DRAFT Evaluation of Treatment Alternatives

City of Pflugerville, Texas

GARVER

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Austin, TX 78704

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Garver Project No.: 19W07185

Engineer's Certification

This Evaluation of Treatment Alternatives for the Pflugerville Water Treatment Plant Expansion is released for interim review under the authority of Ian Toohey, PE, License 116105 on July 2, 2020. It is not to be used for permitting or construction purposes.

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Appendix A: Detailed Cost Estimates
Appendix B: Full Buildout (75 MGD) Site Layouts

1.0 Executive Summary

The City of Pflugerville recently completed a Water Master Plan which outlines the necessity of expanding the City's Surface Water Treatment Plant (WTP) from approximately 17 MGD to 30 MGD by 2022. In 2020, the City retained Garver to complete a treatment alternatives evaluation for the plant expansion prior to commencement of final design. This Evaluation of Treatment Alternatives (ETA) Report outlines the results of those analyses, which at their core consist of the identification and comparison of three filtration alternatives as outlined below:

1. Filtration expansion utilizing the plant's existing membrane technology.
2. Filtration expansion utilizing a new membrane technology.
3. Filtration expansion with a conventional multi-media filter.

In addition to the filtration alternatives evaluation, a high-level alternatives analysis was included for the associated plant improvements necessary for expansion of the WTP to 30 MGD, including raw water pumping capacity, flocculation, sedimentation, disinfection, solids handling, high service pumping capacity, and SCADA improvements. As a component of the analysis, schematics depicting the proposed plant layout at full buildout for each of the filtration alternatives were developed, in order to demonstrate each alternative's footprint at 75 MGD. Ultimately, a preliminary planning cost estimate was developed using the recommended filtration treatment alternative for the 30 MGD expansion.

Alternatives identified for each of the plant components were evaluated against the City's objectives which include:

- The expansion of production capacity of the system to 30 MGD by 2022 in accordance with the adopted 2020 Water Master Plan.
- Increased resiliency of the system for variable influent raw water quality.
- Increased resiliency of the WTP treatment system to handle the growth of invasive species, such as hydrilla and zebra mussels.
- Elimination of the treatment system vulnerabilities that have contributed to recent TCEQ corrective actions.
- Expansion of operator controls for simplified and flexible operations and maintenance.

The following sections of this ETA discuss the existing plant processes, the results of a completed raw water quality analysis, the results of a completed regulatory analysis, and an evaluation and comparison of the water treatment alternatives considered for implementation during the future WTP Expansion.

1.1 Alternatives

Alternatives were evaluated for each of the plant components as outlined in Table 1-1.

Table 1-1: Treatment Train Process Alternatives

Process	Description of Alternatives
Lake Pumping	Expand to 30 MGD firm pumping capacity
Flocculation & Sedimentation (Pre-treatment)	
Alternative 1	Conventional Flocculation and Sedimentation
Alternative 2	Lamella Plate Settlers in a High-Rate Sedimentation Basin
Filtration	
Alternative 1	Expand with existing ZeeWeed 500D® Membranes
Alternative 2	Replace existing membranes with new membrane technology
Alternative 3	Expand with conventional filter process unit
Disinfection	Provide adequate baffling within existing 3 MG clearwell for achieving primary disinfection
High Service Pumping	Expand to 37.5 MGD firm capacity (25% greater than WTP capacity)
Solids Handling	Install additional backwash clarifier for all alternatives
Alternative 1	Expand existing solids pumping capacity to WWTP
Alternative 2	Install sludge thickening and pump thickened solids to WWTP
Alternative 3	Install sludge thickening and onsite dewatering and solids to landfill
Chemical Feed Systems	Construct a new chemical storage and feed facility
SCADA & Electrical Improvements	New central SCADA HMI interface and control system and expansion of standby power.

1.2 Conclusions and Recommendations

Progress meetings and workshops were held with the City throughout the treatment alternatives evaluation process with the objective of responding to critical design decisions in a collaborative manner. Ultimately, based upon estimated planning-level cost and treatment footprint, the high-rate lamella plate treatment option is the recommended sedimentation pre-treatment technology, and a new membrane technology (Alternative 2) is the recommended filtration alternative for the 30 MGD plant expansion. Alternative 2 has the following major benefits:

- Reduced footprint for 30 MGD and full build out (75 MGD) scenarios as compared to Alternatives 1 and 3.
- Reduced cost as compared to Alternatives 1 and 3 (see Table 1-2).
- Improved water quality over existing ZeeWeed 500D® membranes.
- No additional TCEQ reporting requirements as compared to the existing ZeeWeed 500D® membranes.
- Multiple manufacturers for the chosen membrane available for technology procurement and installation, which allows for competitive bidding of membrane technology.

Table 1-2 outlines the selected alternatives for each plant component and associated estimated cost.

Table 1-2: Process Treatment Recommended Alternatives and Estimated Planning-Level Cost (for 30 MGD of production capacity)

Process	Recommended Alternative	Estimated Cost
Lake Water Pumping	Expand to 30 MGD firm capacity and expand existing building	$2,691,000
Flocculation & Sedimentation	Lamella Plate Settler (including splitter box and rapid mix)	$14,106,000
Filtration	Replace existing membranes with new submerged UF membrane technology capable of producing 30 MGD	$17,110,000
Disinfection	Provide adequate baffling within existing 3 MG clearwell for achieving primary disinfection	$1,513,000
High Service Pumping	Expand to 37.5 MGD firm pumping capacity (25% greater than WTP capacity) and expand existing building	$3,639,000
Solids Handling	Expand with one new spent-backwash water clarifier and installation of onsite gravity thickening	$4,225,000
Chemical Feed Systems	Construct a new chemical storage and feed facility	$14,738,000
SCADA & Electrical Improvements	New central SCADA HMI interface and control system and expansion of standby power.	$5,500,000
Other (Site Civil)		$2,046,000
	Total	**$65,568,000**
	Project Escalation to mid-point of construction (2.1%)	$1,377,000
	Total Estimated Project Cost	**$66,945,000**

2.0 Introduction

The purpose of this assessment is to outline the results of the Pflugerville Water Treatment Plant (WTP) treatment alternatives evaluation. The following sections of the report discuss the existing plant processes, the results of a completed raw water quality analysis, and an evaluation of the water treatment alternatives considered for implementation during the future expansion of the WTP to 30 MGD.

2.1 Location

The Pflugerville WTP is owned and operated by the City of Pflugerville in Pflugerville, Texas. The plant is situated along the southeastern shore of Lake Pflugerville on City-owned property at the intersection of East Pflugerville Parkway and Weiss Lane. The intake pipe is located near the Lake Pflugerville Dam and has three intake levels equipped with 400-micron screens: 32 ft, 35 ft, and 42 ft. The WTP obtains its raw water from Lake Pflugerville via the Lake Pump Station. Lake Pflugerville is filled by pumped water from the Lower Colorado River via the Raw Water Pump Station. Figure 2.1 depicts the WTP in relation to the surrounding properties. The Raw Water Pump Station is located approximately 15 miles south of the WTP along the Colorado River at the end of Shelton Road in Austin, Texas.

Figure 2.1: Pflugerville WTP General Location Map

2.2 WTP History

Prior to the construction of the WTP, Lake Pflugerville was constructed as a raw water storage reservoir in 2004 in conjunction with the Colorado River Pump Station (PS) along the Colorado River. The WTP was then constructed with the Lake PS in 2005. The Lake PS supplies water from Lake Pflugerville to the WTP and the Colorado River PS supplies water from the Colorado River to Lake Pflugerville. The initial WTP (as commissioned in 2005) was rated at 10.0 MGD. The WTP has since undergone upgrades in 2011 with the addition of a 3.0 MG Clearwell and updates to the backwash clarifiers and in 2016 with the addition of new ZeeWeed® 500D membrane cassettes that increased the membrane treatment capacity at the plant to 17.7 MGD. The facilities as they are currently rated are listed below:

- Colorado River PS
  - Three (3) 11.5 MGD Pumps
  - 23.0 MGD Firm Capacity
- Lake PS
  - Three (3) 8.0 MGD Pumps
  - 16.1 MGD Firm Capacity
- WTP
  - Five Membrane Trains including:
    - ZeeWeed 500D® Membrane Filtration Units
      - Total TCEQ-rated Capacity 21.6 MGD
    - Five, 3.54 MGD Permeate Pumps
      - Total Capacity 17.7 MGD
  - One (1) 1.0 MG Clearwell
  - One (1) 3.0 MG Clearwell
  - High Service PS
    - Three (3) 8.6 MGD High Service Pumps
    - 17.1 MGD Firm Capacity
  - One (1) backwash clarifier

Additional updates to City-owned facilities include the rehabilitation of the Lake PS in 2014, the installation of an interconnect to the Manville Water Supply Corp. at the WTP in 2016, and electrical improvements in 2017. Recent updates include the replacement of two of the five ZeeWeed 500D® membrane trains in 2019 due to damage from native fresh water clams (not zebra mussels). A third membrane train is being replaced in 2020.

2.3 Existing System

2.3.1 Existing Plant Layout

Figure 2.2 depicts the existing plant layout and the locations of critical plant equipment.

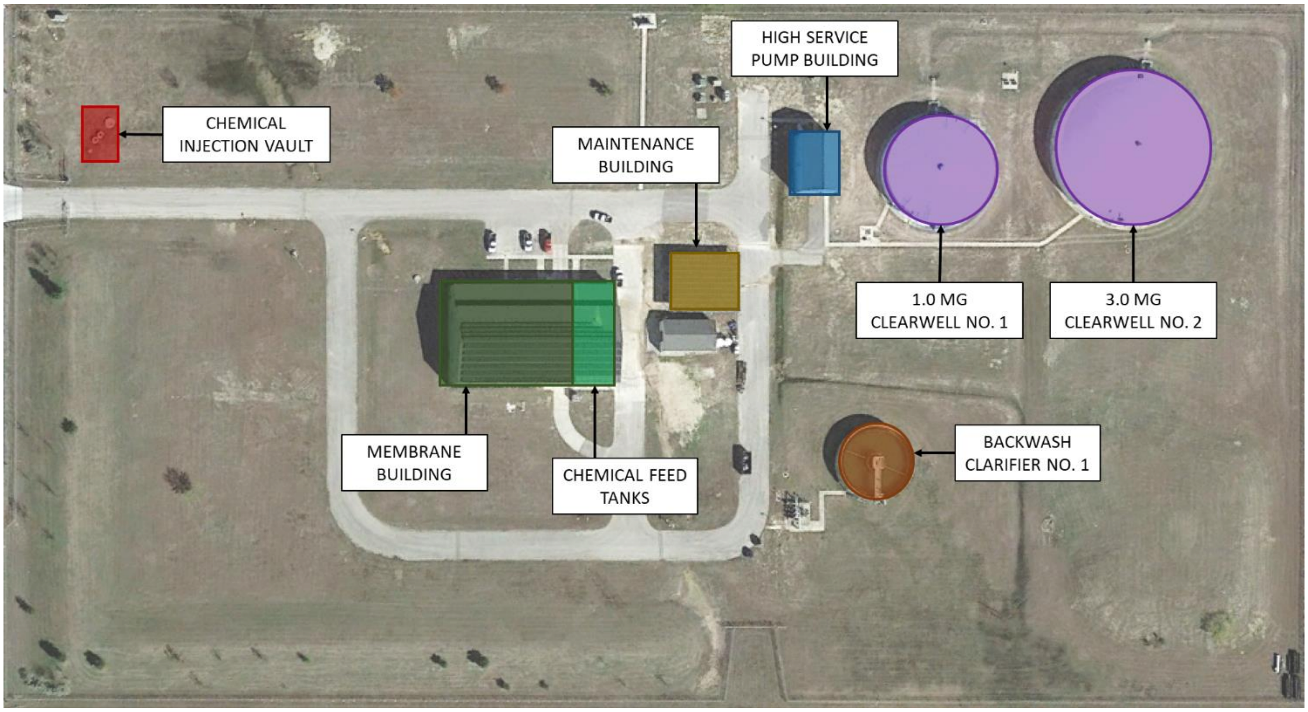

Figure 2.2: Existing Pflugerville WTP Layout

2.3.2 Water Demand

According to the 2020 Water Master Plan produced by others, in 2019 average day water demand was 9.7 MGD and maximum day demand was 19.1 MGD. Average day demands are anticipated to increase to 16.3 MGD by 2030 and 31.6 MGD at full buildout, and maximum day demands are anticipated to increase to 32.4 MGD in 2030 and to 62.8 MGD at full buildout. The plant is therefore slated for several expansions prior to full buildout with the first being an expansion to 30 MGD by 2022. The recommended plant expansions as outlined within the 2020 Water Master Plan are shown in Figure 2.3.

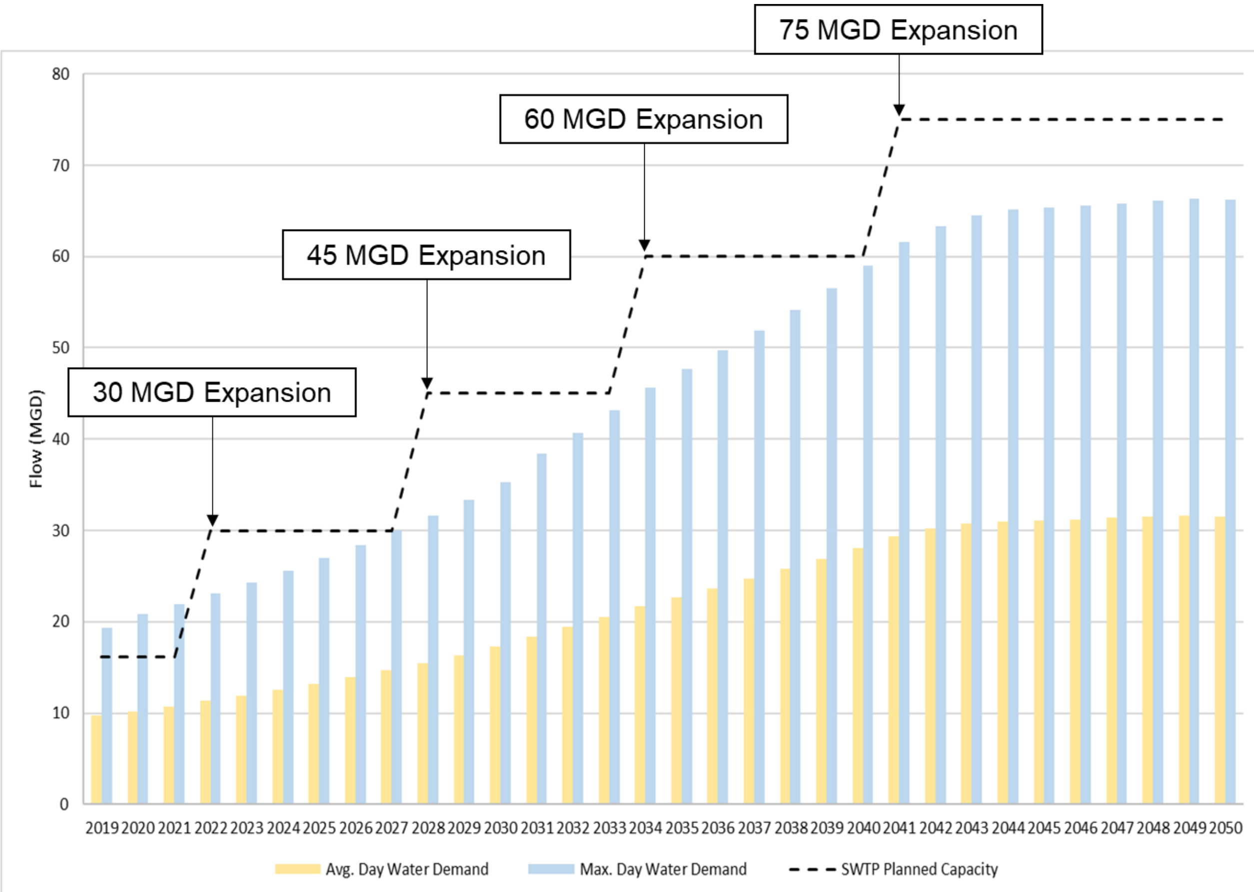

Figure 2.3: Production Capacity Recommendations for the Pflugerville WTP per the 2020 Water Master Plan

2.3.3 Treatment Processes

The Pflugerville WTP currently treats water through coagulation, direct membrane filtration, and disinfection (hypochlorite from onsite generation). The WTP has one (1) water intake pipe from which it pumps water from Lake Pflugerville. Sodium permanganate is injected upstream of the Lake PS as a pre-oxidant to prevent growth and buildup in the pipeline. Upon being pumped from the lake, water is then transported through an inline static mixing vault where aluminum chlorohydrate (ACH) is added as a coagulant prior to membrane filtration. The plant currently has five (5) parallel ZeeWeed® membrane treatment trains. Following membrane filtration, water is chlorinated and stored in two (2) clearwells. Liquid Ammonium Sulfate (LAS) is then injected for secondary disinfection prior to being pumped to the distribution system. The distribution system includes the residents of the City of Pflugerville as well as three wholesale customers: Manville Water Supply Corp (MWSC), SouthWest Water Company, and the City of Manor. A simplified treatment process schematic is shown in Figure 2.4.

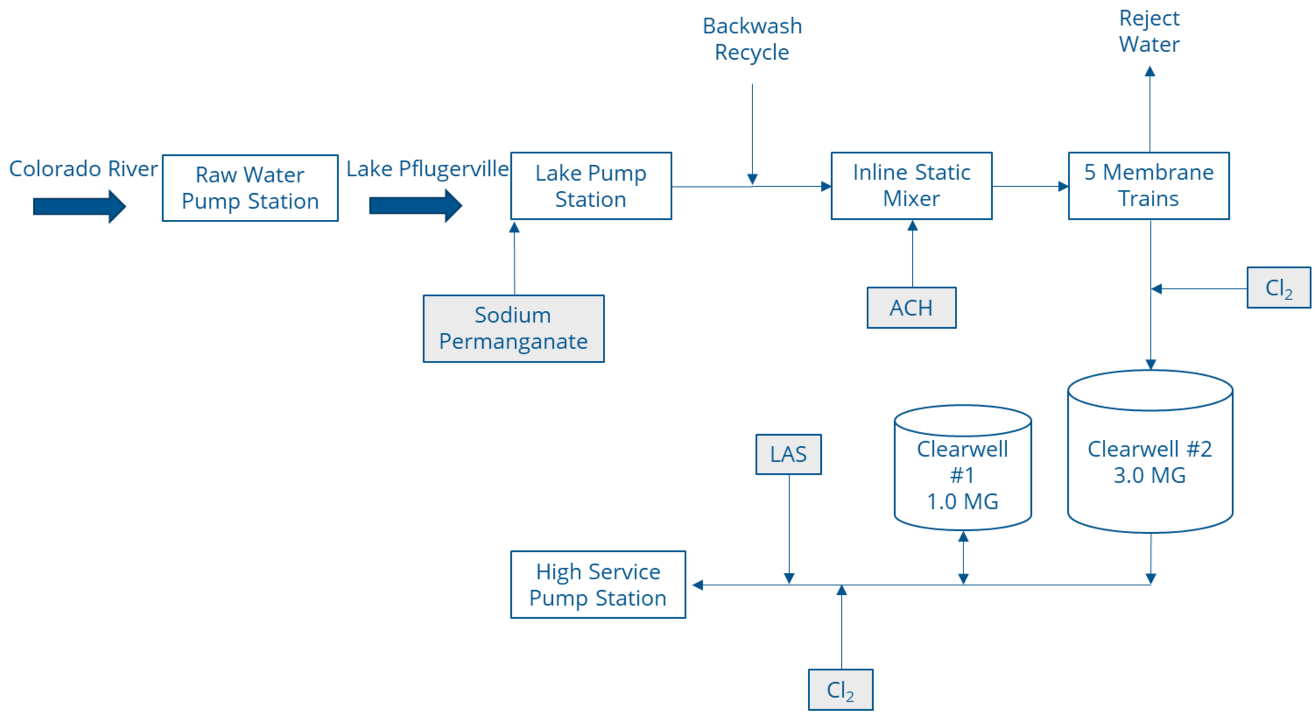

Figure 2.4: Existing Pflugerville WTP Water Treatment Process Schematic

The plant's sludge handling system accepts spent backwash water from the membrane trains. The supernatant water is routed through a clarifier and then recycled to Lake Pflugerville. A simplified sludge treatment process schematic is shown in Figure 2.5.

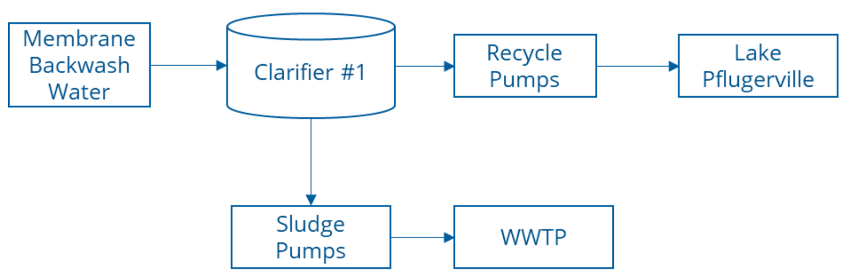

Figure 2.5: Existing Pflugerville WTP Sludge Treatment Process Schematic

2.4 Onsite Soil Conditions

A preliminary review of the existing structures at the plant (e.g. membrane building and clearwells) was completed along with a review of the geotechnical report for the initial WTP construction in 2003. The review determined that onsite soils are of poor quality for the construction of necessary treatment plant structures. Overall, the site is overlaid with a thick layer of swelling clay. To prevent structures from settling or rising, which causes uneven floors and weirs and can also crack masonry, the existing structures have been put on deep foundations (i.e. drilled shafts). The geotechnical report recommended drilled shafts of 15-feet deep and the existing structures onsite have drilled shafts of up to 45-feet deep. Structures recommended as a component of this report include deep foundations as a component of their cost estimate. To prevent the necessity of deep foundations, another option is to over-excavate the project site and fill with higher quality soils prior to construction. It is recommended that an analysis be completed to determine the cost-effectiveness of over-excavation versus deep foundations.

2.5 Project Drivers

A number of factors have led to the City's decision to evaluate and upgrade its treatment processes. Chief among these is the rapid growth of the City within the past 5-10 years. The City nearly doubled the number of water connections to its system between 2009-2019, increasing from approximately 7,500 to 14,500 connections in the 10-year period with an annual average growth rate of 5.6%. Based upon the City's 2020 Water Master Plan, the City will be required to expand its existing treatment capacity to 30 MGD by 2022.

In addition to required capacity expansions, the City has had difficulties in recent years maintaining TCEQ finished water quality requirements. Challenges have stemmed from variances in raw water quality (e.g. turbidity variations) leading to issues with the existing membrane system including excessive backwashing and limited operational controls. Additionally, hydrilla and zebra mussel raw water infestations in Lake Pflugerville have inflicted damage on City equipment. Zebra mussels in particular have grown to such an extent in Lake Pflugerville as to harmfully impact the City's pumping and piping equipment. A secondary impact stemming from variable raw water quality is the considerable added effort on the part of operations and maintenance staff to maintain equipment and address hydrilla and mussel build-ups. The City therefore desires to implement an all-encompassing improvement to its plant including both capacity and treatment upgrades with the goals of eliminating TCEQ violations, providing ample water supply to its future customers, and reducing stress on operations and maintenance staff. In summary, the critical project drivers are:

- Increased Capacity
  - Treatment Capacity
  - Storage Capacity
  - Pumping Capacity
- Improved Water Quality
  - TCEQ/SDWA Requirements
  - Infestation Issues (Hydrilla and Zebra Mussels)
- Ease of Operations and Maintenance

3.0 Project Scope

The City of Pflugerville retained Garver to provide Owner's Representative (OR) services for the expansion of the City's existing water treatment plant (WTP). Prior to the design and construction of the project, Garver is responsible for completing an initial planning phase to assess the suitability of the current WTP treatment process technology and perform a comparative analysis to determine the optimal path forward for the current plant and future expansions. The initial project scope included a treatment analysis for an expansion of the plant to 30 MGD, but the scope was expanded to include a site footprint analysis for each of the proposed treatment technology options at both the 30 MGD and the 75 MGD full buildout scenario. The WTP's full buildout capacity of 75 MGD was identified in the City's 2020 Water Master Plan. This report is a compilation of the results of the initial planning phase and includes the results of the following scoped tasks:

1. Raw Water Characterization
    a. *Water Quality Analysis* - Garver will review available data and consult with the Owner's staff to characterize the current raw water quality and its impact on the treatment process. Characterization of the raw supply will be utilized to identify potential contaminants that may be having an adverse impact on the current WTP performance and to identify potential mitigation strategies for identified items of concern.
    b. *Regulatory Analysis* - Garver will document current and future finished water quality regulatory requirements to assist with identifying potential technology/process improvements needed to meet the finished water goals.
2. Conceptual Process Feasibility Study
    a. *Feasibility Study* - Garver will perform an in-depth feasibility study of three (3) conceptual WTP process improvements agreed upon with City Staff. This study will determine footprint requirements, establish basic design criteria, develop budgetary cost estimates, and develop conceptual exhibits of the proposed improvements, with the objective of communicating the intent of the proposed WTP technology process improvements to the future Design Consultant.
3. Full Buildout Considerations
    a. *Site Facility Layouts* - For each of the three (3) conceptual WTP process improvement alternatives evaluated in #2, a site layout depicting locations of flocculation, sedimentation, filtration and additional plant components such as clearwells, chemical storage facilities, and pump stations will be developed for both the 30 MGD plant expansion and the 75 MGD full build out scenario. The purpose of the layouts being to evaluate site space constraints for each alternative.
4. 30 MGD Plant Expansion Cost Estimate
    a. *Preliminary 30 MGD OPCC* - Once the three (3) conceptual WTP process improvement alternatives are fully developed and a single alternative is recommended, a detailed cost estimate will be developed for all components of the expansion required to reach a production capacity of 30 MGD. The purpose of the comprehensive cost estimate will be to benchmark budgetary allocations for the proposed WTP expansion.

