NORTHERN ARIZONA UNIVERSITY

# Memorandum

**To:** Dr. Jeffrey Heiderscheidt, AZ Water Association, Water Environment Federation

**From:** Copperhead Engineering- Nick Dawson, Moses Marsico, Leyla Still and Samuel Thompson

**Date:** 12/10/2025

**Re:** Final Proposal for the 91st Avenue Advanced Water Purification Facility

Enclosed is our team's Final Proposal for the Design of an Advanced Wastewater Treatment Facility, submitted as part of our CENE 476/486 Capstone Project.The attached proposal includes all required proposal components, including process selection, hydraulic evaluation, cost estimating, and preliminary layout for the facility. The design aims to meet Arizona's regulatory performance criteria while incorporating sustainable and energy-efficient treatment approaches.

As this submission is for academic purposes, no formal acceptance or authorization is required. However, we hope the design effectively demonstrates our understanding of advanced wastewater treatment technologies and our ability to produce a professional engineering deliverable.Thank you for the guidance and support provided throughout the project. Please feel free to reach out if clarification on any section of the proposal is needed.

Sincerely,

Copperhead Engineering

# Project Proposal for the Assessment and Design of the 91st Avenue Regional Advanced Water Purification Facility

COPPERHEAD
ENGINEERS

Draft #6

Prepared by:
COPPEREDHEAD ENGINEERING
1900 S KNOLES DRIVE
FLAGSTAFF, AZ 86001

Prepared for:
DR. JEFFREY HEIDERSCHEIDT, ARIZONA WATER ASSOCIATION
2875 W RAY ROAD, SITE 6-425
CHANDLER, AZ, 85224

Project Team:
Civil Engineer: Moses Marsico, mam2768@nau.edu | 928.326.4601
Environmental Engineer: Nick Dawson, nkd53@nau.edu | 480.208.6995
Civil Engineer: Sam Thompson, swt39@nau.edu | 623.313.4652
Environmental Engineer: Leyla Still, lis34@nau.edu | 253.720.6119

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COPPERHEAD ENGINEERS

## Abbreviations

| | |
|---|---|
| AAC | Arizona Administrative Code |
| ADEQ | Arizona Department of Environmental Quality |
| AOP | Advanced Oxidation Process |
| AWP | Advanced Water Purification |
| AZ Water | Arizona Water Association |
| BOD | Biochemical Oxygen Demand |
| CFR | Code of Federal Regulations |
| CIVPE | Civil Professional Engineer |
| EIT | Engineer In Training |
| EGL | Energy Grade Line |
| ENVPE | Environmental Professional Engineer |
| EPA | Environmental Protection Agency |
| FRW | Flow Regulating Wetland |
| HGL | Hydraulic Grade Line |
| INT | Intern |
| LCC | Life-Cycle Cost |
| MCL | Maximum Contaminant Level |
| MGD | Million Gallons per Day |
| NPDES | National Pollutant Discharge Elimination System |
| NPV | Net Present Value |
| O&M | Operation and Maintenance |
| OPCC | Opinion of Probable Construction Costs |
| PM | Project Manager |
| QA/QC | Quality Assurance and Quality Control |
| RO | Reverse Osmosis |
| S. ENG | Senior Engineer |
| SDC | Student Design Competition |
| SWDA | Safe Water Drinking Act |
| TDH | Total Dynamic Head |
| TDS | Total Dissolved Solids |
| TSS | Total Suspended Solids |
| UF | Ultrafiltration |
| UV | Ultraviolet |
| WEF | Water Environment Federation |
| WWTP | Wastewater Treatment Plant |

## Equations



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# 1. Project Understanding

## 1.1 Project Purpose

One objective of this project is to design a new 91st Avenue Advanced Water Purification (AWP) facility for the City of Phoenix with a capacity of 30 million gallons per day (MGD). The other objective is to compete in the 2025-2026 AZ Water Conference Student Design Competition (SDC). This competition allows universities across Arizona to compete in the Arizona Water Association (AZ Water) SDC. The winner of this competition advances to the Water Environment Federation (WEF) SDC, a national civil and environmental engineering competition. This competition provides students with real world experience in designing, evaluating, and presenting comprehensive solutions to real world water treatment challenges [1].

## 1.2 Project Background

The project for the 2025-2026 competition will be to design the 91st Avenue AWP facility. An AWP facility is a facility which treats effluent from a wastewater treatment plant (WWTP) to be potable. The 91st Avenue AWP facility will treat effluent from the 91st Avenue WWTP which has flown through the Tres Rios Flow Regulating Wetland to Outfall 005 where a pump station will be designed at the start of the 91st Avenue AWP facility [1].

### 1.2.1 Project Location

**Figure 1-1: Location Map** shows where the project is located within Arizona. The map aims to give familiarity with the region where the project site is located and highlights the Phoenix area as the city the project is in. This map was completed with QGIS.

