Civil Engineering Writing Project - Language Unit 2

WORD CHOICE FOR PRECISION AND ACCURACY (TECHNICAL INFORMATION)

What do you need to know about effective writing in civil engineering?

Language unit 1 emphasized the need for accurate, precise word choices. It explained that even when you express non-technical information, you cannot use words for general or vague meanings. This unit focuses on more technical descriptions. The same principles apply, but this unit covers additional concerns about specificity, certainty, measurements, and standards.

<u>What experienced engineering practitioners say</u>

Yes, different words mean different things. It's important to choose the correct near-synonym.

Too many sig figs is a common mistake in novices' writing... The computer will calculate numbers to many decimal places but what matters is what the number is representing...The exact number of sig figs varies depending on what is being measured, the accuracy of the numbers going into the calculation, and even what the numbers will be used for.

What do effective word choices by engineering practitioners look like?

A) Words express the intended meaning as accurately, precisely and unambiguously as possible. Limitations and levels of certainty are neither exaggerated nor minimized.

Effective Word Choices

Examples	Explanation
1. For the timber bridges we <u>performed</u> hands-on inspections of every pile from the ground to a height of up to 7 to 12 feet. <u>In general</u>, piles are <u>more likely</u> to experience rot in the areas subjected to the ground moisture or near the lower end of the cross-brace connections. We <u>sounded</u> every pile at each of the bents to test for solid or hollow conditions. We <u>confirmed</u> deterioration or rot by drilling as necessary. *(Report of bridge inspections, Inspection Approach section)*	• Example 1 effectively describes the engineers' actions with precise verbs: ***performed*** *hands-on inspections*, ***sounded*** *every pile*, ***confirmed*** *deterioration or rot*. For comparison, consider the difference if the writer used *checked on* instead of *confirmed*: *We checked on deterioration or rot by drilling...* Now the end-point of the evaluation is not clear. *Confirmed* meant the evaluation of condition was verified. It expressed an end point. *Checked on* is less specific and leaves the reader wondering, "They checked – and then what?" • Example 1 explicitly marks a generalization and its level of certainty. It notes that ***in general*** piles are ***most likely*** to rot in the

2. <u>During the exploration,</u> <u>we did not encounter</u> liquefiable soils consisting of loose, fine sands or non-plastic silt below the ground water table. Therefore, the <u>risk of liquefaction</u> at this site is <u>low</u>.	region that was inspected. It does not make an inaccurate, absolute claim (e.g. *Piles experience rot in the areas subjected to the ground moisture*). At the same time, it is not vague about what was inspected, as is a description such as *We inspected piles for rot in likely areas*. Example 1 is explicit about how high the inspection went and why, and it does not promise every possible area of rot was found. • Example 2 is explicit in limiting the description to the specific work. Notice that ***during the exploration, we did not encounter*** *liquefiable soils*... has a different meaning than *there are no liquefiable soils....* • Example 2 is also precise about expressing ***the risk of liquefaction*** is ***low***. It does not overstate the certainty (e.g. *Liquefaction will not occur at this site),* nor does it over-hedge the information and become vague (e.g. *the risk of liquefaction seems relatively low during likely seismic events*).

B) Effective writing uses measurements with the degree of precision required – no more, no less. The number of significant figures is appropriate.

Exact Measurements	
Examples	Explanation
1. The minimum permanent vertical clearance shall be <u>23 feet 4 inches</u> measured from the top of the highest rail to the lowest obstruction under the structure. *(Report – Recommendations)* 2. The test results indicate a sulfate concentration of <u>0.0017 percent by weight</u>. *(Report – Data Analysis)*	These sentences provide measurements with the degree of accuracy required in each context – to the inch for vertical clearance in the recommendations and to the fourth decimal place for the analysis of sulfate. The writers use the significant figures required, but no more. The units are clear. These examples also illustrate a policy of many firms to write out units (here *feet*, *inches*, *percent*) because there is less chance of misinterpretation. Depending on the audience, units of length might also be expressed as decimals (23.3 feet) and concentrations as parts per million (17 PPM). For example, architects prefer to read feet and inches, but standard engineering notation uses decimals.