4.0 Overall Design Criteria

4.1 Regulatory Requirements

Title 40 Parts 141, 142, and 143 of the Code of Federal Regulations (CFR) and Chapter 290 of the Texas Administration Code (TAC) are the federal and state regulations that govern drinking water quality in Texas, and thus are the applicable standards for the City of Pflugerville. In general, there are two design approaches that a water utility can choose for a WTP based upon the TAC: conventional or innovative. The Pflugerville WTP was constructed in 2005 using the "innovative" or "alternate" approach (i.e. ZeeWeed 500D® membranes) which was approved by TCEQ. Alternatives for expansion of the WTP include continuing with the "innovative" (a technology with no codified construction standards in the TAC) approach as well as expansion with a more conventional treatment train. The two possibilities have differing state and federal requirements which are delineated for each alternative in Section 5.0. Figure 4.1 depicts a simplified regulatory overview for both the innovative and conventional approaches.

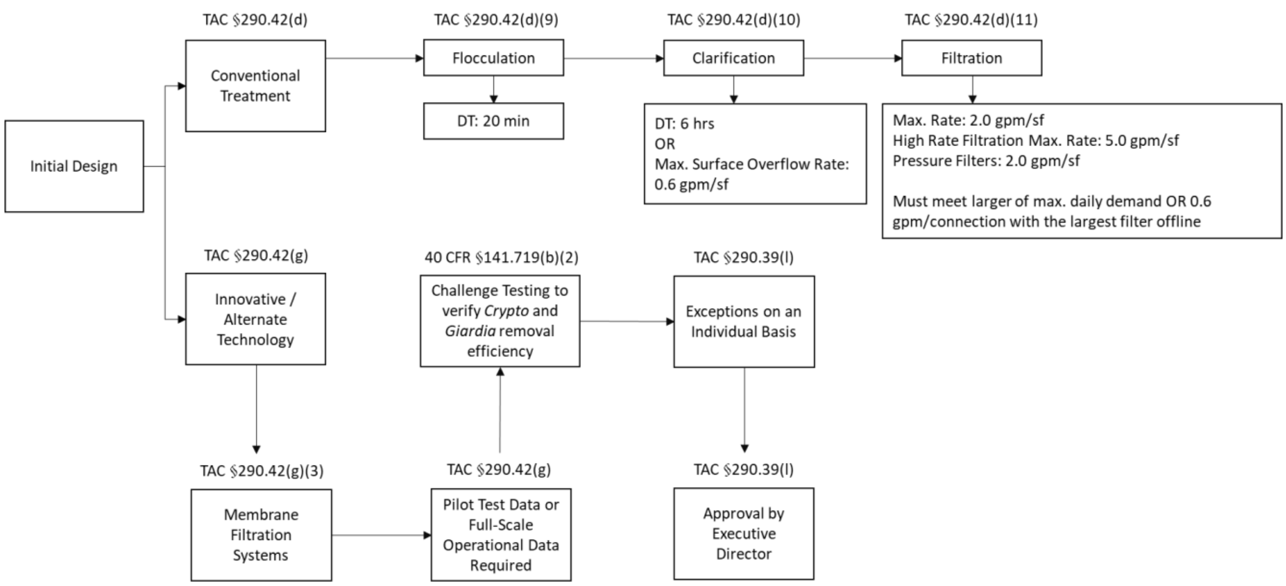

Figure 4.1: Simplified Regulatory Requirements Regarding WTP Design

4.1.1 Existing Water Treatment Plant

Capacity Requirements

The existing TCEQ-approved production capacity of the WTP is 17.7 MGD. The existing membrane trains are rated at 21.6 MGD, but the associated permeate pumps have only 17.7 MGD capacity. TAC §290.42(a)(1) requires that the total treatment capacity for a water system be greater than the anticipated maximum daily demand. Based upon the 2020 Water Master Plan, the maximum daily demand for the City in 2019 was 19.1 MGD. The plant's existing firm high service pumping capacity is 17.1 MGD, and per the 2019 TCEQ Membrane Evaluation Report, the existing membrane capacity is 21.6 MGD. Currently, the City is in compliance with TAC §290.42(a)(1) and has excess production capacity due to the operation of two groundwater wells (total capacity of 6.2 MGD) giving it a total production capacity of 23.3 MGD.

Water Quality Regulations

In accordance with TAC §290.42(g)(3) the plant currently obtains a 3.0-log filtration technology treatment credit for *Giardia* and 2.0-log treatment credit for *Cryptosporidium* removal based upon its membrane system. The plant has only one disinfection zone per the January 29, 2020 Public Drinking Water System Concentration Time Study (CT Study) approved by TCEQ which provides 3.0-log inactivation of viruses. The zone consists of three lengths of pipeline and the 3.0 MG Clearwell as shown in Figure 4.2. TCEQ contaminant removal requirements and the methods of current compliance are outlined in Table 4-1.

Table 4-1: Existing Finished Water Quality Requirements

Regulation	Contaminant	Required Removal	Achieved Removal	Method of Removal
30 TAC §290.42(d)(1)	*Giardia*	3.0-log	3.0-log	Membranes
30 TAC §290.42(d)(1)	*Cryptosporidium*[1]	2.0-log	2.0-log	Membranes
30 TAC §290.42(d)(1)	Virus	4.0-log	4.0-log	1.0-log Membranes 3.0-log Disinfection

[1]The City's WTP is classified as Bin 1 by the US Environmental Protection Agency (EPA).

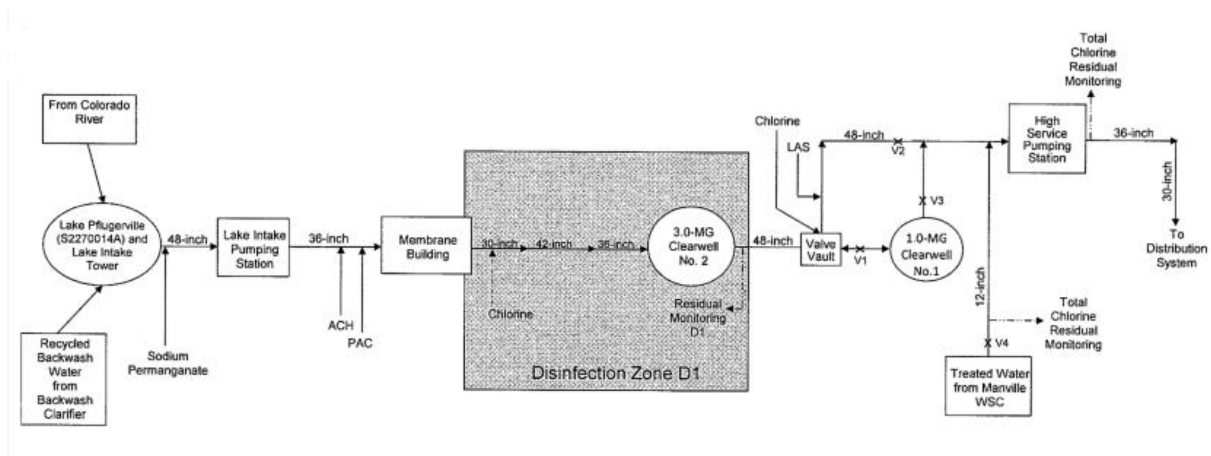

Figure 4.2: Process Schematic Worksheet from 2020 CT Study

TCEQ Monitoring and Reporting Requirements

The City currently submits Surface Water Monthly Operating Reports (SWMOR) to TCEQ on a monthly basis that include the following data:

- Daily Pumping:
  - Raw Water Pumpage
  - Treated Water Pumpage
- Daily Raw Water Quality:
  - Turbidity
  - Alkalinity
- Daily Treated (Finished) Water Quality
  - Membrane Effluent Turbidity

  - Lowest Chlorine Residual
  - Temperature
  - pH
- Daily Membrane Operational Data
  - Pressure
  - Flux
  - Max. Turbidity
- *Giardia* and *Cryptosporidium* Treatment Credits
- *Giardia* Inactivation Credits
- Viral Inactivation Credits

4.2 Water Quality Analysis

4.2.1 Raw Water Characterization

Minimum, average, and maximum values are provided for several raw water quality parameters in Table 4-2. The observed raw water characteristics fluctuate seasonally and with varying weather patterns. Raw water turbidity is currently the critical characteristic and is the driver behind well-functioning membranes.

Table 4-2: Raw Water Characterization

Characteristic	Unit	2019 Minimum	2019 Average	2019 Maximum
TOC[1]	mg/L	4.4	6.9	9.8
Temperature	°C	11.4	20.3	28.6
pH	-	7.1	8.2	8.8
Alkalinity	Mg/L as $CaCO_3$	88	129	183
Turbidity	NTU	0.7	4.0	21.0

[1]2018 data utilized as 2019 data is unavailable.

Figure 4.3 presents the raw water alkalinity and temperature recorded at the WTP over the period of 2018-2020. Natural variation in both parameters is expected in surface water bodies such as Lake Pflugerville.

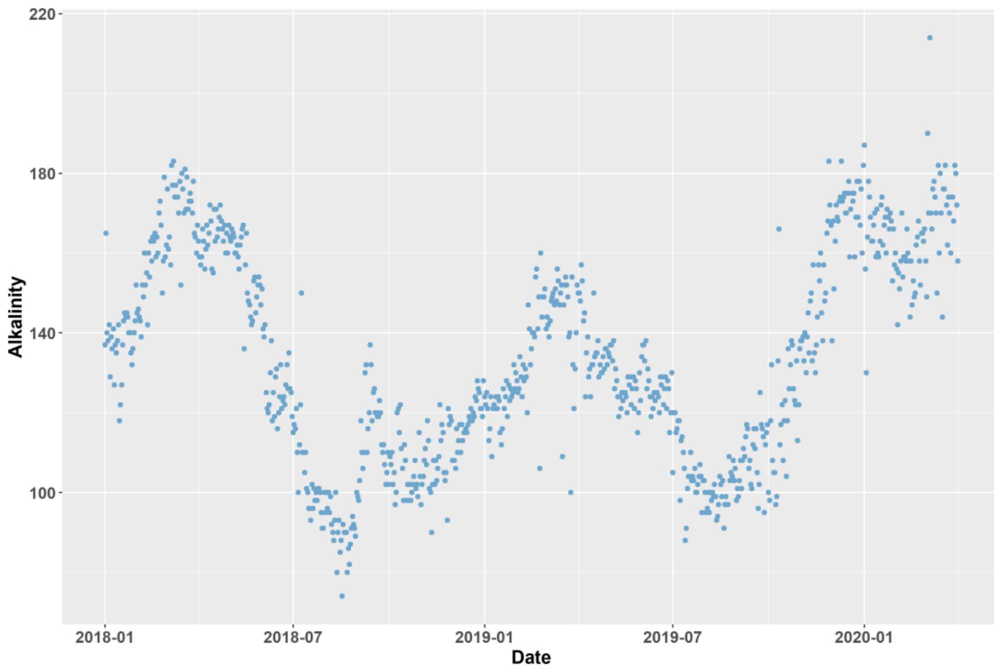

Figure 4.3: Raw Water Alkalinity Recorded from 2018-2020

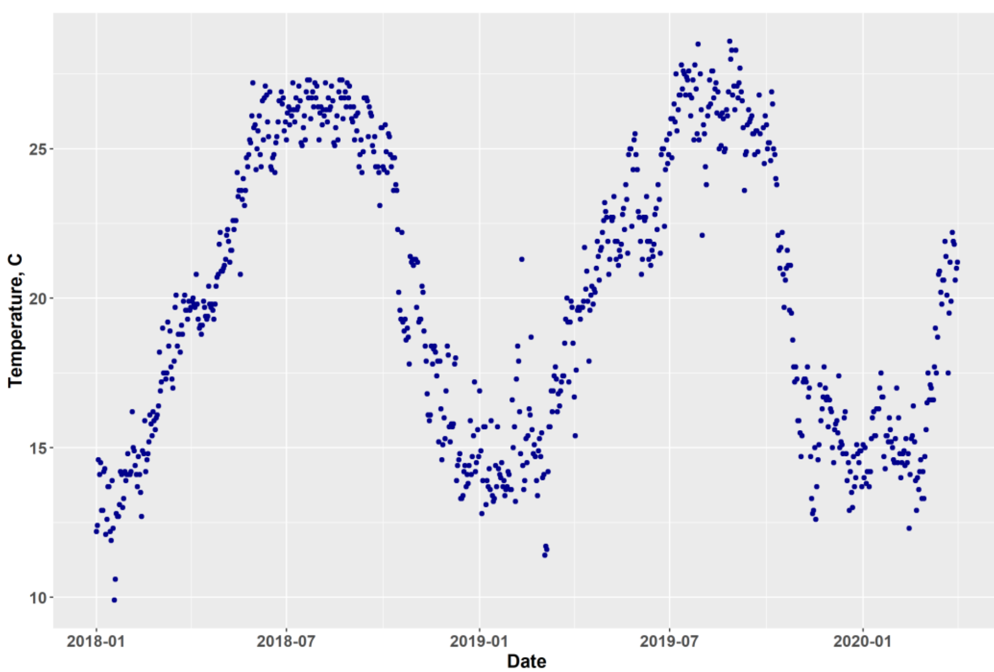

Figure 4.4: Raw Water Temperature Recorded from 2018-2020

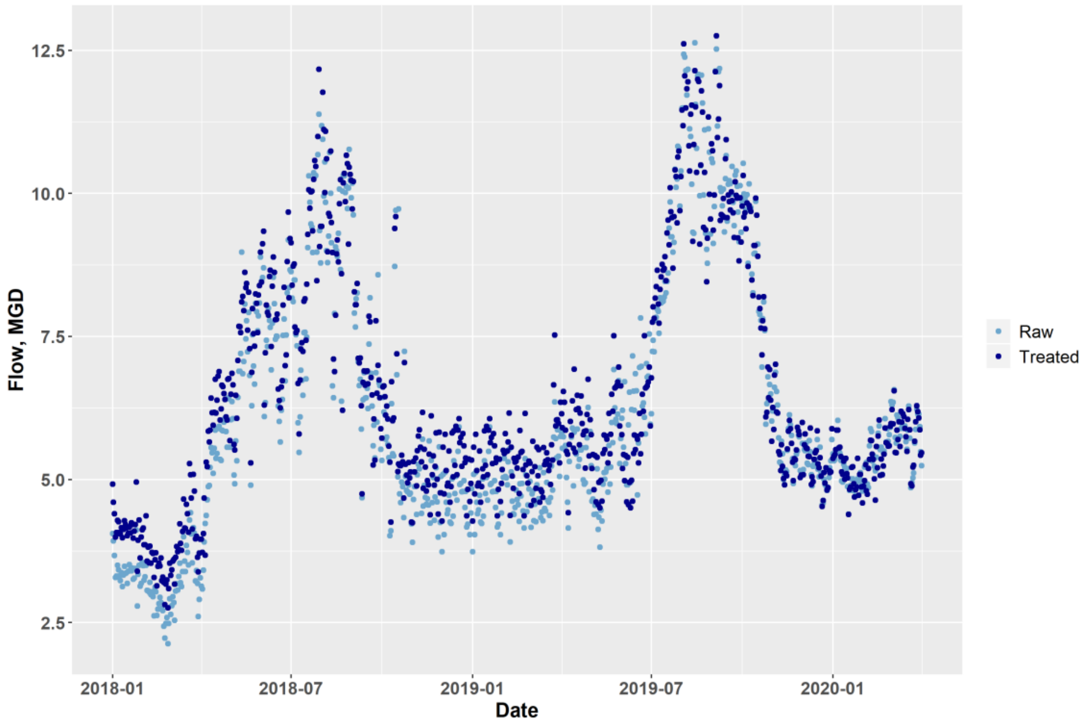

Figure 4.5: Raw and Treated Water Average Daily Pumped Flows from 2018-2020

As shown in Figure 4.5, over the period of 2018–2020, the average daily production rate was as low as 2.5 MGD and as high as 12.5 MGD from the WTP.

4.3 Flow Projections

Flow projections are taken from the 2020 Pflugerville Water Master Plan and are shown in Table 4-3 and Figure 4.6. The Master Plan identifies projections for 3 planning horizons: 2024, 2029, and full buildout. An assumption of 6% growth per year was used, and full buildout is assumed to occur in 2050.

Table 4-3: 2020 Water Master Plan Water Demand Forecast

Planning Year	No. Water Service Connections	Population	Average Day Demand (MGD)	Maximum Day Demand (MGD)	Total Water Demand (acre-feet per year)
2019	19,108	56,558	9.69	19.38	13,035
2024	25,570	75,687	12.53	25.56	16,856
2029	34,216	101,279	16.34	33.33	21,981
Buildout	67,812	200,724	31.56	62.80	42,456

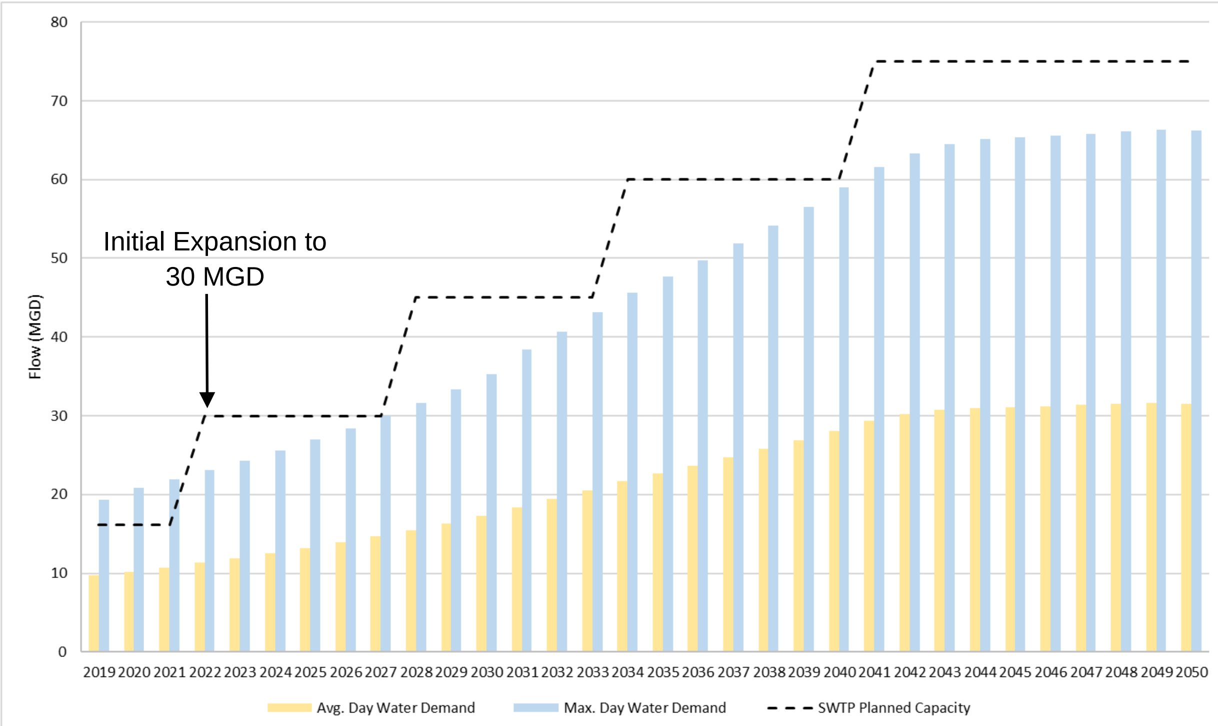

Figure 4.6: 2020 Master Plan Water Demand Projections

5.0 Treatment Process Alternatives Evaluation

To determine the necessary plant improvements to reach a production capacity of 30 MGD, assessments for each process train component were completed and are outlined in the sections below. Process train components included in the analysis are:

- Lake Raw Water Pumping
- Flocculation and Sedimentation Pre-treatment
- Filtration
- Clearwell Storage and Disinfection
- High Service Pumping
- Solids Handling
- Chemical Feed Systems
- SCADA and Electrical Improvements

5.1 Lake Raw Water Pumping

The Lake Pump Station currently houses three pumps. Each pump is rated for 5,600 gpm at 61 feet of head. See Figure 5.1 below for the existing pumps' performance curve.

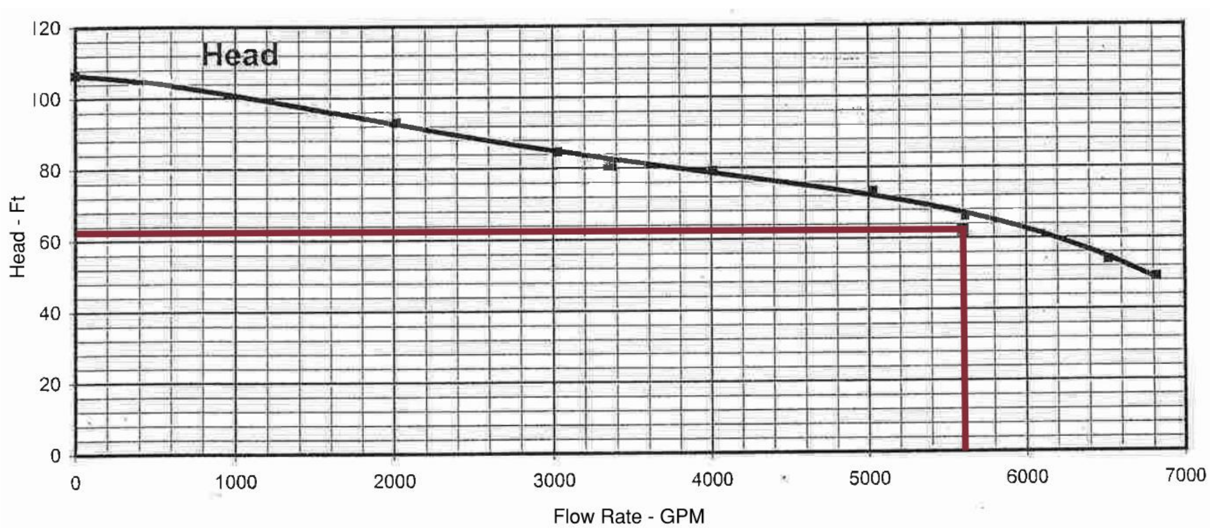

Figure 5.1: Lake Pump Station Performance Curve

The Lake Pump Station has a current firm capacity of approximately 16.1 MGD. To reach the target firm capacity of 30 MGD, additional pumps will be required. It is proposed to add two new pumps to increase the firm capacity of the pump station from 16.1 MGD to 30 MGD. The two new pumps are recommended to run in parallel with the existing pumps. Additional headloss is anticipated due to increased flow as well as the installation of flocculation and sedimentation at the plant, which increases static head. The total head is anticipated to increase by approximately 13 feet. The slight increase in head will cause the existing 5,600 gpm pumps to operate at a reduced capacity of approximately 5,000 gpm (refer to Figure 5.2).

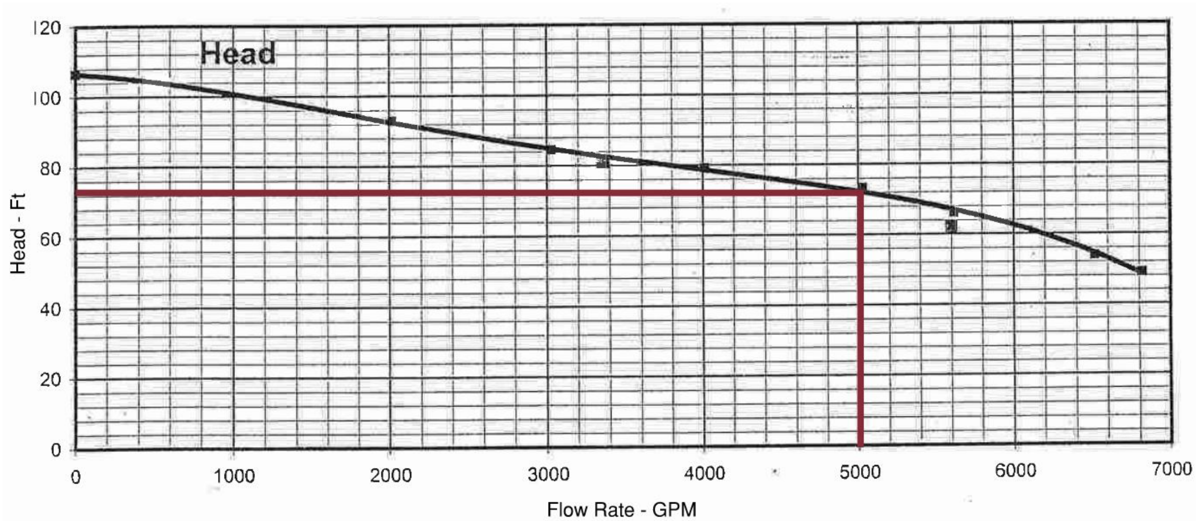

Figure 5.2: Lake Pump Station Future Performance

To compensate for the existing pumps' reduction in flow capacity, the two new pumps will be designed for 5,834 gpm at 75 ft of head. For a summary of the pump station's proposed design criteria, see Table 5-1.

Table 5-1: Proposed Lake Pump Station Data Summary

Existing Pumps		Proposed Pumps	
Number	3	Number	2
Future Flow	5,000 gpm	Design Flow	5,834 gpm
Future Head	75 ft	Design Head	75 ft

In total, the new pump station will have five pumps, three at 5,000 gpm and two at approximately 5,800 gpm. With the largest pump out of service, the station's firm capacity is therefore increased to 30 MGD.

The Lake Pump Station layout will follow that of the record drawings, where items marked "future pump" will be adopted into the design. However, instead of adopting all three proposed pump cans, only the two rightmost cans, closest to the existing pumps, will be included. See Figure 5.3 below for the configuration. The existing building will be expanded to house the new pumps.

The City is also currently installing a permanganate system at the Lake Pump Station to prevent buildup in the intake pipeline from Lake Pflugerville. In addition to expansion of the building to include additional pumps, the permanganate system is proposed to be upgraded to accommodate 30 MGD. The permanganate system is estimated to consist of a bulk storage tank, operating day tank, and chemical feed skid with a transfer pump but should be evaluated during a detailed design phase. Table 5-2 contains the estimated construction cost for the expansion of the Lake Pump Station in addition to an estimated cost of expansion of the permanganate system.

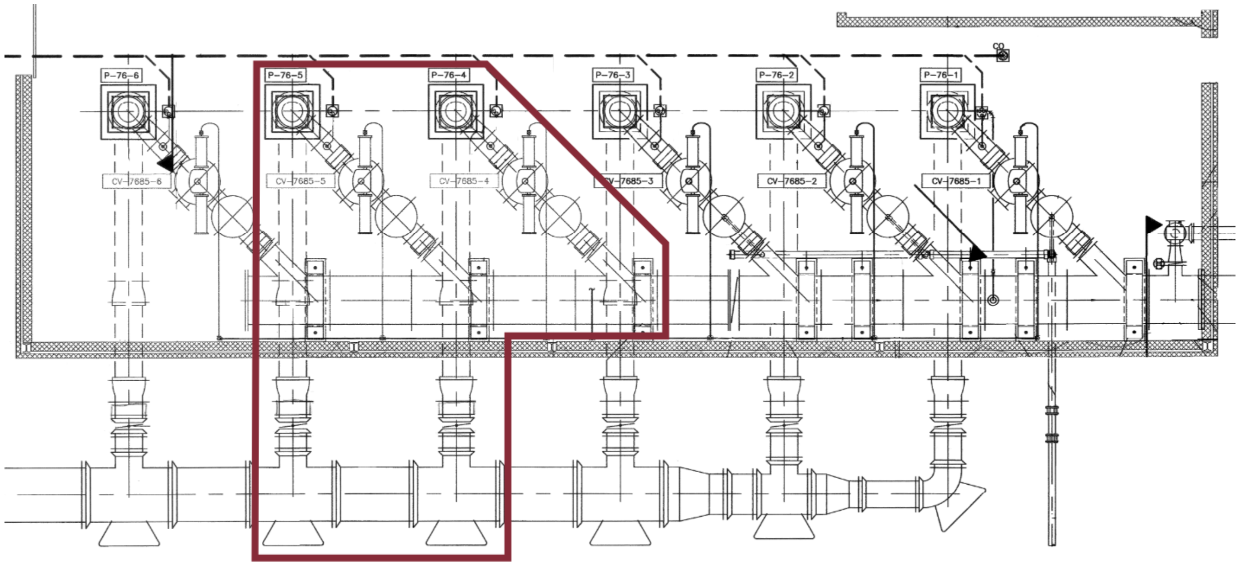

Figure 5.3: Lake Pump Station Proposed Layout

Table 5-2: Lake Pump Station Expansion Estimated Cost of Construction

Division	Total Estimated Cost
Division 2 – Existing Conditions	$3,394
Division 3 – Concrete	$163,484
Division 5 – Metals	$48,896
Division 9 – Finishes	$23,630
Division 26 – Electrical	$400,050
Division 31 – Earthwork	$4,095
Division 40 – Process Integration	$455,292
Division 43 – Process Gas & Liquid Handling	$582,446
Subtotal	**$1,682,000**
Mobilization (5%)	$110,000
Overhead and Profit (18%)	$394,000
Contingency (30%)	$505,000
Total	**$2,691,000**

5.2 Flocculation and Sedimentation

The existing Pflugerville WTP does not currently have flocculant mixing or sedimentation treatment processes in its treatment train. Water proceeds directly from the Lake Pump Station to a chemical injection vault where aluminum chlorohydrate (ACH) is added as a coagulant. It is then routed to the ZeeWeed 500D® membranes. The ZeeWeed 500D® membranes are therefore the first barrier for removal of contaminants in the water. Due to the wide variance in raw water quality, including variances in turbidity and TOC, the ZeeWeed 500D® membranes tend to become clogged easily and require frequent backwashing. To enable better performance of the membranes and to achieve higher finished water quality, a flocculation and sedimentation system is recommended. A flocculation and sedimentation system would address operations and maintenance issues identified by City staff as well as have the potential to increase the capacity of the plant's existing and future treatment systems (e.g. future membrane trains) thereby reducing future capital costs. Benefits from a flocculation and sedimentation system include:

- A treatment barrier for influent turbidity fluctuations
- A treatment barrier for influent hydrilla, freshwater clams, and Zebra mussels
- Additional TOC removal
- Reduced membrane backwash cycling
- Increased membrane useful life
- Increased membrane capacity
- Simplify O&M

Two alternatives are identified for the installation of a flocculation and sedimentation system at the plant: conventional and innovative (or, high-rate). The conventional flocculation and sedimentation option includes large rectangular clarifiers with finger-type weir launders upstream of the membrane filters. This sedimentation basin design would follow the prescriptive design standards for hydraulic detention time, per the TAC. Alternatively, a high-rate technology can be installed in the sedimentation basin to reduce the footprint of the basin. A comparison of the conventional and high-rate flocculation and sedimentation options is included within the sections below.

5.2.1 Sedimentation Technology Options

TCEQ regulations refer only to "conventional" and "innovative" sedimentation options and do not differentiate between innovative technologies. A high-level qualitative comparison was completed between several available sedimentation options to identify those most applicable for meeting the needs of the Pflugerville WTP. Summaries of identified sedimentation technologies are included in Table 5-3.

Table 5-3: High-Rate (or "innovative") Sedimentation Technologies

Technology	Description	Pros/Cons
Dissolved Air Flotation (DAF)	• Air is added under pressure as the water enters the treatment unit • Air bubbles are released and adhere to particulates that form flocs and rise to the surface from where they are skimmed off either hydraulically or mechanically	• High loading rate allows for smaller construction footprint • Mechanically intensive • Applicable for high-solids waters (fats and grease) • Produces a thickened sludge • Multiple possible manufacturers • Typically, no polymers are added which is beneficial for downstream membrane application
Lamella Plate Settler	• Water flows upward between inclined plates which are built at the end of a sedimentation basin allowing solids to drop to the bottom of the basin.	• High TCEQ familiarity • Applications across Texas, large and small footprint • Low footprint • Multiple possible manufacturers • May require polymer addition (can lead to fouled membranes)
High Rate Sludge Blanket Clarifier (Super Pulsator)	• Vacuum generated flow pulsations create a sludge blanket • Combines flocculation and sedimentation into one basin	• Mechanically & energy intensive • Applicable for high-solids waters • May require polymer addition (can lead to fouled membranes) • Proprietary technology – limited competition
Tube Settlers	• Water flows through adjacent angled tubes	• Low TCEQ confidence • Prone to deformation and frequent repairs • Low footprint

After qualitative review and discussions with the City, the lamella plate settler was identified as the recommended innovative technology and is compared to conventional sedimentation in the sections below. The benefits of the lamella plate technology include many known installations throughout Texas and high TCEQ familiarity. In discussion with Marlo Berg with TCEQ on April 24, 2020, lamella plate installations throughout Texas have exceeded the performance of tube settlers. The DAF and super pulsator technologies are generally designed for high solids waters, and an added consideration for the super pulsator is that it is a proprietary technology with only one manufacturer (Suez) which can ultimately lead to both higher capital and O&M costs.

5.2.2 Regulatory Overview

A conventional flocculation and sedimentation system would be subject to the flocculation and sedimentation requirements as outlined in 30 TAC §290.42(d) and which are briefly listed below.

- Flocculation Requirements:
  - Two parallel sets of equipment
  - Minimum detention time of 20 minutes
- Sedimentation Requirements:
  - Two parallel sedimentation units/basins

- Minimum 6-hr detention time OR Maximum 0.6 gpm/sf overflow rate
- Minimum side water depth of 12 feet

A plate settler-based sedimentation design would have similar sludge collection and removal systems, with the advantage of a reduced hydraulic residence time for effective particle capture. 30 TAC §290.42(g) suggests that either a 30-day pre-construction pilot test or 30-days of data from a full-scale operational system must be submitted to TCEQ to obtain approval of modified system characteristics. However, based upon discussion with Marlo Berg from TCEQ on April 24, 2020, a plate settler sedimentation system could be approved without the submission of 30-days of data for the Pflugerville WTP as long as the City does not request virus or other removal credits from the system, and as long as the proposed surface overflow rate is less than or equal to 3.0 gpm/sf.

The installation of a sedimentation system would require the City to begin sampling raw and filtered water TOC concentrations and reporting these values to TCEQ within the SWMORs. While the plant's data reporting requirements would increase, additional TOC removal requirements are not anticipated.

5.2.3 Membrane Permeate Production Capacity

With the installation of a sedimentation pre-treatment system, the existing and any future membranes may be capable of handling higher feed flows (i.e. flux) than they are currently rated for. To achieve a successful re-rating of the membrane filtration trains, data from a 30-day pre-construction pilot study or 30-days of full-scale operational data is required to be submitted to TCEQ along with an associated analysis and report. The City has three options for obtaining the necessary data to achieve a membrane re-rating:

1. Do not complete a pilot-scale study. Obtain 30-days of full-scale operational system data for the combined sedimentation and filtration system.
2. Obtain 30-days of data from a pilot-scale operational system for the flocculation and sedimentation system. Obtain 30-days of full-scale operational system data for the combined sedimentation and filtration system.
3. Obtain 30-days of data from pilot-scale study of sedimentation and filtration systems simultaneously.

If a pilot study is completed prior to plant construction, the risk of under- or over-designing is inherently lower as engineers can rely more heavily upon a water quality dataset specific to the Pflugerville WTP and less heavily upon design standards and assumptions. In addition, pilot study data would allow for more efficient design and construction, due to the establishment of higher membrane flux ratings, which can ultimately lead to reduced costs. However, for specific criteria (e.g. plate dimensions) TCEQ requires the same values be utilized for full-scale operation as used during the pilot study. If different design criteria are adopted between the pilot and final construction, TCEQ may require an additional 30-days of full-scale data prior to approving the membrane re-rating. Since manufacturers have a wide range of design criteria, the City runs the risk of limiting sedimentation system manufacturers to those that can match the design values used during the pilot.

Regardless of method of data collection, an increased flow rate through the membranes will likely be approved by TCEQ, though the extent of the increase in flow rate is to be determined (with pilot or full-scale demonstration).

5.2.4 Design Criteria

With the installation of a sedimentation system, a new splitter box and rapid mix facility can be utilized for equalized flow split to each sedimentation train and to provide chemical injection mixing. The splitter box structure will manage flow to each sedimentation train using a fixed weir configuration to equally split flow to each train. Rapid mix boxes are primarily designed to promote blending of coagulant chemicals and raw water to destabilize organics and particles to facilitate flocculation. TCEQ requires redundant mechanical mixers for plants with design capacities greater than 3.0 MGD. The hydraulic detention time within a rapid mix box is proposed to be low (seconds) to avoid shearing of floc particles as they begin to form. TCEQ does not specify a required hydraulic detention time for rapid mix boxes, but it is common practice to size these structures for a detention time of 10-30 seconds at the design flow. Table 5-4 summarizes the design criteria for a rapid mix structure.

Table 5-4: Design Criteria for Rapid Mix Chambers

Design Criteria	Value	Unit
Design Flow	30.0	MGD
TCEQ Design Standard		
Minimum Number of Mixers	2	EA
Industry Standard for Detention Time	10 – 30	sec
Recommended Detention Time at Design Flow	10	sec
Rapid Mix Characteristics		
Number of Mixing Cells	2	
Number of Mixers per Mixing Cell	1	EA
Min Velocity Gradient	750	1/s
Max Velocity Gradient	1250	1/s
Type	Vertical Turbine	

Design criteria for conventional and lamella plate sedimentation are included in Table 5-5. Design criteria were determined through a combination of TCEQ requirements and information supplied by manufacturers. Notably, the surface overflow rate for the lamella plate settler technology is higher and the detention time lower than the same values used for conventional sedimentation. These two design characteristics allow for a significant footprint reduction for the lamella plate technology as compared to conventional filtration. Sizing of each technology is included in Section 5.2.5.

Table 5-5: Design Criteria for Conventional and Lamella Plate Settler Sedimentation

Criteria	Conventional	Lamella Plate Settler	Unit
Basin Sizing			
Length:Width Ratio	2.0 – 3.0	1.5 – 2.0	-
Side Water Depth	≥ 12	≥ 12	feet
Surface Overflow Rate	0.6 – 1.0	≤ 3.0[1]	gpm/sf
Plate Loading Rate	--	0.3 - 0.5	gpm/sf
Particle Settling Time	5 – 15	5 – 15	minutes
Detention Time	6.0	0.5 – 2.0	hours
Plate Length	N/A	8.5 – 10	feet
Plate Spacing	N/A	1.8 – 3.0	inches

[1]Suface overflow rates of greater than 3.0 gpm/sf are allowed but require justification to TCEQ with 30-days of data.

5.2.5 Size and Location

Preliminary tank and equipment sizing for both the conventional and lamella plate options was evaluated, and values are summarized in Table 5-6. For both technology options four flocculation and four sedimentation basins are provided, even though TCEQ requires only two. Providing four basins allows for greater system redundancy and operational flexibility. If only two basins are provided, when one basin is offline the plant loses half its treatment capacity.

While sizing for a conventional sedimentation system is somewhat straightforward, there are multiple manufacturers of lamella plate technology that can each have different footprints. Multiple manufacturer submissions were reviewed, and a typical lamella plate settler basin size is included in Table 5-6. Depending upon the chosen manufacturer, selected plate size and angle, and plate spacing the overall basin footprint may vary.

Site layouts for each technology are included in Figure 5.4.

Table 5-6: Flocculation/Sedimentation Conceptual Basin Size Comparison[1]

Technology	Treatment	# Basins	Individual Basin Length (ft)	Individual Basin Width (ft)	Total Area for all Basins (sf)
Conventional	Flocculation	4	53	23	4,876
	Sedimentation	4	300	50	60,000
Plate Settler[2]	Flocculation	4	60	24	5,760
	Sedimentation	4	90	24	8,640

[1]All sizing based upon 30 MGD.
[2]Significant variation possible based upon selected manufacturer. Basin sizing assumes surface overflow rate no greater than 3.0 gpm/sf, which could be increased in design with pilot testing or re-rated after construction.

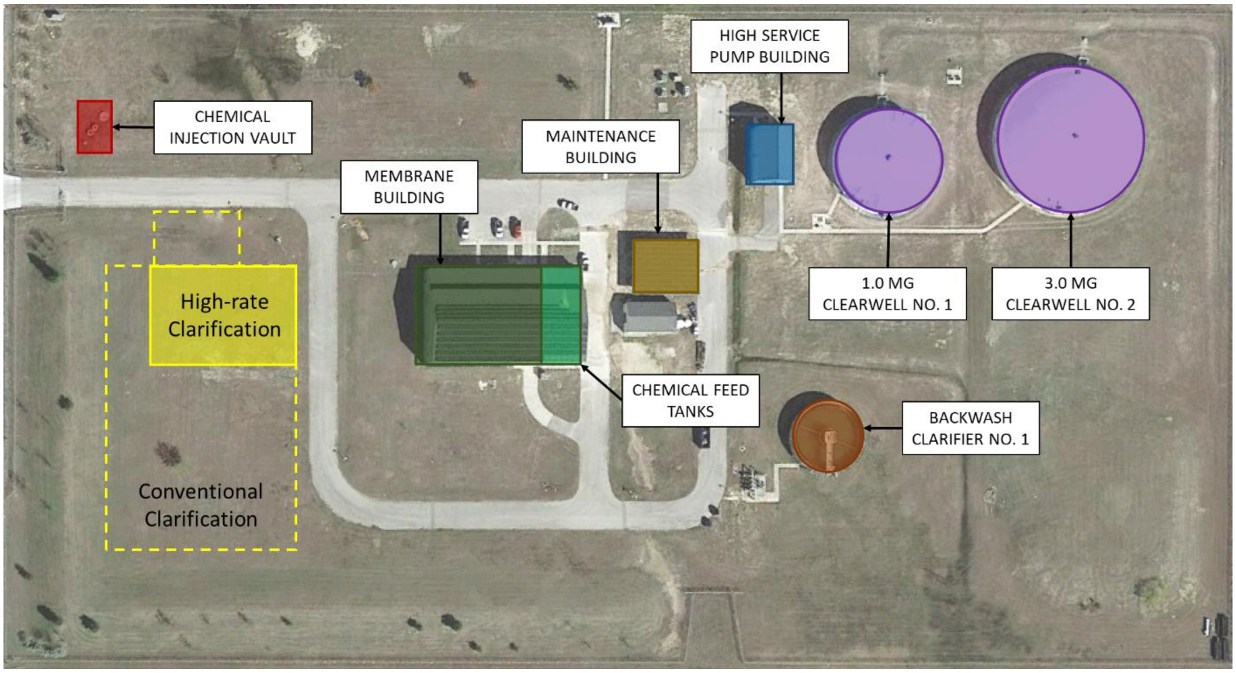

Figure 5.4: Approximate Size and Location of Planned Conventional and High-Rate Sedimentation Pre-treatment Systems

5.2.6 Cost of Construction

Construction costs were developed based upon manufacturer quotes and high-level evaluation of required quantities for standard construction projects including concrete, metals, wood & plastics, electrical, earthwork, and process piping. Summaries of the resulting total estimated costs for conventional and plate settler technology are included within Table 5-7. Table 5-8 outlines the estimated cost for the proposed upstream splitter box and rapid mix setup. The conceptual designs that were utilized for facility cost estimations in this Report follow the Association for the Advancement of Cost Engineering International guidance for Study or Feasibility analysis (Class 4). Estimates for Class 4 are typically prepared for strategic business planning purposes such as detailed strategic planning, technical feasibility, preliminary budget approval, etc. Limited data and information are available at the time of estimate development. Therefore, Class 4 estimates subsequently have wide accuracy ranges such as minus 15 percent to minus 30 percent on the low end, and plus 20 percent to plus 50 percent on the high end, depending on the availability and accuracy of reference information.

Traditionally the lamella plate settler system is constructed from stainless steel. Upon discussion with manufacturers, a synthetic plastic-based material technology, Texler, is newly on the market at a reduced cost as compared to stainless steel. The Texler material technology is included for comparison purposes in Table 5-7. The technology has no current installations and would need to be piloted at the plant prior to recommendation.

Table 5-7: Flocculation and Sedimentation Pre-treatment Opinion of Probable Cost

Division	Conventional	Lamella Plate (Stainless Steel)	Lamella Plate (Texler)
Division 3 - Concrete	$8,019,935	$2,910,420	$2,910,420
Division 5 - Metals	$352,897	$202,694	$202,694
Division 6 - Wood and Plastics	$118,347	$93,077	$93,077
Division 26 - Electrical	$449,276	$506,702	$506,702
Division 31 - Earthwork	$278,190	$62,090	$62,090
Division 40 - Process Integration	$273,405	$240,900	$240,900
Division 44 - Pollution Control Equipment	$1,250,362	$3,576,604	$2,610,353
Subtotal	**$10,742,411**	**$7,593,000**	**$6,041,000**
Mobilization (5%)	$698,257	$494,000	$393,000
Overhead and Profit (18%)	$1,396,513	$1,777,000	$1,415,000
Contingency (30%)	$3,222,723	$2,278,000	$1,813,000
Total	**$17,177,115**	**$12,142,000**	**$9,662,000**

Table 5-8: Splitter Box and Rapid Mix Opinion of Probable Cost

Division	Splitter and Rapid Mix
Division 3 - Concrete	$431,588
Division 5 - Metals	$135,560
Division 26 - Electrical	$93,450
Division 31 - Earthwork	$9,923
Division 40 - Process Integration	$138,645
Division 44 - Pollution Control Equipment	$417,320
Subtotal	**$1,227,000**
Mobilization (5%)	$80,000
Overhead and Profit (18%)	$288,000
Contingency (30%)	$369,000
Total	**$1,964,000**

5.3 Filtration

Three (3) filtration alternatives have been developed for the WTP expansion, each of which is described in detail in the sections below. As described in Section 5.2, it is also the recommendation to construct a flocculation and sedimentation (pre-treatment) system upstream of both the existing membranes and of any filtration technologies that are installed as a component of the three identified alternatives in this section. The sedimentation system impacts the analysis of each of the identified filtration alternatives and is discussed in the sections below.

5.3.1 Filtration Alternative 1 – Expand with Existing ZeeWeed 500D® Membranes

Filtration Alternative 1 consists of expanding filtration capacity at the plant through the installation of additional 500D ZeeWeed® membranes, in a configuration matching those of the existing membranes at the WTP. The plant currently has five (5) membrane trains rated at 4.3 MGD each for a total treatment capacity of 21.6 MGD. However, the membrane permeate pumps are rated at only 3.54 MGD each for a total treatment capacity of 17.7 MGD. The following items are included in Alternate 1:

- The existing membranes would be replaced in-kind
- The permeate pumps for each membrane train would be increased in capacity to match the membrane flow rates
- Three (3) membrane trains would be added to increase the membrane treatment capacity to above 30 MGD.
- Since two of the existing membrane trains were replaced in 2019, and one of the membrane trains is in the process of being replaced in 2020, the remaining two membrane trains are replaced in-kind as a component of Alternative 1.

With the installation of a flocculation and sedimentation pre-treatment system as described in Section 5.2, there exists the possibility to re-rate any existing or newly installed membrane trains for flows higher than 4.3 MGD. The higher flow rate is dependent upon data obtained from either a 30-day pilot study or 30-days of a full-scale operational system. Pending TCEQ approval, it is possible that fewer than three additional membrane trains would be required to reach a 30 MGD treatment capacity; however, in lieu of additional information from a pilot study, this Alternative was planned using currently-approved membrane flux rates.

Table 5-9: Filtration Alternative 1 Capacity Summary

Scenario	Membrane Train Capacity (MGD)	No. of Required Trains	Total Capacity (MGD)	Total Capacity with N-1 Redundancy
Existing	4.3	5	21.6	17.3
Alternative 1	4.3 (x8)	8	34.4	30.1

Alternative 1 does not modify the existing plant treatment train except to increase the number of membrane treatment trains from 5 to 8. The existing process flow diagram is depicted in Figure 2.4.

Regulatory Overview

Under Alternative 1, regardless of whether the membranes are re-rated, the plant's regulatory requirements would not change. The plant would be subject to no additional reporting requirements except those required due to the implementation of the upstream flocculation and sedimentation system.

Design Criteria

Under Alternative 1, the membrane design criteria remain the same as the existing plant membranes. A summary of the design criteria for the existing ZeeWeed 500D® membranes is included in Table 5-10.

Table 5-10: Filtration Alternative 1 ZeeWeed 500D® Membrane Design Criteria Summary

Criteria	Design Range	Unit
Minimum Temperature	11	degrees C
pH	5.0 – 9.5	-
Membrane Pore Size	0.04	µm
Flux	28.4	gfd
Flux with N-1 Redundancy	32.5	gfd
Cassette Surface Area	440	ft^2
Effluent Turbidity	≤ 0.1	NTU 95% of the time
Giardia Removal Credits	≥ 3.0	log
Cryptosporidium Removal Credits	≥ 2.0	log
Backpulse Interval	15	minutes
Membrane Integrity Testing (MIT)	Once per week	-

Size and Location

The existing five (5) membrane trains have five (5) cassettes each and no space for additional cassettes. Each cassette is approximately 8' x 10', and the existing membrane tanks are approximately 40' x 10' each. There is currently no remaining space in the membrane building for any additional membrane tanks. The assumption is that the existing membrane building will be expanded, or a new membrane building will be constructed adjacent to the west of the existing building to house the new membranes and any associated equipment. A conceptual site layout depicting the available onsite space for a new building is shown in Figure 5.5.

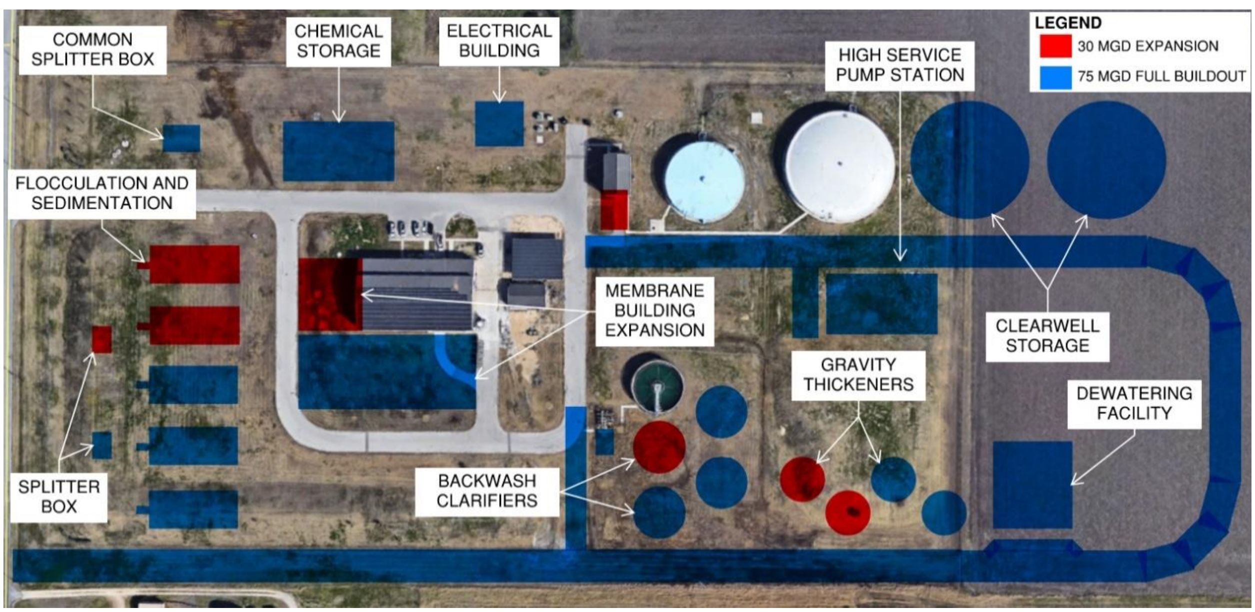

Figure 5.5: Conceptual 75 MGD Site Layout: Filtration Alternative 1

Cost of Construction

Construction costs were developed based upon manufacturer quotes and high-level evaluation of required quantities for standard construction projects including concrete, metals, wood & plastics, electrical, earthwork, and process piping. Costs included in Table 5-11 include costs to build a new membrane building, install three new membrane trains, replace two of the existing membrane trains, and upsize all five of the existing permeate pumps.

Table 5-11: Filtration Alternative 1 (ZeeWeed 500D®) Estimated Cost of Construction

Division	Total Estimated Cost
Division 2 – Sitework	$250,000
Division 3 – Concrete	$1,195,319
Division 5 – Metals	$252,216
Division 7 – Thermal/Moisture Protection	$81,245
Division 8 – Openings	$24,150
Division 9 – Finishes	$20,623
Division 10 – Specialties	$1,410,750
Division 14 – Conveyance	$60,000
Division 23 – HVAC	$82,500
Division 26 - Electrical	$881,375
Division 31 - Earthwork	$370,902
Division 40 - Process Integration	$572,314
Division 44 - Pollution Control Equipment	$7,010,681
Subtotal	**$12,234,000**
Mobilization (5%)	$796,000
Overhead and Profit (18%)	$2,864,000
Contingency (30%)	$3,671,000
Total	**$19,565,000**

Life Cycle Cost Analysis

In addition to initial capital construction costs, a life cycle analysis was completed for filtration Alternative 1. The life cycle analysis includes electricity, chemical, and labor annual operating costs. In addition, based upon information provided by the manufacture, and the plant's experience with the ZeeWeed 500D® membranes, each treatment train was assumed to be replaced every 5-years. Table 5-12 outlines the 20-year net present worth analysis for Alternative 1.

Table 5-12: Filtration Alternative 1 (ZeeWeed 500D®) Life Cycle Cost Analysis

No.	Item Description	Units in Operation	Daily Requirements	Annual Requirements	Unit Cost	Annual Cost
1	Membrane Air Scour Blowers	2	597	217,744	$0.10 / kWh	$ 21,774
2	Air Compressor	2	1790	653,233	$0.10 / kWh	$ 65,323
3	Permeate Pumps	8	9545	3,483,910	$0.10 / kWh	$ 348,391
4	Backpulse Pumps	2	746	272,181	$0.10 / kWh	$ 27,218
5	CIP Pumps	2	24	8,710	$0.10 / kWh	$ 871
6	CIP Electric Heater	2	48	17,420	$0.10 / kWh	$ 1,742
7	Sodium Hypochlorite (12.5%)	-	193	70,480	$3.1 / gal	$ 219,000
8	Citric Acid (50%)	-	32	11,583	$6.2 / gal	$ 73,000
9	Sodium Bisulfite	-	97	35,240	$3.5 /gal	$ 124,100
10	ZeeWeed 500D®[1]	8	-	-	$500k / train	$ 800,000
11	Membrane Labor	-	1	365	$100 / hr	$ 36,500
					Annual O&M	$ 1,718,000
					Initial Capital Cost	$ 19,565,000
					20-year Present Worth (6% Interest)	$ 45,332,000

[1]5-year replacement time frame.

5.3.2 Filtration Alternative 2 – Expand with a New Membrane Technology

Filtration Alternative 2 consists of expanding treatment capacity at the plant by removing the existing ZeeWeed 500D® membrane trains and installing a new membrane treatment technology in its place. Three technologies have been identified for high-level consideration: submerged ultrafiltration membranes, pressure cartridge membranes, and ceramic membranes.

- *Submerged Ultrafiltration Membranes*
  The submerged ultrafiltration (UF) membrane is the same technology as used by the plant's existing membranes. It provides ultrafiltration (0.02-0.04µm pore size) using hollow-fiber membranes and operates through vacuum (i.e., applying a suction on the inside of the membrane fibers) similar to the ZeeWeed 500D® membranes. A retrofit with a new submerged UF membrane system would be relatively straightforward due to the similarity of the hydraulic profile with the existing membranes. The membranes are placed in a tank that is open to the atmosphere and water is drawn through the membranes via a vacuum pump.

- *Pressure Cartridge Membranes*
  Similar to the submerged UF membrane system, a pressure cartridge membrane system would provide a 0.04µm pore size using hollow-fiber membranes, but would operate through a pressure mechanism rather than a vacuum mechanism. In a pressure system, the membranes are not open to the atmosphere and water is pushed through the membranes via a pressure pump. A retrofit with a pressure membrane system within the existing membrane building would require a complete overhaul of the existing piping and equipment connections as the hydraulic profile would require significant modifications.

- *Ceramic Membranes*
  A ceramic membrane system does not use hollow-fiber membranes but contains membranes constructed as ceramic monoliths which are durable and resilient. Similar to pressure membranes described above, filtration happens under pressure, and a retrofit within the existing building would require a complete overhaul of the existing pipe and equipment connections. A ceramic membrane system can withstand a large temperature operating range and a number of influent chemicals (i.e. ozone, chlorine dioxide) that may be used within a water treatment system. Many chemicals that could damage polymeric hollow-fiber membranes are not harmful to ceramic membranes. The drawback to a ceramic membrane system- is like the pressure membranes – in that it would require a complete overhaul of the Plant's hydraulic grade line.

Based upon the drawbacks associated with pressure and ceramic membrane systems (necessity to overhaul the entire membrane building and/or excessive cost), the submerged UF membrane system is the recommended technology for Filtration Alternative 2. The remaining sections within Alternative 2 focus on submerged UF membranes only.

With the installation of a new submerged UF membrane technology, flow rates for the new treatment trains will need to be determined and approved by TCEQ. With a flocculation and sedimentation pre-treatment system as described in Section 5.2, there exists the possibility to obtain a higher approved membrane flow rate (i.e. flux) than would otherwise be possible. The approved membrane flux will depend on data obtained from either a 30-day pilot study or 30-days of a full-scale operational system.

Regulatory Overview

The installation of a new membrane system would require a 30-day pilot study or 30-days of full-scale operational data to demonstrate to TCEQ that the necessary treatment targets can be obtained by the new system as it is an innovative treatment technology. Following the initial 30-day study, reporting requirements are expected to be identical to the existing membrane system, aside from those additional reporting requirements associated with the flocculation and sedimentation system.

Design Criteria

The applicable design criteria for Alternative 2 are largely the same as included in Table 5-10 in Section 5.3.1 The main difference between the existing membranes and the membranes proposed under Alternative 2, is that the membrane flux is more conservative for Alternative 2. A conservative membrane flux is utilized since this technology has not been approved by TCEQ for this facility as yet. Table 5-13 outlines design criteria for the submerged UF membranes that are proposed under Alternative 2.

Table 5-13: Filtration Alternative 2 Design Criteria Summary

Criteria	Design Range	Unit
Minimum Temperature	11	degrees C
pH	5.0 – 9.5	-
Module Surface Area	550	sf
Membrane Pore Size	0.02-0.04	µm
Flux	22	gfd
Flux with N-1 Redundancy	27	gfd
Effluent Turbidity	≤ 0.1	NTU 95% of the time
Giardia Removal Credits	≥ 3.0	log
Cryptosporidium Removal Credits	≥ 2.0	log
Backpulse Interval	15	minutes
Membrane Integrity Testing (MIT)	Once per week	-

Construction Phasing

The major design consideration encountered with Alternative 2 is the necessity for construction phasing. The installation of a new membrane treatment technology in place of the existing membranes necessitates the replacement of the existing membrane trains while keeping the plant in service. Through discussion with membrane manufacturers, the proposed construction phasing would include removing membrane trains from service one at a time and replacing them with the new membrane technology. To accomplish this, a temporary permeate header will be required and the trains will need to be operated on an individual basis through their individual I/O panels. In addition, the construction will need to be accomplished during periods of low demand (winter months) so that the plant can provide adequate production capacity with the available operating train(s).

To obtain an estimate for the construction timeframe, discussions were held with the project manager of a similar membrane retrofit project that is currently on-going in North Texas. The project originally had an estimated retrofit timeframe of 6-months but has been delayed to 8-months. It is conservatively anticipated that the membrane retrofit at the Pflugerville WTP could be completed within 1-year.

Size and Location

A new submerged UF membrane system could be installed through retrofit within the existing membrane tanks. The existing tanks are approximately 40’x10’ each giving a total available space of 2,000 sf within which to retrofit. An expansion of the membrane building would not be required for a submerged UF membrane retrofit under Alternative 2 based upon discussion with multiple submerged UF membrane manufacturers.

Cost of Construction

A retrofit with a new submerged membrane technology would not require additional space outside of the existing membrane building. The cost included in Table 5-14 is the estimated cost for a complete overhaul of the existing membrane equipment including tank modifications, new membranes, and permeate pumps.

Table 5-14: Filtration Alternative 2 (New Membrane Technology) Estimated Cost of Construction

Division	Low Range Estimated Cost	High Range Estimated Cost
Division 2 – Sitework	$385,000	$385,000
Division 3 – Concrete	$264,000	$264,000
Division 26 - Electrical	$611,250	$1,420,000
Division 44 - Pollution Control Equipment	$7,895,550	$10,025,585
Subtotal	**$9,156,000**	**$12,095,000**
Mobilization (5%)	$527,000	$696,000
Overhead and Profit (18%)	$1,896,000	$2,504,000
Contingency (15%)	$843,000	$1,815,000
Total	**$12,953,000**	**$17,110,000**

Life Cycle Cost Analysis

In addition to initial capital construction costs, a life cycle analysis was completed for filtration Alternative 2. The life cycle analysis includes electricity, chemical, and labor annual operating costs. Two membrane manufacturer cost estimates are included in the life-cycle cost; these two estimates are reported below as Type I and Type II. Based upon information provided by manufacturers, a 7-year warranty was applied to the Type I membranes and a 10-year warranty was applied to the Type II membranes. Table 5-15 outlines the 20-year net present worth analysis for Alternative 2.

Table 5-15: Filtration Alternative 2 (New Membrane Technology) Life Cycle Cost Analysis

No.	Item Description	Units in Operation	Daily Requirements	Annual Requirements	Unit Cost	Annual Cost
1	Membrane Air Scour Blowers	1	373	136,090	$0.10 / kWh	$ 13,609
2	Air Compressor	1	1119	408,271	$0.10 / kWh	$ 40,827
3	Permeate Pumps	5	11931	4,354,888	$0.10 / kWh	$ 435,489
4	Backpulse Pumps	1	932	340,226	$0.10 / kWh	$ 34,023
5	CIP Pumps	1	15	5,444	$0.10 / kWh	$ 544
6	CIP Electric Heater	1	30	10,887	$0.10 / kWh	$ 1,089
7	Sodium Hypochlorite (12.5%)	-	219	80,091	$3.1 / gal	$ 248,200
8	Citric Acid (50%)	-	20	7,239	$6.2 / gal	$ 47,500
9	Sodium Bisulfite	-	110	40,046	$3.5 /gal	$ 142,400
10	Membrane Type I[1]	2520	-	-	$1,100 / module	$ 396,000
11	Membrane Type II[2]	3600	-	-	$900 / module	$ 324,000
12	Membrane Labor	-	1	365	$100 / hr	$ 36,500
					Annual O&M Type I	$ 1,396,000
					Annual O&M Type II	$ 1,324,000
					Initial Capital Cost Type I	$ 12,953,000
					Initial Capital Cost Type II	$ 17,110,000
					20-year Present Worth Type I (6% Interest)	$ 33,891,000
					20-year Present Worth Type II (6% Interest)	$ 36,968,000

[1]7-year replacement time frame.
[2]10-year replacement time frame.

5.3.3 Filtration Alternative 3 – Expand with a Parallel Gravity-Driven Filtration Process

Filtration Alternative 3 consists of keeping the existing ZeeWeed 500D® membranes and expanding treatment capacity at the plant by constructing a new gravity-driven granular media filter process parallel to the existing membranes. Two technologies for the proposed parallel filter are considered: a gravity-driven membrane system and mixed-media conventional filtration.

- *Conventional Mixed-Media Filter*
  Gravity filtration through layers of granular media is the most common method of water filtration. Conventional mixed-media filtration typically consists of a combination of sand and granular activated carbon (GAC) or anthracite and is governed by standard TCEQ regulations. Benefits of conventional filtration are high TCEQ and operator familiarity and ease of operations.

- *Gravity-Driven Membranes*
  Gravity-driven membranes are similar in design to the submerged ultrafiltration membranes described in Section 5.3.2; however, permeate pumps are not required as water flows through the membranes by gravity. A gravity-driven membrane filter system would require an analysis of the existing plant hydraulic profile so that the system could be situated on-site such that there is sufficient hydraulic head for the membranes to work by gravity.

Based upon the drawbacks associated with gravity driven membrane systems (excessive cost of membrane filtration material and ancillary equipment), the conventional mixed-media filter is the proposed technology for Filtration Alternative 3. The remaining sections within Alternative 3 focus on a conventional mixed-media filter only.

Under Filtration Alternative 3 flow from the proposed upstream sedimentation system would be split between the existing membranes and the new conventional filters. In addition, a new filter pump station would be required to be installed on the downstream end of the filters to provide the hydraulic head necessary for filtered water to reach the clearwells. An updated process flow diagram outlining Filtration Alternative 3 is included in Figure 5.6.

Under Filtration Alternative 3 it is assumed that the existing membrane trains and associated permeate pumps will not be updated. The parallel filtration system is therefore sized for 13 MGD based upon the existing membrane permeate pumping capacity of 17.7 MGD as shown in Table 5-16.

Table 5-16: Filtration Alternative 3 (Conventional) Capacity Summary

Scenario	Train Capacity (MGD)	No. of Trains	Total Capacity (MGD)
Existing Membrane Permeate Pumps	3.54	5	17.7
Parallel Conventional Filtration	3.25	4	13.0

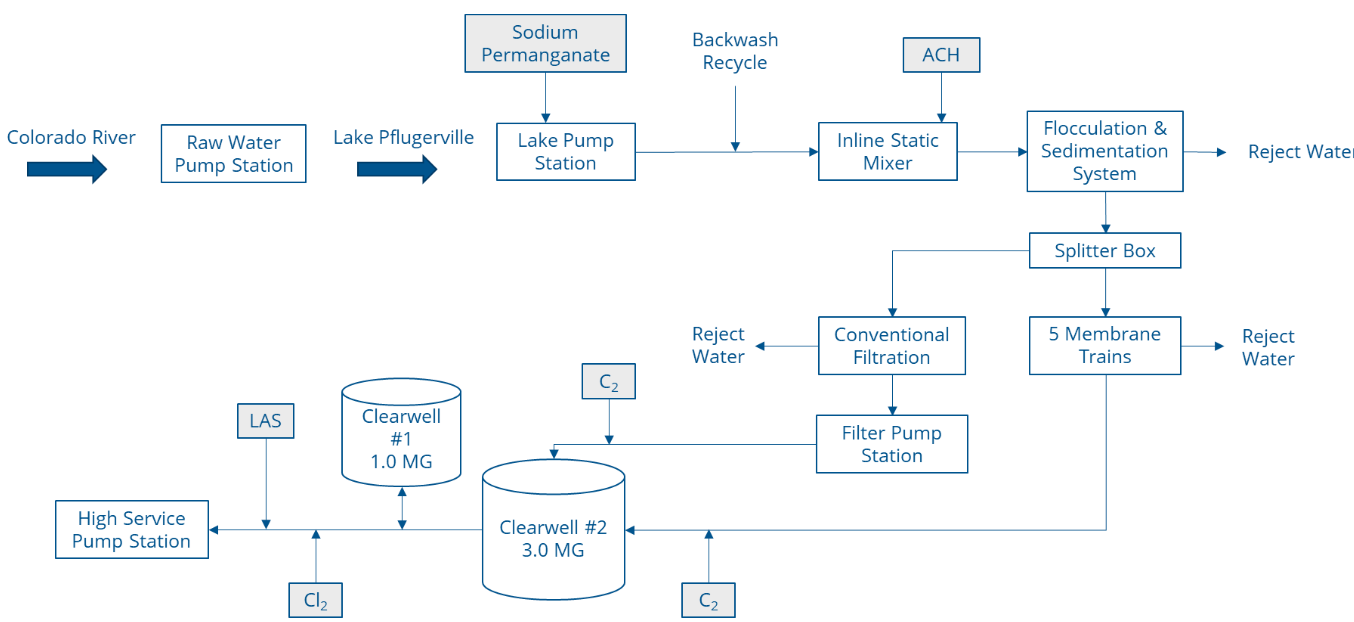

Figure 5.6: Filtration Alternative 3 (Conventional) Proposed Process Flow Diagram

Regulatory Overview

The addition of a conventional filter system would require modifications to the existing CT Study as well as to the City's existing TCEQ reporting requirements. The CT Study would need to be modified to include *Giardia* and *Cryptosporidium* inactivation credits from the new parallel filtration train, and water quality parameters from the filter effluent would need to be monitored and included within the City's existing SWMORs. These updates are in addition to the required updates from the implementation of the upstream flocculation and sedimentation system.

Design Criteria

Table 5-17 summarizes standard design criteria for conventional filtration per TCEQ standards. In accordance with TCEQ standards, the conventional filters are proposed to be sized to meet anticipated flows (13 MGD) with one filter out of service.

Table 5-17: Filtration Alternative 3 (Conventional) Design Criteria

Criteria	Design Range	Unit
Filtration Rate	≤ 5.0	gpm/sf
Total Filter Media Depth	≥ 24	inches
Filter Media L/d Ratio	≥ 1000	-
Backwash Rate	≥ 12.5	gpm/sf

Size and Location

The potential exists for both the parallel conventional filtration system and the existing membrane trains proposed under Alternative 3 to be re-rated and ultimately have a reduced footprint dependent upon TCEQ approval. For this analysis, the assumption is that no re-rates will be obtained, and all sizes are the maximum sizing determined from existing TCEQ regulations. Anticipated sizing is included in Table 5-18 and a layout depicting the proposed location is included in Figure 5.7.

Table 5-18: Filtration Alternative 3 (Conventional) Conceptual Basin Size Summary

Criteria	Value	Unit
Capacity	13.0	MGD
Length	32	ft
Width	19 (x4)	ft
Area	2,432	sf

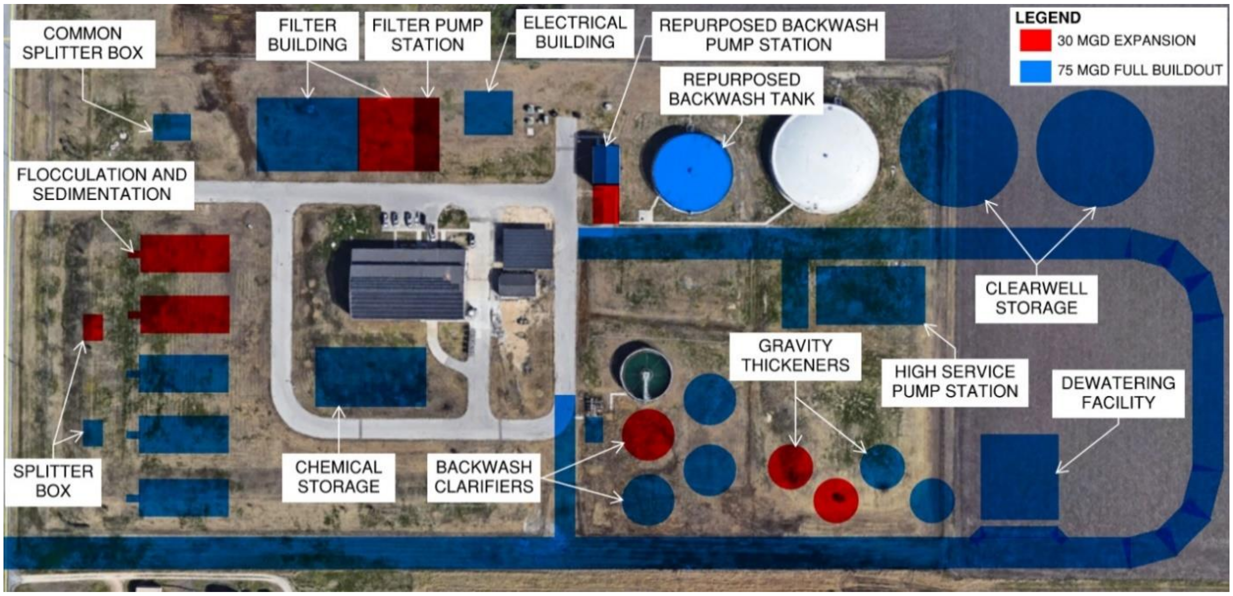

Figure 5.7: Proposed Membrane Conventional Filter Location: Filtration Alternative 3

Cost of Construction

Table 5-19 summarizes the estimated construction costs for a new conventional filter basin and a new gravity membrane filtration system. The cost estimate includes the following major items:

- New 13 MGD mixed-media gravity filter basin.
- New 13 MGD pump station to serve the filter basin.
- New splitter box to divide flows between the new filter basin and the existing membrane trains.

Table 5-19: Filtration Alternate 3 (Conventional) Estimated Cost of Construction

Division	Total Estimated Cost
Division 3 – Concrete	$1,259,087
Division 5 – Metals	$41,535
Division 7 – Thermal/Moisture Protection	$18,964
Division 8 – Openings	$8,050
Division 10 – Specialties	$363,000
Division 22 – Plumbing	$23,166
Division 26 – Electrical	$2,743,250
Division 31 – Earthwork	$903,737
Division 40 – Process Integration	$7,074,412
Division 44 – Pollution Control Equipment	$3,384,700
Subtotal	**$15,828,000**
Mobilization (5%)	$1,029,000
Overhead and Profit (18%)	$3,705,000
Contingency (25%)	$4,749,000
Total	**$25,311,000**

Life Cycle Cost Analysis

In addition to initial capital construction costs, a life cycle analysis was completed for filtration Alternative 3. The life cycle analysis includes electricity, chemical, and labor annual operating costs. In addition, based upon information provided by the manufacture, and existing plant experience, a 5-year warranty was applied to the ZeeWeed 500D® membranes. Table 5-20 outlines the specific items included within the life cycle cost analysis for Alternative 3.

Table 5-20: Filtration Alternative 3 (Conventional) Life Cycle Cost Analysis

No.	Item Description	Units in Operation	Daily Requirements	Annual Requirements	Unit Cost	Annual Cost
1	Membrane Air Scour Blowers	1	932	340,226	$0.10 / kWh	$ 34,023
2	Air Compressor	1	2796	1,020,677	$0.10 / kWh	$ 102,068
3	Permeate Pumps	5	5966	2,177,444	$0.10 / kWh	$ 217,744
4	Backpulse Pumps	1	466	170,113	$0.10 / kWh	$ 17,011
5	CIP Pumps	1	15	5,444	$0.10 / kWh	$ 544
6	CIP Electric Heater	1	30	10,887	$0.10 / kWh	$ 1,089
7	Filter Pumps	2	4,772	1,741,955	$0.10 / kWh	$ 174,196
8	Sodium Hypochlorite (12.5%)	-	121	44,050	$3.1 / gal	$ 138,700
9	Citric Acid (50%)	-	20	7,239	$6.2 / gal	$ 47,500
10	Sodium Bisulfite	-	60	22,025	$3.5 /gal	$ 76,700
11	ZeeWeed 500D®[1]	5	-	-	$500k /train	$ 500,000
12	Silica Sand[2]	2660	-	-	$8.0 / cf	$ 2,200
13	Anthracite[2]	5219	-	-	$14.0 / cf	$ 7,400
14	Membrane Labor	-	1	365	$100 / hr	$ 36,500
15	Filter Media Labor		0.66	240	$100 / hr	$ 24,000
					Annual O&M	**$ 1,379,000**
					Initial Capital Cost	**$ 25,311,000**
					20-year Present Worth (6% Interest)	**$ 46,003,000**

[1]5-year replacement time frame.
[2]20-year replacement time frame.

5.4 Clearwell Storage and Disinfection

5.4.1 Storage Requirements

The existing WTP has two clearwells with 1 MG and 3 MG capacity. The Water Master Plan was completed for the City of Pflugerville in 2020 which outlined design criteria for water storage capacity in the City's water treatment and distribution system. The design criteria in the Master Plan are stated to be "more stringent than the TCEQ requirements and take into consideration additional factors including operational flexibility, fire suppression, system redundancy, and energy efficiency." The design criteria identified within the Master Plan and associated TCEQ regulations are included in Table 5-21.

Table 5-21: Clearwell Capacity Design Criteria

Source	Description	Required Clearwell Capacity at 30 MGD
30 TAC §290.45(b)(2)(D)	A covered clearwell storage capacity at the treatment plant of 50 gallons per connection or, for systems serving more than 250 connections, 5.0% of daily plant capacity.	1.5 MG
2020 Water Master Plan	Ground storage capacity equal to 8 hours of firm pumping capacity by pump station.	13 MG

Through discussion with City staff, the design criteria in the 2020 Water Master Plan were determined to be excessively conservative. The addition of large volumes of clearwell storage may increase the potential for formation of disinfection byproducts (DBPs) and is not required by TCEQ. Based upon the T.A.C., the WTP has adequate onsite clearwell storage capacity in addition to the necessary clearwell capacity used for primary disinfection (CT) credits.

5.4.2 Disinfection Requirements

The City currently uses free chlorine for primary (CT) disinfection and chloramines for secondary (distribution residual) disinfection. The plant has only one disinfection zone per the January 29, 2020 CT Study approved by TCEQ which provides 3.0-log inactivation of viruses. The zone consists of three lengths of pipeline (30-inch, 42-inch, and 36-inch) and the 3.0 MG Clearwell. The existing 3 MG clearwell has a baffling factor of 0.3 based upon the assumption of baffling characteristics for clearwells with top entry with a 2-foot air gap.

As a component of the 30 MGD expansion, it is recommended to introduce some additional baffling to the 3.0 MG clearwell to increase the baffling factor and ultimately provide a more efficient disinfection process. The existing 3.0 MG storage tank provides adequate volume to meet CT at 30 MGD, see CT Study from January 2020 for additional information. A simple weir wall could be added to the existing 3.0 MG concrete clearwell to increase the firm volume utilized for CT determination. Further study of the configuration for proposed baffling or weir wall additions is recommended during detailed design. The estimated construction cost for adding baffling to the existing clearwell is in Table 5-22.

Table 5-22: Estimated Clearwell Baffling Cost of Construction

Division	Dewatering Estimated Cost
Division 43 – Process Gas & Liquid Handling	$945,000
Subtotal	**$945,000**
Mobilization (5%)	$62,000
Overhead and Profit (18%)	$222,000
Contingency (30%)	$284,000
Total	**$1,513,000**

5.5 High Service Pumping

The High Service Pump Station (HSPS) currently houses three (3) pumps. The plant is also currently undergoing a HSPS expansion project that will include the installation of one (1) additional pump. Each of the four (4) pumps will be rated for 5,972 gpm at 315 feet of head.

Following the completion of the ongoing expansion project, the pumps will together support approximately 25.7 MGD of firm capacity. Because the high service pump station has a higher variability in flow as compared to the rest of the plant, the pump station design capacity is proposed to be at least 25% greater than the plant's design capacity. Therefore, the high service pump station is proposed to support 37.5 MGD. In order to reach this target capacity, the installation of additional pumps is required.

To increase the pump station's firm capacity to at least 37.5 MGD (25% greater than the proposed plant capacity), two new 5,972 gpm pumps are proposed to be installed in parallel with the existing pumps. While flow through the high service pump station will be increased, the system head conditions in the distribution network were held constant for this analysis. A more in-depth analysis is recommended to confirm or update this assumption through review of the City's existing hydraulic model prior to final design. For a summary of this station's proposed criteria, see Table 5-23.

Table 5-23: Proposed High Service Pump Station Data Summary

Existing Pumps		Proposed Pumps	
Quantity	4 Pumps	Quantity	2 Pumps
Future Flow	5,972 gpm	Design Flow	5,972 gpm
Future Head	315 ft	Design Head	315 ft

In total, the new pump station is proposed to have six pumps, all at approximately 5,972 gpm. With the largest pump out of service, the station's firm capacity is therefore increased to 43 MGD. The pumps in this analysis are sized to apply to the existing 960' pressure zone to match the existing high service pumps. The 2020 Water Master Plan outlines the addition of an 800' pressure zone to the water distribution system which is proposed to have a separate pump station and associated elevated storage tank. Depending upon the proposed timing of improvements for the new 800' pressure zone, the proposed new high service pumps could be re-allocated to serve the new pressure zone. The re-allocation of the pumps would require a reconfiguration of the discharge header which is not currently included in the estimated cost. The existing discharge header is above ground within the high service pump station building. If the decision is made to allocate the two additional pumps to the 800' pressure zone, a cost analysis is recommended to determine the feasibility of providing a buried discharge header.

The High Service Pump Station layout will follow that of the original WTP's record drawings, where items marked "future pump" will be adopted into the design. See Figure 5.8 below for the proposed pump station plan view. During construction of the plant a change order modified the construction of the pump station to accommodate only the installed pumps and the remainder of the building was postponed to future design and construction. Therefore, the existing pump building is proposed to be expanded to hold the proposed new pumps. However, City staff have noted that the existing pump station building has made it difficult to carry out maintenance on the existing pumps and motors. To remain conservative, the estimated construction cost of the High Service Pump Station expansion currently includes expansion of the pump station building, but the building may be eliminated at a future date to allow for greater ease of operations and maintenance. The estimated construction cost is included in Table 5-24.

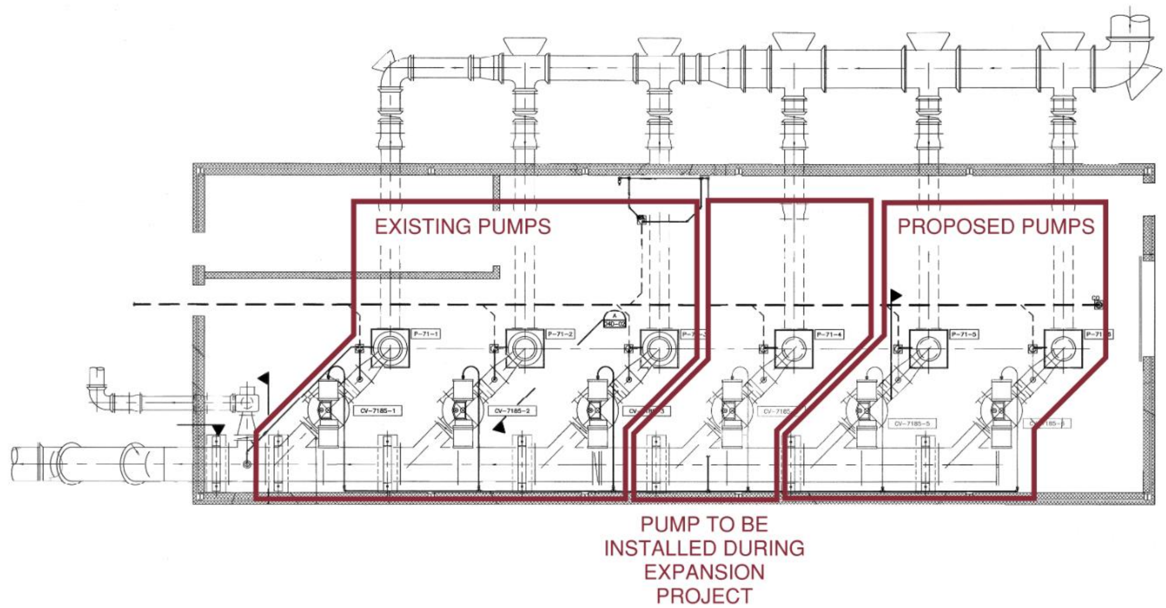

Figure 5.8: High Service Pump Station Proposed Layout

As shown in Figure 5.8, the existing high service pumps are connected to the discharge header via a series of wye connections. Through conversation with City staff, the weld seams at the wye connections have historically failed and caused numerous leaks. The proposed new pumps will therefore be installed with tee connections to reduce existing leakage issues.

Table 5-24: High Service Pump Station Expansion Estimated Cost of Construction

Division	Total Estimated Cost
Division 2 – Existing Conditions	$3,960
Division 3 – Concrete	$73,054
Division 5 – Metals	$52,248
Division 9 – Finishes	$36,956
Division 26 – Electrical	$493,408
Division 31 – Earthwork	$41,496
Division 40 – Process Integration	$699,707
Division 43 – Process Gas & Liquid Handling	$874,125
Subtotal	**$2,2075,000**
Mobilization (5%)	$148,000
Overhead and Profit (18%)	$533,000
Contingency (30%)	$683,000
Total	**$3,639,000**

5.6 Solids Handling

Currently, the plant's solids handling system consists of one (1) 0.5 MG backwash clarifier which accepts reject water from the existing membranes. Decant from the clarifier is routed to Lake Pflugerville while sludge from the clarifier is pumped to an existing 24-inch forcemain along Weiss Lane which leads to the City's Central Wastewater Treatment Plant (WWTP). The City is in the preliminary planning stages for the construction of a new WWTP which is scheduled to be online in 2024. One of the options for the new WWTP would include the elimination of several lift stations and ultimately the abandonment of the 24-inch forcemain that the solids are currently routed to. Therefore, depending upon the chosen WWTP alternative, sludge flow from the WTP to the Central WWTP may need to be eliminated by 2024.

Three solids handling alternatives are identified for the WTP expansion, each of which is described in the sections below. For this evaluation, it was assumed there is available capacity in the backwash recycle system going back to Lake Pflugerville. However, prior to final design, it is recommended to complete a water quality evaluation to ensure that increasing recycle flows to Lake Pflugerville will not cause an accumulation of total organic carbon (TOC). Elevated levels of TOC in the recycled water stream increase the potential to form disinfection byproducts (DBPs) that can reduce finished water quality. If decant is unable to be recycled from the backwash clarifier to Lake Pflugerville, possible alternatives for the decant flow could include the following:

- Expansion of existing or construction of new sanitary sewer to discharge to the WWTP (to be determined based upon abandonment of 24-inch forcemain)
- On-site irrigation

For each of the identified alternatives, a second backwash clarifier will be installed adjacent to the existing clarifier.

5.6.1 Solids Handling Alternative 1 – Pump Solids to WWTP

The first identified solids handling alternative is to keep the current system and pump all sludge from the existing and proposed new backwash clarifiers to the WWTP. Sludge from the new sedimentation units would be pumped directly to the WWTP as well. Figure 5.9 shows a solids flow diagram under Alternative 1. The estimated existing sludge flow from the plant is approximately 200 gpm. With the proposed sedimentation improvements, this would increase to 364 gpm of solids flow, under max month conditions. After discussions with City staff and referencing the existing wastewater hydraulic model, it was determined that the existing 24-inch Weiss Lane forcemain is at capacity and could not handle the increased sludge flows from the plant. Therefore, a direct sewer connection for the coagulated solids was not evaluated further.

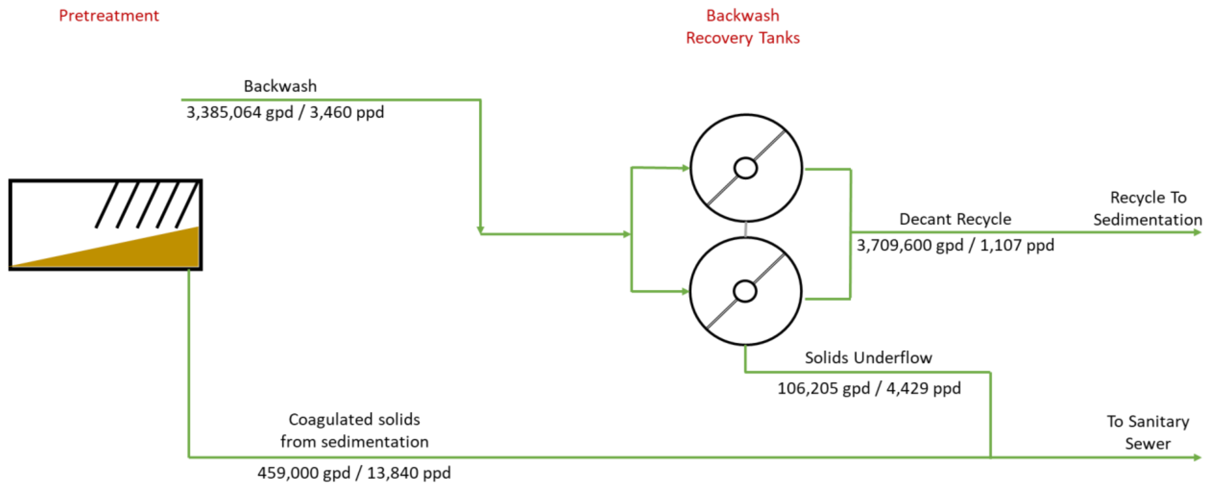

Figure 5.9: Solids Flow Diagram for Alternative 1

5.6.2 Solids Handling Alternative 2 – Onsite Thickening and Pump Solids to WWTP

The second identified solids handling alternative consists of installing a new gravity thickener upstream of existing and proposed new backwash clarifiers. The sludge thickener would accept flows from the plant's proposed sedimentation units. Figure 5.10 shows the solids flow diagram under Alternative 2. The estimated existing sludge flow from the plant is approximately 200 gpm at a WTP capacity of 17 MGD. With solids handling improvements for a gravity thickener system at 30 MGD, the estimated sludge flow from the plant is 93 gpm. The installation of a gravity thickener will generate sludge with a high solids content and ultimately decrease the sludge flow from the estimated current 200 gpm to 93 gpm routed from the WTP to the WWTP.

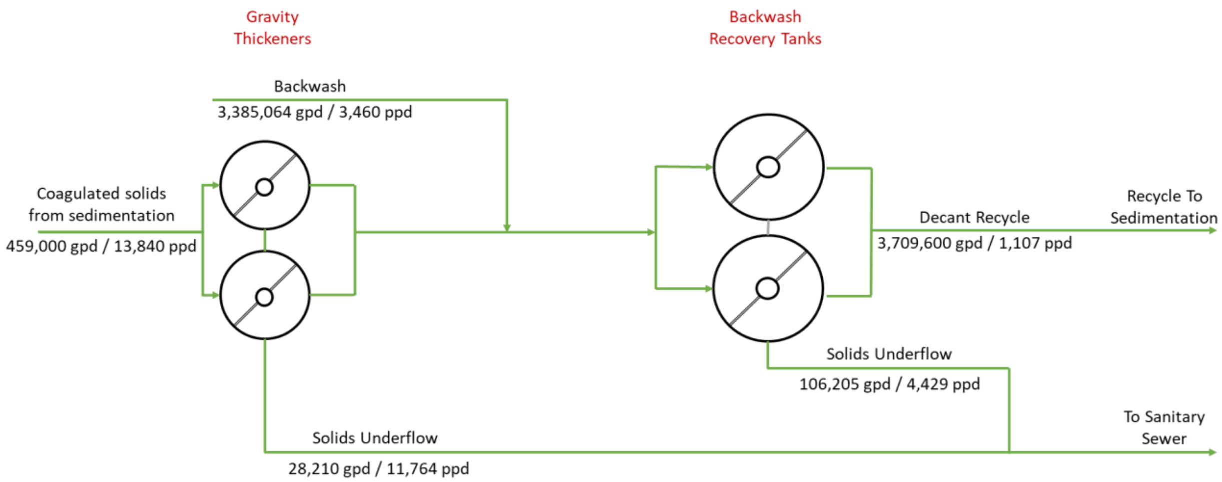

Figure 5.10: Solids Flow Diagram for Alternative 2

Sludge from the thickener will be routed to the sewer along with sludge from the downstream backwash clarifiers. The supernatant from the thickeners would flow to the backwash clarifiers and be recycled back to Lake Pflugerville. Cost estimates for the installation of a new backwash clarifier and a new gravity thickener are included in Table 5-25.

Table 5-25: Estimated Solids Handling Alternate 2 Cost of Construction – Onsite Sludge Thickening

Division	Gravity Thickener Estimated Cost	Backwash Clarifier Estimated Cost
Division 3 – Concrete	$612,675	$619,719
Division 5 – Metals	$56,658	$19,165
Division 6 – Wood and Plastics	$67,097	$69,300
Division 9 – Finishes	$95,252	-
Division 26 – Electrical	$105,266	$75,074
Division 31 – Earthwork	$114,616	$88,531
Division 40 – Process Integration	$80,147	$182,537
Division 46 – Water and Wastewater Equipment	$16,771	$436,800
Subtotal	**$1,149,000**	**$1,492,000**
Mobilization (5%)	$75,000	$97,000
Overhead and Profit (18%)	$269,000	$350,000
Contingency (30%)	345,000	$448,000
Total	**$1,838,000**	**$2,387,000**

5.6.3 Solids Handling Alternative 3 – Onsite Thickening and Dewatering and Solids to Landfill

The third identified solids handling alternative consists of installing both an onsite gravity thickener and an onsite mechanical dewatering system to handle sludge from the gravity thickener. For this evaluation, belt filter press systems were assumed for dewatering but a detailed evaluation of solids handing technologies, such as centrifuges, is recommended for design phase improvements. With the addition of an onsite dewatering system, the dried solids could be hauled offsite to a landfill or be used for land application instead of loading the WWTP. A mass balance of a typical dewatering process with a belt filter press showed the solids flow would be reduced to approximately 87 gpm at the 30 MGD expansion. Figure 5.11 shows a solids flow diagram under Alternative 3.

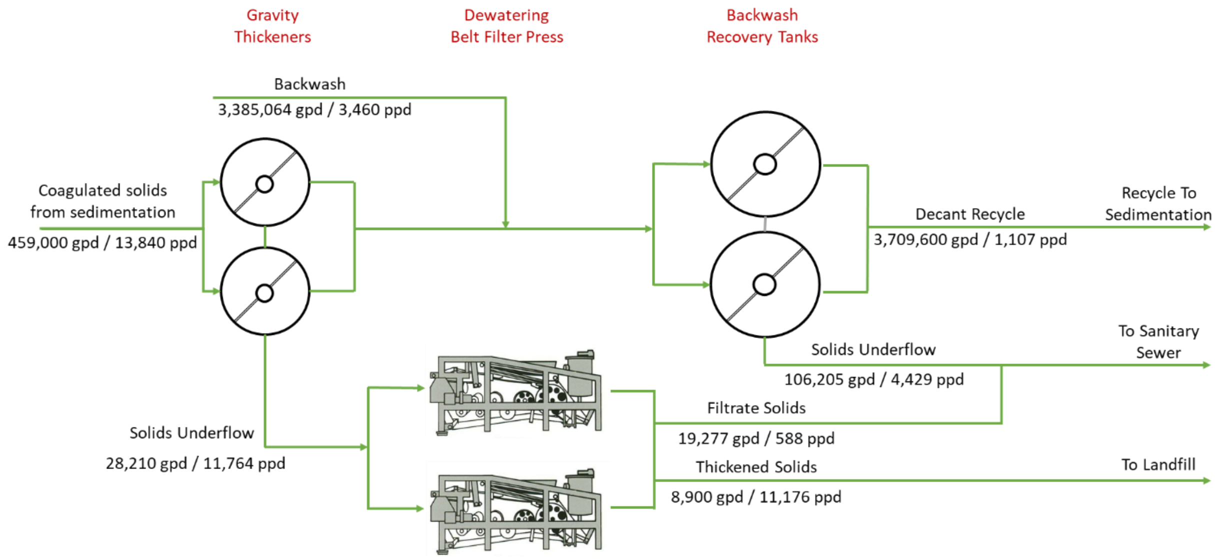

Figure 5.11: Solids Flow Diagram for Alternative 3

A cost estimate for a new dewatering system is included in Table 5-26. The cost estimate for the onsite dewatering system is in addition to the cost for a backwash clarifier and sludge thickener as outlined in Table 5-25.