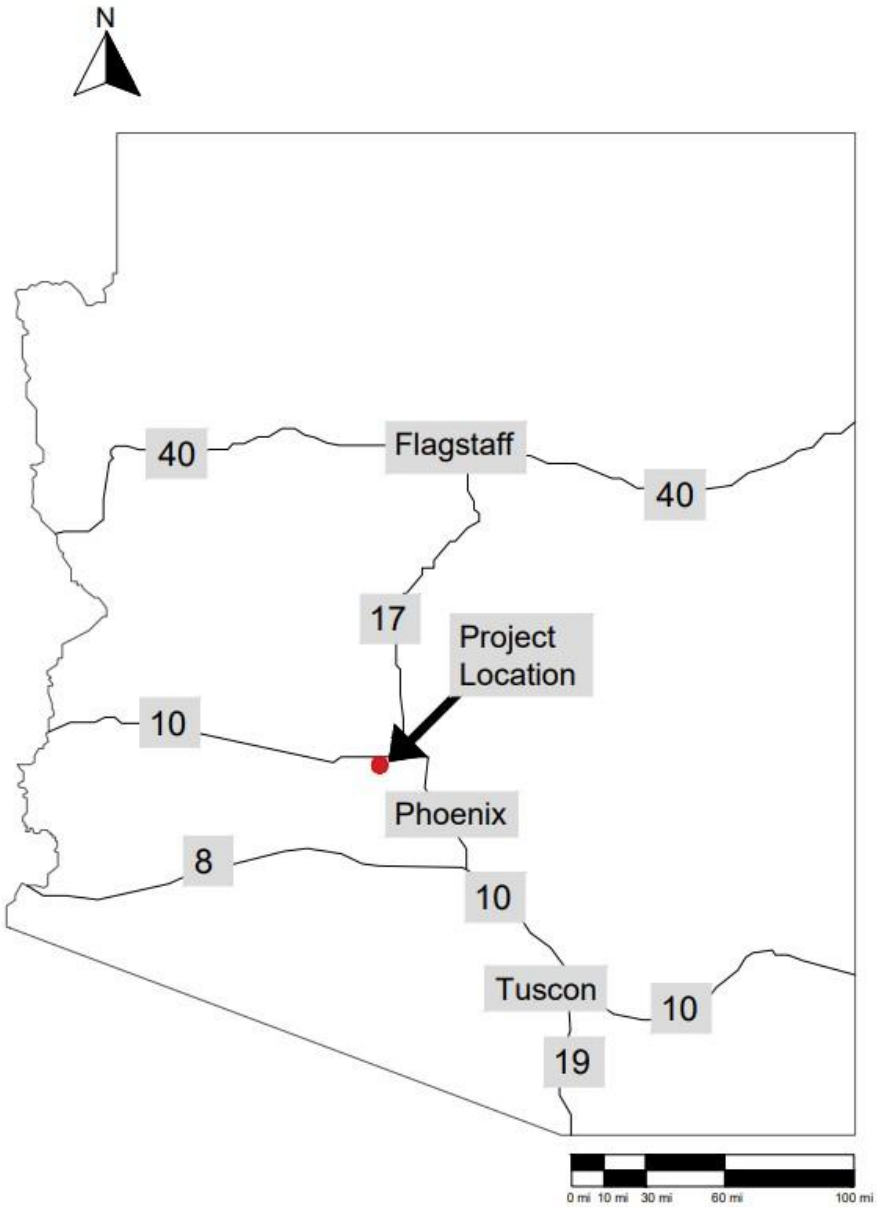


*Figure 1-1: Location Map*

**Figure 1-2: Vicinity Map** below shows the vicinity map of the surrounding area near and around the project site:

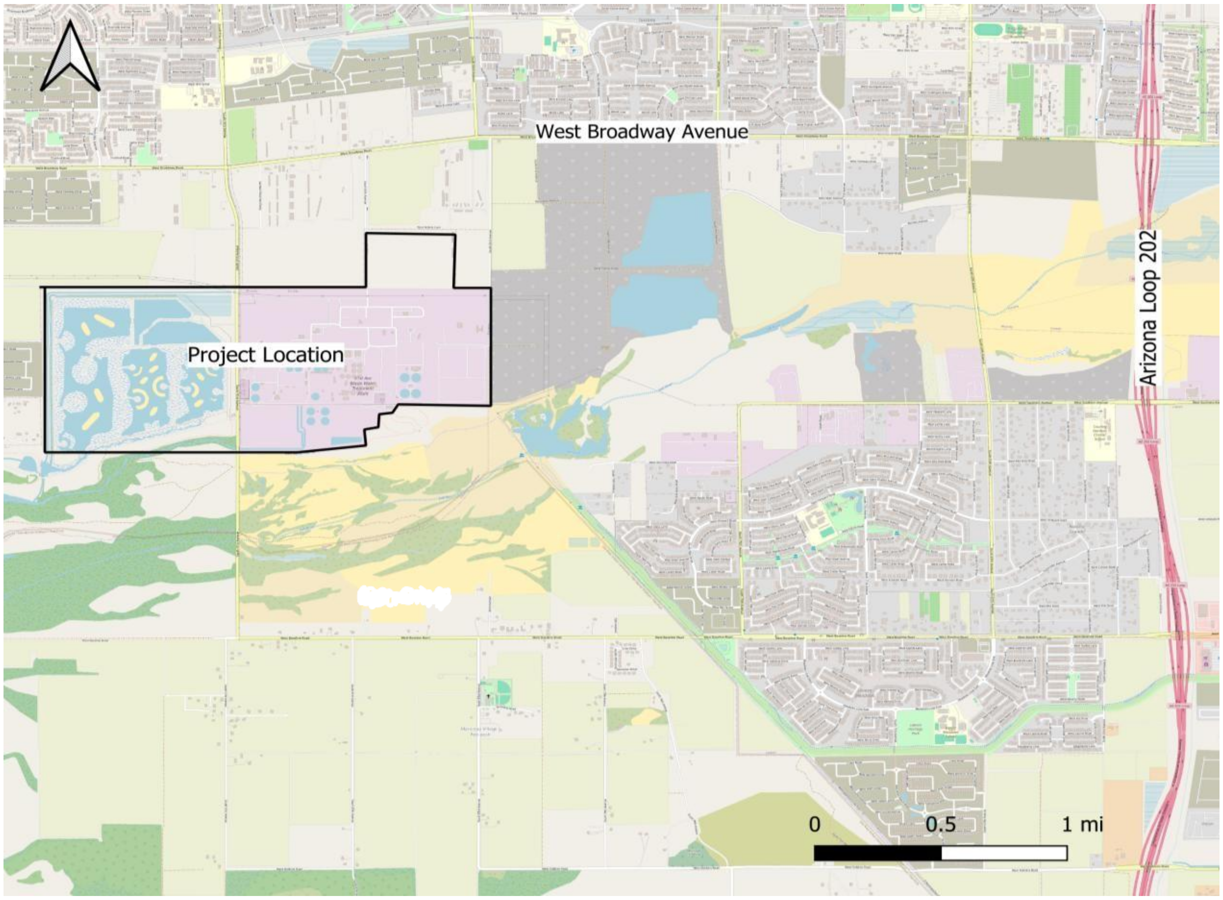


*Figure 1-2: Vicinity Map*

**Figure 1-3: Site Map** below shows the Site map of the surrounding area near and around the project site, all   plots of land highlighted in red are owned by the City of Phoenix and are an option for placement of the AWP.

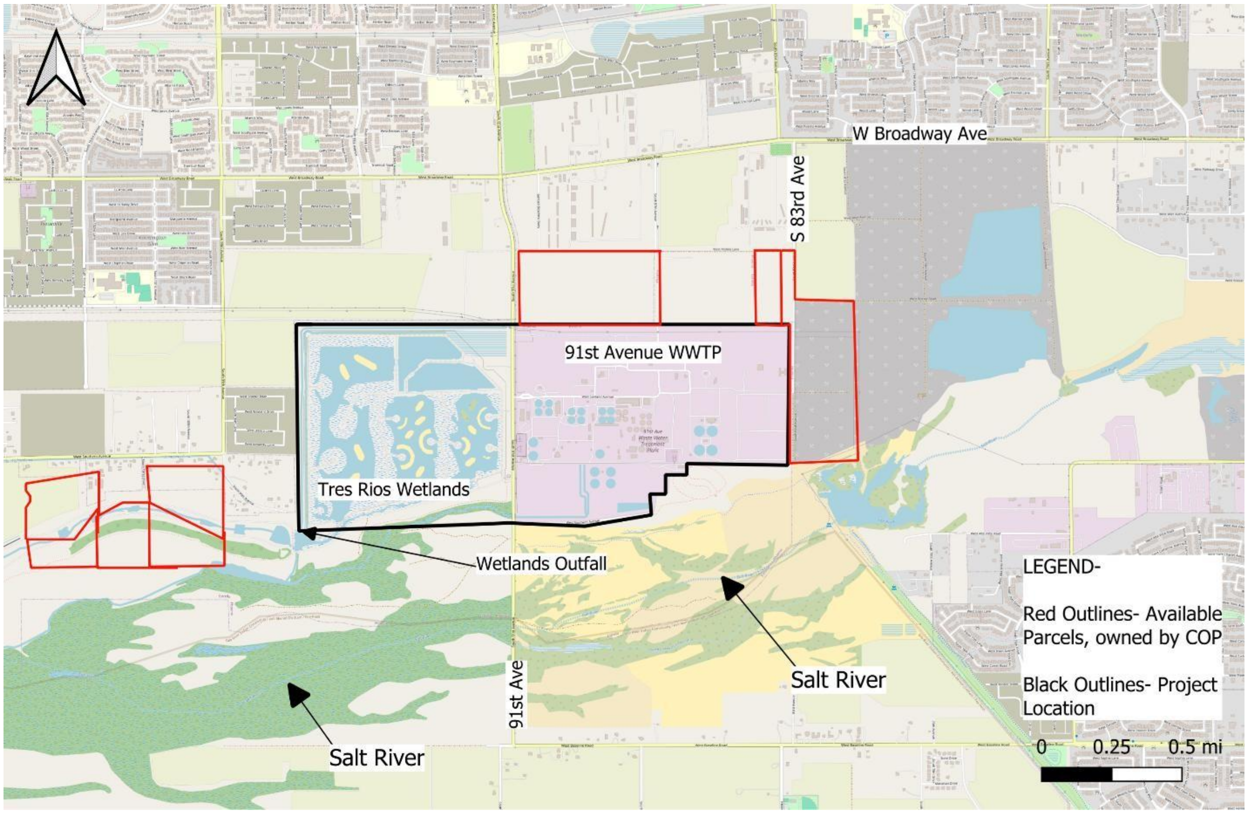


*Figure 1-3: Site Map*

## 1.2.2 Current Conditions

The AWP facility does not exist, the WWTP and the wetlands are what are currently open and operating at 91st Ave WWTP. The wetlands opened in 2012 after starting construction in 2007. Currently the wetlands are a part of a restoration project of natural areas near the Salt and Gila River, restoring about 700 acres of wetlands and natural vegetation [2]. The wetland is in overall good conditions and receives most of the effluent water from the existing WWTP. The WWTP opened in 1958 and then underwent an expansion in the early 2000's to produce 9x as more water than before. Currently the facility produces 230 MGD [3]. Both given locations are running properly and are up to all current federal, state and local codes required.

This project site is surrounded by a variety of different parcels (shown in red in Figure 1-3-) which are the potential location of the new AWP facility. The Wetlands outfall can be found in the Southwest corner of the Tres Rios Wetlands. Within a half of a mile of all parcels shown in the previous figure.

When considering which parcel to use for the new facility, the engineers will consider the size of the parcel to make sure that it is large enough to house the new AWP facility, the distance from the outfall to minimize the amount of new piping that is installed, and proximity to the Salt River to ensure the facility is not in a potential flood zone.

Currently all of the parcels contain minimal development. The parcels to the West of the Wetlands contain the least amount of development with the parcels North of the Salt River containing only farmland and the parcels South of the Salt River being undeveloped. The parcels to the East of the 91$^{st}$ Ave WWTP contain minimal amounts of development that would have to be removed.

## 1.3 Technical Considerations

The following technical considerations will guide the design and evaluation of the proposed 91st Avenue AWP Facility.

### 1.3.1 Hydraulic Analysis

Hydraulic analysis will be performed throughout the project to define how secondary effluent from the Tres Rios Flow Regulating Wetlands (FRW) will be conveyed to and through the proposed AWP facility. The analysis will include determination of flow rates, head losses, energy grade lines (EGL), hydraulic grade lines (HGL), and pump performance requirements under both average-day and peak-day conditions.

A lift station will be required to raise water from FRW Outfall 005 to the AWPF headworks. Pump sizing, wet-well volume, and discharge pipeline configuration will be based on anticipated flow conditions and system elevations. Hydraulic modeling will ensure consistent flow distribution through unit processes such as ultrafiltration (UF), reverse osmosis (RO), and advanced oxidation process (AOP) systems.

*The key outputs will include the following:*

- Hydraulic profiles from FRW Outfall 005 to the finished-water connection point
- Pump curve selection and total dynamic head (TDH) calculations
- Pipe material and diameter optimization for head-loss efficiency

### 1.3.2 Brine Management

Brine management is a critical consideration in the proposed RO treatment process, which concentrates dissolved solids and trace constituents from the influent. The design will assess brine volume and salinity, disposal and handling options including blending or evaporation, and environmental and regulatory compliance with the Arizona Department of Environmental Quality (ADEQ) R18-9-E828 and the National Pollutant Discharge Elimination Systems (NPDES) requirements for waste discharge [4].

