

PBL-2. Home Water Conservation

Learning Objectives:

- a. *Demonstrate critical analysis skills and capabilities expected of practicing water resources engineers, including to identify, evaluate, and recommend alternatives.*
- b. *Apply engineering economic principles and methods to evaluate alternatives.*
- c. *Apply multiple criteria in project evaluation*
- d. *Gather, analyze, and synthesize data*
- e. *Formulate project alternatives*
- f. *Coherently and concisely present engineering analysis in written form*
- g. *Apply tools to your own financial and investment decisions*

The Situation:

You are a practicing engineer employed at EngineeringEcon Pros, an engineering firm located in Logan, Utah. Your housemate/spouse/partner/friend recently saw a “Slow the Flow” ad and has hired your firm to recommend cost-effective water conserving actions his/her household can implement to slow the flow.

Use present worth, rate of return, and simple payback period analysis to recommend promising water conservation actions you client can implement. It is your responsibility to:

- Examine three or more household conservation actions.
- Estimate the water currently used and saved by the appliance/conservation action. See hints on the next page for methods to estimate water use.
- Use the price your client pays for water (e.g., consult a utility bill or look up rates on the city website).
- If your client does not pay for water (e.g., landlord, homeowners association, or someone else does), first do the analysis using your actual water price (\$0/gallon). Then repeat the analysis using the water price paid by a single family residence.
- Use the time horizon appropriate for your client – the time the client plans to continue living in their residence.
- Document sources of information for flow rates, water prices, time horizons, etc.
- Explain uncertainties in your estimates (for example, if the household loses one person, the price of water doubles, uncertainties in your measurements).
- Recommend actions your client should take to slow the flow.

You are responsible to obtain all data you need!!

Submit your report on Canvas in a single MW Word document with the filename:

- LastnameFirstname-PBL2 (original submission)
- LastnameFirstname-PBL2-Resubmit (resubmission)

Suggestions to Measure/Estimate Water Use

Indoors

- *Faucets and Showers.* Use a stop watch to measure the time it takes to fill a bucket of known volume. Divide the volume by fill time to get the flow rate (e.g., gallons per minute). Observe the duration of use (e.g., number of minutes) of the faucet or shower over a few days by household members. Multiply the flow rate by duration to estimate the water volume. Convert to the appropriate units of measurement for engineering economic analysis.
- *Toilets.* Mark the water line when the toilet tank is full. Shut off the water line to the toilet at the wall. Flush the tank. Then pour water into the tank. Measure the volume of water to refill to the line. Observe the number of uses of the toilet over a few days by household members. Multiply the flush volume by the number of uses to estimate the total water volume.
- *Dishwashers, laundry machines, radiators or other appliances.* Look up manufacturer specifications.

Outdoors

- *Hoses and car washing.* Measure flow from the hose using a stop watch and bucket like for faucets and showers.
- Use a water use calculator like:
 - <http://www.home-water-works.org/calculator>
 - <http://www.wecalc.org/>
 - Note: Web calculator estimates will likely differ from the household's actual water use. Make sure your report discusses the differences.

Organize observations in a worksheet to help monitor, track, and estimate water use (Table 1).

Table 1. Water Use Monitoring Worksheet

| Appliance/End Use | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 | Estimated water volume per use (gallons) |
|-------------------|-------|-------|-------|-------|-------|-------|-------|--|
| <u>Bathroom</u> | | | | | | | | |
| Toilet (flushes) | | | | | | | | |
| Shower (minutes) | | | | | | | | |
| Faucet (minutes) | | | | | | | | |
| etc. | | | | | | | | |
| | | | | | | | | |
| <u>Kitchen</u> | | | | | | | | |
| Faucet (minutes) | | | | | | | | |
| Dishwasher (runs) | | | | | | | | |
| etc. | | | | | | | | |