Table 5-26: Estimated Solids Handling Alternate 3 Cost of Construction – Onsite Dewatering

Division	Dewatering Estimated Cost
Division 3 – Concrete	$723,240
Division 5 – Metals	$221,858
Division 7 – Thermal and Moisture Protection	$43,130
Division 8 – Openings	$51,870
Division 9 – Finishes	$112,880
Division 14 – Conveyance	$261,807
Division 22 – Plumbing	$27,437
Division 23 – HVAC	$30,797
Division 26 – Electrical	$202,125
Division 31 – Earthwork	$153,090
Division 40 – Process Integration	$96,075
Division 44 – Pollution Control Equipment	$1,609,403
Subtotal	**$3,534,000**
Mobilization (5%)	$177,000
Overhead and Profit (18%)	$637,000
Contingency (30%)	$1,305,000
Total	**$5,653,000**

5.7 Chemical Feed Systems

The current chemical storage and feed equipment is housed in the membrane building. The current chemicals stored are:

- Sodium hypochlorite (On-site Generation)
- Aluminum chlorohydrate – ACH
- Liquid ammonium sulfate – LAS
- Citric acid
- Sodium bisulfite
- Sodium hydroxide

The chemical feed and storage approach includes relocating all chemicals, with the exception of those dedicated to membrane cleaning and maintenance, to a new chemical storage and feed building sized to store chemicals for a 30 day supply at 30 MGD. Membrane cleaning chemicals will remain in the existing membrane building. The assumptions made here are conservative for planning purposes and include all new tanks and feed equipment. However, the existing chemical storage and feed within the membrane building could potentially be re-used to help accommodate expansion of the system to 30 MGD. This should be further evaluated during design. The new building is planned to include:

Coagulant

- The WTP's existing coagulant is ACH.
- To remain conservative, the coagulant storage and feed system in this report is sized for Alum Storage, as Alum has greater storage and feed requirements than ACH. However, ACH could still be used.
- It is recommended that a water quality study including jar testing be completed either prior to or as a component of design to determine the optimal coagulant.

Disinfection Chemicals

- Bulk Sodium Hypochlorite Storage and Feed
  - The current on-site NaOCl generation system is in poor operating condition and is major maintenance item for the City. In addition, the existing equipment lacks the capacity to scale to a 30 MGD plant. It is recommended to abandon on-site NaOCl generation and replace with a bulk storage system.
- LAS Storage and Feed

pH Control Chemicals

- Sulfuric Acid Storage and Feed
  - The acid feed system is used to lower pH of raw water, to provide enhanced coagulation, and to remove additional TOC from the raw water, which reduces DBP formation potential.
  - In conjunction with the coagulant selection, it is recommended that a water quality study including jar testing be completed either prior to or as a component of design to determine the optimum acid feed.
- Liquid Sodium Hydroxide Storage and Feed

Zinc Orthophosphate

- The chemical storage and feed building will provide space for storage and feed of Zinc Orthophosphate to provide corrosion control within the distribution system

Tables 5-27 through 5-29 outline the estimated chemical feed rates and tank sizes necessary to house the chemicals described above.

Table 5-27: Chemical Feed Application Points

Application Point(s)	Plant Design Flow (mgd) Avg	Max Day
Surface Water	16.0	30.0

Table 5-28: Estimated Chemical Feed Rates

#	Chemical	Application Point(s)	Dosage (mg/L)		Chemical Feed Rate (gpd)	
			Avg	Max	Avg	Max Day
1A	**Coagulant - Alum**	Raw water	80	120	1,969	4,616
1B	**Coagulant - ACH**	Raw Water	20	50	748	3,507
2	**Sodium Hypochlorite**	Finished Water	3	5	329	1,028
3	**Liquid Ammonium Sulfate**	Finished Water	0.75	1.25	114	356
4	**Sulfuric Acid**	Raw Water	15	25	140	438
5	**Sodium Hydroxide**	Filtered Water	30	50	627	1,960
6	**Zinc Orthophosphate**	Finished Water	2	4	52	195

Table 5-29: Estimated Chemical Tank Volumes

#	Chemical	Storage Period (days)	Required Storage Capacity[1] (gal)	Number of Storage Tanks (#)	Min. Volume of Each Tank (gal)
1A	**Alum**	30	59,100	5	11,820
1B	**ACH**	30	22,500	2	11,250
2	**Sodium Hypochlorite**	30	9,900	2	5,000
3	**Liquid Ammonium Sulfate**	30	3,500	2	1,750
4	**Sulfuric Acid**	30	4,300	1	4,300
5	**Sodium Hydroxide**	30	18,900	2	9,450
6	**Zinc Orthophosphate**	30	1,600	1	1,600

Notes:
(1) Volumes are calculated based on average chemical feed rate.

The new building is estimated to be 12,000 square feet with a dedicated room and containment for each chemical. The building will include necessary safety features to protect plant staff from exposure. The building materials and coating will be selected to adequately protect equipment and infrastructure from corrosive chemicals and vapors. Table 5-30 outlines the estimated cost for a new chemical storage and feed facility.

Table 5-30: Estimated Chemical Storage and Feed Cost of Construction

Division	Estimated Cost
Division 3 – Concrete	$873,600
Division 4 – Masonry	$126,000
Division 6 – Wood and Plastics	$245,700
Division 7 – Thermal and Moisture Protection	$134,400
Division 8 – Openings	$197,400
Division 9 – Finishes	$330,750
Division 13 – Special Construction	$1,890,000
Division 21 – Fire Protection	$100.800
Division 22 – Plumbing	$197,243
Division 23 – HVAC	$511,190
Division 26 – Electrical	$1,179,885
Division 31 – Earthwork	$89,775
Division 40 – Process Integration	$1,155,000
Division 43 – Process Gas & Liquid Handling	$989,625
Division 44 – Pollution Control Equipment	$1,194,375
Subtotal	**$9,216,000**
Mobilization (5%)	$600,000
Overhead and Profit (18%)	$2,157,000
Contingency (30%)	$2,765,000
Total	**$14,738,000**

5.8 SCADA and Electrical Improvements

5.8.1 Electrical System Overview

The electrical system at the WTP consists primarily of two separate utility services provided by Oncor. One service operates at 4160V three phase and provides power to the high service pumps. The other service operates at 480V three phase and provides power to all other plant loads including the membrane systems, solids handling, and low voltage loads associated with the high service pump station building.

The electrical systems will require expansion to accommodate the various recommended plant improvements. The need for additional services, new power distribution equipment, and increased electrical capacity will need to be evaluated as design alternatives are further developed. In general, it is expected that the high service pump station will continue to operate at medium voltage due to the motor sizes of the existing and new pumps. The expansion of onsite electrical systems to 30 MGD is expected to be housed within the existing WTP footprint. By full buildout (75 MGD) the addition of a new electrical building is anticipated to house the expanded electrical systems onsite.

5.8.2 Standby Power

The WTP does not currently include any provisions for standby power generation systems. If a utility outage were to occur, the plant would be without the ability to treat water or pump treated water to the distribution system. The addition of a standby power system to the existing HSPS is currently under design by others. It is recommended that standby power be considered as part of any plant expansion alternative to ensure water production and delivery risks are minimized during utility outage situations. Standby power is included for the 30 MGD plant expansion in the form of emergency generators in the cost estimate in Table 5-31. The standby generators are assumed to serve all plant systems excluding the HSPS.

5.8.3 SCADA System

Plant control is currently accomplished through the ZeeWeed® membrane system HMI screens. In addition to control of the membrane system, control of the high service pumps and lake pumps is integrated into the ZeeWeed® system. This integration of the entire plant control system within the membrane system is not an ideal configuration, particularly for a plant of this size with multiple complex systems requiring monitoring and control. Any additions or modifications of the plant control system must go through the proprietary membrane control system, limiting operational flexibility for changes as well as the City’s options for outside SCADA programming support.

As part of the plant expansion, for any of the proposed treatment technology alternatives, it is recommended that a new central SCADA system be installed separate from the membrane manufacturer control system. A new central SCADA system should utilize industry standard software capable of integration with the various treatment and pumping systems at the plant. There are several software options available that are well suited for this application. Some of the major features that should be considered with a new SCADA system include:

- Industry standard software platform with available local support
- Scalability for future plant expansions
- Redundancy layers for increased reliability
- Remote access and mobile access capabilities
- Cybersecurity features to protect plant treatment operations
- Alarm notification and management
- Integration of access control and security systems

In addition to a new SCADA software environment, the existing local PLC control panels should be evaluated for replacement as part of the plant expansion design. Factors for replacement include capacity of the existing panels, age of the equipment, availability of spare parts, manufacturer support, and standardization with new equipment.

5.8.4 Cost of Construction

The estimated cost of construction for the proposed SCADA and electrical improvements including standby power is included in Table 5-31.

Table 5-31: SCADA and Electrical Improvements Estimated Cost of Construction

Division	Total Estimated Cost
Division 26 – Electrical	$3,438,754
Subtotal	**$3,439,000**
Mobilization (5%)	$224,000
Overhead and Profit (18%)	$805,000
Contingency (30%)	$1,032,000
Total	**$5,500,000**

6.0 Recommended Alternatives for 30 MGD Expansion

Alternatives identified for each of the process train components at the plant in Section 5.0 were evaluated against the objectives for the plant expansion as listed below:

- The expansion of production capacity of the system.
- Increased robustness of the system for variable influent raw water quality.
- Increased robustness of the system against raw water infestations such as hydrilla and zebra mussels.
- Elimination of the system failures that yielded TCEQ violation notices in recent years.
- Expansion of operator controls for simplified and flexible operations and maintenance.
- Minimize cost.
- Minimize plant footprint.

The recommended alternatives for each process train component are included in the sections below.

6.1 Lake Raw Water Pumping

As outlined in Section 5.1, to increase the Lake Pump Station's capacity to a firm capacity of 30 MGD, it is recommended to install two new 5,800 gpm pumps in parallel with the existing pumps. The existing pump station will be expanded to house the new pumps. In total, the improved pump station will have five pumps, three at 5,000 gpm and two at approximately 5,800 gpm. With the largest pump out of service, the station's firm capacity is therefore increased to 30 MGD. It is recommended that the design engineer provide a comprehensive hydraulic evaluation of these proposed improvements to verify the appropriateness of the pump design specifications, as well as the capacity of the suction and discharge pipelines.

6.2 Flocculation and Sedimentation

6.2.1 Comparison of Alternatives

A qualitative and quantitative review of the alternatives is shown in Table 6-1. The largest difference between the two alternatives is the site footprint. Conventional sedimentation (Alternative 1) requires over four times the footprint of the lamella plate technology, which is reflected in the capital costs.

Table 6-1: Flocculation and Sedimentation Alternatives Comparison

Comparison	Alternative 1 - Conventional	Alternative 2 – Lamella Plate
30 MGD Site Footprint[1]	65,000 sf	15,000 sf
75 MGD Site Footprint[1]	160,000 sf	37,500 sf
Initial Capital Cost	$17.2M	$12.1M
Qualitative Comparison	• Multiple manufacturers	• Multiple manufacturers
	• Single set of operational controls	• Single set of operational controls
	• Existing system to remain in service during construction	• Existing system to remain in service during construction
	• No pilot study required	• 30-days of full-scale operational data submittal to TCEQ required
	• Optional updates to CT Study	• Optional updates to CT Study
	• Additional TCEQ reporting requirements (TOC)	• Additional TCEQ reporting requirements (TOC)

[1]In addition to the plant's existing footprint.

6.2.2 Recommended Alternative

Upon evaluating the flocculation and sedimentations alternatives against the City's objectives, the recommended alternative for installation of pre-treatment sedimentation at the plant is the high-rate lamella plate settler system. The lamella plate system has both the lowest capital cost and the smallest footprint of the alternatives. The system is proposed to be located west of the existing membrane building and south of the plant's access road.

Depending upon the chosen design criteria, the installation of a sedimentation pre-treatment system at the plant may or may not require a 30-day pilot study or 30-days of full-scale operational data to demonstrate to TCEQ that the necessary treatment targets can be obtained. If the lamella plate system is installed with a surface overflow rate of ≤ 3.0gpm/sf and no disinfection credits are desired by the City, then 30-days of data are not required to be submitted to TCEQ.

If the lamella plate system is installed with a surface overflow rate of > 3.0 gpm/sf or the City does desire disinfection credits from the sedimentation system, then either a small scale or full-scale pilot will be required. In order to maximize the efficiency of the design and minimize both footprint and cost, it is recommended that the City conduct pre-construction, small-scale piloting of the recommended pre-treatment system to establish a pre-approved set of design criteria with TCEQ. This piloting could be conducted before or during the preliminary design phase to mitigate schedule delays.

Furthermore, the addition of sedimentation pre-treatment at the plant will require the City to begin sampling and reporting raw and filtered water TOC concentrations in the monthly SWMORs.

6.3 Filtration

6.3.1 Comparison of Alternatives

A quantitative and qualitative comparison between the three identified filtration alternatives was completed and the results are shown in Table 6-2. A comparison of the 20-year life cycle net-present values for each alternative is included in Figure 6.1. Site layouts for each alternative were developed for the plant expansion and are included in Appendix B.

Table 6-2: Filtration Alternatives Comparison

Comparison	Alternative 1	Alternative 2	Alternative 3
30 MGD Site Footprint[1]	8,500 sf	No Additional	2,400 sf
75 MGD Site Footprint[1]	34,000 sf	8,500 sf	10,500 sf
Initial Capital Cost	$19.5M	$13.0 - $16.0M[2]	$25.3M
20-year Life Cycle Cost	$45.3M	$33.9 - $37.0M[2]	$46.0M
Qualitative Comparison	• Single manufacturer	• Multiple manufacturers[2]	• Multiple manufacturers
	• Single set of operational controls	• Single set of operational controls	• Parallel sets of operational controls
	• Existing system to remain in service during construction	• Existing system to be taken out of service in phases during construction	• Existing system to remain in service during construction
	• No pilot study required	• 30-days of full-scale operational data submittal to TCEQ required	• 30-days of full-scale operational data submittal to TCEQ required
	• Minimal required updates to CT Study	• Minimal required updates to CT Study	• Major revisions to CT Study required
	• No additional TCEQ reporting requirements	• No additional TCEQ reporting requirements	• Additional TCEQ reporting requirements

[1]In addition to the plant's existing footprint.
[2]Cost estimate range is provided to account for multiple technologies.

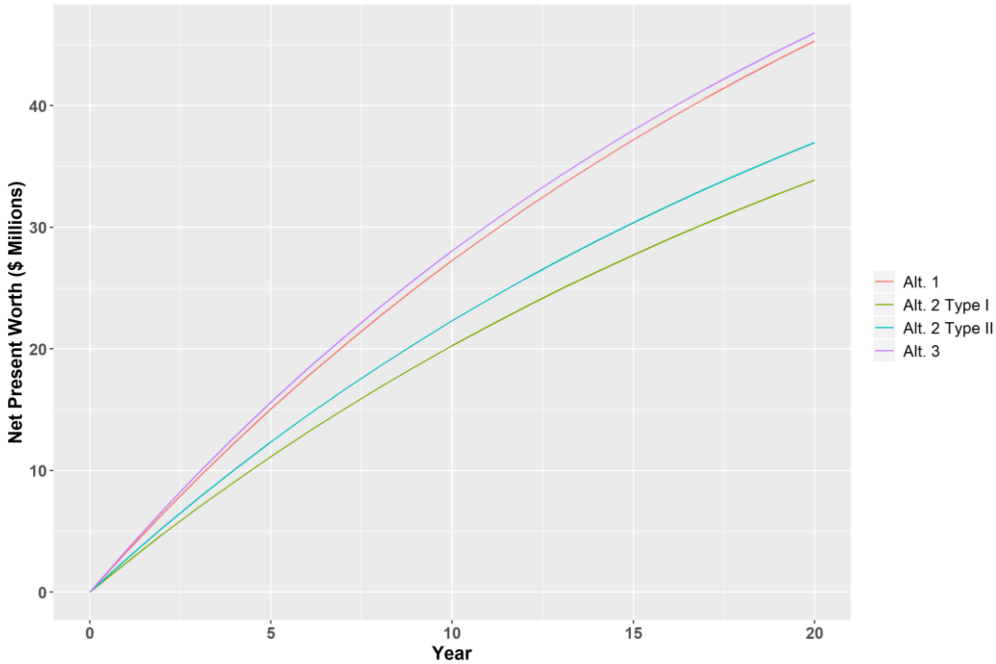

Figure 6.1: Net Present Value ($ Millions) Comparison for Filtration Alternatives 1, 2, 3 with 6% Interest

6.3.2 Recommended Alternative

Upon evaluating the three filtration alternatives against the City's objectives, the recommended alternative for expansion of filtration capacity at the plant is Filtration Alternative 2 (New Membrane Technology). Filtration Alternative 2 consists of expanding treatment capacity at the plant by removing the existing ZeeWeed 500D® membrane trains and installing new submerged ultrafiltration membranes. The plant's filtration firm capacity can be expanded to 30 MGD within the existing membrane building and therefore does not increase the plant's footprint. In addition, Alternative 2 has both the lowest capital and 20-year present worth cost of the three evaluated alternatives. However, the installation of a new membrane treatment technology in place of the existing membranes necessitates the replacement of the existing membrane trains while keeping the plant in service. Alternative 2 will require detailed design to account for a complicated construction phasing process.

The installation of a new membrane system will require a 30-day pilot-scale study or 30-days of full-scale operational data to demonstrate to TCEQ that the necessary treatment targets can be obtained by the new system as it is an innovative treatment technology. Following the initial 30-day study, no additional reporting requirements would be required to TCEQ on top of what is currently reported, except for those reporting requirements associated with the flocculation and sedimentation system.

6.4 Clearwell Storage and Disinfection

The existing 3.0 MG storage tank provides adequate volume to meet CT at 30 MGD, see CT Study from January 2020 for additional information. It is recommended to introduce additional baffling to the 3.0 MG clearwell to increase the baffling factor and ultimately provide a more efficient disinfection process. The addition of baffling will reduce hypochlorite demand and the concentration of regulated disinfection byproducts leaving the WTP.

6.5 High Service Pumping

As outlined within Section 5.5, it is recommended to increase the high service pump station's firm capacity to at least 37.5 MGD (25% greater than the proposed plant capacity) with the addition of two new 5,972 gpm pumps to be installed in parallel with the existing pumps. The existing pump station structure will be expanded to hold the proposed new pumps. In total, the improved pump station will have six pumps, each at approximately 5,972 gpm. With the largest pump out of service, the station's firm capacity is therefore increased to 43.0 MGD.

It is recommended that the design engineer provide a comprehensive hydraulic evaluation of these proposed improvements to verify the appropriateness of the pump design specifications, as well as the capacity of the suction and discharge pipelines.

6.6 Solids Handling

6.6.1 Comparison of Alternatives

A quantitative and qualitative comparison between the three identified solids handling alternatives was completed and the results are shown in Table 6-3. All alternatives include the addition of a backwash clarifier.

Table 6-3: Solids Handling Alternatives Comparison

Comparison	Alternative 1 – Increase Pumping to Sanitary Sewer	Alternative 2 – Onsite Sludge Thickening	Alternative 3 – Onsite Sludge Thickening & Dewatering
30 MGD Site Footprint[1]	N/A	5,655 sf	11,155 sf
75 MGD Site Footprint[1]	N/A	11,310 sf	22,310 sf
Initial Capital Cost	N/A	$4.2M	$9.9M
Qualitative Comparison	• Does not reduce sludge flow from the plant	• Reduces sludge flow from the plant	• Reduces sludge flow from the plant
	• Does not require offsite hauling of solids	• Does not require offsite hauling of solids	• Requires offsite hauling of solids

[1]In addition to the plant's existing footprint.

6.6.2 Recommended Alternative

Upon evaluating the three solids handling alternatives against the City's objectives, the recommended alternative for expansion of solids handling capacity at the plant is Alternative 2. Alternative 2 consists of the installation an onsite sludge thickening system installed upstream of the existing and proposed new backwash clarifiers to reduce the quantity of sludge required to be pumped to the wastewater treatment plant from approximately 200 gpm to 93 gpm. The supernatant from the thickeners will flow to the backwash clarifiers and be recycled to Lake Pflugerville.

Alternative 2 is recommended as an interim option prior to the installation of onsite dewatering. Onsite dewatering could help further reduce or eliminate sludge flows from the WTP. Depending upon the proposed timeline for abandonment of the existing 24-inch forcemain, dewatering may need to be implemented sooner than the next proposed WTP expansion in 2028.

The proposed solids handling alternative was chosen to reduce solids flow and ultimately reduce loading on the downstream WWTP. However, the proposed alternative increases the recycle stream from the backwash clarifier to Lake Pflugerville. Elevated levels of total organic carbon (TOC) in the recycled water stream increase the potential to form disinfection byproducts (DBPs) that can reduce finished water quality. A detailed evaluation on water characteristics is recommended during the design phase to analyze any potential to create a concentrated TOC stream.

6.7 Chemical Feed Systems

A new chemical storage and feed building is proposed for chemicals not used for membrane cleaning and maintenance. The new building is estimated to include:

- Coagulant (Sized for the larger volume required for alum coagulation)
- Disinfection Chemicals
  - Bulk Sodium Hypochlorite Storage and Feed – Abandon on-site NaOCl generation
  - LAS Storage and Feed
- pH Control
  - Sulfuric Acid Storage and Feed
  - Sodium Hydroxide Storage and Feed
- Zinc Orthophosphate – Optional distribution system corrosion control

It is recommended that a water quality study including jar testing be completed either prior to or as a component of design to determine the optimal coagulant and acid.

The new building is estimated to be 12,000 square feet with a dedicated room and containment for each chemical. The building will include necessary safety feature to protect plant staff from exposure. The build materials and coating will be selected to adequately protect equipment and infrastructure from corrosive chemicals and vapors.

6.8 SCADA and Electrical Improvements

The proposed SCADA and electrical improvements for the 30 MGD capacity expansion include:

- Expansion of the electrical system to accommodate additional load from a 30 MGD WTP
- Expansion of standby power to accommodate plant processes at 30 MGD excluding the HSPS. Standby power for the HSPS is currently is currently being designed by others.
- New central SCADA system

6.9 Summary of Recommendations

A summary of the recommended updates and expansions to facilities at the Pflugerville WTP is included in Table 6-4. A site layout of the WTP improvements for the 30 MGD capacity expansion is presented in Figure 6.2.

Table 6-4: Process Treatment Recommended Alternatives (for 30 MGD of production capacity)

Process	Recommended Alternative
Lake Pumping	Expand to 30 MGD firm capacity and expand existing building
Flocculation & Sedimentation	Lamella Plate Settler (including splitter box and rapid mix)
Filtration	Replace existing membranes with new submerged UF membrane technology capable of producing 30 MGD
Clearwell Storage & Disinfection	Provide adequate baffling within existing 3 MG clearwell for achieving primary disinfection
High Service Pumping	Expand to 37.5 MGD firm pumping capacity (25% greater than WTP capacity) and expand existing building
Solids Handling	Expand with one new spent-backwash water clarifier and installation of onsite gravity thickening
Chemical Feed Systems	Construct a new chemical storage and feed facility
SCADA and Electrical Improvements	New central SCADA HMI interface and control system and expansion of standby power.