### 1.3.3 Applicable Codes and Regulatory Framework

The driving factor when designing an AWP facility is the applicable codes and regulatory framework for the area. In Arizona, the regulatory framework when designing an AWP facility is the Arizona Advanced

Water Purification Rule [5]. This document is produced by the ADEQ and regulates AWP in Arizona. Regulations that need to be considered are at the federal, state, and city levels. These codes and framework recommend standards for AWP facilities and should be used as guidance so that project plans comply with technical design standards. Some other guidelines that need to be considered include effluent guidelines in the Code of Federal Regulations (CFR) 40 CFR Part 133 which describes minimum treatment facility performance standards.

### 1.3.4 Process Design for Treatment Systems

The design process will focus on determining the most effective and efficient treatment system for the 91st Avenue AWP facility. For this project, at least three different options for treatment trains must be created and analyzed [1]. Per the Arizona Administrative Code (AAC) R18-9-F832, the treatment system must include at least three distinct barriers that are physical, chemical, and biological that can provide pathogen and contaminant removal redundancy. A variety of calculations and variables will be needed to do this such as flow rates, settling velocity, tank dimensions, detention time, and more will be required. These different treatment trains will then be evaluated using a decision matrix, and the most efficient train will be selected. The final design process will meet any applicable state, federal, and local AWP and potable water requirements.

The three treatment train alternatives will be developed and evaluated using a decision matrix. The final process configuration will include detailed flow diagrams, unit sizing, and equipment selection for filtration, RO, ultraviolet disinfection, AOP treatment steps, ensuring the design meets regulatory compliance and performance objectives.

### 1.3.5 Lifecycle Cost Evaluation

Life-cycle cost (LCC) analysis will assess total project cost that includes capital, operation, maintenance, and replacement cost over the expected facility life. The evaluation will use Net Present Value (NPV) methods and incorporate inflation, discount rate, and energy-cost escalation consistent with City of Phoenix financial guidelines. The outputs will include the opinion of probable cost, annual operation and maintenance cost, and the LCC comparison between treatment alternatives and past historic bids for each treatment.

### 1.3.6 Pollutant Concentration and Load Calculations

Pollutant load analysis will determine influent and effluent water-quality parameters through each treatment stage. Calculations will include biochemical oxygen demand (BOD), total suspended solids (TSS), total dissolved solids (TDS), nitrogen, and pathogen log-removal rates. The design will ensure that all finished-water concentrations meet or exceed the Environmental Protection Agency (EPA) maximum contaminant levels (MCLs) and ADEQ AWP Rule standards. Mass-balance analyses will be used to verify compliance with discharge and potable reuse criteria, forming the basis for process sizing and brine-management calculations.

## 1.4 Potential Challenges

Developing an AWP facility provides many challenges that must be addressed in the successful completion of the project, generally these issues include:

Climate and Weather: Weather is a universal challenge experienced by any project. One example of this for this project could be a delay in the site investigation for a project, which could move the entire schedule back if it is an essential part of the project. Additionally, weather affects the design decisions and design requirements depending on the expected extremes of the location such as open flow channels being required to withstand flooding of 50 yr. storm events (depending on state/local regulations). Additionally, climate and weather affect potential natural and geological challenges. In Arizona these constraints would involve droughts, flash floods, dense soil, and protected wildlife (specifically the saguaro cactus).

Land Availability/Site Constraints: Along with the constraint of attempting to maintain the site's existing production, the site must also remain within the existing permitted land constraints. Issues, such as capacity specifically, must be solved efficiently where a simple solution such as expanding the perimeter of facilities may be impossible due to these constraints. Additionally, constraints such as land availability challenge flood control and other climate change solutions provided.

The solution to all constraints is comprehensive planning and well-developed alternatives that can be applied if the threat of not complying with the challenges' demands is met. For example, if the weather can cause a delay in meetings, investigation, or development of the project, backup plans or plans for such a delay will be made. In terms of construction, plans made consider the existing infrastructure production requirements, land availability, and supply chain delays by providing alternative tasks that can be accomplished in waiting for resources or alternatives that can be implemented if resources cannot be acquired or land/production constraints cannot be met.

## 1.5 Stakeholders

The existing wastewater facility is owned by the City of Tolleson and Maricopa County. These public entities are the primary stakeholders for the AWP facility, meaning that all outcomes from the AWP facility are their responsibility. The secondary stakeholders for this project are the residents and citizens who will receive this water. This demands more interest in the process and outcomes, ensuring that the city and county regulations are in place to prevent different pathogens, leaks, minimized flow and other factors that can impact the function of the facility and the health of the people receiving this water.

Because the purpose of the facility is to purify wastewater into potable, or drinking, water, a valuable stakeholder is ADEQ. The ADEQ oversees the permitting and treatment process of the water, requiring a certain level of pathogen removal, removal of TSS and TDS, salinity, and more. This organization has set the groundwork for the standards for treating wastewater into potable water. They also provide protection to those who live and work near the facility.

Currently the competition requirements are designed by WEF and AZ Water; they are the immediate stakeholders in the competition. These groups will determine which design fulfills the design standards given by the competition. They are also considered clients in this situation, providing outside detail required for the facility beyond the state and federal standards. The clients are the ones funding the project so valuing their thoughts and inputs in the project is necessary. Northern Arizona University is also involved in the project since it is being designed by 4 of their Civil and Environmental Engineering students, maintaining professionalism is vital to university relations with competitions such as the WEF SDC.

Communities located near a treatment plant can be significantly affected by factors such as odor, noise, and land use. If the facility is not properly managed, property values may decline along with a decrease in recreation and activity in the surrounding areas. The residents may become dissatisfied, ultimately putting pressure on the city. Additionally, if treated water is distributed to surrounding areas, inadequate treatment or oversight could pose risks to public health and safety.

# 2. Scope of Services

## 2.1 Task 1: Research Preparation

The research preparation is the introduction to the project. The research preparation covers the initial induction into the assignment, research on the summary of the project, potential challenges, and technical requirements needed for the project.

### 2.1.1 Task 1.1: WEF Application

The team will email AZ Water to inform them of their intent to compete in the SDC and submit a completed entry form.

### 2.1.2 Task 1.2: Regulation Research

Before the project is designed, the team will research what regulations will apply when designing the AWP facility. This will include both the guidelines for the WEF SDC as well as regulations about AWP. This will include AWP regulations on a federal, state, and local level such as the Arizona AWP Rule, the Safe Water Drinking Act (SWDA), and more.

## 2.2 Task 2: Site Assessment

The students will visit the assigned treatment facility and gather data pertaining to existing site conditions.

### 2.2.1 Task 2.1: Site Visit

The team will visit the assigned site to assess the existing infrastructure and gather information on current operations and maintenance practices. Engaging with facility employees about observed challenges will also provide valuable insights to guide potential improvements.

### 2.2.2 Task 2.2: Data Analysis

Existing data for the assigned sites such as hydrology and hydraulics, soil characteristics, land use, and historical records will be provided to the team. In addition, external research on comparable processes and facilities will be conducted and incorporated throughout the design process. Topographic maps of the facility area will be provided to help the team evaluate site conditions and determine the hydraulic measures necessary to design the most energy-efficient system.

## 2.3 Task 3: Treatment Selection Process

During this task, the different steps and processes for advanced water treatment plants will be selected.

### 2.3.1 Task 3.1: Determine Plant Requirements

When designing the treatment trains, certain treatment processes must be used. This competition requires the use of ultraviolet (UV) disinfection, an AOP, and at least one physical separation process. Beyond these required components, students have the flexibility to select additional processes needed to achieve the specified final water quality parameters.

### 2.3.2 Task 3.2: Coagulation/Flocculation

Coagulation and flocculation will be considered supplementary pretreatment processes to enhance fine particle destabilization and support improved solids removal efficiency before UF. Chemical pretreatment may reduce fouling, extend membrane lifespan, and stabilize influent quality.

#### 2.3.2.1 *Task 3.2.1: Define Criteria*

Evaluation criteria will focus on turbidity and natural organic matter reduction, compatibility with downstream RO membranes, chemical storage requirements, brine environmental impacts, and costbenefit contribution toward long-term operational performance.

#### 2.3.2.2 *Task 3.2.2: Develop Treatment Alternatives*

Options including aluminum-based, iron-based, and polymer coagulants will be reviewed, along with rapid-mix and flocculation basin configurations sized for AWP flow rates from the FRW. Jartesting data from comparable facilities will be referenced to estimate dose requirements.

#### 2.3.2.3 *Task 3.2.3: Eliminate Least Suitable Alternatives*

Alternatives will be scored based on pathogen-barrier strengthening, compatibility with UF/RO/AOP performance needs, and secondary impacts such as sludge generation and brine concentration. If coagulation/flocculation does not provide measurable enhancement, it may not be included in the final selected treatment train.

### 2.3.3 Task 3.3: Sedimentation

Sedimentation will be evaluated as a potential pretreatment step to reduce turbidity and solids loading prior to membrane filtration. Settling processes may improve performance reliability and reduce membrane fouling within downstream advanced treatment units. This task will assess whether sedimentation is operationally and economically justified based on the influent water quality from the Tres Rios FRW Outfall 005.

#### 2.3.3.1 *Task 3.3.1: Define Criteria*

Performance criteria will include turbidity reduction, pathogen removal contribution, chemical requirements, footprint constraints within City-owned property, and operational impacts such as sludge handling. These metrics will ensure sedimentation is only included if it significantly contributes toward regulatory compliance and membrane protection.

#### 2.3.3.2 *Task 3.3.2: Develop Treatment Alternatives*

Alternatives such as conventional sedimentation basins, plate settlers, or high-rate clarification systems will be evaluated based on removal efficiency, hydraulic compatibility, constructability near the site, and O&M complexity.

#### 2.3.3.3 *Task 3.3.3: Eliminate Least Suitable Alternatives*

Each sedimentation alternative will be assessed using a decision matrix aligned with ADEQ AWP Rule objectives. If sedimentation does not demonstrate clear benefits when compared to physical membrane filtration alone, it may be excluded from the final treatment train configuration.

### 2.3.4 Task 3.4 Membrane Filtration

Membrane Filtration is meant to remove any large particles or solids that came back into the water after the WWTP and movement in the wetlands. This is to avoid clogging and pumps or contaminating the rest of the water source.

#### 2.3.4.1 *Task 3.4.1: Define Criteria*

The membrane filtration requires the removal of many of the particles which were not removed in primary treatment, to avoid the damage to the rest of the AWP. Some pathogens are required to be decreased during this step including Giardia and Cryptosporidium.

#### 2.3.4.2 *Task 3.4.2: Develop Treatment Alternatives*

Preliminary is required for all treatment methods, specifically in potable water. Different types of methods are available, but they must all achieve the same outcome.

#### 2.3.4.3 *Task 3.4.3: Eliminate Least Suitable Alternatives*

Types of preliminary filtration will be assessed and the filtration method that completely adheres to Arizona State and federal policies on potable water will be chosen for the beginning of the treatment process.

### 2.3.5 Task 3.5: Advanced Oxidation

Advanced oxidation processes are processes which destroy organic matter constituents which preclude traditional water reclamation processes such as pesticides, pharmaceuticals, and endocrine disruptors. This is done by producing a hydroxide radical which completely oxidizes most organic compounds, destroying the harmful effects of these compounds without producing a waste stream [7].

#### 2.3.5.1 *Task 3.7.1: Define Criteria*

The goals for advanced oxidation will be analyzed and made into tangible goals for this step including but not limited to cost, maintenance, and efficacy. These will then be used as criteria for determining what alternative should be used in the treatment train.

#### 2.3.5.2 *Task 3.7.2: Define Treatment Alternatives*

The different reverse osmosis processes, such as ozone/UV, ozone/hydrogen peroxide, and hydrogen peroxide/UV [7], will be researched and developed for consideration.

#### 2.3.5.3 *Task 3.7.3: Eliminate Least Suitable Alternatives*

The different alternatives will be assessed and rated quantitatively based on the criteria which have been previously designed. Once these alternatives have been rated, the alternative with the highest score will be selected.

### 2.3.6 Task 3.6: Ultraviolet Disinfection

This is the third stage of the AWP process. During this stage, UV light is used to break down any remaining organic compounds [6]. This is a required process, so rather than determining criteria and determining what the best alternatives are, one method of UV disinfection will be created and implemented into the design.

### 2.3.7 Task 3.7: Final Chlorination

The final chlorination process of water treatment is a process which disinfects the water in the system through the addition of a chlorine containing compound [7]. Additionally, the addition of chlorine provides the water with a residual level of chlorine as required by the SWDA [7] and the AAC [5].

#### 2.3.7.1 *Task 3.7.1: Define Criteria*

The goals for final chlorination will be analyzed and made into tangible goals for this step including but not limited to cost, maintenance, and efficacy. These will then be used as criteria for determining what alternative should be used in the treatment train.

#### 2.3.7.2 *Task 3.7.2: Define Treatment Alternatives*

The different final chlorination processes will be researched and developed for consideration.

#### 2.3.7.3 *Task 3.7.3: Eliminate Least Suitable Alternatives*

The different alternatives will be assessed and rated quantitatively based on the criteria which have been previously designed. Once these alternatives have been rated, the alternative with the highest score will be selected. [6]

### 2.3.8 Task 3.8: Brine Management

During the reverse osmosis phase of the AWP process, a brine is created. This is the liquid which remains on the high-pressure side of the membrane once the reverse osmosis process is completed. This liquid is high in salts and other microscopic solids and is referred to as brine.

#### 2.3.8.1 *Task 3.8.1: Define Criteria*

The goals for brine management will be analyzed and made into tangible goals for this step including but not limited to cost, maintenance, and efficacy. These will then be used as criteria for determining what alternatives should be used in the treatment train.

#### 2.3.8.2 *Task 3.8.2: Define Treatment Alternatives*

The different brine management processes will be researched and developed for consideration.

#### 2.3.8.3 *Task 3.8.3: Eliminate Least Suitable Alternatives*

The different alternatives will be assessed and rated quantitatively based on the criteria which have been previously designed. Once these alternatives have been rated, the alternative with the highest score will be selected.

### 2.3.9 Task 2.9: Develop and Select Treatment Trains

Once the least suitable treatment alternatives for each process are eliminated, the design team will organize these different treatment processes into three different treatment trains. These treatment trains will then be analyzed using the previous criteria and cost, and the best treatment train will be selected as the final treatment train.

The final AWP treatment process will be determined through evaluation of all decision-matrix alternatives, focusing on performance, operational reliability, and regulatory compliance with the ADEQ AWP Rule and the U.S. EPA National Primary Drinking Water Regulation standards. Based on the 91st Avenue WWTP's secondary effluent quality flow through the Tres Rios FRW, the design team will select and integrate three advanced treatment processes that achieve potable water standards. Core processes under consideration include ultrafiltration, reverse osmosis, UV, and AOP for pathogen removal, total dissolved solids reduction, and organics destruction. Each process will be analyzed for removal efficiency, redundancy, footprint, and ease of operation within the 30 MGD system target. The final treatment configuration will ensure a minimum of three treatment barriers to meet pathogen logremoval and water-quality goals defined by AAC R18-9-E828 [5].

## 2.4 Task 4: Final Design

### 2.4.1 Task 4.1: Final Design of Selected Treatment Train

The final AWPD treatment process will be converted into a final process design beginning with the final design of the treatment processes in the selected treatment train. This will include technical calculations for the treatment processes such as sizing and configuring tanks and other processes, calculating chemical concentrations to achieve regulatory limits for potable water, and more.

### 2.4.2 Task 4.2: Site Layout

The site layout will illustrate the proposed AWPF located near the existing 91st Avenue WWTP, showing integration with existing infrastructure and proximity to the Tres Rios FRW outfall [1]. Layout drawings will identify the pump station, conveyance piping from Outfall 005, treatment structures, chemical storage, electrical and control buildings, and finished-water discharge connections to the City's potable distribution system. Grading and access routes will be optimized for constructability, maintenance access, and safety while maintaining compliance with City property limits and floodplain constraints [5].

### 2.4.3 Task 4.3: Hydraulic Analysis

The team will analyze the hydraulics of the facility and consider what pumps and fittings will be needed for improvements. A detailed hydraulic analysis will be conducted to evaluate flow conveyance from the FRW to the proposed AWP facility and through each unit process. The analysis will establish HGLs and EGLs for normal and peak flow conditions, determine static and dynamic pump head requirements, and confirm that flow velocities and head losses are within acceptable design limits. System elevations and pipe alignments will be refined to ensure efficient gravity and pumped conveyance throughout the treatment train.

#### 2.4.3.1 *Task 4.3.1: Lift Station Design*

A new lift station will be designed to raise the secondary effluent from the Tres Rios FRW Outfall 005 to the AWP facility headworks [1]. The design will include pump selection (capacity, TDH, and redundancy), wet-well sizing, electrical and control systems, and standby power provisions. The lift station will be integrated with the AWP facility's automation system to ensure reliable operation under variable influent flow conditions [5].

#### 2.4.3.2 *Task 4.3.2: Pump Selection*

A pump and pipe system will be selected and created based on the current conditions of the facility and what the future conditions are looking to meet. Furthermore, the flow and head loss of the current facility will need to be analyzed to calculate and identify the best pump for the AWP facility.

#### 2.4.3.3 *Task 4.3.3: Piping Design*

Hydraulic profiles and utility maps will be prepared to verify conveyance from the FRW Outfall 005 lift station to the AWPF inlet structure. Designs will include head loss calculations, material sizing, and layout of transmission mains, yard piping, and inter-process connections to maintain continuous flow and operational redundancy.

### 2.4.4 Task 4.4: Public Outreach Plan

Public outreach is critical to ensuring community understanding and support for direct potable reuse initiatives. The outreach plan will aim to educate residents, stakeholders, and local organizations on the purpose, safety, and sustainability benefits of the AWP facility.

The team will develop a communication strategy that aligns with City of Phoenix water initiatives and emphasizes transparency, health protection, and resource conservation. Moreover, some things to consider will be developing informational materials that explain the AWP facility, presenting slides for the community meetings and other community meetings, providing activities that allow the public to be included in, and an FAQ section that can address any common concerns about the safety and quality of the treatment.