CEE 4200, PBL-2 Grading Rubric

Student: _____

| Category (Max. Score) | No Evidence | Far Below Standard | Below Standard | Meets Standard | Exceeds Standard | Self- Score | Instructor Score |
|---|--|---|---|---|---|----------------|---------------------|
| Title Page (3) | Absent 0 | Evidence of two or fewer title page elements 0 | Unclear title, or only 3 of 5 title page elements present. 1 | Separate title page. Title, Name, Instructor, Course, Date present 2 | Separate title page. Can assess main point from title alone. Name, Instructor, Course, Date, Neat 3 | | |
| Introduction (7) | Absent, no evidence 0 | There is no clear introduction, main topic, or description of the report's contribution. 1 - 2 | Introduction states the main topic but either: 1. Does not give a full overview, or 2. Too detailed, leads to repetition later. 3 - 4 | The introduction states the main topic and previews the structure of the report. 5 - 6 | Introduction states the main problem, describes report contribution, and previews report structure. Overviews solution strategy. Makes reader want to continue reading. 7 | | |
| Organization and report structure (10) | No content provided. 0 | Paragraphs fail to develop the main idea. No section headers or guide to help the reader understand how material is organized. 1 - 4 | Organization of ideas not fully developed. Paragraphs lack supporting detail sentences. No transitions or section headers. Main report exceeds 2 page. Appendices exceed 2 pages. 5 - 6 | Paragraph development present but not perfected. Each paragraph has sufficient supporting sentences. Section headers. Few transitions. 2-page main report. 7 - 8 | Writer demonstrates logic and sequencing of ideas through well-developed section headers, paragraphs, and transitions. The first sentence of each paragraph is the summary sentence. Main report is 2 page or less. Appendices, if present, do not exceed 2 pages. 9 - 10 | | |
| Engineering Economic Analysis (60) | Engineering economic analysis point(s) not addressed. 3 - 42% | The writer has no clue what they are talking about. 45 - 58% | Sketchy: left out required points. Did not work on this as much as you should have. Several important answers are incorrect. 61 - 79% | Necessary points are covered. Most answers are correct. Adequate explanation of methods. 82 - 88% | Provides what was explicitly asked for. The function of each piece is demonstrated to the reader in adequate, but not overwhelming, detail. Answers are correct and reasonable. 91 - 100% | | |
| | a) Estimate water use before and after each proposed conservation measure (10) | | | | | | |
| | b) Cash flow diagram for each conservation measure (5) | | | | | | |
| | c) Present worth, rate of return, and payback period of each conservation measure (25) | | | | | | |
| | d) Uncertainties/limitations of recommendations (10) | | | | | | |
| | e) Recommended action(s) for client (10) | | | | | | |

| Category (Max. Score) | No Evidence | Far Below Standard | Below Standard | Meets Standard | Exceeds Standard | Self- Score | Instructor Score |
|---|----------------------------------|--|--|--|--|----------------|---------------------|
| Word Usage and Format (10) | Not applicable | Numerous and distracting errors in punctuation, capitalization, spelling, sentence structure, word usage, significant figures, tables, and figures. Data vomited onto page(s). Unacceptable / unprofessional at the graduate level. 1 – 5 | Misspelled words, poor English grammar and word choice. Main body of report is either longer or significantly less than one page. Figures are too small and/or under-labeled, although they are usually of acceptable quality and focus. Tables incoherent or not cohesive. Bad font sizes. Too much or too little data in appendices. Could be improved by being more meticulous. 6 – 7 | Almost no errors in punctuation, capitalization, spelling, sentence structure, word usage, significant figures, and presentation of figures, tables, and appendices. 8 | Punctuation, capitalization, spelling, sentence structure, word usage, and significant figures all correct. Clear, consistent fonts. Good word processing skills. Figures have adequate contrast. Informative figure and table titles with numbers. Figures have appropriate axis tick spacing, labels, units, and legends. Table columns cohesive, labeled, and specify units. Equations are numbered. Appendices, if provided, are separated by topic, and each have a title, discussion, and proper formatting and display of information. 9 - 10 | | |
| Conclusion (7) | Absent 0 | Incomplete and/or not focused. 1-2 | The conclusion does not adequately restate the main results. 3-4 | The conclusion restates the main results. 5 | The conclusion restates the main results, and is an effective summary. 7 | | |
| References (3) | Absent 0 | Many errors, off- the-wall sources used, and/or few sources cited 0 | Some prior work, data, and sources cited. A few references formatted correctly. 1 | Most prior work, data, and sources cited. Formatting generally correct. 2 | All prior work, data, and sources cited and referenced in correct format. References section is at end of report. 3 | | |
| Engineering Writing Center (5) | No evidence 0 | Evidence of meeting with Engineering Writing Center consultant attached to end of report 1 | | Evidence of meeting with Engineering Writing Center consultant attached to end of report AND report addresses consultant feedback 5 | | | |
| TOTAL (105) | | | | | | | |

Additional Comments: