4 was assessed four upper-division classes (101 samples; see Table 4-1 on the next page). Although both Goal 1 and Goal 2 were met with 71% of student work rating a 2 and 85% of student work rating a 1 or 2 (Figure 4-1), we continue to refine our assessment of this outcome. We would like to specifically question students about the ASCE Code of Ethics in additional courses. Instructors also need to have students consider the impacts of engineering solutions in all four contexts listed in the outcome. This year, most assignments only looked at some, but not all, of the four contexts.

![Outcome 4](image-url)

**Figure 4-1**: Summary of ratings of student work on Outcome 4
Table 4-1: List of student work assessed for Outcome 4

<table>
<thead>
<tr>
<th>Class</th>
<th>Name</th>
<th>Instructor</th>
<th>Term</th>
<th>Enrol</th>
<th>Method</th>
<th>Description</th>
<th>Assessment score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEE</td>
<td>EnvE sophomore seminar</td>
<td>McLean</td>
<td>Sp 2019</td>
<td>17</td>
<td>quiz</td>
<td>quiz on ASCE code of ethics and ethics case studies</td>
<td>82% 6% 12%</td>
</tr>
<tr>
<td>CEE</td>
<td>Drinking Water Engineering</td>
<td>McNeill</td>
<td>Sp 2019</td>
<td>35</td>
<td>HW</td>
<td>written essay on Flint MI - ASCE Code of Ethics</td>
<td>83% 11% 6%</td>
</tr>
<tr>
<td>CEE</td>
<td>Drinking Water Engineering</td>
<td>McNeill</td>
<td>Sp 2019</td>
<td>35</td>
<td>HW</td>
<td>written essay on Flint MI - consider all impacts</td>
<td>49% 20% 31%</td>
</tr>
<tr>
<td>CEE</td>
<td>Air Quality Management</td>
<td>Martin</td>
<td>F 2018</td>
<td>14</td>
<td>HW</td>
<td>written reflection on &quot;God and Smog&quot; symposium speaker</td>
<td>86% 14% 0%</td>
</tr>
</tbody>
</table>
**FE Exam Results**

Our goal is to have 100% pass rate on the FE exam; our minimum acceptable level of performance is a pass rate at or above the national average. Table 4-2 summarizes the FE results for the past six years, including the percentage of students who had passed the FE exam by the time of graduation. The USU EnvE pass rate has been 100% except in 2016 when one student (of 9 graduates) did not pass the exam.

<table>
<thead>
<tr>
<th>Table 4-2: CE Graduates Passing FE Exam vs. National Annual Pass Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year</strong></td>
</tr>
<tr>
<td>2013-14</td>
</tr>
<tr>
<td>2014-15</td>
</tr>
<tr>
<td>2015-16</td>
</tr>
<tr>
<td>2016-17</td>
</tr>
<tr>
<td>2017-18</td>
</tr>
<tr>
<td>2018-19</td>
</tr>
</tbody>
</table>

* for first-time test takers

FE Exam performance by first-time test takers on the ethics and professional practice section is summarized in Figure 4-2. Over the past five years, EnvE students performed at or above the national average, considering the uncertainty range (error bars). Overall, the fact that nearly all EnvE students continue to pass the FE exam is a strong independent external indicator for meeting Student Outcome 4. It is also a strong indication of a good foundation for life-long (independent) learning skills.

![Figure 4-2: Scaled Fe Exam results for the ethics and professional practice section. Error bars represent uncertainty range for scaled scores.](image-url)
Senior Exit Interviews
Graduating seniors complete an anonymous online exit interview to provide feedback about the EnvE program and rate their perceived progress in meeting each of the outcomes. The survey response rate was 9 of 11 students (82%). The performance goal is to have at least 80% of the students rating their attainment as “fully met” or “partly met”, which was achieved in 2018-2019 with 100% of students rating Outcome 4 as “fully met” (Figure 4-3). Acknowledging that this is a subjective self-evaluation, these exit interview results are taken as a general indication that students feel they are meeting the outcome.

![Outcome 4 Rating](image)

Figure 4-3: Student exit interview ratings of progress on Outcome 4

Summary
The evaluation of student work, FE results, and senior exit interviews indicates that Outcome 4 is being met. However, we need to expand assessment of this outcome into additional courses and be sure students are considering all four listed contexts (global, economic, environmental, and societal).

Recommendations
Evaluate Outcome 4 as planned during the 2020-21 school year. Ensure that additional courses specifically assess the ASCE Code of Ethics and evaluate the impacts of engineering solutions in the four listed contexts.