Department of Civil Engineering
California State University, Sacramento
Sacramento, California

August, 2010
This document is prepared in response reports the assessment activities that the Department carried out last year (AY 2009/2010).

**Assessment of Program Educational Objectives**

One of the issues that the Department identified when preparing its self-study report was that the alumni survey response was not adequate (six responded out of more than 200 surveyed). ABET visiting team also raised this issue. Accordingly, the Department conducted its own survey in December 2009 after the ABET visit. The Department conducted the survey directly using an alumni database. The survey was designed and analyzed using Student Voice (www.studentvoice.com; the University has a license for their software). The survey instrument and the results are shown in Appendix A.

Two hundred and six alumni responded to the survey. Part of the survey included the following questions that are directly related to the Department’s program objectives:

*Please indicate your level of agreement with the following statements:*

1. The Civil Engineering Program at Sacramento State prepared me well to . . . *Identify, analyze, and solve practical civil engineering problems*
2. The Civil Engineering Program at Sacramento State prepared me well to . . . *Apply knowledge of (environmental, geotechnical, structural, transportation, or water resources) engineering to design civil engineering projects*
3. The Civil Engineering Program at Sacramento State prepared me well to . . . *Communicate effectively with peers, other professionals, decision makers, and the general public, in the conduct of my work*
4. The Civil Engineering Program at Sacramento State prepared me well to . . . *Practice civil engineering in a professionally responsible and ethical manner*

The above-listed questions correspond to the Department’s four educational objectives as identified in its self-study report. The respondents were asked to rate their response on a five-point scale with scores ranging from five indicating strong agreement to one indicating strong disagreement with the four statements. The survey results are shown below in the same order as listed above:

1. 95.3% strongly agree or agree with achieving objective 1.
2. 90.1% strongly agree or agree with achieving objective 2.
3. 77.6% strongly agree or agree with achieving objective 3.
4. 89.6% strongly agree or agree with achieving objective 4.

Based on the results above, the Department is achieving its educational goals.
Future Plans and Continuation of Activities for Assessment of the Program Educational Objectives:
The Department will continue to analyze the data collected from this recent survey to further parse the data to gain any further insight from the data. For example, is there any difference in response between recent graduates (less than five years) and other graduates (more than five years)?

The Department will continue to use this instrument every three years. In addition, the Department will engage stakeholder in evaluating the educational objectives before the survey is sent to the alumni. The survey will be adjusted, if there is any adjustment to the educational objectives.

Assessment of Program Learning Outcomes – Direct Measures
The Department conducted direct assessment of its program learning outcomes by extracting specific course activities to be included as direct measures of learning outcomes. The activities included assignments, quizzes, papers, reports, or specific test questions from the courses in the Civil Engineering curriculum. The Department normalized the scores for course activities to a five-point scale ranging five to one corresponding to “Excellent” to “Poor”, respectively as shown in Table 1. The courses in the major that were included in this assessment activity are shown in
Table 2. The reported scoring scales for grading course activities are also shown in Table 2. The scores for the activities that did not follow the five-point scale were normalized to a five-point scale system using the percentages shown in Table 1. That is, scores that were greater than or equal 90% were given 5, scores greater than or equal 80% (but less than 90%) were given 4, and so on. The details of the activities that were included in this assessment are documented in Appendix B.

Table 1. Normalized Scoring System for Outcome Assessment.

<table>
<thead>
<tr>
<th>Point Scale</th>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Demonstrate mastery of the outcome associated with the activity being measured, assumptions are clearly stated, show clear organization of approach.</td>
<td>&gt; 90</td>
</tr>
<tr>
<td>4</td>
<td>Demonstrate understanding of the outcome associated with the activity being measured, assumptions are well stated with minor gaps, demonstrate clear organization with minor gaps.</td>
<td>&gt; 80</td>
</tr>
<tr>
<td>3</td>
<td>Demonstrate basic understanding of the outcome associated with the activity being measured, assumptions are documents with a number of gaps, demonstrate some organization with gaps.</td>
<td>&gt; 70</td>
</tr>
<tr>
<td>2</td>
<td>Demonstrate some understanding of the outcome associated with the activity being measured, no clear documentations of assumptions, limited organization.</td>
<td>&gt; 60</td>
</tr>
<tr>
<td>1</td>
<td>Limited understanding of the outcome associated with the activity being measured; no documentation of assumptions, no organization of approach.</td>
<td>&lt; 60</td>
</tr>
<tr>
<td>Outcome</td>
<td>Corresponding ABET Outcome</td>
<td>Outcome Description</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1A</td>
<td>a</td>
<td>Ability to apply knowledge of mathematics, science, and engineering</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1B</td>
<td>k</td>
<td>Ability to use techniques, skills and modern engineering tools</td>
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<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>2A</td>
<td>b</td>
<td>Ability to design and conduct experiments and to analyze and interpret data</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>2B</td>
<td>c</td>
<td>Ability to design a system, component, or process to meet desired needs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2C</td>
<td>-</td>
<td>Ability to function on a team</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td>2D</td>
<td>d</td>
<td>Ability to function on an interdisciplinary team</td>
</tr>
<tr>
<td>2E</td>
<td>e</td>
<td>Ability to identify, formulate, and solve engineering problems</td>
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<td></td>
</tr>
<tr>
<td>2F</td>
<td>i</td>
<td>Recognition of need for, and ability to engage in lifelong learning</td>
</tr>
<tr>
<td>3</td>
<td>g</td>
<td>Ability to communicate effectively</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>4A</td>
<td>h</td>
<td>Understanding impacts of engineering solutions in the global and societal context</td>
</tr>
<tr>
<td>4B</td>
<td>j</td>
<td>Knowledge of contemporary issues</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5A</td>
<td>-</td>
<td>Understanding of Civil Engineering practice</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5B</td>
<td>f</td>
<td>Understanding of professional and ethical responsibility</td>
</tr>
</tbody>
</table>

*Reported as GPA, a grade given to the final report
The assessment data from various course activities were analyzed using JMP software. The results are shown below and are organized by learning outcomes. The results are presented by showing the frequency histogram of percentage of students in each of the score category (1 through 5). The results for each outcome also show the courses and the corresponding activities for that outcome. A summary for each outcome is included. For the purposes of this analysis, the Department considers a learning outcome is achieved if 75% of the students are included in the range of 3 to 5 categories.

### Outcome 1A – Ability to Apply Knowledge of Mathematics, Science, and Engineering (ABET Outcome a)

![Histogram showing frequency distribution]

**Activities:** (Course number - Course Title; Activity; Title of the activity)
- E112 – Mechanics of Materials; quiz; bending stresses
- CE137 – Water Resources Engineering; critical flow analysis
- CE170 – Principles of Environmental Engineering; A problem in the final exam; carbonate system.

**Summary:**
For this outcome 73% of the students scored between three and five.

### 1B – Ability to Use Techniques, Skills, and Modern Engineering Tools (ABET Outcome k)

![Histogram showing frequency distribution]

**Activities:** (Course number - Course Title; Activity; Title of the activity)
- CE101 – Computer Applications in Civil Engineering; Final Exam; Excel and VBA application solving engineering problems.
- CE147 – Transportation Engineering; Lab; AutoCAD, Civil 3D assignment
- CE161 – Theory of Structures I; Final Exam; Problem 1

**Summary:**
For this outcome 83% of the students scored between three and five.
2A – Ability to Design and Conduct Experiments and to Analyze and Interpret Data  
(ABET Outcome b)

Activities: (Course number - Course Title; Activity; Title of the activity)
CE113 – Structural Lab; Lab; Wood problem including handouts and presentation.
CE147 – Transportation Engineering; Lab; Speed survey.
CE170 – Principles of Environmental Engineering; Lab; Coagulation lab.
CE171A – Soil Mechanics; Lab; Direct shear measure.

Summary:
For this outcome 92% of the students scored between three and five.

2B – Ability to Design a System, Component, or Process to Meet Desired Needs  
(ABET Outcome c)

Activities: (Course number - Course Title; Activity; Title of the activity)
CE137 – Water Resources Engineering; Homework assignment; Culvert design problem
CE147 – Transportation Engineering; Final exam; pavement design problem
CE164 – Reinforced Concrete Design; Homework assignment; Design of doubly reinforced beam

Summary:
For this outcome 80% of the students scored between three and five.
### 2C – Ability to Function on a Team
(Not ABET Outcome)

#### Activities: (Course number - Course Title; Activity; Title of the activity)
- CE113 – Structural Lab; Lab; End of the year peer evaluation.
- CE147 – Transportation Engineering; Lab, Peer evaluation.
- CE190 – Senior Project; project; Peer evaluation

#### Summary:
For this outcome 91% of the students scored between three and five.

### 2D – Ability to Function on an Interdisciplinary Team
(ABET Outcome d)

#### Activities: (Course number - Course Title; Activity; Title of the activity)
- CE190 – Senior Project; Project; Peer Evaluation

#### Summary:
For this outcome 88% of the students scored between three and five.
2E – Ability to Identify, Formulate, and Solve Engineering Problems
(ABET Outcome e)

<table>
<thead>
<tr>
<th>Frequencies</th>
<th>Confidence Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>Count</td>
</tr>
<tr>
<td>1</td>
<td>71</td>
</tr>
<tr>
<td>2</td>
<td>26</td>
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<td>3</td>
<td>14</td>
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<td>4</td>
<td>50</td>
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<tr>
<td>5</td>
<td>133</td>
</tr>
<tr>
<td>Total</td>
<td>294</td>
</tr>
</tbody>
</table>

N Missing 0

Activities: (Course number - Course Title; Activity; Title of the activity)
E112 – Mechanics of Materials; Homework assignment; Composite beams.
CE 101 – Computer Applications in Civil Engineering; Quiz; Traffic accident analysis.
CE161 – Theory of Structures I; Final Exam; problem on solving an indeterminate structure problem using any method learned in the course.
CE170 – Principles of Environmental Engineering; A problem in a final exam and homework assignment; reactor analysis
CE171A – Soil Mechanics; Problem 3 on Final Exam; Differential settlement problem

Summary:
For this outcome 67% of the students scored between three and five. The Department will include this learning outcome as one of the outcome that will be evaluated and more measure will be included.

2F – Recognition of the Need for and Ability to Engage in Life-Long Learning
(ABET Outcome i)

<table>
<thead>
<tr>
<th>Frequencies</th>
<th>Confidence Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>Count</td>
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<tr>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
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<td>4</td>
<td>13</td>
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<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
</tr>
</tbody>
</table>

N Missing 0

Activities: (Course number - Course Title; Activity; Title of the activity)
CE164 – Reinforced Concrete Design; Homework assignment; Computer analysis of a one-way slab.