### 2.4.5 Task 4.5: Construction Phasing

Although this project mainly consists of the creation of the new AWP facility, there will also be additions to the existing WWTP. To do this, the construction will have to have phasing which ensures that the plant is not taken offline. The best course of action to deal with this would be to consider if the expansion should be carried out in a timely manner or slowly. Moreover, what times are best to work and what times are not best to work so that daily demand is not disturbed or interrupted. Construction phasing also will consider when materials should be brought and where the best location on site for the material is. Similar and past projects can be reviewed as an examination source to verify how inflation will affect this.

## 2.5 Task 5: Cost Assessment

This task evaluates the total cost of the proposed 91st Avenue Advanced Water Purification Facility (AWPF) over its entire service life, including construction, operation, maintenance, and replacement costs. The analysis will provide a framework for comparing treatment alternatives and determining the most costeffective and sustainable solution for the City of Phoenix.

### 2.5.1 Task 5.1: Opinion of Probable Construction Costs (OPCC)

Construction costs will be the sum of the total materials, all equipment, transportation, and elements that were included in the treatment plants construction process. Cost estimates will be derived from recent regional bid data, RS Means construction cost indices [8], and vendor equipment quotations when available [9]. Once the final site layout and process configuration are confirmed, a refined OPCC will be developed to ensure alignment with City of Phoenix capital budgeting standards. Moreover, these capital expenditures may include site preparation, grading, yard piping, control systems, engineering electrical systems for the AWPF, and any conveyance piping from the FRW Outfall 005.

### 2.5.2 Task 5.2: Operation and Maintenance (O&M) Cost

The O&M cost assessment will account for all annual expenses associated with operating the AWPF. This includes energy consumption, chemical usage, membrane cleaning and replacement, labor, and routine maintenance. The cost of this will change consistently based on what improvements are made to the AWPF and what the client wants and needs. To elaborate, these costs are spent on any repairs that are needed within the plant, such as power outages, piping changes, capacity increases and decreases, pH adjustments, membrane clearing, UV-AOP power demand, and any operations and technician staff costs. These costs will best fit the clients' budget by comparing and documenting upgrades and potential improvements that want to be made. These improvements should include alternatives and an average cost for what the plant spends per year on operating and maintaining. [8] [9]

### 2.5.3 Task 5.3: Life Cycle Cost

The Life Cycle Cost (LCC) analysis will combine all capital and annual O&M costs to evaluate the total economic impact of each treatment alternative over the facility's design life (typically 20–30 years). The LCC will include the initial capital cost, annual operation and maintenance costs, replacement and rehabilitation costs for major components, and inflation and discount rate per City of Phoenix financial policy. This can be calculated using the net present value equation to also help in determining the preferred treatment train. [8]

*Equation 2--1. Net Present Value (NPV) Calculation*

$$NPV = \sum_{t=0}^{n} \left( \frac{C_t}{(1 + r)^t} \right)$$

**$C_t$ = annual cost in year (t) r**

**= discount rate (typ. 3-4%)**

**n = analysis period (years)**

## 2.6 Task 6: Impact Analysis

This section includes the discussion of positive and negative impacts the treatment facility will have on the environment, society, and the economy. The social impact portion examines the ways in which the local community is affected by the treatment facility, ranging from concerns such as odor complaints to benefits such as reduced risk of waterborne illnesses due to effective wastewater management.

The environmental impact analysis evaluates how the function of the treatment facility influences water quality and the spread of pathogens and bacteria in the surrounding area, as well as how its operation contributes to greenhouse gas emissions. The economic analysis will assess how a well-functioning treatment facility supports the local economy, as well as the potential challenges that may arise if the plant underperforms. The analysis will also examine job creation and the influence of population growth on economic outcomes.

## 2.7 Task 7: Project Deliverables

This project includes several key deliverables required by the Water Environment Federation (WEF), AZ Water Student Design Competition, and CENE476/486 course. Each submittal milestone represents a progressive stage in project development, ensuring that design decisions are supported by technical analysis and aligned with the competition requirements.

### 2.7.1 Task 7.1: 30% Deliverable

The 30% deliverable will establish the foundational elements of the design. It will summarize the work completed in Tasks 1 and 2, including project background, problem statement, site description, regulatory framework, and preliminary treatment process alternatives. At this stage, the focus is on defining project objectives, identifying key design criteria, and developing an initial decision matrix for evaluating treatment train options. The delivery will consist of a written report and presentation outlining the basis of design and preliminary findings for instructor and client review.

### 2.7.2 Task 7.2: 60% Deliverable

The 60% deliverable will demonstrate substantial design progress and refinement of engineering details. It will summarize results from Tasks 3 and 4, including updated treatment process configurations, preliminary hydraulic profiles, and early site layout concepts showing the proposed AWPF in relation to the existing 91st Avenue WWTP and Tres Rios FRW. This submittal will also present refined process flow diagrams and the first iteration of the Opinion of Probable Construction Cost (OPCC). The 60% deliverable will include a draft report and presentation that incorporate feedback from prior reviews and guide the next phase of design.

### 2.7.3 Task 7.3: 90% Deliverable

The 90% deliverable will present a near-final design package that integrates all major components of the project. It will summarize the results from Tasks 5 and 6, including finalized treatment train selection, detailed hydraulic analysis, updated OPCC and Operation & Maintenance (O&M) estimates, and draft Life-Cycle Cost (LCC) calculations. Supporting materials such as the project website, technical poster, and presentation will also be completed at this stage. The 90% deliverable will undergo internal quality review and instructor feedback to ensure accuracy before final submission.

### 2.7.4 Task 7.4: Final Deliverable

The final delivery will incorporate all corrections, clarifications, and recommendations from the 90% review to produce a polished, professional design package. It will include the final report, refined hydraulic profiles, complete cost summaries, and updated community outreach materials. The presentation and website will be finalized to reflect the approved design for submission to CENE476/486. This version represents the fully developed engineering solution and serves as the official submittal prior to the competition phase.

### 2.7.5 Task 7.5: Competition Final Report

The final competition report will present a comprehensive and professional summary of the entire project. It will consolidate all previous deliverables into a single, cohesive document that meets the AZ Water Student Design Competition format and judging criteria. The report will highlight key design decisions, treatment selection rationale, cost evaluation, and the project’s alignment with sustainability and community objectives. This final submittal will serve as both the formal written record of the team's work and the primary reference for the competition presentation.

### 2.7.6 Task 7.6: Competition Final Presentation

The competition's final presentation will be presented at the WEF competition and will include all required and relevant information from throughout the duration of the project.

## 2.8 Task 8: Project Management

Effective project management is essential for the successful completion of any engineering project. To ensure efficiency and quality, this task focuses on three key aspects: scheduling, resource allocation, and communication.

### 2.8.1 Task 8.1: Schedule Management

The team will maintain a detailed project schedule outlining all deliverables, responsible team members, and estimated completion times for each milestone. The schedule will also include contingency activities to accommodate unforeseen challenges or design revisions during the project. The schedule will also reserve coordination windows with 91st Ave WWTP operations to validate constructability of the Outfall 005 lift-station and yard-piping alignments so that existing treatment and the Tres Rios FRW flows are not disrupted. Risks to schedule (membrane vendor data, HGL updates, site constraints) will be tracked in a risk register with owners and mitigation actions.

### 2.8.2 Task 8.2: Resource Management

Staffing and resource allocation will be continuously monitored throughout the design process to ensure the project remains within scope and budget. Workload distribution will reflect technical expertise in areas such as process design, hydraulics, and cost analysis, with weekly reviews to ensure schedule adherence. Budget focus items include time for vendor coordination (UF/RO/UV), hydraulic iterations from revised elevations, and City of Phoenix drawing standards. The Copperhead engineering team will control scope, hours, and deliverable quality against the engineering budget, with weekly earned-hours checks at the task level and change-control for any scope additions

### 2.8.3 Task 8.3: Meetings

Weekly meetings will be held among the engineering team, technical advisor, grading instructor, and client to maintain clear communication and ensure all deliverables meet the required standards. Meeting minutes will document key decisions and action items for accountability.

## 2.9 Exclusions

This project will rely solely on data and information provided by the client and publicly available sources. No new field surveys, sampling, or mapping will be conducted by the design team. The analysis and design will be conceptual, based on existing hydraulic, topographic, and regulatory data.

# 3. Project Schedule

The project schedule outlines the sequence, duration, and interdependencies of all major tasks required to complete the 2025–2026 WEF Student Design Competition deliverables. A detailed Gantt chart summarizing these tasks, their durations, and milestone dates is provided in Appendix A. This schedule ensures that the team progresses efficiently from initial research through final design, cost estimation, impact evaluation, and final deliverable preparation.

## 3.1 General Scheduling Plan

The project begins on October 27, 2025, and concludes with the submission of final deliverables in May 2026. Major phases include:

- **Task 1.0 – Research Preparation:** Application submission and regulation research
- **Task 2.0 – Site Assessment:** Site visit and initial data evaluation
- **Task 3.0 – Treatment Selection Process:** Detailed criteria development, alternatives analysis, and final process selection for each unit operation
- **Task 4.0 – Final Design:** Hydraulic modeling, treatment process design, site layout, and supporting plans
- **Task 5.0 – Cost Assessment:** Construction, O&M, and LCC estimation
- **Task 6.0 – Impact Analysis:** Environmental, social, and economic assessment
- **Task 7.0 – Deliverables:** Preparation of the 30%, 60%, 90%, and Final submittals

The due dates for the Task 7 deliverables can be found below. More information can be found on this in Appendix A.

