LETTER OF TRANSMITTAL

Water Environmental Federation Student Design Competition Team
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Northern Arizona University

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Prof. Dianne McDonnell
Northern Arizona University

Dear Prof. McDonnell,

The Water Environment Federation student design competition team is pleased to submit this proposal for our capstone project at Northern Arizona University. Our team of four will be completing a design or redesign of wastewater treatment plant infrastructure at a plant in Arizona. The project is estimated to cost $66,000 and will be begin January 16th, 2017 and is expected to be completed May 4th, 2017.

Water Environmental Federation Student Wastewater Design Competition Proposal

Prepared for: Dianne McDonnell

Prepared on: 12/14/17

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Contents

List of Figures

List of Tables

1.0 Project Understanding

1.1 Project Purpose

The Water Environment Federation's (WEF) Student design competition includes a redesign of a components of a wastewater treatment plant (WWTP) and or other wastewater infrastructure components including hydraulics, unit design, of water and solids quality requirements, and economics. The location will be released in January along with the competition prompt. The Water Environment Federation (WEF) will define the scope of this project, but it will pertain directly to wastewater treatment. The project may include sewer and pump station design, WWTP expansions, biological treatment, reuse, constructed wetlands, sustainability efforts, and storm water management. While the problem statement has not yet been released for this project, past projects include the preliminary design of a sewer collection system, a WWTP expansion, and a reuse irrigation distribution system [1].

1.2 Project Background

1.2.1 Project Description

The location of the existing or proposed wastewater treatment plant will be released, in the prompt, in January. However, the treatment plant will be located somewhere in Arizona, and that we will be designing or adding to a wastewater treatment plant. A site tour is required early in the contest, this will be accomplished before the end of January.

In preparation for the contest three plants have been toured. Tollesen WWTP treats 5 MGD, and unique aspects of the plant included, trickling filters, three different solidifiers, odor control, and activated sludge gas capture for burning at the heat exchanger. The plant operator explained how the plant had undergone many changes increasing in size and polishing of effluent.

Figure 1: Tollesen WWTP Trickling Filter

Wildcat WWTP in Flagstaff Arizona treats water to be distributed into the towns reclaimed water distribution. One unique aspect in this plant is that the activated sludge process uses a hybrid between fixed and suspended media. The tank was filled with 1” diameter, high surface area plastic media. The secondary clarifiers caused some difficulty because they are square instead of the easier to operate round clarifiers. The plant operator emphasized the how proper timing and conditions in the plant reduced the need for additional chemicals.

Figure 2: Wildcat WWTP Aeration Basin

The largest plant toured was Flamingo Water Resource Center the end of the line plant for Las Vegas, Nevada. With a capacity of 150 MGD and average operation of 96 MGD it is an important treatment plant. The plant uses membrane filtration and UV disinfection. One process unique to Flamingo was the Bio-P process, Lake Meade is a phosphorous limited system so the plant needed to remove phosphorous instead of nitrogen. A unique alternating system of aerobic and anoxic zones removes the organic nitrogen and was made possible by stable pH due to mineral content, and warm tempters do to climate conditions. This demonstrated how each water plant has different requirements that must be met within the constraints of the system [3].

1.3 Technical Considerations

1.3.1 Approach to Competition

Research was conducted on the components of wastewater treatment in preparation for the problem statement given in January by the WEF competition. This includes site visits to wastewater treatment plants in the Flagstaff, Cottonwood, and Phoenix area. This provides context for the layout of local treatment plants and as well as understanding scale and unique challenges present for different waste water properties. Research will be centered on the treatment processes, discharge, and hydraulics of WWTPs.

1.3.2 Design Portion of Competition

Wastewater unit design will be a large portion of this project. Using the information given in the prompt and the knowledge gathered in the background research, analysis will give the necessary design constraints and criteria. Some examples of the possible criteria include a hydraulic profile, computerized hydraulic modeling, drafting of the treatment system components, and pipe network modeling. The individual treatment units can be designed to meet the needs that are given in the prompt, and to achieve the specified quality of effluent.

1.3.3 Laws, Regulations, and Codes

Potential standards that the team will need to follow include the Centralized Waste Treatment (CWT) Effluent Guidelines and Standards, the Clean Water Act (CWA) of 1972, and The Arizona Administrative Code from the Department of Environmental Quality (ADEQ) on Water Quality Standards. The CWT is relevant because it provides standards for the acceptable limit of effluent discharge from a wastewater treatment plant [4]. The CWA makes it a law to acquire a National Pollutant Discharge Elimination System (NPDES) permit to discharge flows into surface waters [5]. The Arizona Administrative Code on Water Quality Standards, provides standards to determine what class of reclaimed water can be produced from a wastewater treatment plant [6].

1.3.4 Software

AutoCAD or Civil 3D may be used by the team to draft plans and sections of WWTP units. The team could also use modeling software such as WaterGEMS or ArcGIS if analysis is needed for collection systems or reuse distribution systems. Additional software may be used as the team learns more about the demands of the design.

1.4 Potential Challenges

1.4.1 Time Management

Timing challenges can be resolved through efficient project scheduling. Major task will be broken up into smaller sub-tasks. Another way to help prevent timing issues, is to consult the grading instructor and technical advisor to identify most time-consuming tasks and make a detailed schedule to follow. Finally, making an explicit scope will mitigate the possibility of scope creep and save valuable time.

1.5 Stakeholders

1.5.1 Municipality

The municipality, the investors, the community, and those that are downstream of the wastewater treatment plant or use the reclaimed water are stakeholders. Municipalities and large companies, referred to as the client, need raw sewage and other waste water to be treated in order for it to be legal and prudent to release into the environment.

1.5.2 Community

Another important stakeholder is the community being serviced by the wastewater plant as well as those that live in the immediate vicinity. Those that live close to the plant may have additional aesthetic, and odor concerns that could affect, property value as well as quality of life. The WWTP neighbors are one of the stakeholders that require the most outreach and education. The not-in-my-backyard mentality is of concern for wastewater treatment plant.

1.5.3 Reuse

Treated water can be used to recharge aquifers, to water golf courses, or discharged into natural water bodies. People that are exposed or use recycled water also are stakeholders in this project. Finally, the environment while not represented by individuals is also a stakeholder. Improper treatment can negatively affect streams and rivers, potentially and causing sickness. Wastewater affects everyone in the community because reliable treatment is a health concern. [7]

2.0 Project Scope

2.1 Task 1: Define Project

The group will receive the contest prompt in early January and will need to define the requirements and identify criteria for each deliverable. When the prompt is received the tasks that will need to be completed will be more specific and the real work will begin.

2.1.1 Task 1.1: Map Existing Flow Diagram

Create an existing flow diagram of the plant focusing on the portion that is required for the remodel. This needs to be started before the tour and completed directly after the tour.

2.1.2 Task 1.2: Create New Flow Diagram

Create the modified flow diagram including location along the treatment process that requires modification.

2.1.3 Task 1.3: Identify all the constraints and nature of the deliverables.

Time must be dedicated to identifying each of the design criteria required within the contest so that each criterion is met, and no extra work is performed.

2.2 Task 2: Site Investigation

Our team will tour multiple wastewater treatment plants to research the layout of the treatment plants and the processes in a treatment plant. Additionally, once the prompt is released, a tour of the actual wastewater treatment plant to be modified will be given. During this tour, the team will ask questions, take notes, pictures, and videos pertaining to the requirements from the prompt.

2.2.1 Task 2.1: Tour Wastewater Treatment Plants

- Determine travel to treatment plant
- Determine date and time to tour
- Create possible questions
- Obtain contact information for a resource

2.2.2 Task 2.2: Tour Competition Wastewater Treatment Plant

Once the location of the treatment plant is known, our team must immediately set up a time and date for a tour. Travel means will be determined based on the location. For the tour, tasks will be given to each member for note taking, videoing, and asking questions.

2.3 Task 3: Layout of Existing Wastewater Treatment Plant

After the site visit the layout of the existing WWTP will need to be analyzed to understand the hydraulics, treatment methods, capacity, and expansion potential. The layout of the existing plant must be fully understood in order to begin plans for design. Hydraulics, treatment methods or units, capacity, and expansion potential will need to be analyzed in their respective ways to gain a full picture understanding of the constraints and criteria for the design.

2.3.1 Task 3.1: Hydraulics

Plant hydraulics will be analyzed using information from the plant layout and a diagram will be drawn illustrating the hydraulic and energy grade lines. This will focus mainly on the part of the plant that the project is on. There are head, velocity and flow requirements for each unit that are set by various municipalities to ensure successful WWTP hydraulics [7].

2.3.2 Task 3.2: Treatment Methods/Units

The treatment methods will be listed to and the units will be modeled. The area of focus for the project will be analyzed more in depth to determine what will be required for the design stage. The units that may need to be designed could range from bar screens, grit removal, primary sedimentation, secondary clarifiers, disinfection, digestion, and dewatering [7].

2.3.3 Task 3.3: Capacity

The capacity of the plant will be considered to determine how much wastewater is being treated and therefore what size the units will be. This will become especially important if the capacity of the WWTP is being upgraded. The largest capacity that could potentially need to be dealt with would the City of Phoenix WWTP which has a capacity of 230 MGD [8].

2.3.4 Task 3.4 Expansion Potential

The expansion potential will consider layout constraints such as limited space or other environmental factors that may impact the design.

2.4 Task 4: Design

After defining the project, completing the site visit and ensuring the existing WWTP layout is fully understood the design will begin. The project prompt will dictate specifically what needs to be designed. Depending on the constraints and criteria the work to be completed will vary but the team will first analyze various alternatives that can be implemented and select the best solution. From there the design will be divided up to each group member based on skill set. To reach a final design everyone in the group must work together and approve of each component of the design.

2.4.1 Task 4.1: Technology selection

The first step in the design is to identify alternatives that can be used to solve the issue. The group will create a decision matrix that will include all viable alternatives and then do analysis to determine which will best satisfy the constraints and criteria of the project.

2.4.2 Task 4.2: Technology

Once the best alternative is selected the design work will be split up among the group based on skill set. All design work must work together and be approved by each group member.

2.5 Task 5: Economic Analysis

Depending on the AZ water competition requirements, our team will conduct an analysis on the costs of design and implementation of the specified part of the treatment plant. This includes but is not limited to design work, construction, maintenance, and a lifetime-cost feasibility.

2.5.1 Task 5.1: Cost Design Work

The extent of the design work is dependent on the treatment plant process part that is to be added or re-done.

2.5.2 Task 5.2: Cost Construction

This includes the costs to create or buy the treatment part, remove existing infrastructure in the plant, and install the new equipment. Additionally, the costs to hire a construction company will be evaluated based on the design.

2.5.3 Task 5.3: Cost Maintenance

Maintenance will need to be determined prior to and once the part is installed. Ideally, the part should require little maintenance to reduce incurring costs for the wastewater treatment plant. If maintenance is necessary, downtime costs for the treatment plant should be determined and alternative solutions need to be explored.

2.5.4 Task 5.4: Cost Lifetime-Cost Feasibility

Any treatment plant design that is added should have a cost incurred over time analysis. This ensures that the final product will last the lifetime of the plant, and not create extra costs for the wastewater treatment plant.

2.6 Task 6: Project Management

Project management for this project will include deliverables, team meetings, and the competition. The 50% deliverable will be completed on week 8, the final report will be completed on April 27th, 2017, and the final presentation will be completed on May 4th, 2017. The team will meet at least once a week for around an hour but more if necessary to complete required tasks and stay on schedule.