Summary:
For this outcome 72% of the students scored between three and five. The Department will include this learning outcome as one of the outcome that will be evaluated and more measure will be included.
### 3 – Ability to Communicate Effectively
(ABET Outcome g)

<table>
<thead>
<tr>
<th>Norm_score</th>
<th>Frequencies</th>
<th>Confidence Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>Count</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>12</td>
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<tr>
<td></td>
<td>2</td>
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<td>22</td>
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<tr>
<td></td>
<td>4</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>54</td>
</tr>
<tr>
<td>Total</td>
<td>139</td>
<td>1.00000</td>
</tr>
<tr>
<td>N Missing</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Activities:** (Course number - Course Title; Activity; Title of the activity)

- CE113 – Structural Lab; Lab; Cantilever report
- CE147 – Transportation Engineering; Presentation; Transportation issues in the news.
- CE190 – Senior Project; Project; Final report and presentation.

**Summary:**
For this outcome 81% of the students scored between three and five.

### 4A – Understanding Impacts of Engineering Solutions in the Global and Societal Context
(ABET Outcome h)

<table>
<thead>
<tr>
<th>Norm_score</th>
<th>Frequencies</th>
<th>Confidence Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>Count</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Total</td>
<td>57</td>
<td>1.00000</td>
</tr>
<tr>
<td>N Missing</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Activities:** (Course number - Course Title; Activity; Title of the activity)

- CE1147 – Transportation Engineering; Presentation (in class); Transportation issues in the news

**Summary:**
For this outcome 96% of the students scored between three and five.
4B – Knowledge of Contemporary Issues
(ABET Outcome j)

Activities: (Course number - Course Title; Activity; Title of the activity)
CE147 – Transportation Engineering; Presentation (in class); Transportation issues in the news.
CE170 – Principles of Environmental Engineering; A problem in final exam; Issues related to acid rain

Summary:
For this outcome 76% of the students scored between three and five.

5A – Understanding of Civil Engineering Practice
(Not an ABET Outcome)

Activities: (Course number - Course Title; Activity; Title of the activity)
CE1A – Civil Engineering Seminar; Paper; Final Project.
CE171A – Soil Mechanics; Test (Midterm 2); Problem 1, flownet and heaving/piping analysis for a dam problem.
CE190 – Senior Project; Proposal, Preparation of a proposal in response to a Request for Proposal (RFP).

Summary:
For this outcome 83% of the students scored between three and five.

Future Plans and Continuation of Assessment Activities of the Program Learning Outcomes:
Based on these initial results, the Department will focus on three outcomes in Years One, Two, and Four in the six year cycle. In Year Three, the program educational objectives will be reviewed and the alumni survey will be conducted. Four outcomes will be evaluated in Year Five. Table 3 shows the assessment plan for the Department in the six-year evaluation cycle from 2011 to 2016.

<table>
<thead>
<tr>
<th>Year</th>
<th>Outcomes</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>Outcomes 1A, 2E, and 2F</td>
<td>The three outcomes scored below 75% of the students were between three and five</td>
</tr>
<tr>
<td>Two</td>
<td>Three other outcomes will be selected by faculty for evaluation</td>
<td>Closing the loop for year One</td>
</tr>
<tr>
<td>Three</td>
<td>Review of program educational objectives and alumni survey</td>
<td>Closing the loop for Year Two</td>
</tr>
<tr>
<td>Four</td>
<td>Three outcomes will be selected by faculty for evaluation</td>
<td>Closing the loop for alumni survey</td>
</tr>
<tr>
<td>Five</td>
<td>Four outcomes will be selected by faculty for evaluation</td>
<td>Closing the loop for Year Four</td>
</tr>
<tr>
<td>Six</td>
<td>No assessment activity</td>
<td>Closing the loop for Year Five; Completion of any outstanding assessment activities.</td>
</tr>
</tbody>
</table>

Other Assessment Activities

The focus inquiry will be accomplished by the following data collection methods: 1) Focus Group, 2) Survey of the graduates, and 3) Survey of the alumni of the graduate program. These surveys will be part of the assessment plan of the graduate program. The assessment plan for the graduate program is summarized in Table 4.

Table 4. Five-Year Assessment Plan for CE Graduate Program

<table>
<thead>
<tr>
<th>Activity</th>
<th>AY10/11</th>
<th>AY11/12</th>
<th>AY12/13</th>
<th>AY13/14</th>
<th>AY14/15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct measures</td>
<td>Technical competence for solving complex problems</td>
<td>Communication Skills</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graduate Survey</td>
<td>Every semester</td>
<td>Every Semester</td>
<td>Every Semester</td>
<td>Every Semester</td>
<td>Every Semester</td>
</tr>
<tr>
<td>Alumni Survey</td>
<td></td>
<td></td>
<td></td>
<td>Fall 2013</td>
<td>Fall 2015</td>
</tr>
</tbody>
</table>
Appendix A – Alumni Survey Instrument and Results

Part I – Survey Instrument used for the Alumni Survey in December 2009
**Q1 Did you graduate from the Sacramento State Civil Engineering Program?**

<table>
<thead>
<tr>
<th>Option</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes - B.S. [Code = 1] (Go To Page 2)</td>
<td></td>
</tr>
<tr>
<td>Yes - M.S. [Code = 2] (Go To Page 2)</td>
<td></td>
</tr>
<tr>
<td>Yes - B.S. and M.S. [Code = 3] (Go To Page 2)</td>
<td></td>
</tr>
<tr>
<td>No [Code = 4] (Go To End)</td>
<td></td>
</tr>
</tbody>
</table>

**Required answers: 1  Allowed answers: 1**

**Next Page: Conditional**

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**Q2 When did you graduate from the CE Program?**

<table>
<thead>
<tr>
<th>Year</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
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<td>1978 (Code = 32)</td>
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<td>1976 (Code = 34)</td>
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<td>1974 (Code = 36)</td>
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<td>1970 (Code = 40)</td>
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<td>1966 (Code = 44)</td>
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<td>1964 (Code = 46)</td>
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<td></td>
</tr>
<tr>
<td>Not applicable (Code = 56)</td>
<td></td>
</tr>
</tbody>
</table>

Q3 What is/was your focus area in the Master's program?

- Environmental [Code = 1]
- Geotechnical [Code = 2]
- Structural [Code = 3]
- Transportation [Code = 4]
- Water resources [Code = 5]
- None/General [Code = 6]
- Other (please specify) [Code = 7] [TextBox]

**Display if Q1='Yes - M.S.' OR Q1='Yes - B.S. and M.S.'**

Next Page: Sequential
### Q4 Are you currently working in civil engineering or a related field?
- Yes [Code = 1]
- No [Code = 2]

Required answers: 1  Allowed answers: 1

Next Page: Sequential

### Q5 Have you worked in civil engineering or a related field during your career?
- Yes [Code = 1]
- No [Code = 2]

Required answers: 1  Allowed answers: 1

Display if Q4='No'

Next Page: Sequential

### Q6 In what sector is your employer located?
- Private sector [Code = 1]
- Public sector - federal agency [Code = 2]
- Public sector - state agency [Code = 3]
- Public sector - local government [Code = 4]
- Other (please specify) [Code = 5] [TextBox]
- Not sure [Code = 6]

Required answers: 1  Allowed answers: 1

### Q7 What is your primary area of specialization in civil engineering related field?
- Environmental [Code = 1]
- Geotechnical [Code = 2]
- Structural [Code = 3]
- Transportation [Code = 4]
- Water resources [Code = 5]
- Construction [Code = 6]
- None/General [Code = 7]
- Other (please specify) [Code = 8] [TextBox]

Required answers: 1  Allowed answers: 1

### Q8 How many total years of experience in the civil engineering field do you have?
- Less than 1 year [Code = 1]
- 1 - 5 years [Code = 2]
- 6 - 10 years [Code = 3]
- 11 - 20 years [Code = 4]
- More than 20 years [Code = 5]
### Q9: How many years do you have with your current employer?

- Less than 1 year [Code = 1]
- 1 - 5 years [Code = 2]
- 6 - 10 years [Code = 3]
- 11 - 20 years [Code = 4]
- More than 20 years [Code = 5]
- Not sure [Code = 6]

### Q10: In what sector was your employer located?

- Private sector [Code = 1]
- Public sector - federal agency [Code = 2]
- Public sector - state agency [Code = 3]
- Public sector - local government [Code = 4]
- Other (please specify) [TextBox]
- Not sure [Code = 6]

### Q11: What was your primary area of specialization in civil engineering related field?

- Environmental [Code = 1]
- Geotechnical [Code = 2]
- Structural [Code = 3]
- Transportation [Code = 4]
- Water resources [Code = 5]
- Construction [Code = 6]
- None/General [Code = 7]
- Other (please specify) [TextBox]

### Q12: How many total years of experience in the civil engineering field did you have?

- Less than 1 year [Code = 1]
- 1 - 5 years [Code = 2]
- 6 - 10 years [Code = 3]
- 11 - 20 years [Code = 4]
- More than 20 years [Code = 5]
- Not sure [Code = 6]
### Q13 Have you received your professional engineering (PE) license?

- Yes [Code = 1]
- No [Code = 2]

**Required answers: 1  Allowed answers: 1**

### Q14 In what year did you receive your PE license?

- 2009 [Code = 1]
- 2008 [Code = 2]
- 2007 [Code = 3]
- 2006 [Code = 4]
- 2005 [Code = 5]
- 2004 [Code = 6]
- 2003 [Code = 7]
- 2002 [Code = 8]
- 2001 [Code = 9]
- 2000 [Code = 10]
- 1999 [Code = 11]
- 1998 [Code = 12]
- 1997 [Code = 13]
- 1996 [Code = 14]
- 1995 [Code = 15]
- 1994 [Code = 16]
- 1993 [Code = 17]
- 1992 [Code = 18]
- 1991 [Code = 19]
- 1990 [Code = 20]
- 1989 [Code = 21]
- 1988 [Code = 22]
- 1987 [Code = 23]
- 1986 [Code = 24]
- 1985 [Code = 25]
- 1984 [Code = 26]
- 1983 [Code = 27]
- 1982 [Code = 28]
- 1981 [Code = 29]
- 1980 [Code = 30]
- 1979 [Code = 31]
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<td>1960</td>
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- Not sure [Code = 37]
- Not applicable [Code = 38]

**Q15** Have you received a specialized license **beyond** your professional engineering (PE) license, such as a structural engineering (SE), geotechnical engineering (GE), transportation engineering (TE) licensure?

