FINAL PROJECT
CE 474/574: Unit Operations in Environmental Engineering

<u>ASSIGNMENT</u>: Provide an overall design for both a water treatment plant and a wastewater plant. The goal here is *not* to re-design the units, but to take the existing units you have already designed and put them all together into a "master plan." The expected components are listed below. Your grade will be based on how many details you can provide and how accurately you provide them. Covering all the items suggested below gets you a A+ grade on the final project. Cutting back in any area brings your grade down, but still can result in a good score. In other words, do the best job you can but it is not necessary to kill yourself.

For the water treatment plan, design it for surface water with coagulation/flocculation/settling and NO hardness removal. Please calculate the proper detention time (volume) and size of the flocculation unit. You do NOT need to calculate any details about the paddle speed, power use, etc., for the flocculator; just size it and show it in your drawings.

<u>Checklist for Final Design</u>

A complete design will address all of the items listed. You need not work out every minor detail (e.g., you don't have to design a Parshall flume or a grit remover) but you should at least indicate the presence of a particular device or operation and indicate its location in a logical place in the system. *[In the brackets I have provided some guidance as to the grade value of various overall features of your design report.]*

OVERALL POINTS FOR BOTH WATER AND WASTEWATER SYSTEMS:

☐ Present in a scale drawing a logical layout that minimizes space use and piping, provides proximity of related units, yet allows access for maintenance and emergency operations. You can do this as a schematic hand drawing, but make it clean, neat, and drawn to scale. *[This is worth about 0.5 of a letter grade; e.g. an otherwise "A" system with a haphazard layout drops to a B+.]*

☐ Prepare formal mass balances (both liquid and solids streams) for each unit operation, and present this in away that it is easy to see where the water goes at each point, where the solids go at each point, and what the overall flows of solids and water are.

☐ Don't forget that not *all* water follows the effluent train; some water exits with the sludge pathways. And then some of that water gets separated in later dewatering steps, and must be returned to an appropriate point in the treatment train (and accounted for in the water balance) *[Mass balances are worth up to a full letter grade. Absence of clear and accurate mass balances will cost you a letter grade. The presence of mass balances, but poorly prepared and present can cost you up to 0.5 letter grade.]*

☐ It's vitally important to plan for redundancy and maintenance. You *must* have a system where the peak daily flow can be accommodated such that at least one complete element of the treatment unit can be offline. Thus, if you have two units, one must be capable of handling the entire flow. It usually is cheaper to design a system where there are 3 or 4 units in parallel in which the total flow can be handled by 2 or 3, respectively. *[Failure to deal with this drops you as much as a full letter grade]*.

☐ Summarize the total consumption of all chemicals when appropriate. For the final overall design, if one chemical is used in both plants, lump them together to get a grand total for the municipal utility system. [*Up to 0.5 letter grade]*.

Specifics: WATER TREATMENT SYSTEM

SCOPE: Elk Creek source, coagulation, flocculation, sedmentation, disinfection.

☐ Water demand forecast; annual average and peak capacity required

☐ Total annual chemical usage for coagulation/flocculation

☐ Preliminary disinfection for water system? [Your call, but think about pros & cons, why & where, and how much]

☐ Chlorine demand and chemical usage, storage, loading, access (for both water and WW systems).

☐ Chemical storage for coagulants (loading dock and truck access?)

☐ What coagulant(s) will be used?

☐ Flocculator system: shape, volume, dimensions, operating parameters (include just the basics: detention time, volume, area and depth)

☐ Clarifier design: shape, volume, dimensions, sludge collection apparatus, operating parameters (detention time, surface loading rate, etc.)

☐ Volume and mass of sludge from clarifier; annual average and peak day

☐ Basic flow path for sludge from clarifiers to thickening/dewatering equipment to final off-loading onto trucks for disposal. (Loading dock and truck access available?)

WASTEWATER TREATMENT SYSTEM

SCOPE: Serving the "Greater Drain" district as in the DA's; pretreatment, primary, secondary aeration, nitrification and denitrification, and final disinfection (i.e., the Full Monty).

☐ Inlet facilities, pretreatment, grit removal, and flow measurement

☐ Access to pretreatment for removal of trash by carts or trucks

☐ Volume & mass of sludge from primary clarifier; solids content; annual average & peak day

☐ Basic flow path for sludge from primary and secondary clarifiers to digesters to thickening/dewatering equipment to final off-loading onto trucks for disposal. (Loading dock and truck access available?)

☐ Secondary aeration basins: Shape, volume, dimensions,, operating parameters (detention time, surface loading rate, MLSS, return ratio, sludge age, sludge wastage rate, expected effluent quality, etc.)

☐ Secondary clarifier design: Shape, volume, dimensions, sludge collection apparatus, operating parameters (detention time, surface loading rate, etc.)

☐ Volume & mass of sludge from secondary clarifier; solids content; annual average and peak day

☐ Denitrification units: Shape, volume, dimensions, operating parameters (detention time, surface loading rate, expected effluent quality); methanol consumption

☐ Anaerobic digestion: Include simple process design based on the) DA-9. Include info on shape, volume and dimensions of the digester.

- ☐ Indicate the expected flow and composition of offgas from the digester. Bonus points for estimating the BTU of heat energy that could be obtain by combustion of this off ga

GRAD STUDENT TEAMS ONLY

Select one unit operation and provide a good description of an alternative method that achieves good results. Include a discussion of what are the pros and cons of the method compared to more conventional methods. Total write up should be 2-3 pages including diagrams or pictures.

Ideas:

Tube clarifiers

Alternate nite-denite formats

Combined flocculator-clarifiers

Sequential batch reactors

Micro-filtration