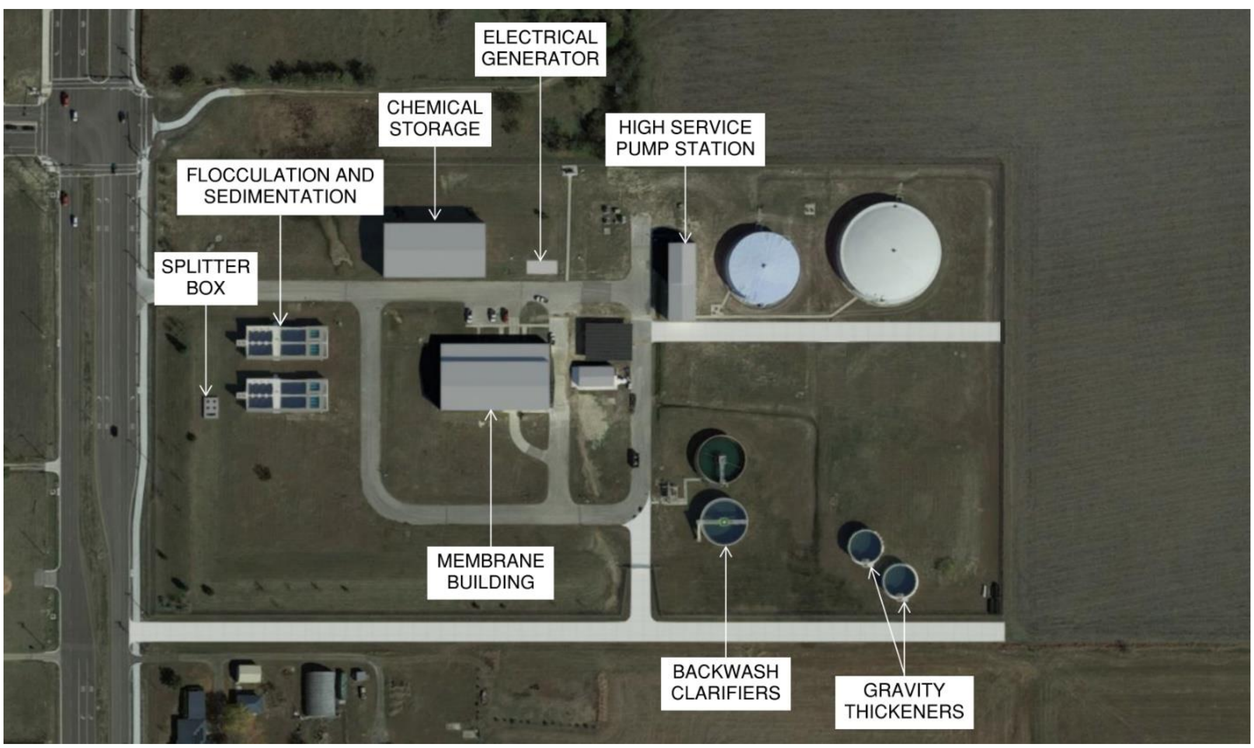

Figure 6.2: Conceptual 30 MGD Expansion Site Layout with Recommended Alternatives

7.0 Conclusions

The improvements as outlined in Section 6.0 are recommended to meet the City's quantitative and qualitative objectives as listed below:

- The expansion of production capacity of the system to 30 MGD in accordance with the adopted 2020 Water Master Plan.
- Increased resiliency of the system for variable influent raw water quality.
- Increased resiliency of the WTP treatment system to handle the growth of invasive species, such as hydrilla and zebra mussels.
- Elimination of the treatment system vulnerabilities that have contributed to recent TCEQ corrective actions.
- Expansion of operator controls for simplified and flexible operations and maintenance.
- Minimize cost.
- Minimize footprint.

7.1 Estimated Cost of Construction

A detailed construction cost estimate for each of the recommended improvements to facilities at the WTP and associated appurtenances (e.g. site piping) is included in Appendix A. A summary of the cost estimates for each facility is included in Table 7-1.

Table 7-1: Estimated Cost of Construction

Process	Recommended Alternative	Estimated Cost
Lake Water Pumping	Expand to 30 MGD firm capacity and expand existing building	$2,691,000
Flocculation & Sedimentation	Lamella Plate Settler (including splitter box and rapid mix)	$14,106,000
Filtration	Replace existing membranes with new submerged UF membrane technology capable of producing 30 MGD	$17,110,000
Disinfection	Provide adequate baffling within existing 3 MG clearwell for achieving primary disinfection	$1,513,000
High Service Pumping	Expand to 37.5 MGD firm pumping capacity (25% greater than WTP capacity) and expand existing building	$3,639,000
Solids Handling	Expand with one new spent-backwash water clarifier and installation of onsite gravity thickening	$4,225,000
Chemical Feed Systems	Construct a new chemical storage and feed facility	$14,738,000
SCADA & Electrical Improvements	New central SCADA HMI interface and control system and expansion of standby power.	$5,500,000
Other (Site Civil)		$2,046,000
	Total	**$65,568,000**
	Project Escalation to mid-point of construction (2.1%)	$1,377,000
	Total Estimated Project Cost	**$66,945,000**

7.2 Proposed 75 MGD Expansion Site Layout

The general approach taken for increasing the plant capacity to the full buildout of 75 MGD is to expand or replicate the 30 MGD plant facilities. Utilizing the recommendations outlined within this ETA, including the Alternative 2 filtration process, a full buildout site layout for 75 MGD plant capacity is presented in Figure 7.1. It is assumed that a portion of the existing clearwell storage capacity would be utilized for CT disinfection credit during full buildout. An approximate location for future clearwell storage is shown but it is recommended that an in-depth evaluation be conducted during detailed design phase to analyze baffling potential and onsite storage requirements.

With the reduced finished water storage capacity and no existing standby power generation plan, the WTP is susceptible to a critical loss in water treatment capability and delivery to the distribution system. It is recommended to include backup power systems during expansion to minimize risks to production and delivery. A detailed evaluation should be conducted during detailed design, but improvements could include a dedicated electrical building and onsite backup power generators as shown.

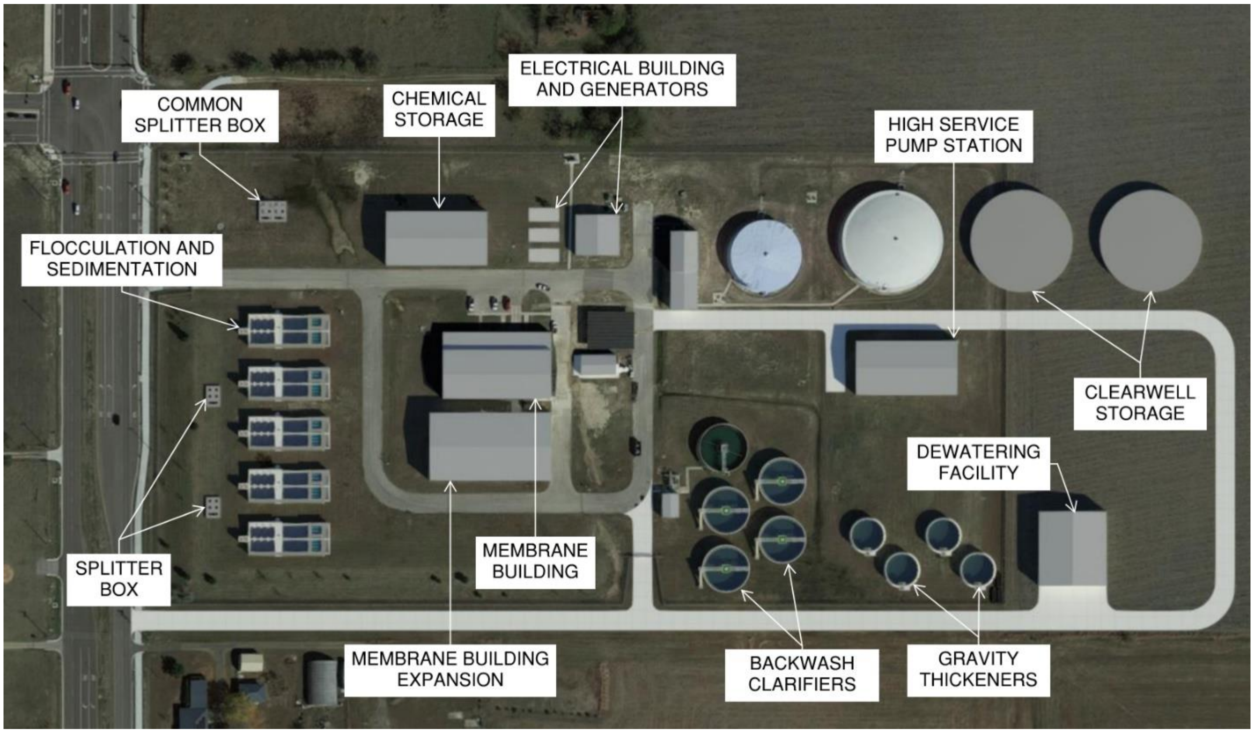

Figure 7.1: Conceptual 75 MGD Full Buildout Site Layout with Recommended Alternatives

7.3 Proposed Timing of Improvements

7.3.1 Design Schedule and Selection of Equipment Providers

Based upon the recommendations as outlined in Section 6.0, the major components of proposed design and construction for the plant expansion are:

- Addition of 2 pumps and expansion of the existing Lake Pump Station
- Construction of proposed new flocculation and sedimentation basins
- Rehabilitation of existing 5 membrane trains within existing membrane building
- Addition of baffling to existing 3MG clearwell
- Addition of 2 pumps and expansion of the existing High Service Pump Station
- Construction of a new backwash clarifier
- Construction of two new sludge thickeners

The next stage in the WTP Expansion Project is to procure a design consultant to complete a preliminary engineering report (PER), 30%, 60%, 90%, and 100% design documents and to carry out bidding and construction phase services.

The recommendation for expansion of the filtration system at the plant is to replace the existing membrane trains with a new submerged ultrafiltration membrane technology. There are multiple manufacturers with various membrane products that can meet the design criteria as outlined within this report. In conversation with membrane equipment providers, rehabilitation of the existing membrane system at the Pflugerville WTP will be highly specialized and the design will need to be tailored to the specific membrane product that is proposed. Coordination efforts between the membrane provider and the design consultant are anticipated to take months and will include the development of detailed construction phasing plans to ensure the plant stays in operation during construction. The City has multiple options for handling the selection of the proposed membrane manufacturer as outlined below:

- Option 1: Multiple Membrane Package Bid Packages
    - Identify membrane manufacturers and complete separate system designs for each of the potential equipment providers.
    - Have multiple sets of bid documents to allow for competition on bid day.
    - Utilize the equipment manufacture with the lowest price on bid day.
- Option 2: Pre-select Membrane Package
    - Identify membrane manufacturers and submit requests for information to the equipment providers at the beginning of the design process.
    - Based upon an evaluated bid process from various membrane equipment providers (which will include estimates of probable cost), pre-select a membrane system within the initial 30% design phase.
    - Reach an agreement between the membrane manufacturer and the City regarding the manufacturer's scope of work and cost.
    - Complete only one set of plans and specifications applicable to the chosen membrane manufacturer.
    - Include the agreed upon cost of equipment from the membrane manufacturer with the contractor's bid documents.

As the project timeline is critical, Option 2 is the recommended option to reduce the anticipated timeline for design. Significant coordination effort between the selected design consultant and the selected membrane equipment manufacturer will be required and the sooner the equipment provider is selected, the more efficient the design process will be. It is anticipated that design of the 30 MGD plant expansion will take approximately 12 months and will kick-off in the fall of 2020.

7.3.2 Construction Schedule

It is estimated that the design of the 30 MGD expansion will require 12 months, from fall of 2020 to fall of 2021; even this is an aggressive design schedule for the scale of expansion considered herein. In order to meet the timeline of the 2020 Water Master Plan, which designates 2022 as the in-service date for the 30 MGD expansion, construction would need to be completed by April or May of 2022 in order to meet projected max day. This would leave only approximately six months for the bidding and construction phases of the project, which is an unrealistically short timeframe.

With an appropriate timeframe for traditional project bidding, the earliest realistic timeline for issuance of a construction notice-to-proceed will be around January of 2022. This shifts the construction completion milestone to April of 2023 at the latest, in order to allow for membrane acceptance testing by TCEQ, and for the plant's full capacity to be put online before peak 2023 demands arrive in May or June. This allows a more adequate timeframe of approximately 15 months for construction to occur. Unfortunately, at this point, peak demands during the summer of 2022 will need to be managed carefully with existing treatment infrastructure while construction is underway. The City will realize benefit from its current investments in additional elevated storage infrastructure.

The timeline could be accelerated by using a collaborative delivery method, such as Construction Management-At-Risk (CMAR), to reduce potential schedule risks due to changes in construction, and by bypassing the bid phase through qualifications-based pre-selection of the CMAR team. The CMAR delivery method differs from a traditional design-bid-build approach by pre-selecting a construction contractor prior to final design. The design engineer and the construction contractor form the CMAR team and collaboratively develop the design together. The construction contractor can be added to the CMAR team at an interim design date (e.g. 30% or 60%) or can be pre-selected at the beginning of design along with the design engineer. The collaborative nature of the CMAR approach can reduce the construction timeframe. In addition to eliminating the bid process, the contractor is intimately familiar with the contract documents from an early date which helps reduce change orders and can allow construction to occur more rapidly. Typically, under this approach the CMAR team provides a construction cost estimate at various stages throughout design. The contract can be arranged such that at each cost estimate stage, the Owner can decide to opt out of the CMAR process and revert to a traditional design-bid-build approach if the estimate is not accepted. Additionally, at each stage of design the CMAR team is required to submit a "guaranteed maximum price" which cannot be exceeded except through written agreement with the Owner.

Our recommendation to manage this construction sequencing as best as possible will be to front-load the critical infrastructure needed to proceed with the membrane retrofit. The proposed new membranes cannot operate adequately without an upstream sedimentation pre-treatment process; therefore, prior to rehabilitation of the membrane trains, the new flocculation and sedimentation pre-treatment units must be fully constructed and operational. It is recommended that ancillary facilities, such as the clearwell storage, electrical, or pump station upgrades, be constructed and tested until the point of connection to the existing system. The construction of the flocculation and sedimentation units are in the critical path and should be the first item constructed onsite so that the membrane trains can be rehabilitated in a timely manner.

Based on these considerations, a high-level design and construction schedule is proposed below:

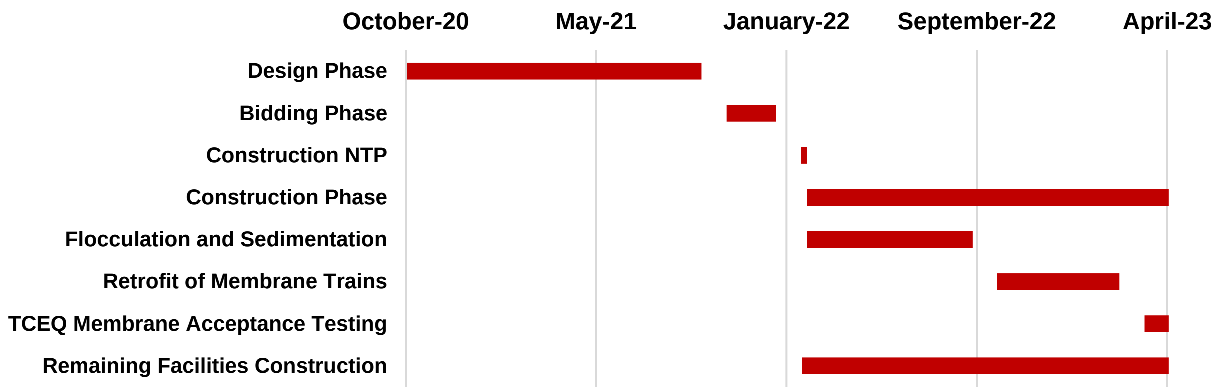

Table 7-2: Proposed Design and Construction Schedule

Phase	Start Date	End Date	Duration
Design	October 2020	October 2021	1 year
Bidding	November 2021	January 2022	2 months
Construction	February 2022	April 2023	1 year, 3 months
Flocculation and Sedimentation	February 2022	September 2022	8 months
Retrofit of Membrane Trains	October 2022	March 2023	6 months
TCEQ Membrane Acceptance Testing	April 2023	April 2023	1 month
All remaining facilities	February 2022	April 2023	1 year, 3 months

Appendix A: Detailed Cost Estimates

GARVER - Pflugerville WTP Expansion

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1. Lump Sum Work (Facilities or Areas)				$ Total
10 Site Civil				$2,046,000
27 Lake Pump Station				$2,691,000
35 Splitter Box and Rapid Mix				$1,964,000
36 Pretreatment - Lamella Plates				$12,142,000
40 Membranes - CSII System Alt 2				$17,110,000
50 High Service Pump Station				$3,639,000
55 Clearwell Storage				$1,513,000
60 Chemical Storage and Feed				$14,738,000
80 Dewatering Building				$5,653,000
82 Gravity Thickener				$1,838,000
85 Backwash Clarifiers				$2,387,000
90 SCADA Systems and Controls				$5,500,000
Subtotal Estimated Lump Sum Work				$71,221,000
Less Dewatering				$65,568,000
Project Escalation				**$ Total**
Escalation of Cost to Midpoint Construction	1	Years @	2.1%	$1,377,000
Complete Project				$65,568,000
Complete Project with Escalation				$66,945,000

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Facility Number: 10
Facility Description: Site Civil

Description	Qty	Unit	Unit Cost	Labor	Total Cost
Division 2 - Existing Conditions					
Clearwell Tanks					
Erosion Control	2	LS	$ 20,000.00	$ 6,000.00	$ 52,000
Miscellaneous	5%				$ 2,600
			Subtotal Division 2		**$ 54,600**
Division 3 - Concrete					
Miscellaneous	5%				$ -
			Subtotal Division 3		**$ -**
Division 31 - Earthwork					
Splitter Box and Rapid Mix					
Excavation for 36" Buried Ductile Iron Pipe	150	LF	$ 111.11	$ 33.33	$ 21,667
Backfill for 36" Buried Ductile Iron Pipe	150	LF	$ 162.76	$ 48.83	$ 31,737
Excavation for 24" Buried Ductile Iron Pipe	500	LF	$ 105.56	$ 31.67	$ 68,611
Backfill for 24" Buried Ductile Iron Pipe	500	LF	$ 153.44	$ 46.03	$ 99,739
Clearwell Tanks					
Grading	3430	SY	$ 2.00		$ 6,860
Excavation for 48" Buried Ductile Iron Pipe	500	LF	$ 116.67	$ 35.00	$ 75,833
Backfill for 48" Buried Ductile Iron Pipe	500	LF	$ 179.06	$ 53.72	$ 116,386
Solids Handling					
Miscellaneous	5%				$ 11,088
			Subtotal Division 31		**$ 431,922**
Division 32 - Exterior Improvements					
Clearwell Tanks					
Paving	1715	SY	$ 60.00	$ 18.00	$ 133,770
Exterior Improvements Allowance (Grade, Sod, Groundcover, etc.)	1	LS	$ 80,000.00		$ 80,000
Solids Handling					
Miscellaneous	5%				$ 10,689
			Subtotal Division 32		**$ 224,459**
Division 40 - Process Integration					
Splitter Box and Rapid Mix					
36" Buried Ductile Iron Pipe	150	LF	$ 252.42		$ 5,048
36" BEND: 90° MJ	2	EA	$ 7,958.59		$ 15,917
24" Buried Ductile Iron Pipe	500	EA	$ 180.00		$ 3,600
24" BEND: 90° MJ	4	EA	$ 7,800.00		$ 15,600
24" BEND: 45° MJ	4	EA	$ 7,945.00		$ 31,780
Clearwell Tanks					
48" Buried Ductile Iron Pipe	500	LF	$ 357.50		$ 178,750
48" Butterfly Valve	2	EA	$ 53,483.25		$ 106,967
48" x 48" MJ Tee	2	EA	$ 29,500.00		$ 59,000
48" 90° Elbow	6	LS	$ 25,831.00		$ 154,986
48" 45° Bend	6	LS	$ 25,831.00		$ 154,986
Chemical Storage					
Solids Handling					
Miscellaneous	5%				$ 18,449
			Subtotal Division 40		**$ 387,421**
Subtotal This Facility					**$ 1,278,000**
Contingency				**30%**	**$ 384,000**
Mobilization				**5%**	**$ 84,000**
Contractor's Overhead and Profit				**18%**	**$ 300,000**
Total Estimated Facility Costs					**$ 2,046,000**

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Facility Number: 27
Facility Description: Lake Pump Station

Description	Qty	Unit	Unit Cost	Labor	Total Cost
Division 2 - Existing Conditions					
Demo Existing Siding	695	SF	$ 2.00	$ 417.00	$ 1,807
Demo Existing CMU Blocks	4	CY	$ 300.00	$ 328.89	$ 1,425
Miscellaneous	5%				$ 162
	Subtotal Division 2				**$ 3,394**
Division 3 - Concrete					
Concrete Slab	30	CY	$ 400.00	$ 3,611.11	$ 15,648
CMU Blocks (448 SY)	4637	SF	$ 12.00	$ 16,692.48	$ 72,334
(9) 24"-Diameter 35ft-Deep Piers	362	LF	$ 110.00	$ 11,954.25	$ 51,802
(1) 30"-Diameter 35ft-Deep Pier	35	LF	$ 130.00	$ 1,365.00	$ 5,915
Concrete Secondary Containment Allowance	1	LS	$ 10,000.00		$ 10,000
Miscellaneous	5%				$ 7,785
	Subtotal Division 3				**$ 163,484**
Division 5 - Metals					
Insulated Metal Siding (112 LF x 16 FT High)	2231	SF	$ 9.00	$ 6,023.70	$ 26,103
Insulated Metal Roofing	1749	SF	$ 9.00	$ 4,722.71	$ 20,465
Miscellaneous	5%				$ 2,328
	Subtotal Division 5				**$ 48,896**
Division 9 - Finishes					
Pipe Coatings	1	LS	$ 21,049.08	$ -	$ 21,049
Exterior Paint	560	SF	$ 2.00	$ 336.00	$ 1,456
Miscellaneous	5%				$ 1,125
	Subtotal Division 9				**$ 23,630**
Division 11 - Equipment					
Miscellaneous	5%				$ -
	Subtotal Division 11				**$ -**
Division 26 - Electrical					
New Electrical Service	1	LS	$ 30,000.00	$ 30,000.00	$ 60,000
Electrical Allowance	1	LS	$ 321,000.00	$ -	$ 321,000
Miscellaneous	5%				$ 19,050
	Subtotal Division 26				**$ 400,050**
Division 31 - Earthwork					
Site Preperation for Building Addition	1500	SY	$ 2.00	$ 900.00	$ 3,900
Miscellaneous	5%				$ 195
	Subtotal Division 31				**$ 4,095**
Division 40 - Process Integration					
Suction Line					
24" DIP	82	LF	$ 890.00	$ 21,894.00	$ 94,874

24" FExFE Flexible Expansion Joint	4	EA	$ 1,032.00	$ 1,238.40	$ 5,366
24" 90-Degree Bend	2	EA	$ 4,500.00	$ 2,700.00	$ 11,700
1" Packing Drain Line	8	LF	$ 4.28	$ 10.27	$ 45
Packing Drain Line Solenoid Valve	2	EA	$ 860.00	$ 516.00	$ 2,236
Discharge Line					
18" DIP	28	LF	$ 650.00	$ 5,460.00	$ 23,660
42" DIP	26	LF	$ 1,500.00	$ 11,700.00	$ 50,700
Pressure Switch, Transmitter, and Gauge Assembly	2	EA	$ 2,500.00	$ 1,500.00	$ 6,500
16"x18" Reducer	2	EA	$ 1,600.00	$ 960.00	$ 4,160
2" Vertical Turbine Air Release and Vacuum Relief Valve with 2" Isolation Ball Valve	2	EA	$ 4,000.00	$ 2,400.00	$ 10,400
2" Air/Vacuum Valve Drain Line	24	LF	$ 9.33	$ 67.18	$ 291
18" Restrained Coupling	2	EA	$ 2,451.00	$ 1,470.60	$ 6,373
18" Pump-Check Valve and Actuator	2	EA	$ 29,799.00	$ 17,879.40	$ 77,477
18" Automatic Strainer	2	EA	$ 40,000.00	$ 24,000.00	$ 104,000
6" `Strainer Drain Line	38	LF	$ 175.00	$ 1,995.00	$ 8,645
18" Butterfly Valve	2	EA	$ 5,474.00	$ 3,284.40	$ 14,232
1/2" Compressed Air Line	50	LF	$ 2.20	$ 33.00	$ 143
1/2" Ball Valve	2	EA	$ 66.95	$ 40.17	$ 174
1/2" Air Line 90-Degree Bend	1	EA	$ 2.00	$ 0.60	$ 3
1/2" Air Line Tee	1	EA	$ 2.00	$ 0.60	$ 3
Pipe Supports	1	LS	$ 12,629.45	$ -	$ 12,629
Miscellaneous	5%				$ 21,681
			Subtotal Division 40		**$ 455,292**
Division 43 - Process Gas & Liquid Handling					
Lake Pump and Motor	2	EA	$ 95,000.00	$ 57,000.00	$ 247,000
Pump Cans	3	EA	$ 45,000.00	$ 40,500.00	$ 175,500
Sodium Permanganate Bulk Tank (2,000 gal)	1	EA	$ 15,000.00	$ 4,500.00	$ 19,500
Sodium Permanganate Day Tank (75 gal)	1	EA	$ 5,000.00	$ 1,500.00	$ 6,500
Sodium Permanganate Feed Skid	1	EA	$ 35,000.00	$ 10,500.00	$ 45,500
Sodium Permanganate Transfer Pumps	1	EA	$ 35,000.00	$ 10,500.00	$ 45,500
Chem Feed Piping and Valve Allowance	1	LS	$ 11,700.00	$ 3,510.00	$ 15,210
Miscellaneous	5%				$ 27,736
			Subtotal Division 43		**$ 582,446**
Subtotal This Facility					**$ 1,682,000**
Contingency				**30%**	**$ 505,000**
Mobilization				**5%**	**$ 110,000**
Contractor's Overhead and Profit				**18%**	**$ 394,000**
Total Estimated Facility Costs					**$ 2,691,000**