- Yes [Code = 1]
- No [Code = 2]
- Not applicable [Code = 3]

**Q16** Please explain why you have not received your professional engineering (PE) license:

[Code = 1] [TextBox]

- Required answers: 0
- Allowed answers: 1

**Q17** Have you received your EIT/FE certification?

- Yes [Code = 1]
- No [Code = 2]

- Required answers: 1
- Allowed answers: 1

Display if Q13='Yes'

**Display if Q13='No'**
### Q18 How likely are you to take the EIT/FE exam?

|------------------------|-----------------------------|--------------------------------------|-------------------------------|-------------------------|

Display if Q17 = 'No'

### Page - Assessment of Sacramento State Civil Engineering Program Outcomes

Please indicate your level of agreement with the following statements:

#### The Civil Engineering Program at Sacramento State prepared me well to . . .

**Q19 Identify, analyze, and solve practical civil engineering problems**

|---------------------------|-----------------|-------------------|-------------------|-----------------------------|--------------------------|

**Q20 Apply knowledge of (environmental, geotechnical, structural, transportation, or water resources) engineering to design civil engineering projects**

|---------------------------|-----------------|-------------------|-------------------|-----------------------------|--------------------------|

**Q21 Communicate effectively with peers, other professionals, decision makers, and the general public, in the conduct of my work**

|---------------------------|-----------------|-------------------|-------------------|-----------------------------|--------------------------|
Q22 Practice civil engineering in a professionally responsible and ethical manner

- Strongly agree[Code = 5]
- Agree[Code = 4]
- Neutral[Code = 3]
- Disagree[Code = 2]
- Strongly disagree[Code = 1]
- Unable to judge[Code = 0]

Required answers: 1 Allowed answers: 1

Q23 Are you willing to help the Department with additional feedback and program assessment efforts?

- Yes[Code = 1]
- No[Code = 2]

Required answers: 1 Allowed answers: 1

Please provide the following information (optional):

Q24 First name:

[Code = 1] [TextBox]

Required answers: 0 Allowed answers: 1

Q25 Last name:

[Code = 1] [TextBox]

Required answers: 0 Allowed answers: 1

Q26 Maiden name (if applicable):

[Code = 1] [TextBox]

Required answers: 0 Allowed answers: 1

Q27 Company/agency:

[Code = 1] [TextBox]

Required answers: 0 Allowed answers: 1

Q28 Title or position:

[Code = 1] [TextBox]

Required answers: 0 Allowed answers: 1
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Required answers: 0  Allowed answers: 1

**Q33 Zip/Postal code:**
[Code = 1] [TextBox]

Required answers: 0  Allowed answers: 1

**Q34 Country:**
[Code = 1] [TextBox]

Required answers: 0  Allowed answers: 1

**Q35 Phone number (with area code):**
[Code = 1] [TextBox]

Required answers: 0  Allowed answers: 1

**Q36 E-mail address:**
[Code = 1] [TextBox]
<table>
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<tr>
<th>Q37 Are you interested in receiving biannual issues of the Sacramento State CE Connections Newsletter sent via e-mail?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (please provide your e-mail address)</td>
</tr>
<tr>
<td>No</td>
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</table>

<table>
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<tr>
<th>Q38 Do you have any additional comments or suggestions related to this survey or the Department?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (please explain)</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>
Part II – Results of the Alumni Survey, December 2009
Q1. Did you graduate from the Sacramento State Civil Engineering Program?

Q2. When did you graduate from the CE Program?
Q3. What is/was your focus area in the Master's program?

Q4. Are you currently working in civil engineering or a related field?

Q5. Have you worked in civil engineering or a related field during your career?
Q6. In what sector is your employer located?

Q7. What is your primary area of specialization in civil engineering related field?
Q8. How many total years of experience in the civil engineering field do you have?
Q9. How many years do you have with your current employer?

Q10. In what sector was your employer located?
Q11. What was your primary area of specialization in civil engineering related field?

Q12. How many total years of experience in the civil engineering field did you have?
Q13. Have you received your professional engineering (PE) license?

Q14. In what year did you receive your PE license?

Q15. Have you received a specialized license beyond your professional engineering (PE) license, such as a structural engineering
Q15. Have you received a specialized license beyond your professional engineering (PE) license, such as a structural engineering (SE), geotechnical engineering (GE), transportation engineering (TE) licensure?

Q16. Please explain why you have not received your professional engineering (PE) license:

Q17. Have you received your EIT/FE certification?
Q18. How likely are you to take the EIT/FE exam?

Q19. Please indicate your level of agreement with the following statements:
The Civil Engineering Program at Sacramento State prepared me well to . . . - Identify, analyze, and solve practical civil
Q19. Please indicate your level of agreement with the following statements: The Civil Engineering Program at Sacramento State prepared me well to . . . - identify, analyze, and solve practical civil engineering problems

Q20. Please indicate your level of agreement with the following statements:

The Civil Engineering Program at Sacramento State prepared me well to . . . - Apply knowledge of (environmental, geotechnical, structural, transportation, or water resources) engineering to design civil engineering projects
Q21. Please indicate your level of agreement with the following statements:

The Civil Engineering Program at Sacramento State prepared me well to ... - Communicate effectively with peers, other professionals, decision makers, and the general public, in the conduct of my work

Q22. Please indicate your level of agreement with the following statements:

The Civil Engineering Program at Sacramento State prepared me well to ... - Practice civil engineering in a professionally responsible and ethical manner
Q23. Are you willing to help the Department with additional feedback and program assessment efforts?

Q24. First name:

Q25. Last name:
Q26. Maiden name (if applicable):

Q27. Company/agency:
Q35. Phone number (with area code):

Q36. E-mail address:
Q37. Are you interested in receiving biannual issues of the Sacramento State CE Connections Newsletter sent via e-mail?
Q38. Do you have any additional comments or suggestions related to this survey or the Department?

Yes (please explain) 21.28%

No 78.72%
Appendix B – Supporting Documents for direct outcome assessment activities
Learning Outcome 1A (ABET a)

Ability to apply knowledge of mathematics, science, and engineering

List of courses included in the assessment of this outcome.

1. ENGR112 – Mechanics of Materials
2. CE137 – Water Resources Engineering
3. CE170 – Principles of Environmental Engineering


Given: \( I = 3.36 \text{ in}^3 \)

Determine: Minimum and maximum bending stresses
Note that the first part used for the design outcome (2B) and the second part was used for the ability to apply mathematics, science, and engineering (Outcome 1B)

CE137 – Water Resources Engineering

Your company has been hired to perform rainfall-runoff analysis for the watershed provided in the figure below. The City wants to design a culvert that is located at the outlet of the watershed in preparation for a new highway to be constructed in the future. The culvert is to be designed to pass the 100-year design flow. Sub-watershed 1 has sheet flow for a length of 54 ft (n=0.52, 2-year and 24-hour rainfall = .35 in, the general slope is 2.47%). What are the Peak Discharge and the total volume? (35 points).
Use the figure below to determine the critical depth, critical velocity, flow rate for a trapezoidal channel with a bottom width of 15 ft, side slope of 3H:1V, and bed slope of 0.1% . (15 Points)
CE 170 – Principles of Environmental Engineering
Problem from the final exam (Fall 09)

P2. (12 points) If the total carbonate concentration \( C_t \) is \( 8.35 \times 10^{-4} \) M and the pH is 10, what is the alkalinity in mg/L as CaCO₃?
Learning Outcome 1B
(ABET k)

Ability to use techniques, skills and modern engineering tools
List of courses included in the assessment of this outcome.

1. CE101 – Computer Applications in Civil Engineering
2. CE147 – Transportation Engineering
3. CE161 – Theory of Structures I
CE101 – Computer Applications in Civil Engineering

Table 1: Accidents at Each Intersection: 2006 to 2008

<table>
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<tr>
<th></th>
<th>1st Ave</th>
<th>2nd Ave</th>
<th>3rd Ave</th>
<th>4th Ave</th>
<th>5th Ave</th>
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<td>Vest</td>
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<td></td>
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<td></td>
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<tr>
<td>1st St</td>
<td>6</td>
<td>3</td>
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<td>2nd St</td>
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Table 2: Intersection Accidents Averaged to Reflect Adjacent Intersections

<table>
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<tr>
<th></th>
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<td>3rd St</td>
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<tr>
<td>4th St</td>
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</tbody>
</table>

Example Result: For the intersection of 8th Ave and 4th St, the average value is 4.0, turning cell text Red and Bold.
Overview: Civil 3D is the latest software developed by AutoDesk, and it has powerful advantages over the previous software, Land Development Desktop. The most notable advantage is that Civil 3D is a dynamic engineering model that allows for design changes to be made very easily, and it also allows those changes to be relayed automatically through all related design elements. [Note: Students with a valid educational e-mail address can download and install a free personal copy of the full version of AutoCAD Civil 3D (valid for 12 months) from the website: http://students.autodesk.com.]

Groups: For this lab, you will work in small groups of two or three.

Objectives: In this lab exercise, you will start with basic topographic information from which you will create a roadway corridor using Civil 3D. The roadway will be a two-lane road with a shoulder. The design requirements for the road are:

- Approximately 1500-ft long roadway.
- Two horizontal curves with a 650-ft minimum radius.
- Minimum vertical curve length is 100’.
- 45 mph design speed.
- Two 12-ft travel lanes sloped at 2% from the centerline to the edge of travel way.
- 5-ft paved shoulder sloped at 5% from edge of travel lane.
- 3-ft dirt shoulder sloped at 5% from edge of pavement.
- 2:1 slope from edge of dirt shoulder to existing ground.
- Net earthwork maximum import or export of 500 cubic yards.

Follow the steps below to construct your roadway using Civil 3D.

Creating an Alignment

In this portion of the lab you will be creating and editing a new alignment. This alignment will be used to attain and create horizontal data. It will also represent the new roadway centerline layout in plan view.

1. Open the file called Lab5_Alignment.dwg.

2. Click Alignments Menu > Create Alignment by Layout.
a. In the Create Alignment - Layout dialog box: Give the alignment an appropriate Name and Starting station (use 10+00.00). Make sure that your Alignment style is set to Proposed, and that your Alignment label set is set to All Labels.

3. After selecting ok within the Create Alignment – Layout dialog box an Alignment Layouts toolbar will appear.

4. Within the first pull down along the left side of the toolbar, select Tangent-Tangent (With Curves).

5. In the drawing area, draw your roadway tangents. Hit escape when you are done.

6. Within the Alignment Layouts toolbar (if you no longer have the toolbar simply Click Alignments > Edit Alignment Geometry and click the alignment that you just created) click Alignment Grid View.

   a. Within this box you will see some data on the alignment that you have created.

   b. Change at least one radius on one of the horizontal curves that you have created and watch as the alignment is automatically updated. (Help: If you see the message “NO SOLUTION AVAILABLE,” try to reduce the grades so that a curve will fit.)

   c. Also try playing and moving either the end or any of the points of intersection (PIs) of your alignment and see how the alignment is automatically updated.

7. Once you have manipulated your alignment to the desired location save the file as an appropriate name.

Creating an Existing Profile

Profiles are in essence vertical alignments. Profiles are used to attain and create vertical data whereas alignments (just like the one created in the previous section of this lab) are used to attain and create horizontal data.
1. Click Profile menu > Create Profile From Surface.