Approximate Measurements	
Examples	Explanation
3. The bridge design includes a steel girder superstructure consisting of plate girders. Since the width of the bridge varies, the girder spacing varies from approximately 4 feet to 6 feet on center. *(Report)*	An approximate measure has a low number of significant figures, and the approximation may be a range (here *4 to 6*). The units of measure and the location for the measurements (*feet, on center*) are still specified. As covered in Part 1, an adverb (*approximately*) precedes the measurement. Example 3 also illustrates the practice of many firms to write out the word *to* rather than use a hyphen. The phrase *4 feet to 6 feet* has less chance of misinterpretation than *4-6'*.

Tips for Improving Your Writing

When you revise technical descriptions in your writing, you should employ all the techniques covered in Part 1. In addition, three new techniques are added below. Read over all the techniques and then apply them in the practice section that follows.

Review from Part 1

Technique 1:	Choose specific words that unambiguously convey your intended meaning.
Technique 2:	Refer to quantities and measurements with an appropriate level of precision.
Technique 3:	Delete unnecessary words.
Technique 4:	Check the literal meaning of the idea expressed in each sentence, not just individual words.

Additional Techniques

Technique 5: Choose words with an accurate level of certainty. Absolute words are rarely accurate, so check them carefully.	
Original Needing Revision	Revision
1. The storm sewer system will begin with intakes and manholes located a maximum of 300 feet apart. This will ensure all intakes can accommodate the large amount of runoff from a one in a fifty year storm.	The stormwater system is designed with intakes and manholes located a maximum of 300 feet apart to accommodate the expected flows from the fifty-year storm event.
Explanation. • The original expresses an inaccurate level of certainty with *ensure.* The meaning is a guarantee that the system will accommodate runoff from the 50-year storm event. However, the outcome cannot be guaranteed. Even though the design is for the 50-year storm event, there are many other variables that will affect performance. The revision accurately describes designing for *expected flows*, but it does not express a guarantee. • The revision also changes terms to be more precise: *begin with* → *is designed* and *a one in a fifty*	

year storm → *the fifty-year storm event.* Note that *the fifty-year storm event* refers to a published figure, but *a one in fifty year storm* is not an established term.

Original Needing Revision	Revision
2. *[Previous paragraphs have presented the design criteria, and then presented 3 options + a no-build alternative]* Overall, the light rail transit system was determined to be the best option. It met the most goals of the project than the other options. The tables below show a summary table showing the alternative evaluation results.	The alternatives were evaluated against the primary and secondary design criteria. The light rail option fulfilled all the primary criteria and more of the secondary criteria than the other options (Table 5). Therefore, the preferred alternative is the light rail transit system.

Explanation.

- In the original the writers express an inaccurate level of certainty by declaring they ***determine*** the ***best*** option. In fact, there are many other possible options; they have not considered every possibility. In addition, "best" can mean different things to different people. The revision refers to the *preferred alternative*, after making clear the criteria for evaluating the alternatives.

A number of other changes also contribute to making the revisions more effective:

- The revision is more specific about the evaluation criteria, mentioning *the primary and secondary design criteria* rather than *most goals of the project*.
- The revision uses a number to refer to the table, making the sentence more concise (*Table 5* rather than *the tables below show a summary table*).
- The revision places evidence before the conclusion, following the expected flow of information in engineering. It tells what the process will be (using the design criteria), presents the evidence, and then presents the preferred alternative. It also states the preferred alternative in the place of greatest emphasis – the end of the sentence and the end of the paragraph. Although the preferred alternative will already be predictable from the evidence and readers will not be surprised, this important conclusion deserves emphasis. (See Unit 4, Parts 1 and 2 for more on information flow and the place of emphasis.)
- The revision has no editing errors but the original does *(the most goals of the project than the other options*).

Technique 6: Use appropriate units and significant figures.

Original Needing Revision	Revision
1. Building Deflection. A 2D model was analyzed in the SAP2000 computer program and produced a maximum elastic deflection of 1.456 inches, based on the applied lateral load of 67.661k. This value was then multiplied by ... *(Report)*	A 2D model was analyzed in the SAP2000 computer program and produced a maximum elastic deflection of less than 5 inches, based on the applied lateral load of 67k. This value was then multiplied by ...