- **30% Deliverable:** February 27, 2026
- **60% Deliverable:** March 24, 2026
- **90% Deliverable:** April 23, 2026
- **Final Deliverable:** May 8, 2026
- **Competition Final Report:** April 13, 2026
- **Competition Final Presentation:** April 30, 2026

Each phase contains sub-tasks with defined durations and dependencies. This structured sequence ensures that technical analyses feed directly into design decisions and that all competition deadlines are met.

## 3.2 Critical Path and Purpose

The critical path includes all tasks that directly influence the completion of the Final Deliverables. Delays in any of these tasks will delay the total project duration. Based on the Gantt chart, the critical path includes:

- **Task 1.2 – Regulation Research**
- **Task 3.0 – Treatment Selection Process and related sub-tasks**
- **Task 4.0 – Final Design (all subcomponents, including hydraulic analysis and layout)**
- **Task 5.0 – Cost Assessment**
- **Task 6.0 – Impact Analysis**
- **Task 7.3 – 90% Deliverable**
- **Task 7.4 – Final Deliverable**

These tasks constitute the longest continuous chain from project start to project completion. Because each design phase depends on decisions from the treatment selection process, the critical path reflects the technical workflow required to develop a complete and defensible AWPF design.

To ensure timely completion, the team will prioritize all critical path activities, allocate additional work sessions as needed over weekends and spring break, and monitor upcoming deadlines during weekly meetings. Milestones at 30%, 60%, 90%, and Final submission points highlight progress and allow the team to adapt the schedule based on actual completion rates. To ensure that these deadlines are met, the team will take advantage of float time over weekends and spring break if they fall behind.

## 3.3 Schedule Maintenance

The team will track progress and update the project schedule weekly. Any deviation within early completion, delay, or scope change will be documented and reflected in Microsoft Project to maintain schedule accuracy. Critical path tasks will receive priority in staffing and workload distribution.

If a task is completed earlier than predicted, successors may be shifted forward to accelerate the schedule. Conversely, if delays occur, the team will adjust workloads, redistribute responsibilities, or add weekend work sessions to maintain critical path timing and avoid timeline slippage.

# 4. Staffing Plan

## 4.1 Staffing Positions

The facility to be developed requires several people of different backgrounds to work together and collaborate on the design to ensure quality. The different members of the team will have different tasks and background knowledge to ensure quality work through the completion of the project. These roles will include:

- Senior Engineer (SENG)
- Project Manager (PM)
- Project Engineer (PE)
- Assistant Engineer/Engineer-in-Training (EIT)
- Intern (INT)

## 4.2 Position Qualifications and Responsibilities

The SENG is a professional engineer that has been practicing with their PE in civil or environmental engineering, for at least 10 years. Many SENG have a specialty that they focus on but can practice different civil/environmental engineering disciplines. They will oversee engineering design processes such as client meetings and design review. The SENG will not have as many billable hours as the rest of the engineering roles due to their higher billable rate.

The PM is an engineer with a Project Manager Professional (PMP) certification. Their role is oversight of the entire project, from stakeholders to quality control. This role requires 5-7 years of prior experience in project management and other engineering jobs. The PM is a direct point of contact for technical and nontechnical roles throughout the facility design.

The PE is a professional engineer with a PE license in civil or environmental engineering. The PE will be responsible for both hydraulic and structural design of the treatment facility, as well as treatment and disinfection process design. This engineer is a licensed professional with a minimum of 4 years of experience in the engineering field. The PE handles the more complex design tasks and reviews the work of lower-level engineers before it is reviewed by the SENG.

The EIT is a newer engineer, someone who has only taken the Fundamentals of Engineering (FE) exam and has yet to take the Principles and Practice of Engineering (PE) exam. There is no requirement for how long this engineer has practiced for, but rather the engineer must have graduated from an ABET accredited program, with a civil or environmental engineering degree. This role typically has many billable hours due to their low billable rates, completing data collection and organization, calculations and analysis, reports, and preliminary designs of the project. Depending on the knowledge and experience of the EIT, responsibilities can vary. The EIT is the first point of contact for the intern when there are questions but can go up the chain of command if the answer is unknown.

The INT is a student who has been studying civil or environmental engineering for at least a year (Sophomore and above) and has little to no experience in the field. This role is minimal, working on redlines, simple drafting, some calculations, and data collection. The intern can also oversee preliminary research such as finding existing conditions and historical information on the project site.

## 4.3 Staffing Plan Matrix

Below, Table 4-1 shows a summary of the Staffing Matrix. The full staffing matrix can be found in **Error! Reference source not found.**, accounting for each task in Section 2 for each listed role in Section 4.1. Copperhead Engineers estimate to work about 690 hours in total on the project design process.

*Table 4-1: Staffing Matrix Summary*

| **Tasks:** | **SENG (hrs)** | **PM (hrs)** | **PE (hrs)** | **EIT (hrs)** | **INT(hrs)** | **Total** |
|---|---|---|---|---|---|---|
| 1. Research Preparation | 1 | 0 | 1 | 12 | 16 | **30** |
| 2. Site Assessment | 9 | 0 | 9 | 14 | 10 | **42** |
| 3.Treatment Selection Process | 10 | 10 | 40 | 80 | 70 | **210** |
| 4. Final Design | 10 | 10 | 30 | 70 | 38 | **158** |
| 5. Cost Assessment | 0 | 0 | 5 | 20 | 15 | **40** |
| 6. Impact Analysis | 0 | 0 | 5 | 10 | 10 | **25** |
| 7. Project Deliverables | 15 | 5 | 15 | 50 | 30 | **115** |
| 8. Project Management | 5 | 15 | 10 | 20 | 20 | **70** |
| Total | **50** | **40** | **115** | **276** | **209** | **690** |

# 5. Cost of Engineering Services

**Table 5-1** shows the total cost of engineering services including needed personnel, travel expenses, and software/computer lab rental to be $94,642 with personnel accounting for the vast majority. The billing rate is based on the base pay which reflects the experience and expertise of the role, employee benefits such as insurance, dental and more which in the state of Arizona is about 25% of the wage along with overhead hours and company profit. All these factors make up the billing rate seen in section 1 of table 5-1. The trip accounts for 2 separate trips, one site visit to the existing WWTP and wetlands which will be a day trip and only account for a van and milage. The second trip accounts for a 2-day, 1 night stay trip down to the competition with a rental van and 3 hotel rooms for the engineers. The values below are based on the fleet rates for the year 2026 for Northern Arizona University [10]. Also included is rental of NAU software and computer lab used throughout the project.

*Table 5-1: Cost of Engineering Services*

| 1.0 Personnel | Classification | Billing Rate ($/hr) | Time (hrs) | Cost |
|---|---|---|---|---|
| | SENG | 325 | 50 | $16,250 |
| | Engineer (PE) | 190 | 115 | $21,850 |
| | Project Manager | 174 | 40 | $6,960 |
| | EIT | 130 | 276 | $35,880 |
| | Engineer Intern | 42 | 209 | $8,778 |
| | Total Personnel | - | | $89,718 |
| 2.0 Travel/ Competition | | Units | Cost | |
| | WEF Application | 4 People | $21/person | $84 |
| | 2 trip (round) | 620 mi | $0.42/mi | $260 |
| | Vehicle | 3 days | $77/day | $230 |
| | Hotel: rooms x nights | 3 x 3 | $150/night | $1,350 |
| | Per Diem 5 ppl | 2 days | $62/day | $620 |
| | Total Travel | | | $1,924 |
| 3.0 Supplies | | | | |
| | Software and Computer Lab | 30 | $100/day | $3,000 |
| Total EGR Team | | | | $94,642 |