2. A Create Profile from Surface dialog box will appear.
   a. Check to make sure that the correct alignment is selected. Also make sure the existing surface is highlighted (in this case Existing Ground) and then click Add>>
   b. The Information for the profile should then be added to the profile list.
   c. Then click Draw in profile view.

3. A Create Profile View – General dialog box should appear.
   a. Appropriately name the profile under Profile view name.
   b. All the other defaults should be ok, but feel free to take a look at the other options that are available when creating profiles by clicking next. Otherwise simply click Create Profile View.
   c. Then click anywhere in the drawing space to place the profile.
   d. You should now have a profile of the existing ground along the alignment.
   e. If you adjust the alignment you will now see how the profile is dynamically updated and linked to the alignment.

**Creating a Finished Surface Profile**

The finished surface profile is the centerline profile of your new roadway. It will be designed along the horizontal alignment that you previously created.

1. Click the Profile menu > Create Profile by Layout
a. The Create Profile box should appear.

b. In the Name box, give the finished surface profile you are about to create an appropriate name. Also make sure that the Profile style is set to Design Profile and that the Profile label set is set to Complete Label Set.

c. The Profile Layout Tools toolbar should appear. Click the draw tangents button (without curves). Start drawing by left clicking on the starting point of the existing profile. Pick more points as necessary to complete your finished surface road. Hit escape when finished. (Hint, your finished profile should somewhat match the existing profile and try not to use more than 5 or 6 line segments.)

d. Click on the pull down on the vertical curve button (the sixth button from the left) in the Profile Layout Tools toolbar. Select Free Vertical Curves (Parameter).

e. Select the first line segment and then the second. It will ask you for a vertical curve length. Pick an appropriate vertical curve length. (Help: If you see the message “NO SOLUTION AVAILABLE,” try to reduce the grades so that a curve will fit.)

f. Repeat for the rest of the PVIs.

g. View your K values as they are displayed in the information above the vertical curves. (Do they exceed the required K values that correspond to the given design speed?)

h. Adjust your profile as necessary.

Creating an Assembly

An assembly is a component of creating a corridor. It is a cross-section that can be applied incrementally to any point along an alignment.

1. Click Corridor menu > Create Assembly.
2. In the Create Assembly dialog box, enter an appropriate name for the assembly.

   a. The Assembly style should be set to Basic and the Code set style should be set to All Codes

3. Within the drawing area, click a location for the baseline and zoom into the baseline (Assemblies are drawn to scale and therefore are typically small with respect to other items within a drawing).

4. Click Corridor menu > Subassembly Tool Palettes

   a. These subassemblies are the building blocks of the assembly you want to create. In this lab exercise you will only use subassemblies within the Imperial – Basic Tab within this palette.

5. Remember, you will be creating a two-lane roadway with a shoulder and conforming the road to match the existing terrain.

   a. First get your properties tool palette to open by typing “properties”. This is where you will be making minor adjustments to the subassemblies.

   b. Now select the BasicLane subassembly within the Subassembly Tool Palette

      i. Notice that after selecting the BasicLane subassembly you now have some information on the subassembly within your properties tool palette.

      ii. Within the advanced options there is an option designated as side. This option can be set as either right or left. Set this option to say right and place the BasicLane subassembly to the right of the baseline by clicking the baseline.

      iii. Attach one more BasicLane assembly at the end of the previous BasicLane subassembly to the right. Then place a BasicSideSlopeCutDitch subassembly to the right of the previous subassembly. (There should be a total of three BasicLane and one BasicSideSlopeCutDitch assemblies within the drawing.)

      iv. Now manipulate the subassemblies within the properties palette in order to have the following criteria.
12’ Travel Lane (Subassembly = BasicLane)
- Width = 12’
- Depth = 0.670’
- Slope = -2%

5’ Shoulder (Subassembly = BasicLane)
- Width = 5’
- Depth = 0.670’
- Slope = -5%

3’ Additional Pavement (Subassembly = BasicLane)
- Width = 3’
- Depth = 0.670’
- Slope = -5%

Cut/Fill Slope (Subassembly = BasicSideSlopeCutDitch)
- Daylight Link = Include Daylight link
- Cut Slope = 2:1
- Fill Slope = 4:1
- Foreslope Slope = 4:1
- Foreslope Width = 4’
- Bottom Width = 2’
- Backslope Slope = 4:1
- Backslope Width = 4’
- All other parameters should be left alone (defaults)

[Note: You are creating three “basic lanes” here: one that acts as the 12-foot travel lane, one that acts as a five-foot shoulder, and one that acts as three-foot gutter.]

c. Repeat step b. for the left side of the assembly

6. Once you have successfully created the entire assembly (one full cross-section of the roadway), save the file as an appropriate file name.

Creating a Corridor
A corridor is a three dimensional roadway created by applying an assembly along a vertical alignment at regular intervals.

1. Click the Corridors menu > Create Simple Corridor
   a. The Create Simple Corridor box should appear.
   b. Name the corridor appropriately per your previous descriptions.
   c. Click OK

2. Select the Horizontal Alignment.

3. Select the Finished Surface Profile.

4. Select the Assembly.

5. The Target Mapping box will appear.
   a. In the first box under the Object Name heading click and select existing surface and click OK

6. The corridor should be drawn over the horizontal alignment. Save.

7. Manipulate the horizontal alignment and profile to see the corridor automatically adjust.

**Creating a Surface from a Corridor**

A surface is a three dimensional projection of the designed finished roadway. It can be used to determine elevations and earthwork volumes.

1. Select the corridor and right click. Pick Corridor Properties.

2. Move to the Surfaces tab if it’s not the default.
3. Click the Create a Corridor Surface button.

4. Under the Surface Style tab pick a style for the surface. For this lab please use the style called Contours 1’ and 5’ (Design).

5. Make sure that the data type is set to Links and the Specify Code is set to Top. This is telling the surface to use the top of the corridor links, which were created through the subassembly and assembly, in order to create this surface.

6. Click on the Add Surface Item button. It is the button with the blue plus on it. Click OK.

7. The surface should be shown over the corridor.

Checking the Earthwork Volumes

In this portion of the lab you will determine the earthwork volumes necessary to construct the road that you previously designed.

1. Under the Surfaces menu select Utilities > Volumes.

2. Click the Create New Volume Entry button. It is the left most of the buttons in the top left.

3. Under Base Surface select the existing ground.

4. Under Comparison Surface select the Surface that you just created in the previous portion of the lab.

5. The volumes should be computed and shown in the box. Review the Net number. Adjust the design as necessary to meet the maximum earthwork requirements by manipulating the vertical or horizontal alignment. (Note: You may need to automatically update the earthwork volumes. In the Prospector menu on the left-hand side, right-click on corridors and make sure that “Rebuild – Automatic” is checked.)
[Note: If you see some strange lines, go to Corridor Properties, click on the Boundaries tab, right-click and select “Add Auto” then select top daylight; press Apply.]

**Submission Instructions:** Submit your completed file as *LastName_FI_Lab5.dwg* using the last name and first initial of any group member. Only one file submission is required per group. Attach the file to an e-mail and send it to *shafizadeh@csus.edu* in six days by 5 pm. Use the subject line: “CE147 Section X Lab 5 Civil 3D” where the X represents your lab section. In the body of your e-mail, please indicate the participating members of your group and the net earthwork required to complete your design. If you are unable to follow these precise submission instructions, your group’s lab grade will be penalized.

**Acknowledgments:** This lab exercise was written and designed by Mr. Steve Schmitt, PE, and Mr. Chris Jones of RBF Consulting in Sacramento.
Problem #1: Given the roof girder with the loading shown below, find the following:

- a. Reactions at B and C. (10 points)
- b. Equations for moments for segments AB, BC, and CD. (10 points)
- c. Shear diagram (label all values). (15 points)
- d. Moment diagram (label all values). (15 points)

**Section 1 girder:**

**Section 2 girder:**
Learning Outcome 2A
(ABET b)

Ability to design and conduct experiments and to analyze and interpret data

List of courses included in the assessment of this outcome.

1. CE113 – Structural Lab
2. CE147 – Transportation Engineering
3. CE170 – Principles of Environmental Engineering
4. CE171A – Soil Mechanics
# CE113 – Structural Lab

CE 113—Structural Laboratory  
Wood Proposal/Handout Evaluation

**CE113____/ GROUP___**

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CE113 Oral Presentation Evaluation Form

**Score:** 10=Excellent; 9=V. Good; 8=Good; 7=Fair; 6=Poor; <6=Unacceptable

1. Overall Impression (impact)
2. Team Preparation/Coordination (rehearsed/fluid)
3. Organization (clear, logical presentation flow)
4. Technical Content (sound, appropriate concepts)
5. Slides (legibility, clarity, attractiveness)
6. Professionalism/Mannerisms (demeanor; eye contact, voice, gestures, enthusiasm)
7. Handouts (content, organization, usefulness)

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**Comments/Questions**
### CE113 Oral Presentation Evaluation Form

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**Students:**

**Overall:**

**Comments/Questions**
# CE113 Oral Presentation Evaluation Form

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Page | B 55
Peer Rating of Teammates

<table>
<thead>
<tr>
<th>Your Name</th>
<th>Day/Group (e.g., Tues/Group 1)</th>
</tr>
</thead>
<tbody>
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</table>

Fill in your name and your team name above. Then, use the rating descriptions **below** to rate **yourself first** and then rate all teammates. Put your rating in the first row, then your teammates’ ratings in the subsequent rows. Email me this evaluation form by the due date.

Ratings should reflect the degree to which each member fulfilled his/her responsibilities in contributing to the team throughout the semester. Contributions include, but are not limited to, preparing for and conducting experiments, attending and participating in team meetings, conducting tasks, and preparing team deliverables. Consider also initiative, reliability, quality of work, creativity, helpfulness on team, time and effort spent throughout semester, timeliness and faithfulness to produce for deadlines, etc.

Since grades for team members will be modified (decreased or increased) based upon your rating and comments, please be honest, accurate, fair, and specific. All comments will be kept confidential. In unusual cases, I may request a meeting with you to discuss your comments.