Explanation. In the original, the writer has reported too precise of a number (in other words, the writer did not pay attention to significant figures). The writer needs to consider questions such as "How confident are you about the value of the load? How confident are you about the assumptions that went into the calculation of the deflection – assumptions that include values of the material properties, theories of elasticity, boundary conditions, etc.?"

- The original implies that the writer knows the deflection to within 1/1000 of an inch and the loads within a pound (.001k). This level of accuracy is unrealistic.
- The revision uses an appropriate and more realistic number of significant figures by applying judgment to the calculated results. You can start to build judgment by noticing the level of accuracy used by experienced professionals.

Original Needing Revision	Revision
2. Foundations: *[Initial explanation establishes that the structure has square and continuous footings and that settlement controls for calculating minimum footing widths.]* The allowable settlement for both footings was defined as 0.5 inches. The expected settlement with the footing parameters in Table 1 are 0.46 inches for the square footings and 0.38 inches for the continuous footings. *(Report)*	According to the design criteria, the allowable settlement for both footings is 0.5 inches. We calculated a settlement of 0.46 inches for the square footings and 0.38 inches for the continuous footings. Therefore, the expected settlement is less than an inch.

Explanation. The original's ineffectiveness is caused by a combination of imprecise wording and too many significant figures for discussing expected footing settlement.

- The original uses *the **expected** settlement* to refer to the **calculated** settlement, but the terms mean different things. The ***expected*** *settlement* is an interpretation of results. It is a way of saying, "based on the results and our engineering judgment, here is what we expect. " The calculations lead to the ***calculated*** *settlement*, but that is not an interpretation . The revision makes explicit the calculation (*we calculated...*) and differentiates it from *the expected settlement*.
- Although settlement calculations can be presented up to hundredths of an inch, geotechnical engineers know from their professional experience that soil is not that predicable. The original represents an expected settlement with the accuracy of the calculated settlement (to the hundredth of an inch – 0.46 and 0.38), which is unrealistic. The revision changes it to *less than an inch*. Judgment like this requires experience, but you can help yourself learn faster by noticing the level of accuracy used by experienced professionals when they write about different materials and situations.
- *was defined as* is a vague, inaccurate passive. It suggests a mysterious "definer" behind the scenes. Allowable settlement is not "defined;" it is in the design criteria. The revision makes the source explicit (*according to the design criteria*).

Original Needing Revision	Revision
3. The normal annual precipitation amount for the project area is approximately 45 inches (114.3 cm).	The normal annual precipitation amount for the project area is approximately 45 inches (110 cm).

Explanation. This writer forgot to pay attention to significant figures when converting units. If the rainfall estimate was approximate to the inch, it cannot be accurate to a tenth of a centimeter. The revision expresses a similar level of accuracy for the two systems of measurement.

Technique 7: Refer to specific standards or expected measures.

Original Needing Revision	Revision
1. Conclusion. It is my opinion that the friction angles in the sandy layers are low with respect to the associated relative densities and therefore can be considered conservative. *(Lab Report)*	The measured friction angle in the sandy layer is lower than the expected value based on the relative density (NAVFAC 1986). Therefore, we consider the measured value conservative.

Explanation.

- In the original the information is presented as though it is a baseless "opinion." In addition, the term *low* is vague because low is a relative term – low compared to what?
- The revision expresses the information as an evaluation based on a standard source. The *measured friction angle* is differentiated from *the expected value*. The source for the expected value is clear (NAVFAC 1986 – a published resource for expected friction angles based on relative density of soils).
- The revision also improves the evaluation by stating it in active voice (*we consider...*). This sentence structure makes the responsibility for the evaluation overt and places the most important information (that the measured value is conservative) where it receives most emphasis - the end of the sentence. (See unit 3 for more on active/passive voice and unit 4, part 2, for the place of emphasis.)

Original Needing Revision	Revision
2. The bridge is within the floodplain, and the new bridge will have to meet requirements for construction there. *(Bridge Replacement Report)*	The bridge is within the regulated floodway. Floodplain development regulations are governed by Dodd County. Construction of the proposed bridge will have to meet the requirements of the Dodd County Code Section 19.352 for development inside the regulated floodway.

Explanation.