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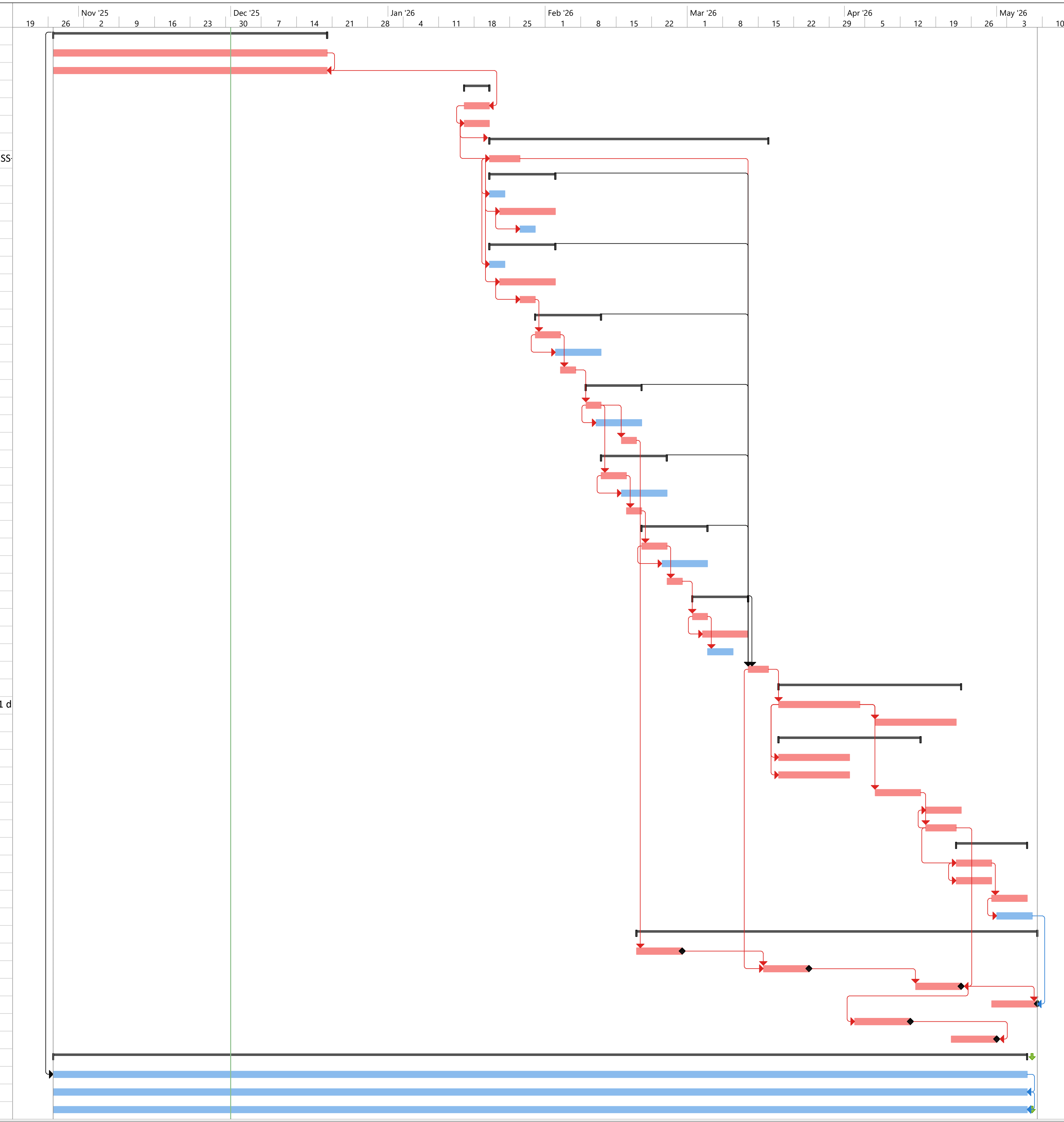
# 6. Appendices

Appendix A: Project Schedule

Appendix B: Staffing Matrix

# Appendix A: Project Schedule

| ID | Task Mode | Task Name | Duration | Start | Finish | Predecessors | Successors |
|---|---|---|---|---|---|---|---|
| 1 | | **Task 1.0: Research Preparation** | **40 days** | **Mon 10/27/25** | **Fri 12/19/25** | | **60SS** |
| 2 | | Task 1.1 WEF Application | 40 days | Mon 10/27/25 | Fri 12/19/25 | | 3FF |
| 3 | | Task 1.2 Regulation Research | 40 days | Mon 10/27/25 | Fri 12/19/25 | 2FF | 5FF+22 days |
| 4 | | **Task 2.0: Site Assessment** | **3 days** | **Fri 1/16/26** | **Tue 1/20/26** | | |
| 5 | | Task 2.1 Site Visit | 3 days | Fri 1/16/26 | Tue 1/20/26 | 3FF+22 days | 6SS |
| 6 | | Task 2.2 Data Analysis | 3 days | Fri 1/16/26 | Tue 1/20/26 | 5SS | 7SS+2 days,8SS+3 days |
| 7 | | **Task 3.0: Treatment Selection Process** | **39 days** | **Wed 1/21/26** | **Mon 3/16/26** | **6SS+2 days** | |
| 8 | | Task 3.1 Determine Plant Requirements | 4 days | Wed 1/21/26 | Mon 1/26/26 | 6SS+3 days | 10SS,11SS+2 days,37,14SS,15SS |
| 9 | | **Task 3.2 Coagulation/Flocculation** | **9 days** | **Wed 1/21/26** | **Mon 2/2/26** | | **37** |
| 10 | | Task 3.2.1 Define Criteria | 3 days | Wed 1/21/26 | Fri 1/23/26 | 8SS | |
| 11 | | Task 3.2.2 Treatment Alternatives | 7 days | Fri 1/23/26 | Mon 2/2/26 | 8SS+2 days | 12SS+2 days |
| 12 | | Task 3.2.3 Eliminate Least Suitable Alternative | 3 days | Tue 1/27/26 | Thu 1/29/26 | 11SS+2 days | |
| 13 | | **Task 3.3 Sedimentation** | **9 days** | **Wed 1/21/26** | **Mon 2/2/26** | | **37** |
| 14 | | Task 3.3.1 Define Criteria | 3 days | Wed 1/21/26 | Fri 1/23/26 | 8SS | |
| 15 | | Task 3.3.2 Treatment Alternatives | 7 days | Fri 1/23/26 | Mon 2/2/26 | 8SS+2 days | 16SS+2 days |
| 16 | | Task 3.3.3 Eliminate Least Suitable Alternative | 3 days | Tue 1/27/26 | Thu 1/29/26 | 15SS+2 days | 18 |
| 17 | | **Task 3.4 Membrane Filtration** | **9 days** | **Fri 1/30/26** | **Wed 2/11/26** | | **37** |
| 18 | | Task 3.4.1 Define Criteria | 3 days | Fri 1/30/26 | Tue 2/3/26 | 16 | 20,19SS+2 days |
| 19 | | Task 3.4.2 Treatment Alternatives | 7 days | Tue 2/3/26 | Wed 2/11/26 | 18SS+2 days | |
| 20 | | Task 3.4.3 Eliminate Least Suitable Alternative | 3 days | Wed 2/4/26 | Fri 2/6/26 | 18 | 22 |
| 21 | | **Task 3.5 Advanced Oxidation** | **9 days** | **Mon 2/9/26** | **Thu 2/19/26** | | **37** |
| 22 | | Task 3.5.1 Define Criteria | 3 days | Mon 2/9/26 | Wed 2/11/26 | 20 | 24FS+2 days,26,23SS+2 days |
| 23 | | Task 3.5.2 Treatment Alternatives | 7 days | Wed 2/11/26 | Thu 2/19/26 | 22SS+2 days | |
| 24 | | Task 3.5.3 Eliminate Least Suitable Alternative | 3 days | Mon 2/16/26 | Wed 2/18/26 | 22FS+2 days | 53 |
| 25 | | **Task 3.6 Ultraviolet Disinfection** | **9 days** | **Thu 2/12/26** | **Tue 2/24/26** | | **37** |
| 26 | | Task 3.6.1 Define Criteria | 3 days | Thu 2/12/26 | Mon 2/16/26 | 22 | 28,27SS+2 days |
| 27 | | Task 3.6.2 Treatment Alternatives | 7 days | Mon 2/16/26 | Tue 2/24/26 | 26SS+2 days | |
| 28 | | Task 3.6.3 Eliminate Least Suitable Alternative | 3 days | Tue 2/17/26 | Thu 2/19/26 | 26 | 30 |
| 29 | | **Task 3.7 Final Chlorination** | **9 days** | **Fri 2/20/26** | **Wed 3/4/26** | | **37** |
| 30 | | Task 3.7.1 Define Criteria | 3 days | Fri 2/20/26 | Tue 2/24/26 | 28 | 32,31SS+2 days |
| 31 | | Task 3.7.2 Treatment Alternatives | 7 days | Tue 2/24/26 | Wed 3/4/26 | 30SS+2 days | |
| 32 | | Task 3.7.3 Eliminate Least Suitable Alternative | 3 days | Wed 2/25/26 | Fri 2/27/26 | 30 | 34 |
| 33 | | **Task 3.8 Brine Management** | **9 days** | **Mon 3/2/26** | **Thu 3/12/26** | | **37** |
| 34 | | Task 3.8.1 Define Criteria | 3 days | Mon 3/2/26 | Wed 3/4/26 | 32 | 36,35SS+2 days |
| 35 | | Task 3.8.2 Treatment Alternatives | 7 days | Wed 3/4/26 | Thu 3/12/26 | 34SS+2 days | |
| 36 | | Task 3.8.3 Eliminate Least Suitable Alternative | 3 days | Thu 3/5/26 | Mon 3/9/26 | 34 | |
| 37 | | Task 3.9 Develop & Select Treatment Trains | 2 days | Fri 3/13/26 | Mon 3/16/26 | 8,9,13,17,21,25,29,33 | 39FS+2 days,54SS+1 day |
| 38 | | **Task 4.0: Final Design** | **26 days** | **Thu 3/19/26** | **Thu 4/23/26** | | |
| 39 | | Task 4.1 Selected Treatment Design Process | 12 days | Thu 3/19/26 | Fri 4/3/26 | 37FS+2 days | 40FS+1 day,42SS,43SS,44FS+1 d |
| 40 | | Task 4.2 Site Layout | 12 days | Tue 4/7/26 | Wed 4/22/26 | 39FS+1 day | |
| 41 | | **Task 4.3 Hydraulic Analysis** | **20 days** | **Thu 3/19/26** | **Wed 4/15/26** | | |
| 42 | | Task 4.3.1 Lift Station Design | 10 days | Thu 3/19/26 | Wed 4/1/26 | 39SS | |
| 43 | | Task 4.3.2 Pump Selection | 10 days | Thu 3/19/26 | Wed 4/1/26 | 39SS | |
| 44 | | Task 4.3.3 Piping Design | 7 days | Tue 4/7/26 | Wed 4/15/26 | 39FS+1 day | 46FS+1 day |
| 45 | | Task 4.4 Public Outreach Plan | 5 days | Fri 4/17/26 | Thu 4/23/26 | 46SS | |
| 46 | | Task 4.5 Construction Phasing | 4 days | Fri 4/17/26 | Wed 4/22/26 | 44FS+1 day | 48SS+4 days,55FF,45SS |
| 47 | | **Task 5.0: Cost Assessment** | **10 days** | **Thu 4/23/26** | **Wed 5/6/26** | | |
| 48 | | Task 5.1 Opinion of Probable Construction Costs | 5 days | Thu 4/23/26 | Wed 4/29/26 | 46SS+4 days | 49SS,50 |
| 49 | | Task 5.2 Operation and Maintenance Costs | 5 days | Thu 4/23/26 | Wed 4/29/26 | 48SS | |
| 50 | | Task 5.3 Life Cycle Costs | 5 days | Thu 4/30/26 | Wed 5/6/26 | 48 | 51SS+1 day |
| 51 | | Task 6.0: Impact Analysis | 5 days | Fri 5/1/26 | Thu 5/7/26 | 50SS+1 day | 56FF |
| 52 | | **Task 7.0: Project Deliverables** | **57 days** | **Thu 2/19/26** | **Fri 5/8/26** | | |
| 53 | | Task 7.1 30% Deliverable | 7 days | Thu 2/19/26 | Fri 2/27/26 | 24 | 54FS+10 days |
| 54 | | Task 7.2 60% Deliverable | 7 days | Mon 3/16/26 | Tue 3/24/26 | 53FS+10 days,37SS+1 day | 55FS+15 days |
| 55 | | Task 7.3 90% Deliverable | 7 days | Wed 4/15/26 | Thu 4/23/26 | 54FS+15 days,46FF | 56FS+4 days,57FS-15 days |
| 56 | | Task 7.4 Final Deliverable | 7 days | Thu 4/30/26 | Fri 5/8/26 | 55FS+4 days,51FF | |
| 57 | | Task 7.5 Competition Final Report | 7 days | Fri 4/3/26 | Mon 4/13/26 | 55FS-15 days | 58FF+13 days |
| 58 | | Task 7.6 Competition Final Presentation | 7 days | Wed 4/22/26 | Thu 4/30/26 | 57FF+13 days | |
| 59 | | **Task 8.0: Project Management** | **138 days** | **Mon 10/27/25** | **Wed 5/6/26** | | |
| 60 | | Task 8.1 Schedule Management | 138 days | Mon 10/27/25 | Wed 5/6/26 | 1SS | 61FF |
| 61 | | Task 8.2 Resouce Management | 138 days | Mon 10/27/25 | Wed 5/6/26 | 60FF | 62FF |
| 62 | | Task 8.3 Meetings | 138 days | Mon 10/27/25 | Wed 5/6/26 | 61FF | |