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<th>Description</th>
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<td><strong>Excellent</strong></td>
<td>Consistently went beyond, tutored teammates, carried more than his/her fair share of the load.</td>
</tr>
<tr>
<td><strong>Very Good</strong></td>
<td>Consistently did what he/she was supposed to do, very well prepared and cooperative.</td>
</tr>
<tr>
<td><strong>Satisfactory</strong></td>
<td>Usually did what he/she was supposed to do, acceptably prepared and cooperative.</td>
</tr>
<tr>
<td><strong>Ordinary</strong></td>
<td>Often did what he/she was supposed to do, minimally prepared and cooperative.</td>
</tr>
<tr>
<td><strong>Marginal</strong></td>
<td>Sometimes failed to show up or complete assignments, rarely prepared.</td>
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<tr>
<td><strong>Deficient</strong></td>
<td>Often failed to show up or complete assignments, rarely prepared.</td>
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<tr>
<td><strong>Unsatisfactory</strong></td>
<td>Consistently failed to show up or complete assignments, unprepared.</td>
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<tr>
<td><strong>Superficial</strong></td>
<td>Practically no participation at all.</td>
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<tr>
<td><strong>No Show</strong></td>
<td>No participation at all.</td>
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My Name: __________________________
My Rating: ________________________
Justification/Explanation:

Teammate’s Name: __________________
Rating: __________________________
Justification/Explanation:

Teammate’s Name: __________________
Rating: __________________________
Justification/Explanation:

Teammate’s Name: __________________
Rating: __________________________
Justification/Explanation:
Overview: Speed is an important transportation consideration because road users relate speed to economics, safety, time, comfort, and convenience. Spot speed studies are designed to measure speeds at specific locations under traffic and environmental considerations prevailing at the time of the study.

Problem: The segment of road near Hornet Crossing is a pedestrian and bicycle passage to the west side of the Sacramento State Campus. This campus access point also serves students, staff, and faculty commuting to campus via light rail. This area, however, has been receiving complaints as being unsafe for pedestrians and bicyclists because of high vehicle speeds and vehicle failure to yield to non-motorized modes. It also poses a safety risk to users of the new Recreation and Wellness Center.

Objectives:

1. Collect spot speed data.
2. Determine 85th percentile, average, and pace speed.
3. Determine the violation rate
4. Recommend corrective actions, if necessary.

Safety – As with all field studies, safety is paramount when conducting spot speed surveys. The measurement of speeds involves being in the proximity of the roadway, and observers must use care and vigilance at all times. **Observers must wear neon vests at all times and must act in a manner that does not distract motorists or influence their driving behavior.** For safety reasons, you are prohibited from listening to audio devices or mobile communication (e.g. cell phones) during lab.

Equipment – Radar guns and a measuring wheel.

First Exercise – Equipment Calibration

*Calibration*. The radar manufacturer’s recommended calibration tests should be made before the start of data collection. Usually, this initial test is made in the office to ensure the radar unit is operable before traveling to the site. A second calibration test is conducted to verify that your equipment was working properly throughout the data collection period. The results of any calibration tests should be included your report.

Second Exercise – Data Collection

*Proper Vehicle Sampling*. Unless you are able to measure the speed of all vehicles, sampling generally required. The problem is that observers have a tendency to record those vehicles that “stand out” in
some way, such as fast vehicles, slow vehicles, larger vehicles (e.g. trucks), etc. A procedure that controls for biases is to select every second, third, or “n"th vehicle.”

Another source of bias occurs when you have “platooning” vehicles, where a group of vehicles are restricted by a slower “lead vehicle.” In practice, only the speeds of “unconstrained” vehicles are used to determine true free-flow speeds. As a filter, you should only measure the speed of vehicles with sufficient headway. In practice, a three (3) to four (4) second gap (at 35 mph = 150 to 200 ft) is often used. In most cases, you may even want to do your speed studies during the “off-peak” travel period to sample unconstrained vehicles.

**Location.** Selecting the location to take the speed measurement, the time period of which to collect the data, and the roadway traffic or weather conditions under which to conduct the spot speed study are all generally a matter of common sense. Speed measurements should be taken at the at least 100 feet away from a stop sign or an intersection. Concealment during data collection using vegetation or roadside structures will prevent motorist distraction (a safety concern) and/or reaction (a source of bias).

<table>
<thead>
<tr>
<th>Group</th>
<th>Location</th>
<th>Traffic Direction</th>
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<tr>
<td>1</td>
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<td>NB</td>
</tr>
<tr>
<td>2</td>
<td>JSO Hornet Crossing</td>
<td>SB</td>
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<tr>
<td>3</td>
<td>JNO Hornet Crossing</td>
<td>NB</td>
</tr>
<tr>
<td>4</td>
<td>JNO Hornet Crossing</td>
<td>SB</td>
</tr>
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</table>

JSO = “just south of” & JNO = “just north of”

**Documentation:** The final layout of the data collection site should be fully described in any speed survey report. An accurate sketch should be included of the site showing the number of lanes, the position of the radar unit, and the x- and y-dimensions (as shown in the figure below). The x- and y-dimensions permit the calculation of the angle of incidence so that a cosine error correction may be applied. The start time, end time, any downtime, and the conditions prevailing during the study should also be recorded. Digital photos of the study area are also useful.

**Third Exercise – Data Analysis**

**Speed Correction**

1. Correct speeds for error using the formula below:

   \[
   \text{Corrected Speed} = \frac{\text{Observed Speed}}{\cos(\text{Angle of Incidence})}
   \]
The greater your angle is during measurement, the greater your speed correction will be and the farther your measured speed will be from the corrected speed (i.e., the vehicle’s true speed) as shown in the table below.

![Graph](image)

**TABLE 3-1**

Radar: True Speed and Cosine Error

<table>
<thead>
<tr>
<th>Angle (deg)</th>
<th>30 mph</th>
<th>40 mph</th>
<th>50 mph</th>
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<td>16.85</td>
<td>21.86</td>
<td>26.82</td>
<td>33.78</td>
</tr>
</tbody>
</table>

Source: Robertson, 2000.

From this point on, you should use your “corrected” speeds to complete your analysis.

**Speed Data Analysis**

2. **Construct a Speed Distribution**
   a. Group speeds in one mile per hour “bins,” starting with the lowest observed speed and ending with the highest observed speed.
   b. Calculate the observed frequency for each speed bin and the relative percent.
Table 5. Speed Frequency Table

<table>
<thead>
<tr>
<th>Speed Bin</th>
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<th>Observed Percent</th>
<th>Cumulative Frequency</th>
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<td>...</td>
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</table>

3. Plot the relative frequency (recommendation: bar or column chart) and cumulative frequency (recommendation: x-y scatter line chart). What percentage of the observed traffic was observed traveling over the speed limit – the “violation rate”?

4. Determine and discuss 85th percentile speed and the pace speed.
   a. The 85th percentile speed is what most drivers view as the upper limit of safe travel speeds. Many engineers consider the 85th percentile speed to be what drivers view as the design speed of the roadway.\(^1\,\text{,}\,^2\) How do the 85th percentile speed and the posted speed limit compare?
   b. The pace speed of traffic is the 10-mph range (continuous) containing the greatest number of observations.

5. Is the range of speeds on this facility particularly broad or narrow? Explain.

6. Plot the number of observations (indicating speeders and non-speeders) versus time. Are there any patterns in the number of speeding violations you observe during the duration of the data collection period (speeders versus time)?

7. Did you observe any reoccurring characteristics, patterns, or behaviors among speeding drivers?

Fourth Exercise – Report

Your group is required to produce a report that addresses the questions posed in the lab. Your report should have a professional appearance. Each report should be typed in Microsoft Word, double-spaced using one-inch margins and 12-pt font. All figures and tables should be labeled appropriately and discussed in the text. Sections should be labeled, and pages should be numbered. It should include the following sections:

1. **Cover Page** – List all group members, lab section, and the due date.\(^3\)
2. **Introduction/Background/Objective** – What is the motivation and purpose of this type of study? Were there concerns by your client that led to the study?
3. **Data** – Discuss the data collection process. Include a map along with a sketch, or photo of the site. Properly indicate when the data were collected and the direction of traffic. Make note of any equipment calibration done during the data collection process. Discuss the accuracy of your data and possible sampling biases or sources of error.

---

\(^1\) In practice, if the speeds are being sampled to determine the 85th percentile speed used for establishing the speed limit, the data should be collected over one or more 24-hour periods on several typical days.

\(^2\) The 85th percentile speed can be found directly from the cumulative frequency plot. The 50th percentile speed is the same as the median speed, which is the middle value of the ordered set of speeds and is not the average speed.

\(^3\) Do not include a page number on the title page! The first page of report text should start on page one.
4. **Analysis and Results** – Along with presenting properly captioned tables and figures required above, discuss the values that you obtained and the answers to the questions noted above in the report. What software or analytical tools did you use to do your analysis? Explain to your client how you determined the 85th percentile, average, and pace speeds.

5. **Recommendations** – Based on your analysis, is there a speeding problem? If so, what remedies might you suggest to your client? Suggest a three-pronged approach using the “3Es”:
   a. **Engineering** – Identify common speed mitigation strategies/devices that you see in practice. If necessary, do independent research on potential engineering strategies. There are many good sites out there. (See City of Sacramento, 2009 or FHWA, 2009, for example.)
   b. **Enforcement** – Suggest effective enforcement techniques to the campus police.
   c. **Education** – Identify how you could implement an effective educational campaign on campus.

   **The recommendation section is the most important part of the entire report and should be where you devote the majority of your time and energy.** Use common sense and creativity when discussing results and suggesting remedies. Make sure the remedy is appropriate for the problem. Discuss your recommendations as a group before making your recommendations in your report.

6. **Conclusions** – Summarize your findings and the implications of your work.

7. **References** – Properly cite any websites, books, manuals, etc. that you used in completing your report. Any table, figure, text, or idea that you did not create must be cited briefly in the text of the report by author and year, and detailed information must be provided in the references.

8. **Appendices** – Attach all of your raw data and field notes here. (Consider scanning them into a digital form and including them directly in your Word file.)

**References**


City of Sacramento, “Neighborhood Traffic Management Program (NTMP),”


Submission Instructions: Submit your analysis and report together as LastName_FI_Lab2.xls and
LastName_FI_Lab2.doc, respectively, where LastName is the last name and F.I. is the first initial of any
one of the group members. Only one submission is required per group. E-mail your files to
shafizadeh@csus.edu in 13 days (the day before lab meets in two weeks) by 5 pm.
Transportation Engineering Report Writing Suggestions

- It is always a good idea to include a map, picture, or photograph of where the data in your study were collected. In general, it is a good idea to bring a digital camera with you during any data collection process.
- Data is a plural term. “The data indicate...”
- Names of specific facilities are usually capitalized, such as “Interstate 80” or “State University Drive West”.
- Traffic directions like “northbound” or “westbound” are one word.
- You should always refer to tables and figures in your text. You should capitalize the table and figure when referring to a specific table or figure, such as Table 1 or Figure 2. Similarly, when referring to a specific lane, we capitalize Lane 1.
- When writing reports certain technical terms are important. We write about:
  - “pedestrians” – not “walkers”
  - “bicyclists” or “motorcyclists” – not “bikers”
  - “vehicles” not “cars”
- Avoid confusing “breaking” with “braking”. You hope your vehicle does not break when you try to brake. Also, avoid the difference between the “peak” and a “peek”.
- Do not use “this” or “that” as the subject of a sentence. Check if you can continue the previous sentence using the word “which” instead.
- If a number is less than 10, generally write out in words. You can use numbers in conjunction with the word: “There are four (4) lanes at this location.” Note that measurements are an exception: “The average speed was 35 mph.”
- Label all equations, figures and tables, etc.
- Do not use contractions.
- Do not use “since” when you should use “because.” “Since” usually involves time.
- Cite references when any information or ideas come from another source. When citing the idea or work of others, you should properly cite the study at the end of the sentence and in the references section of your report. The sentence would look something like this one (Mannering et al., 2009). The reference in the reference section provides enough detail so that someone else can find it. [Note that this method is only one of many acceptable formats.]