- The original is vague about the requirements the proposed bridge will have to meet. The governing body and specific regulations are important information for the project. The revision states the jurisdiction (*Dodd County*) and tells the exact code section. It also refers to the zone by its legal designation (*the regulated floodway*).

Practice

Instructions: Apply the techniques above and those from other units to make the following more accurate, precise and effective. In a-d pay particular attention to the underlined words but also make other revisions as needed. In e-g you must apply your own judgment about what needs to be revised.

a. Conclusion
The experiment generally reinforced established properties of concrete.
(Student Lab Report)
Hint: The writer is trying to say the experiment results were close to what was described for concrete in the course textbook, Mamlouk and Zaniewski 2006.

b. Field Exploration
In March of 2012, three borings were conducted using a mud rotary drill rig to 30 feet.
(Report)
Hint: Be sure to address two problems - the verb itself and the sentence structure that makes it sound like another technique was used below 30 feet. Thirty feet was the end of the drilling.

c. Stormwater
The system piping was sized to handle a 50-yr storm (Rational Method) using the Manning's full pipe flow equation. Once the system was initially designed, its functioning was checked using WaterCAD to ensure the adequacy of the system pipe sizes.

d. Design Loads
Using ASCE, the correct live load for each floor was determined. For the 2nd to 5th floors, a live load of 100 PSF was utilized. Due to the decreased amount of live load expected on the roof floor, a live load of 20.3 PSF was used. For equivalent seismic weight, only the dead load was applied.

Hints: The writer used ASCE 7-10 as the resource for the live loads.

e. The key factors in facilitating project achievements are ensuring relevance, which is that the project answered the needs of the target beneficiaries. In addition, establishing a partnership, where within the design of the project there was shared responsibility and accountability for project results between design/implementation team and community members.
(Student Proposal)
Hint: This team is trying to emphasize their approach to the project, emphasizing their focus relevance and partnership.

f. We did five borings. The first two borings found a shallow depth of organic top soil that was silty with a moderate moisture content. The other three borings....
(Tech Memo – field exploration)
Hints: Data: topsoil depth = 1-1.5 feet, borings were numbered (B-1 through B-5), the moisture content for the silt was 24-30%.

g. Appropriate management strategies were used in the preparation of this hydrologic analysis. The site falls into the third category of the stormwater destination/disposal hierarchy. This requires pollution reduction, flow control, and a surface retention facility.
(Stormwater Report)
Hints: The stormwater regulations are covered in the City of Franklin Stormwater Management Manual 2012. The categories are numbered (i.e., the third category is named Category 3).

h. *[In this report, previous information has presented the average wind pressure value and the calculated seismic force (1,630 lbs.). Now they move on to the calculated wind force.]*

The projected area that the wind forces will be acting upon is 40,000 SQ. FT. By multiplying our projected area by our average wind pressure value, we obtained a final wind force value of 1400.0. By comparing our final wind force (1400) to our final seismic force (1630), we can see that seismic forces will govern and will be utilized in our final building design. See Table 19 below for a summary of the wind force comparison against seismic. (*Student Design Report*)

Practice II

Context: The following is a section of a preliminary design report for a system to prevent avian predation on migrating fish as the fish pass through a dam. Preceding sections presented background about the problem and the scope of work. There has been no discussion of the design options until this section.
Instructions: Apply the techniques above and others you know to improve the effectiveness of the Wire Array section. Revise the section and describe any movement of content to other sections. You do not need to fill in the sections about the other alternatives.

Summary of Design Ideas

Wire Array
One design option was to use a wire array. Each wire would stretch from a support on one side of the river to a support on either the dam itself or on the other side of the river. Using the straight line distance and a fudge factor to account for sag, it was estimated that a length of 700,140ft to 900,327ft of wire would be needed. Many options for the material of the wire are readily available. Either steel or synthetic wires are both possible design options we are considering.
There are several reasons why a typical wire array was determined to be the best design option. The construction of the array is easy. It would be easier to repair any failure of wires. The materials needed for construction would be more accessible than a custom made net. The supports needed on the bank of the river would be much easier and more cost effective to create than a support in the river. Finally, the environmental impact of such a design is small.

Wire Netting
explanation of wire netting option

Pier
explanation of the pier option

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