Project: 91st Ave. Regional AWPF Project
Date: Mon 12/1/25

Task · Split · Milestone · Summary · Project Summary · Inactive Task · Inactive Milestone · Inactive Summary · Manual Task · Duration-only · Manual Summary Rollup · Manual Summary · Start-only · Finish-only · External Tasks · External Milestone · Deadline · Critical · Critical Split · Progress · Manual Progress

# Appendix B: Staffing Matrix

COPPERHEAD ENGINEERS

## Staffing

| Tasks | S ENG (hrs) | PM (hrs) | PE (hrs) | EIT (hrs) | INT (hrs) | Total |
|---|---|---|---|---|---|---|
| 1. Research Preparation | **1** | **0** | **1** | **12** | **16** | **30** |
| 1.1 WEF Application | 1 | 0 | 0 | 1 | 1 | |
| 1.2 Regulation Preperation | 0 | 0 | 0 | 11 | 15 | |
| 2. Site Assesment | **9** | **0** | **9** | **14** | **10** | **42** |
| 2.1 Site Visit | 0 | 0 | 9 | 9 | 9 | |
| 2.2 Data Analysis | 0 | 0 | 0 | 5 | 1 | |
| 3. Treatment Selection Process | **10** | **10** | **40** | **80** | **70** | **210** |
| 3.1 Determing Plant Requirements | 0 | 0 | 0 | 2 | 3 | |
| 3.2 Coagulation/Flocculation | 0 | 0 | 5 | 6 | 9 | |
| 3.2.1 Define Criteria | 0 | 0 | 0 | 2 | 3 | |
| 3.2.2 Develop Treatment Alterative | 0 | 0 | 0 | 2 | 3 | |
| 3.2.3 Determine Least Suitable Alterantaive | 0 | 0 | 0 | 2 | 3 | |
| 3.3 Sedimentation | 0 | 0 | 5 | 6 | 9 | |
| 3.3.1 Define Criteria | 0 | 0 | 0 | 2 | 3 | |
| 3.3.2 Develop Treatment Alterative | 0 | 0 | 0 | 2 | 3 | |
| 3.3.3 Determine Least Suitable Alterantaive | 0 | 0 | 0 | 2 | 3 | |
| 3.4 Membrane Filtration | 0 | 0 | 0 | 6 | 9 | |
| 3.4.1 Define Criteria | 0 | 0 | 5 | 6 | 9 | |
| 3.4.2 Develop Treatment Alterative | 0 | 0 | 0 | 2 | 3 | |
| 3.4.3 Determine Least Suitable Alterantaive | 0 | 0 | 0 | 2 | 3 | |
| 3.5 Advanced Oxidation | 0 | 0 | 0 | 2 | 3 | |
| 3.5.1 Define Criteria | 0 | 0 | 5 | 9 | 9 | |
| 3.5.2 Develop Treatment Alterative | 0 | 0 | 0 | 3 | 3 | |
| 3.5.3 Determine Least Suitable Alterantaive | 0 | 0 | 0 | 3 | 3 | |
| 3.6 Ultraviolet Disinfection | 0 | 0 | 0 | 3 | 3 | |
| 3.7 Final Chlorination | 10 | 10 | 10 | 20 | 0 | |
| 3.7.1 Define Criteria | 10 | 10 | 30 | 70 | 38 | |
| 3.7.2 Develop Treatment Alterative | 5 | 0 | 6 | 10 | 5 | |
| 3.7.3 Determine Least Suitable Alterantaive | 0 | 0 | 5 | 10 | 7 | |
| 3.8 Brine Management | 5 | 0 | 9 | 30 | 15 | |
| 3.8.1 Define Criteria | 1.5 | 0 | 3 | 10 | 5 | |
| 3.8.2 Develop Treatment Alterative | 1.5 | 0 | 3 | 10 | 5 | |
| 3.8.3 Determine Least Suitable Alterantaive | 2 | 0 | 3 | 10 | 5 | |
| 3.9 Develop and Select Treatment Trains | 0 | 5 | 5 | 10 | 5 | |
| 4. Final Design | **10** | **10** | **30** | **70** | **38** | **158** |
| 4.1 Select Treatment Process | 5 | 0 | 6 | 10 | 5 | |
| 4.2 Site Layout | 0 | 0 | 5 | 10 | 7 | |
| 4.3 Hydraulic Analysis | 5 | 0 | 9 | 30 | 15 | |
| 4.3.1 Lift Station Design | 1.5 | 0 | 3 | 10 | 5 | |
| 4.3.2 Pump Design | 1.5 | 0 | 3 | 10 | 5 | |
| 4.3.3 Pipe Design | 2 | 0 | 3 | 10 | 5 | |
| 4.4 Public Outreach Plan | 0 | 5 | 5 | 10 | 5 | |
| 4.5 Construction Phasing Plan | 0 | 5 | 5 | 10 | 5 | |
| 5. Cost Assesment | **0** | **0** | **5** | **20** | **15** | **40** |
| 5.1 Opinion of Probable Cost | 0 | 0 | 2.5 | 10 | 5 | |
| 5.2 Operation and Maintance Cost | 0 | 0 | 0 | 5 | 5 | |
| 5.3 Life Cycle Cost | 0 | 0 | 2.5 | 5 | 5 | |
| 6. Impact Analysis | **0** | **0** | **5** | **10** | **10** | **25** |
| 7. Project Deliverables | **15** | **5** | **15** | **50** | **30** | **115** |
| 7.1 30% Deliverable | 0 | 0 | 0 | 5 | 5 | |
| 7.2 60% Deliverable | 0 | 0 | 0 | 10 | 5 | |
| 7.3 90% Deliverable | 0 | 0 | 0 | 10 | 5 | |
| 7.4 Final Deliverable | 5 | 5 | 5 | 5 | 5 | |
| 7.5 Competition Final Report | 5 | 0 | 5 | 10 | 5 | |
| 7.6 Competition Final Presentation | 5 | 0 | 5 | 5 | 5 | |
| 8. Project Management | **5** | **15** | **10** | **20** | **20** | **70** |
| 8.1 Schedule Management | 0 | 5 | 0 | 5 | 5 | |
| 8.2 Resource Management | 0 | 5 | 0 | 0 | 0 | |
| 8.3 Meetings | 5 | 5 | 10 | 15 | 15 | |
| | **50** | **40** | **115** | **276** | **209** | **690** |