- Do not cite your lab report as a reference; find a true source.
SPEED SURVEY WORKSHEET

Observer Team Members:

Street: ____________________________ Location: ____________________________
Segment: __________________________ Direction: ____________________________
Date: ___________ Day: ___________ Times: ____________________________
Weather: __________________________ Posted Speed (mph): ____________________

Start Time: ________  Spot Speed Field Data Collection Worksheet  Calibration Fork#: ________

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<th>Time (min)</th>
<th>Recorded Speeds</th>
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(Indicate commercial trucks with *, indicate motorcycles with ^)

End Time: ___________  Calibration Fork#: ________

Additional Comments:
**Driver Observations**

Observer(s): ________________________________________ Date: ______________

Location: __________________________________________ Weather: ______________

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<th>Speeding? (Y/N)</th>
<th>Appox Age of Driver</th>
<th>Student/Faculty/Staff/Unknown?</th>
<th>Comments</th>
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CE170 – Principles of Environmental Engineering
Coagulation lab for CE 170 (F09)

The total score of 20 applies to the lab write-up, discussion questions, and problem.

Procedures

Objectives

1. Describe in general terms (not the detailed reactions) the physical and chemical processes occurring in coagulation/flocculation. (Knowledge)
2. Given a set of jar test results, recommend a chemical dose and velocity gradient for a treatment process and justify your choice. (Comprehension, evaluation)
3. Apply the concepts of velocity gradient (G) and hydraulic detention time to calculations involving flocculation facilities such as tank size and power requirement. (Application)
4. Given a power equation for a particular type of mixer, calculate the design parameters (e.g., rpm, paddle size) to achieve a desired G value. (Application)
5. Given TSS data, chemical doses, and removal rates, calculate chemical requirements and sludge masses for a full-scale plant. (Application)

Overview

The purpose of this lab is to use laboratory jar testing to determine the optimum dosage of alum and optimum degree of mixing for coagulating and flocculating a water sample.

Procedures

A. Jar Test to Determine Optimum Dose at a Single Mixing Speed

1. Measure the temperature of the test water thoughtfully prepared in advance by your instructor.

2. Measure the initial turbidity of the test water, using the turbidimeter, as per your instructor’s direction.

3. Measure out five samples into the square 2L test beakers (or as directed by your instructor). Fill the beakers directly from the carboy or bucket with the raw water sample; then top off with water from a small beaker. To the best of your ability, shake the carboys or stir the buckets before taking samples to assure uniform concentrations of solids in your samples.

4. Center the beakers on the multiple-paddle mixer.
5. Calculate the volumes of stock solution needed to achieve the target dosages ($C_{jar}$). Based on conservation of mass:

$$C_{stock} V_{stock} = C_{jar} (V_{jar} + V_{stock})$$

where

- $C_{stock} =$ concentration of alum stock solution
- $C_{jar} =$ concentration alum desired in the jar
- $V_{jar} =$ volume of the jar
- $V_{stock} =$ volume of stock solution to be added to the jar to achieve $C_{jar}$

Solving for $V_{stock}$:

$$V_{stock} = \frac{C_{jar} V_{jar}}{(C_{stock} - C_{jar})}$$
If $C_{\text{jar}}$ is small compared to $C_{\text{stock}}$, it can be neglected in this equation. This is the same as neglecting the effect of adding $V_{\text{stock}}$ to the jar, as illustrated below:

$$C_{\text{stock}}V_{\text{stock}} = C_{\text{jar}}V_{\text{jar}} \quad \text{or} \quad V_{\text{stock}} = \frac{C_{\text{jar}}V_{\text{jar}}}{C_{\text{stock}}}$$

6. Measure out the appropriate volumes of alum stock solution into small beakers or graduated cylinders. Your instructor will specify the test concentrations. **Don’t add the coagulant to the water samples yet.**

7. Start the mixers on the highest possible speed. When you are ready to start timing, add the pre-measured alum stock to all the jars **simultaneously**. After 10 seconds, reduce the mixer’s speed to 45 rpm and flocculate for 15 minutes. Observe and record the time required for flocs to form in each sample.

8. After flocculating for 15 minutes, turn off the mixer. **Immediately** observe and record the relative average floc sizes for the samples (see scale on the data sheet).

9. Allow the samples to settle for 20 minutes.

10. Use the sampling tube to remove about 50 mL of supernatant from each beaker. **Flush the tube** first to get rid of any water from a previous experiment. **Don’t disturb** the settled material. Measure the turbidities of these samples.

11. Select the two "best" flocculation dosages based on the first appearance of floc, floc size, final turbidity (most significant factor), and coagulant dose. (See discussion below for hints on how to choose the doses to be tested further.) Discuss your choices with your instructor before proceeding.
B. Jar Test to Determine Optimal Speed

1. Obtain two more samples from your carboy or bucket as before.

2. Repeat the jar test at 75 rpm using the "best" alum doses as determined in the 45 rpm test. It isn't necessary to record the time to first floc formation, or the relative floc sizes, but do measure and record the final turbidities.

3. Repeat the test as described above at 15 rpm.

Note: To save time, coordinate with other lab groups and run all the 75 rpm samples at the same time on one mixer, and all the 15 rpm samples on another.

Data Analysis

Create a spreadsheet to accomplish the following computations:

1. Plot the data from the 45 rpm test using coagulant dosage as the abscissa (x) and turbidity as the ordinate (y). (Be sure your graph is properly and completely labeled.) (See example graph in “hints” below.) Be sure to include the zero dose turbidity on your graph.

2. Calculate the velocity gradients at the three mixing speeds. (See equations in background notes.) Show a sample hand calculation. Fill in the table of calculated G values and associated turbidities above.

3. Plot the data from the three samples at the “best” doses using velocity gradient (G) as the abscissa (x) and turbidity as the ordinate (y). (See “hints” for example graph.)

4. Submit your two graphs with your lab. You do not have to submit the spreadsheet used to make the graphs. Don’t forget sample calculations.

Coagulation Lab Hints

How to choose the "best" dosages
The turbidity standard for drinking water is 0.5 NTU. Is it necessary to achieve this after settling? No. In a conventional treatment plant, settling is followed by sand filtration. Conventional sand filters are capable of reliably producing this quality when the influent turbidity is 10 NTU or less. Your goal for the flocculation process is to choose the lowest cost parameters that produce a water quality that can be treated by sand filtration. You should consider costs of chemicals (dose) as well as energy costs for mixing (G).

**Examples of graphs**

**Settled Turbidity as a Function of Dose at 30 rpm**

**Settled Turbidity as a Function of Mixing Intensity**

**Hints for Memo Problem (scale-up of jar test results)**
Power and energy calculations – Unless the memo problem states otherwise, assume the same flocculation time as that used in the jar test. Using this value as the hydraulic detention time of the flocculation tank, you can calculate the tank volume. Assume the same G value as in the jar test. With G and V, you can calculate P. (Don't forget to correct μ for the full-scale plant temperature.) Remember that a KW is a power unit and a KWH is an energy unit.

Estimating sludge quantities

Total sludge = sludge from turbidity + alum sludge

Sludge from turbidity: For turbidities less than 100 NTU, you can often assume that 1 NTU ≈ 1 mg/L TSS (Montgomery). Be careful. This is an empirical result that varies by location and by season. *Use rules of thumb like this only for preliminary estimates.*

Alum sludge: When you add alum (Al₂(SO₄)₃·14H₂O) to water, the precipitate you make is Al(OH)₃·1.25H₂O (Montgomery). Looking at the stoichiometric weight ratios:

\[
2\text{Al(OH)}_3 \cdot 1.25\text{H}_2\text{O} / \text{Al}_2\text{(SO}_4\text{)}_3 \cdot 14\text{H}_2\text{O} \\
= 2(27 + 3(16+1) + 1.25(2+16)) / 2(27) + 3(32+4(16)) + 14(2+16) \\
= 2(100.5) / 594 \\
= 0.34 \text{ mg sludge per mg alum added}
\]

Reference

Montgomery, James M., Consulting Engineers, *Water Treatment Principles and Design*, John Wiley and Sons, 1985 (p 287)
Discussion questions

1. Explain your reasoning for choosing the concentrations you did for testing at the lower and higher speeds (i.e., the two “best” concentrations).

2. Make recommendations for alum dose and G value that should be used to treat the test water. Explain why you chose the values you did, and why you didn't choose other values.

3. Solve the lab application problem by hand on engineering paper. Use the water characteristics spreadsheet (or some equivalent source) to obtain the temperature-appropriate viscosity. Base your calculations on your lab results.

Lab Application Problem

As an engineer for Hornet Engineering, you’ve been asked to prepare some preliminary estimates of chemical and energy requirements and sludge production for a proposed 4.5 MGD (million gallons per day) water treatment plant in Johnstown, CA. The plant will use Cruz Creek as its water source. In the lab, you’ve done a jar test using a sample from the creek. Based on your jar test results, calculate the following:

1. The plant alum requirement (in dry lb per day and per year).

2. The dry mass of sludge (in lb per day) captured in the settling tanks. Assume 1 NTU = 1 mg/L TSS and that 0.34 mg of sludge is generated for every mg of alum used (see lab notes for derivation). Assume the settling tank removes 77% of the influent suspended solids (i.e. it is 77% efficient).

3. The flocculation power requirement. Express your answer in KWH/day (kilowatt-hours per day) of electricity. In this calculation, assume that only 60% of the electrical power is actually transferred to the water, the rest being lost to friction and heat in the electrical equipment. Assume the temperature of the water in the full-scale plant is 11°C, and that the flocculation tank has a hydraulic detention time of 25 minutes.
## Direct Shear Test

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<td>Soil description:</td>
<td>Specific gravity, $G =$</td>
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### Void Ratio Determination

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<th>Length, $L$ (cm)</th>
<th>Area, $A$ (cm²)</th>
<th>Volume, $V$ (cm³)</th>
<th>Dry mass, $M_s$ (gm)</th>
<th>Dry density, $\rho_d$ (gm/cm³)</th>
<th>Void ratio, $e \left( \frac{G \rho_w}{\rho_d} - 1 \right)$</th>
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### Stress - Strain Determination

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<tr>
<td>Loading ring constant (kg/div.) =</td>
<td>Strain rate (mm/min) =</td>
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<th>Load ring dial ( )</th>
<th>Vertical dial ( )</th>
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Learning Outcome 2B
(ABET c)

Ability to design a system, component, or process to meet desired needs

List of courses included in the assessment of this outcome.