3.0 Scheduling

3.1 Overview

The time constraints of the project are based on the deliverables for the contest. While tours and research are conducted during the fall 2017 semester the project doesn't start until the prompt is released in January and will last the entire semester.

3.2.1 Major Deliverables

The major deliverables are determined by the contest rules and include the each of the items that will be judged during the contest.

Table 1: Major Deliverables

Name	Estimated Date
Site Tour	Jan 19, 2017
Project Plan	Feb, 14 2017
50% Deliverable	Week 8
Final Report	April 27, 2017
Final Presentation	May 4, 2017

3.2.2 Critical Path

The critical starts with the assignment of the prompt, the second task in the critical path is to define constraints and criteria of the assigned prompt. Sizing and capacity analysis will be followed by technology selection followed by design implementation. These parts of the critical path conclude with the submittal of the final design followed by final presentation preparation. The critical path ends on May 4th with the presentation at the conference.

3.2.3 Maintaining Schedule

The schedule will be maintained by allowing flex time on each part of the project. Task durations are overestimated to allow for sick days and other unforeseen events. Each task end date will be considered an internal deliverable for the team. Additional resources will be dedicated to any tasks that are behind schedule.

4.0 Project Staffing

4.1 Staffing and Qualifications

The rates for the project manager, senior engineer, engineer in training, and drafter were found from the U.S. Bureau of Labor Statistics website. These rates have benefits and overhead built in to them.

Project Manager: $140/hr

The project manager will ensure that the schedule of the project is kept as well as provide expertise when needed. The project manager will also review and approve deliverables to the client and manage any needed sub-contractors. Ten to fifteen years of experience is suggested for this position. The ability to balance resources and clear professional communication is necessary [9].

Senior Engineer: $105/hr

This is a position with 5-10 years of experience. Engineers will develop proposals and plans based on the information provided and gathered from the client under the guidance of the project manager. Will confirm the effectiveness of selected technology based analysis and testing. Set and maintain schedule by setting project timeline and maintaining it. Maintain project data base through collecting and maintaining information electronically and writing reports. Control project cost through scheduling and management of subcontractors [9].

Engineer in Training: $85/hr

An engineer in training (EIT) is a position that requires 0-3 years of experience and works directly under the senior engineer. The EIT will be doing the majority of the design analysis and reports. The EIT is in charge of site visits and investigation and will contribute to the economic analysis.

Drafter: $75/hr

The drafter should have a minimum of a year experience in professional drafting with and expert understanding of drafting software's and techniques. Will work under the project engineers and project managers to create technical drawing to convey precise design and building requirements to the client and the contractor that will build the designed components [9].

4.2 Hourly Task Breakdown

The following in a breakdown of each task included in the schedule with breakdown of the hours spent on the project by each member of the staff.

Table 2: Staffing Hours

STAFFING (hours)					
Task	**Project Manager**	**Project Engineer I**	**Engineer in Training**	**Drafter**	**Total**
Define Project	7	4	4	6	21
Site investigation	11	11	11	11	44
Layout WWTP	8	9	14	32	63
Design	25	80	90	90	305
Economic Analysis	8	10	14	16	48
Deliverables	25	40	50	50	145
Staff Total	84	154	183	205	626

5.0 Cost of Engineering Services

5.1 Cost for Personnel

Table 3: Cost for Personnel

Cost for Personnel				
Staff	**Project Manger**	**Project Engineer I**	**Engineer in Training**	**Drafter**
Rate	$140	$105	$85	$75
Hours	84	154	183	205
Total	$17,640	$16,170	$15,555	$15,375
Combined Total	$64,740			

5.2 Additional Costs

Table 4: Additional Costs

Additional Costs				
Other Expenses	**Travel (mi)**	**Night Stay**	**Travel Meals**	**Printing/Postage**
Unit	400	2	24	3
Rate	$0.5	$250	$20	$20
Total	$200	$500	$480	$60
Sum Total	$1,240			

The estimated total cost of the project in approximately $66,000.

References

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