1. CE137 – Water Resources Engineering
2. CE147 – Transportation Engineering
3. CE164 – Reinforced Concrete Design
Note that the first part used for the design outcome (2B) and the second part was used for the ability to apply mathematics, science, and engineering (Outcome 1B)

CE137 – Water Resources Engineering
Your company has been hired to perform rainfall-runoff analysis for the watershed provided in the figure below. The City wants to design a culvert that is located at the outlet of the watershed in preparation for a new highway to be constructed in the future. The culvert is to be designed to pass the 100-year design flow. Sub-watershed 1 has sheet flow for a length of 54 ft (n=0.52, 2-year and 24-hour rainfall = .35 in, the general slope is 2.47%). What are the Peak Discharge and the total volume? (35 points).
Use the figure below to determine the critical depth, critical velocity, flow rate for a trapezoidal channel with a bottom width of 15 ft, side slope of 3H:1V, and bed slope of 0.1%. (15 Points)
CE147 – Transportation Engineering

FINAL EXAM

PART II - OPEN BOOK (CLOSED NOTES)

Please state any assumptions, showing all work (including referenced table or figure numbers), and box only your final answer with the appropriate units. You may use the back if necessary.

1. You have been asked to design the pavement for a service road with heavy truck traffic. The daily truck traffic consists of 500 single axles at 25,000 lbs each, 100 tandem axles at 39,000 lbs each, and 50 triple axles at 48,000 lbs each. The highway is to be designed with a rigid pavement having a modulus of rupture of 600 lb/in², and a modulus of elasticity of 5 million lb/in². The reliability is to be 95%, the overall standard deviation is 0.4, the drainage coefficient is 0.9, the initial PSI is 4.2, and the load transfer coefficient is 3.2. The modulus of subgrade reaction is 200 lb/in³. If a 20-year design life is desired, determine the required slab thickness. Note that local standards require that any initial assumptions be within 20% of the final recommendation.

Interpolate when necessary and use the appropriate nomograph provided, write each value next to each scale on the nomograph.
Problem 1) Design of a Doubly Reinforced Beam

A beam cross section is limited to the size shown in Figure 1. Determine the required area of tension and compression reinforcement and specify the appropriate reinforcement. The total factored moment is $M_u = 5.6$ ft-kips. Use $f'_c = 400$ psi and $f_y = 60$ ksi.

![Beam Diagram]

Figure 1: Problem 1
Learning Outcome 2C  
(Not an ABET outcome)

Ability to function on a team

List of courses included in the assessment of this outcome.

1. CE113 – Structural Lab
2. CE147 – Transportation Engineering
3. CE190 – Senior Project
CE113 – Structural Lab
Refer to the document under Outcome 2A (Ability to design and conduct experiments and to analyze and interpret data.)
CE147 – Transportation Engineering

Lab Exercise #2 – Freeway Traffic Flow Analysis

Group Peer Evaluation

Please rate yourself and others in your group in last week’s lab by:

- their willingness to work on assigned tasks,
- their reliability to complete assigned tasks,
- their ability to work well with others in the group, and
- their contributions to the final product.

Lab Section: _____

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Explain any “Poor,” “Very Bad,” or “No” ratings below:
CE190 – Senior Project

Only data were submitted.
Learning Outcome 2D (ABET d)

Ability to function on an interdisciplinary team

List of courses included in the assessment of this outcome.

1. CE190 – Senior Project
CE190 – Senior Project
Learning Outcome 2E  
(ABET e)

**Ability to identify, formulate, and solve engineering problems**

List of courses included in the assessment of this outcome.

1. ENGR112 – Mechanics of Materials
2. CE101 – Computer Applications in Civil Engineering
3. CE161 – Theory of Structures I
4. CE170 – Principles of Environmental Engineering
5. CE171A – Soil Mechanics
Problem 3) Bending Stresses in Composite Beams - Transformed Section

A timber beam 200 mm wide x 350 mm deep has a 200 mm wide x 16 mm thick steel plate fastened to its bottom face. The moduli of elasticity for the wood and steel are 12 GPa and 200 GPa, respectively. If the allowable flexural stresses are 10 MPa in the wood and 75 MPa in the steel, determine the maximum load $P$ that can be applied to the center of a simply supported beam having a span of 4 m. Use the method of transformed section.
CE101 – Computer Applications in Civil Engineering
Excel based problem – Traffic accident data analysis
Problem #3: Using any approach covered during the course of the semester, please find the rotation of point C. Assume $E = 29,000$ ksi and $I = 100\text{ in}^4$. (50 points)

Section 1 beam:

![Section 1 beam diagram]

Section 2 beam:

![Section 2 beam diagram]
From final exam in CE 170 (F09)

P4. (12 points) A biotechnology company wants to grow a special strain of bacteria that can use gaseous methane (CH₄) as a food source. A company engineer proposes to dissolve the methane into the feed water using a pressure tank as shown below. If 2x10⁻³ M of methane is required in the water at the exit of the tank, and the gas in the space over the water in the transfer vessel is 80% methane by volume, what must the total gas pressure in the tank be? Assume the water is in the tank long enough to establish equilibrium conditions and that the temperature is 20 °C. Report your answer in psig (gage).
CE171A – Soil Mechanics
Problem 3 (20 points)

For the shown soil profile and properties,
(a) Estimate the differential settlement between the two centers of square footings A and B.
(b) What is the amount of settlement directly under the footing B one year after the loads have been applied?
Learning Outcome 2F (ABET i)

Recognition of need for, and ability to engage in lifelong learning

List of courses included in the assessment of this outcome.

1. CE164 – Reinforced Concrete Design
Problem 1) *Computer Analysis of a One Way Slab*

A reinforced concrete building floor system consists of a continuous one-way slab built monolithically with its supporting beams, as shown in Figure 1. Service live loads will be 125 psf. Dead loads include a 10 psf allowance for nonstructural lightweight concrete floor ill and surface and a 10 psf allowance for suspended loads, plus the self weight of the floor. Using Visual Analysis (or the structural engineering software of your choice), calculate the design moments and shears in the slab. Assume a slab thickness of 10 inches.

Your solution should include all needed hand calculations and should clearly represent the results from Visual Analysis.

*Figure 1: Problem 1*
Learning Outcome 3  
(ABET g)

Ability to communicate effectively

List of courses included in the assessment of this outcome.

1. CE113 – Structural Lab
2. CE147 – Transportation Engineering
3. CE170 – Principles of Environmental Engineering
4. CE190 – Senior Project
CE113 – Structural Lab

Refer to the document in under Outcome 2A (Ability to design and conduct experiments and to analyze and interpret data.)
CE147 – Transportation Engineering

TRANSPORTATION ISSUES IN THE NEWS

In this course, you will all give a brief (three- to five-minute) presentation to the class which distills a local, state, national, or international transportation-related news story found in the mass media (newspapers, Internet, etc.). You can check the news on almost any day and find a transportation-related story.

Requirements:

1. Introduce yourself and identify the source and date of your article.
2. Briefly synthesize the main point of the article and discuss its implications. If your article is long, focus on the main or most interesting point of the article.
3. Discuss the issue in a broader context. Clearly explain why the article is important. Explain how the article is related to: 1) topics discussed in the course, 2) changes or challenges to the profession, 3) broader global or societal impacts, or 4) your audience of entry-level professional engineers. (Warning: This information may not be found in the article and may require independent thinking!)

Bring a copy of your article to class with your name written on it, and turn it in. Your article must indicate the published source and date.

Evaluation Criteria: Your presentation will be evaluated based on:

1. Appropriateness – Article and subject matter was appropriate for the class and met all constraints and requirements. (10%)
2. Organization – Your ability to briefly discuss the article without notes in the allotted time. (20%)
   - Student gave audience proper introduction of him/herself and the topic.
   - Information was presented in a well-organized logical sequence that the audience was able to easily follow.
   - Student gave audience proper ending to the presentation.
3. Content Knowledge – Your ability to synthesize the important point(s) of the article, speak about your subject intelligently, and answering questions. (30%)
   - The article was clearly and briefly synthesized without use of notes.
   - Student demonstrated full knowledge of subject with concise explanations.
   - Presentation contained no factual errors or errors in logic.
   - Student spoke about the subject and answered questions intelligently and accurately.
4. Broader Context – Your ability to think beyond the scope of the article and give it meaning in a broader context. (20%)
   - Student discussed the issue in a broader context.
   - Student was elaborated on facts of the article as they related to: the audience of young civil engineers, course topics in CE147, or the general fields of transportation or civil engineering.
5. Delivery – Your ability to speak clearly and without notes while maintaining eye contact with your audience. (10%)
   - Student appeared to be at ease with content and spoke clearly.
   - Student spoke without notes while maintaining eye contact with the entire audience.
   - Student demonstrated appropriate attentive posture and engaging body language.
6. Voice and Language – Appropriate use of technical vocabulary and correct grammar. (5%)
o Student used a clear, distinct voice.
o Student used appropriate technical terms when necessary.
- Presentation contained no grammatical or pronunciation errors.

7. **Appearance** – Demonstrating appropriate attire, posture, and body language. (5%)
- Student demonstrated appropriate attire and appearance.

**Constraints:**

- Your presentation will **not** exceed five minutes. You will not be permitted to use notes, a laptop, or an overhead projector during your presentation. If your article contains interesting pictures or figures, you are welcome to bring photocopies/handouts for your audience. If your article contains important data, you are permitted to write them on the chalkboard before class. (You are not required to memorize factoids!)
- Your article cannot be more than two weeks old, must exceed 250 words, and must be a stand alone article in the mass media. (No “Q&A” pieces like “Dear Abby.”)
- The article must originate from a **reputable** news or information source, like the Sac Bee, SF Chronicle, Sac Business Journal, State Hornet(?), etc. (No blogs. No press releases.).
- To avoid presentations about the same subject on the same day, the subject of your presentation will be constrained to a geographic region (inside Northern CA, inside the U.S., or outside the U.S.).
- Your presentation cannot address a topic already presented in the class.
- When necessary, you should do a little background research so that you know what you are talking about and are able to answer questions on the subject intelligently!

**Partial List of Potentially Good Topics:**

- New or Innovative Local Transportation Projects and Its Challenges/Constraints
- Recent Research Findings
- New or Innovative Technologies, Engineering, Planning, Operations, or Financing Practices
- Changing Law, Public Policy, or Enforcement
- Traffic/Transit/Multimodal Issues
- Transportation-related Sociological, Cultural, or Behavioral Issues/Challenges
- Unusual/Odd/Humorous Events in the Context of Transportation Engineering or Planning

If necessary, you can make arrangements **at least one day prior to class** to have your article reviewed for appropriateness.
For this outcome, only Tasks 1-4 are applicable. Score= 25 for these tasks

Problem

The city of Johnstown discharges its treated wastewater to Cruz Creek. Like other cities, Johnstown is required to provide secondary treatment to its wastewater, and it successfully does that with an average effluent BOD$_5$ of 30 mg/L. The plant’s current discharge point is 6 km upstream of the confluence of Cruz Creek and the Rinconada River (see map below). The current water quality objective for dissolved oxygen in both the river and the creek is 5 mg/L. In the future, however, this limit is going to be raised to 6 mg/L to improve habitat for the endangered Hornet trout. Dissolved oxygen measurements in the stream show that this limit is not currently being met.

Two approaches have potential for meeting the new limit. One is to improve the treatment process at the plant to decrease the BOD$_5$ of the effluent. The second is to build a pipeline and discharge to the river rather than the creek. The larger flow of the river gives it a greater waste assimilation capacity. Consequently, the treatment requirements may not be great for wastewater discharged there. A potential location has been identified 1 km downstream of the confluence of the two streams. The hope is that the savings from lesser treatment will offset the cost of the pipe and annual pumping.

To decide which alternative most cost effectively meets the dissolved oxygen requirement in the river, you will have to do some environmental modeling. Based on the results of your modeling, and some cost calculations, you are to make a recommendation on which alternative Johnstown should pursue.
Specific Tasks

Task 1. Construct the Model

Complete the Excel-based DOSAG (pronounced “dee-oh sag”) model. Start with the template distributed by your instructor. Complete the model by performing the tasks described in comments placed in the spreadsheet. Look around the spreadsheet to be certain you have addressed all the comments. Your model should start at x=0 as defined on the map above.

Task 2. Calibrate the Model

Calibrate your model. In practice, the textbook values for constants needed to run a model are either not available or are not accurate for a specific situation. For this reason, models must be calibrated against field data to have credibility and usefulness for prediction. In this project, the biodegradation coefficient (kd) of the waste in the river isn’t known and must be determined using field data. On the other hand, a first order decay coefficient for the BOD test (kBOD) has been measured in the lab. That value can be used to convert BOD5 to BODu values. Also, the following empirical equation can be used for the reaeration constant.

\[ k_r = \frac{3.9u^{1/2}}{h^{3/2}} \]

where

- \( k_r \) = the reaeration coefficient at 20°C (d⁻¹)
- \( u \) = average stream velocity (m/s)
- \( h \) = average stream depth (m)

The reaeration coefficient can be adjusted for temperature as follows:

\[ k_r = k_{r,20} \theta^{(T-20)} \]

where \( \theta = 1.024 \). The BOD test coefficient doesn’t need to be adjusted because the test is always run at 20°C.

For calibration, use your DOSAG model to simulate the river under current conditions. Then, compare your output with dissolved oxygen measurements taken in the creek and river (shown below). Try different \( k_d \) values in your model until the model output reproduces the current conditions in the river. You have data for two seasons; you should expect to get two different coefficients.

How will you know when you have the \( k_d \) that best fits the field data? Looking at the graph and comparing the calculated values with the field data is one way. A better way is to minimize the differences between the model output and the data using a least-squared error procedure. In linear regression, the best fit line is the one that minimizes the sum of the squared errors. Use this method.
For each location, calculate the difference between the field concentration and the calculated concentration, square it, and sum all the squared differences. The $k_d$ that gives the smallest sum is the best choice. (Do you see how Solver can assist you in this task?)

Once you have found $k_d$ in the river, you do not have to adjust it for temperature. (Do you see why?)

**Task 3. Determine the Treatment Required**

Use your calibrated model to determine the allowable BOD$_5$ in the plant's waste stream in the worst case season for each location ($x=1$ and $x=8$). Vary the BOD in the model input until the lowest dissolved oxygen level in the river is greater than or equal to the water quality objective. Of course, to minimize costs, you will want to be as close to the objective as possible.

**Task 4. Calculate Costs**

Using the cost functions provided, calculate the present worth cost of the treatment needed for the plant, and for the pipeline. (Hint: Check the sign convention for the PV function in Excel before using it. If is the opposite of what you think.) Use a discount rate of 4% and a 35-year life.

*Treatment Cost Functions (in $1000 or $1000 per year)*

Capital = 19,000 + (60*(30-BOD$_5$)$^2$)

Annual operations and maintenance (O&M) = 150 + (2*(30-BOD$_5$)$^2$)

where BOD$_5$ is the BOD$_5$ allowed under the worst case season. (The plant will produce this quality in the other season as well.)

*Pipeline and Pumping Cost Functions (in $1000 or $1000 per year)*

Capital = 13,000 + (700*Q)

Annual operations and maintenance (O&M) = 500*Q

where Q is the flow (m$^3$/s). These functions already incorporate the distance, land values, and other site-specific costs. The functions are based on flow because the pipe diameter and the power required for pumping vary as a function of the flow to be delivered. Remember that if you need to treat the flow being sent through the pipe, you need to add a treatment cost to the pipeline cost.
**Task 5. Write a Report**

Prepare a memo report addressed to your lab instructor (your hypothetical boss) describing the problem, what you did to solve it, and your proposed solution. You should describe which season is the worst case and why. Also, describe what kind of computer model you used to give your boss an idea about how accurate your solution might be and what its limitations are. Look at the assumptions behind the model.

The memo report should be typed and double-spaced using Times New Roman, 12-pt font with a 1.25” left-hand margin and 1” margins elsewhere, and assembled in a cover (not just stapled pages). The narrative should be 500-1000 words long, *not* including computer printouts. Include the following in an appendix and make proper reference to them in your memo:

a. Printouts of the calibrated model (calculations and graphs) for both seasons. The calibration graphs should show the field data as symbols and the model output as a line without symbols. Adjust your page set-up or print area to get the calculations on one page and both graphs on another.

b. Printouts of the model at your recommended level of treatment for each location (original and new pipeline). You only need to provide these printouts for worst-case season.

c. Handwritten or spreadsheet economic calculations.

**Deliverables**

1. The project report as described above.

2. Digital copies of your completed spreadsheet files. Send these to your instructor through WebCT. Name your file: your_last_name DOSAG.xls.

**Conditions of Work**

This is an individual project. You may collaborate with classmates, but the final product is to be an individual effort. This project is worth 2.5 regular labs (50 points).

Due dates:

Week of Nov 23 – Email the completed template to your lab instructor (10 points)

Week of Nov 30 – Receive comments back on template. Opportunity to ask questions during the lab session.

Week of Dec 7 – Final write-up due (40 points).
CE190 – Senior Project
Final report of the student teams were evaluated by professionals as it was discussed in the self-study report.
Learning Outcome 4A
(ABET h)

Understanding impacts of engineering solutions in the global and societal context

List of courses included in the assessment of this outcome.

1. CE147 – Transportation Engineering
# CE147 – Transportation Engineering

Refer also to assessment of Outcome 3 (Ability to communicate).

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**CE147 News Presentation Evaluation**

| Name: ______________________________ | Tuesday, August 10, 2010 |
| Topic: ______________________________ | Source & Date: ______________________________ |

### Appropriateness (10%)
- □ Article and subject matter was appropriate for the class and met all constraints and requirements.

### Organization (20%)
- □ Speaker gave audience proper introduction of him/herself and the topic.
- □ Speaker presented information in a simple, well-organized, logical sequence.
- □ Speaker clearly and briefly synthesized the article *without the use of notes* in the allotted time.
- □ Speaker gave audience proper conclusion/ending to the presentation.

### Content Knowledge (30%)
- [ABET Outcome 4B]
  - □ Speaker demonstrated good knowledge of subject and provided concise explanations of the issues.
  - □ Presentation contained no factual errors or errors in logic.
  - □ Speaker used appropriate technical terms and explained technical jargon, when necessary.
  - □ Speaker answered questions intelligently and accurately.

### Broader Context (20%)
- [ABET Outcome 4A]
  - □ Speaker was able to discuss the article in a broader global or societal context.
  - □ Speaker discussed a challenge or constraint as it related to the civil or transportation engineering fields.
  - □ Speaker elaborated on facts of the article as they related to: the audience (entry-level civil engineers) or course topics in CE147/CE148.

### Delivery (10%), Voice (5%), and Appearance (5%)
- [ABET Outcome 3]
  - □ Speaker appeared to be at ease with content and spoke clearly.
  - □ Speaker maintained eye contact with the entire audience.
  - □ Speaker demonstrated attentive posture and engaging body language.
  - □ Speaker used a clear, distinct voice.
  - □ Speaker demonstrated appropriate attire and appearance.

Comments:
Learning Outcome 4B
(ABET j)

Knowledge of contemporary issues

List of courses included in the assessment of this outcome.

1. CE147 – Transportation Engineering
2. CE170 – Principles of Environmental Engineering
CE147 – Transportation Engineering

Refer to the assessment of Outcomes 3 (Ability to communicate) and 4A (Understanding impacts of engineering solutions in the global and societal context.)
SA3. (8 points)

a. List the pollutants that lead to acid rain. Circle the one that is the major problem in California.
b. State why acid rain is an environmental problem.
c. Name the water quality parameter that best indicates whether a lake will be badly affected by acid rain and describe why.
Learning Outcome 5A
(Not an ABET Outcome)

Understanding of Civil Engineering practice

List of courses included in the assessment of this outcome.

1. CE1A – Civil Engineering Seminar
2. CE171A – Soil Mechanics
3. CE190 – Senior Project
CE1A – Civil Engineering Seminar
Final Project (100 points)

Visit a recently completed civil engineering project in the area. The project could include improvements to a public works facility such as a road, bridge, levee, or water treatment facility. It could also include private improvements such as a new building or parking lot. Suggest what the most challenging issues on the project might have been and describe how it was most likely dealt with. Directions – Begin with a thesis that clearly but concisely introduces the topic (the completed CE project) and then the main points (the most challenging issue and the most likely solution). The first body paragraph should examine and discuss in detail the challenge – why and how was this a challenge? What would the repercussions be if this challenge were not solved? Etc. The second body paragraph will then discuss in detail the likely solution – how exactly was the challenge solved and what methods were used? Were there perhaps any other solutions that might have worked as well, if not better? The same writing rules apply – No 1st or 2nd person. Be very detailed, but keep to one page. No conclusion needed. 2 spaces after end punctuation.

*You are encouraged to team up with one or two of your class peers to visit and study these CE projects. The paper however, must be completed individually.
CE171A Soil Mechanics
Problem 1 (24 points)

For the boundary conditions drawn to the scale and the homogenous silty sand shown below:

(a) Draw the flow net.
(b) Determine the flow rate under the 320 m long concrete dam in m³/day.
   The coefficient of permeability for the silty sand soil is \(1.5 \times 10^{-3}\) cm/sec.
(c) Estimate the pore pressure at points A and B.
(d) Find the factor of safety against piping (heave) in the soil with \(\gamma_{\text{sat}} = 19.5\) kN/m³.