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Facility Number: 35
Facility Description: Splitter Box and Rapid Mix

Description	Qty	Unit	Unit Cost	Labor	Total Cost
Division 3 - Concrete					
Splitter Box					
Base Slab	75	CY	$ 710.00		$ 53,250
Freestanding Wall	200	CY	$ 980.00		$ 196,000
Elevated Slab	2	CY	$ 1,250.00		$ 2,500
Rapid Mix					
Base Slab	25	CY	$ 710.00		$ 17,750
Freestanding Wall	150	CY	$ 980.00		$ 147,000
Elevated Slab	2	CY	$ 1,250.00		$ 2,500
Miscellaneous	5%				$ 12,588
			Subtotal Division 3		**$ 431,588**
Division 5 - Metals					
Splitter Box					
Alum Guardrail - Two Rail w/Posts	150	LF	$ 83.29		$ 12,494
AL Grating	700	SF	$ 37.88		$ 26,516
Stairs	30	Riser	$ 2,218.97		$ 66,569
Stair Landing	8	LF	$ 1,365.00		$ 10,920
Rapid Mix					
Alum Guardrail - Two Rail w/Posts	120	LF	$ 83.29		$ 9,995
AL Grating	100	SF	$ 37.88		$ 3,788
Miscellaneous	5%				$ 5,279
			Subtotal Division 5		**$ 135,560**
Division 26 - Electrical					
Splitter Box					
Electrical (General, Lighting)	1	LS	$ 5,000.00		$ 5,000
Rapid Mix					
Electrical (Conduit, Disconnects)	2	LS	$ 42,000.00		$ 84,000
Miscellaneous	5%				$ 4,450
			Subtotal Division 26		**$ 93,450**
Division 31 - Earthwork					
Splitter Box					
Excavation	200	CY	$ 14.78		$ 2,956
Structure Backfill, Native	80	CY	$ 22.11		$ 1,769
Granular Fill	20	CY	$ 70.28		$ 1,406
Rapid Mix					
Excavation	45	CY	$ 14.78		$ 665
Structure Backfill, Native	64	CY	$ 22.11		$ 1,415
Granular Fill	20	CY	$ 70.28		$ 1,406
Miscellaneous	5%				$ 307
			Subtotal Division 31		**$ 9,923**
Division 40 - Process Integration					
Splitter Box					
36" Wall Collar	1	EA	$ 2,337.00		$ 2,337
36" Buried Ductile Iron Pipe	20	LF	$ 252.42		$ 5,048
36" BEND: 90° MJ	2	EA	$ 7,958.59		$ 15,917
36" BEND: 45° MJ	2	EA	$ 15,000.00		$ 30,000
24" Wall Collar	2	EA	$ 2,983.51		$ 5,967
24" Buried Ductile Iron Pipe	20	LF	$ 180.00		$ 3,600
24" BEND: 90° MJ	2	EA	$ 7,800.00		$ 15,600
24" BEND: 45° MJ	2	EA	$ 7,945.00		$ 15,890
Rapid Mix					
24" Wall Collar	2	EA	$ 2,983.51		$ 5,967
24" Buried Ductile Iron Pipe	20	LF	$ 180.00		$ 3,600
Chemical Piping/Valving Allowance	2	LS	$ 15,000.00		$ 30,000
Miscellaneous	5%				$ 4,718
			Subtotal Division 40		**$ 138,645**
Division 44 - Pollution Control Equipment					

Splitter Box					
8' Weir Plate	4	EA	$ 2,000.00		$ 8,000
36" x 36" Slide Gate	2	EA	$ 10,000.00		$ 20,000
Stop Plate	4	EA	$ 3,500.00		$ 14,000
Rapid Mix					
Rapid Mixer	4	EA	$ 93,305.00		$ 373,220
Miscellaneous	5%				$ 2,100
		Subtotal Division 44			**$ 417,320**
Subtotal This Facility					**$ 1,227,000**
Contingency				**30%**	**$ 369,000**
Mobilization				**5%**	**$ 80,000**
Contractor's Overhead and Profit				**18%**	**$ 288,000**
Total Estimated Facility Costs					**$ 1,964,000**

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Facility Number: 36
Facility Description: Pretreatment - Lamella Plates

Description	Qty	Unit	Unit Cost	Labor	Total Cost
Division 3 - Concrete					
42" Dia x 45' Long Drilled Pier	2835	CY	$ 195.00		$ 552,825
36" Dia x 45" Long Drilled Pier	345	CY	$ 145.00		$ 50,025
36" x 36" Grade Beam	330	CY	$ 600.00		$ 198,000
24' x 36" Grade Beam	120	CY	$ 600.00		$ 72,000
18" Base Slab	770	CY	$ 500.00		$ 385,000
22" Walls	1280	CY	$ 800.00		$ 1,024,000
Stair Foundations	1	CY	$ 350.00		$ 350
22" Center Walls	500	CY	$ 800.00		$ 400,000
Miscellaneous	10%				$ 228,220
		Subtotal Division 3			**$ 2,910,420**
Division 5 - Metals					
Galvanized W 18 x 46	13851	LBS	$ 1.90		$ 26,317
Alum Guardrail - Two Rail w/ Posts	500	LF	$ 60.00		$ 30,000
Stairs	35	Riser	$ 600.00		$ 21,000
Stair Landing	6	LF	$ 150.00		$ 900
AL Grating	1768	SF	$ 60.00		$ 106,050
Miscellaneous	10%				$ 18,427
		Subtotal Division 5			**$ 202,694**
Division 6 - Wood & Plastics					
FRP Weirs					$ -
FRP Sedimentation Basin Covers					$ -
Structrual Supports	1	LS	$ 69,615.00	$ 15,000.00	$ 84,615
					$ -
Miscellaneous	10%				$ 8,462
		Subtotal Division 6			**$ 93,077**
Division 26 - Electrical					
30A Disconnect Sludge Collector #1					$ -
20A Feeder to Sludge Collector #2 - 1" Conduit					$ -
20A Feeder to Sludge Collector #2 - #10					$ -
30A Disconnect Sludge Collector #2					$ -
Lighting (with poles, bases)					$ -
Low Voltage Power Wiring					$ -
Motor Control Panel					$ -
Low Voltage Control Wiring					$ -
Testing, Commissioning, Startup					$ -
Electrical System Studies (Arc Flash, Coordination)	1.5	LS	$ 307,092.00		$ 460,638
Miscellaneous	10%				$ 46,064
		Subtotal Division 26			**$ 506,702**
Division 31 - Earthwork					
Excavation (Facility)	1220	CY	$ 30.00		$ 36,600
Grading	1545	SY	$ 1.00		$ 1,545
Spoils Offsite Disposal	1220	CY	$ 15.00		$ 18,300
Miscellaneous	10%				$ 5,645
		Subtotal Division 31			**$ 62,090**
Division 40 - Process Integration					
Buried MJ Pipe	1	LS	$ 115,000.00		$ 115,000
Buried Pipe	1	LS	$ 20,000.00		$ 20,000
Slide Gates	4	EA	$ 7,500.00	$ 2,250.00	$ 39,000
Chemical Piping/Valving Allowance	1.5	LS	$ 30,000.00		$ 45,000
Miscellaneous	10%				$ 21,900
		Subtotal Division 40			**$ 240,900**
Division 44 - Pollution Control Equipment					
Chain and Flight Sludge Collector	2	EA	$ 85,000.00	$ 25,500.00	$ 221,000
Horizontal Paddle Wheel Flocculators	1	LS	$ 225,000.00	$ 67,500.00	$ 292,500
Baffle Walls	1.5	LS	$ 212,127.00	$ 84,638.54	$ 445,148
Rapid Mixer	2	EA	$ 19,000.00	$ 5,700.00	$ 49,400
Plate Settlers	1	LS	$ 1,725,700.00	$ 517,710.00	$ 2,243,410
Miscellaneous	10%				$ 325,146
		Subtotal Division 44			**$ 3,576,604**

Subtotal This Facility		$	**7,593,000**
Contingency	**30%**	$	**2,278,000**
Mobilization	**5%**	$	**494,000**
Contractor's Overhead and Profit	**18%**	$	**1,777,000**
Total Estimated Facility Costs		$	**12,142,000**

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Facility Number: 40
Facility Description: Membranes - CSII System Alt 2

Description	Qty	Unit	Unit Cost	Labor	Total Cost
Division 2 - Existing Conditions					
ZeeWeed 500D Demolition	1	LS	$ 250,000.00		$ 250,000
Allowance for Temporary Maintenance of Operation	1	LS	$ 100,000.00		$ 100,000
Miscellaneous	10%				$ 35,000
		Subtotal Division 2			**$ 385,000**
Division 3 - Concrete					
Concrete Wall Work	30	CY	$ 800.00		$ 24,000
Concrete Wall Dowels	1000	EA	$ 50.00		$ 50,000
Concrete Slab Work	25	CY	$ 600.00		$ 15,000
Concrete Slab Dowels	500	EA	$ 50.00		$ 25,000
Surface Wall Repair	1200	SF	$ 50.00		$ 60,000
Concrete Coating	1500	SF	$ 60.00		$ 90,000
Miscellaneous	0%				$ -
		Subtotal Division 3			**$ 264,000**
Division 26 - Electrical					
SCADA Programming	1	LS	$ 100,000.00		$ 100,000
Permeate Pump VFDs	5	EA	$ 55,000.00	$ 13,750.00	$ 343,750
Blower VFDs	2	EA	$ 20,000.00	$ 5,000.00	$ 50,000
CIP Pump VFDs	3	EA	$ 6,000.00	$ 1,500.00	$ 22,500
Neutralization Pump VFDs	3	EA	$ 6,000.00	$ 1,500.00	$ 22,500
Backpulse Pump VFDs	3	EA	$ 35,000.00	$ 8,750.00	$ 131,250
Electrical Distribution Equipment and Install	1	LS	$ 500,000.00	$ 250,000.00	$ 750,000
Miscellaneous	0%				$ -
		Subtotal Division 26			**$ 1,420,000**
Division 40 - Process Integration					
Miscellaneous	5%				$ -
		Subtotal Division 40			**$ -**
Division 44 - Pollution Control Equipment					
CS Membrane System/CS Cell	1	LS	$ 6,457,000.00	$ 968,550.00	$ 7,425,550
Filtrate System	1	LS	$ 525,900.00	$ 78,885.00	$ 604,785
Backwash System	1	LS	$ 336,500.00	$ 50,475.00	$ 386,975
Clean-In-Place System	1	LS	$ 337,500.00	$ 50,625.00	$ 388,125
Neutralization System	1	LS	$ 283,000.00	$ 42,450.00	$ 325,450
Compressed Air System	1	LS	$ 157,000.00	$ 23,550.00	$ 180,550
Air Scour System	1	LS	$ 621,000.00	$ 93,150.00	$ 714,150
Miscellaneous	5%				$ -
		Subtotal Division 44			**$ 10,025,585**
Division 46 - Water and Wastewater Equipment					
Miscellaneous	5%				$ -
		Subtotal Division 46			**$ -**
Subtotal This Facility					**$ 12,095,000**
Contingency				**15%**	**$ 1,815,000**
Mobilization				**5%**	**$ 696,000**
Contractor's Overhead and Profit				**18%**	**$ 2,504,000**
Total Estimated Facility Costs					**$ 17,110,000**

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Facility Number: 50
Facility Description: High Service Pump Station

Description	Qty	Unit	Unit Cost	Labor	Total Cost
Division 2 - Existing Conditions					
Demo Existing Siding	821	SF	$ 2.00	$ 492.60	$ 2,135
Demo Existing CMU Blocks	4	CY	$ 300.00	$ 377.78	$ 1,637
Miscellaneous	5%				$ 189
	Subtotal Division 2				**$ 3,960**
Division 3 - Concrete					
Concrete Slab	28	CY	$ 400.00	$ 3,377.78	$ 14,637
CMU Blocks (492 SY)	554	EA	$ 3.00	$ 498.15	$ 2,159
(7) 24"-Diameter 35ft-Deep Piers	245	LF	$ 110.00	$ 8,085.00	$ 35,035
(3) 30"-Diameter 35ft-Deep Piers	105	LF	$ 130.00	$ 4,095.00	$ 17,745
Miscellaneous	5%				$ 3,479
	Subtotal Division 3				**$ 73,054**
Division 5 - Metals					
Insulated Metal Siding	2581	SF	$ 9.00	$ 6,968.70	$ 30,198
Insulated Metal Roofing	1672	SF	$ 9.00	$ 4,514.40	$ 19,562
Miscellaneous	5%				$ 2,488
	Subtotal Division 5				**$ 52,248**
Division 9 - Finishes					
Pipe Coatings	1	LS	$ 33,916.94	$ -	$ 33,917
Exterior Paint	492	SF	$ 2.00	$ 295.20	$ 1,279
Miscellaneous	5%				$ 1,760
	Subtotal Division 9				**$ 36,956**
Division 11 - Equipment					
Miscellaneous	5%				$ -
	Subtotal Division 11				**$ -**
Division 26 - Electrical					
Electrical Allowance	1	LS	$ 226,855.32	$ 68,056.60	$ 294,912
600HP Medium Voltage Soft Starter	3	EA	$ 50,000.00	$ 25,000.00	$ 175,000
Miscellaneous	5%				$ 23,496
	Subtotal Division 26				**$ 493,408**
Division 31 - Earthwork					
Site Preperation for Building Addition	1520	SY	$ 20.00	$ 9,120.00	$ 39,520
Miscellaneous	5%				$ 1,976
	Subtotal Division 31				**$ 41,496**
Division 40 - Process Integration					
Suction Line					

36" DIP	54	LF	$ 1,370.00	$ 22,194.00	$ 96,174
24" DIP	72	LF	$ 890.00	$ 19,224.00	$ 83,304
24" FExFE Flexible Expansion Joint	6	EA	$ 1,032.00	$ 1,857.60	$ 8,050
36"x24" Tee	3	EA	$ 23,254.00	$ 20,928.60	$ 90,691
1" Packing Drain Line	17	LF	$ 4.28	$ 21.19	$ 92
Packing Drain Line Solenoid Valve	3	EA	$ 860.00	$ 774.00	$ 3,354
Discharge Line					
24" DIP	39	LF	$ 890.00	$ 10,413.00	$ 45,123
42" DIP	30	LF	$ 1,500.00	$ 13,500.00	$ 58,500
Pressure Switch, Transmitter, and Gauge Assembly	3	EA	$ 2,500.00	$ 2,250.00	$ 9,750
16"x24" Reducer	3	EA	$ 5,163.00	$ 4,646.70	$ 20,136
2" Vertical Turbine Air Release and Vacuum Relief Valve with 2" Isolation Ball Valve	3	EA	$ 4,000.00	$ 3,600.00	$ 15,600
2" Air/Vacuum Valve Drain Line	44	LF	$ 9.33	$ 121.76	$ 528
24" Restrained Coupling	3	EA	$ 3,581.00	$ 3,222.90	$ 13,966
24" Pump-Check Valve and Actuator	3	EA	$ 49,595.00	$ 44,635.50	$ 193,421
24" Butterfly Valve	3	EA	$ 10,044.00	$ 9,039.60	$ 39,172
1/2" Compressed Air Line	74	LF	$ 2.20	$ 48.84	$ 212
1/2" Ball Valve	3	EA	$ 66.95	$ 60.26	$ 261
1/2" Air Line 90-Degree Bend	1	EA	$ 2.00	$ 0.60	$ 3
1/2" Air Line Tee	2	EA	$ 2.00	$ 1.20	$ 5
Pipe Supports	1	LS	$ 20,350.17	$ -	$ 20,350
Miscellaneous	5%				$ 1,018
	Subtotal Division 26				**$ 699,707**
Division 43 - Process Integration					
Suction Line					
36" DIP	54	LF	$ 1,370.00	$ 22,194.00	
24" DIP	72	LF	$ 890.00	$ 19,224.00	
24" FExFE Flexible Expansion Joint	6	EA	$ 1,032.00	$ 1,857.60	
36"x24" Tee	3	EA	$ 23,254.00	$ 20,928.60	
1" Packing Drain Line	17	LF	$ 4.28	$ 21.19	
Packing Drain Line Solenoid Valve	3	EA	$ 860.00	$ 774.00	
Discharge Line					
24" DIP	39	LF	$ 890.00	$ 10,413.00	
42" DIP	30	LF	$ 1,500.00	$ 13,500.00	
Pressure Switch, Transmitter, and Gauge Assembly	3	EA	$ 2,500.00	$ 2,250.00	
16"x24" Reducer	3	EA	$ 5,163.00	$ 4,646.70	
2" Vertical Turbine Air Release and Vacuum Relief Valve with 2" Isolation Ball Valve	3	EA	$ 4,000.00	$ 3,600.00	
2" Air/Vacuum Valve Drain Line	44	LF	$ 9.33	$ 121.76	
24" Restrained Coupling	3	EA	$ 3,581.00	$ 3,222.90	
24" Pump-Check Valve and Actuator	3	EA	$ 49,595.00	$ 44,635.50	
24" Butterfly Valve	3	EA	$ 10,044.00	$ 9,039.60	
1/2" Compressed Air Line	74	LF	$ 2.20	$ 48.84	
1/2" Ball Valve	3	EA	$ 66.95	$ 60.26	
1/2" Air Line 90-Degree Bend	1	EA	$ 2.00	$ 0.60	
1/2" Air Line Tee	2	EA	$ 2.00	$ 1.20	
Pipe Supports	1	LS	$ -	$ -	
Miscellaneous	5%				
	Subtotal Division 40				
Division 43 - Process Gas & Liquid Handling					
High Service Pump and Motor	3	EA	$ 150,000.00	$ 135,000.00	$ 585,000
Pump Cans	3	EA	$ 75,000.00	$ 22,500.00	$ 247,500
Miscellaneous	5%				$ 41,625
	Subtotal Division 43				**$ 874,125**
Subtotal This Facility					**$ 2,275,000**
Contingency				**30%**	**$ 683,000**
Mobilization				**5%**	**$ 148,000**
Contractor's Overhead and Profit				**18%**	**$ 533,000**
Total Estimated Facility Costs					**$ 3,639,000**

GARVER - Pflugerville WTP Expansion

City of Pflugerville

19W07185

Take Me Back to the Summary Sheet

Facility Number: 55

Facility Description: Clearwell Storage

Description	Qty	Unit	Unit Cost	Labor	Total Cost
Division 2 - Existing Conditions					
1 MG Tank - Steel Repair, Coating, and Painting Allowance	0	LS	$ 300,000.00		$ -
Miscellaneous	5%				$ -
		Subtotal Division 2			**$ -**
Division 43 - Process Gas & Liquid Handling					
1 MG Tank Curtain Baffle Walls	0	LS	$ 300,000.00		$ -
3 MG Tank Curtain Baffle Walls	3	LS	$ 300,000.00		$ 900,000
					$ -
Miscellaneous	5%				$ 45,000
		Subtotal Division 43			**$ 945,000**
Subtotal This Facility					**$ 945,000**
Contingency				**30%**	**$ 284,000**
Mobilization				**5%**	**$ 62,000**
Contractor's Overhead and Profit				**18%**	**$ 222,000**
Total Estimated Facility Costs					**$ 1,513,000**

GARVER - Pflugerville WTP Expansion
City of Pflugerville
19W07185

Take Me Back to the Summary Sheet

Facility Number: 60
Facility Description: Chemical Storage and Feed

Description	Qty	Unit	Unit Cost	Labor	Total Cost
Division 2 - Existing Conditions					
Miscellaneous	5%				$ -
		Subtotal Division 2			**$ -**
Division 3 - Concrete					
Concrete Base Slab	500	CY	$ 400.00	$ 120.00	$ 260,000
Concrete Equipment Pads	700	CY	$ 400.00	$ 120.00	$ 364,000
Concrete Freestanding Wall	200	CY	$ 800.00	$ 240.00	$ 208,000
Miscellaneous	5%				$ 41,600
		Subtotal Division 3			**$ 873,600**
Division 4 - Masonry					
CMU Walls	10000	SF	$ 12.00		$ 120,000
Miscellaneous	5%				$ 6,000
		Subtotal Division 4			**$ 126,000**
Division 5 - Metals					
Miscellaneous	5%				$ -
		Subtotal Division 5			**$ -**
Division 6 - Wood & Plastics					
FRP Grating	4500	SF	$ 40.00	$ 12.00	$ 234,000
Miscellaneous	5%				$ 11,700
		Subtotal Division 6			**$ 245,700**
Division 7 - Thermal/Moisture Protection					
Roofing	12000	SF	$ 9.00		$ 108,000
Insulation	10000	SF	$ 2.00		$ 20,000
					$ -
Miscellaneous	5%				$ 6,400
		Subtotal Division 7			**$ 134,400**
Division 8 - Openings					
Overhead Doors	2	EA	$ 12,000.00		$ 24,000
Exterior Doors-Single -FRP	4	EA	$ 5,000.00		$ 20,000
Exterior Doors-Double - FRP	10	EA	$ 9,000.00		$ 90,000
Interior Doors - FRP	11	EA	$ 3,000.00		$ 33,000
Windows	7	EA	$ 3,000.00		$ 21,000
Miscellaneous	5%				$ 9,400
		Subtotal Division 8			**$ 197,400**
Division 9 - Finishes					
Coatings	35000	SF	$ 9.00		$ 315,000
Miscellaneous	5%				$ 15,750
		Subtotal Division 9			**$ 330,750**
Division 13 - Special Construction					
12000 SF Building	12000	SF	$ 150.00		$ 1,800,000

Miscellaneous	5%				$ 90,000
		Subtotal Division 13			**$ 1,890,000**
Division 21 - Fire Protection					
Fire System	12000	SF	$ 8.00		$ 96,000
Miscellaneous	5%				$ 4,800
		Subtotal Division 21			**$ 100,800**
Division 22 - Plumbing					
Drainage System	1	LS	$ 10,000.00	$ 3,000.00	$ 13,000
Water Heater	1	EA	$ 5,000.00	$ 1,500.00	$ 6,500
Tempered Water Accessories (temperting valve/recirculation pump/cabinet/etc)	1	LS	$ 7,500.00	$ 2,250.00	$ 9,750
Piping (Tempered Water + Washdown + Other)	1	LS	$ 100,000.00	$ 30,000.00	$ 130,000
Combination Shower/Eyewash Unit - Indoors	8	EA	$ 1,500.00	$ 450.00	$ 15,600
Combination Shower/Eyewash Unit - Outdoors	5	EA	$ 2,000.00	$ 600.00	$ 13,000
Miscellaneous	5%				$ 9,393
		Subtotal Division 22			**$ 197,243**
Division 23 - HVAC					
Indirect Gas Fired Makeup Air Unit w/ cooling coil (400 MBH input heating)	3	EA	$ 20,000.00	$ 6,000.00	$ 78,000
Condensing Unit (18 tons)	3	EA	$ 12,000.00	$ 3,600.00	$ 46,800
233416100326 - 5,080 CFM, 20" diameter connection	8	EA	$ 3,406.00		$ 27,248
Motorized Intake Louver/Damper	8	EA	$ 2,000.00	$ 600.00	$ 20,800
Ductwork/fittings/hangers/accessories (per SF basis)	11000	SF	$ 25.00		$ 275,000
Controls	1	LS	$ 30,000.00	$ 9,000.00	$ 39,000
Miscellaneous	5%				$ 24,342
		Subtotal Division 23			**$ 511,190**
Division 26 - Electrical					
Building Electrical (Lighting, Receptacles, Grounding, Wiring Devices, etc.)	12000	SF	$ 8.00	$ 12.00	$ 240,000
Grounding, Lightning Protection	12000	SF	$ 1.00	$ 2.00	$ 36,000
HVAC Electrical	1	LS	$ 100,000.00	$ 50,000.00	$ 150,000
200A Lighting Panel and Transformer	1	LS	$ 10,000.00	$ 5,000.00	$ 15,000
I&C Wiring/Conduit - Chemical Systems	1	LS	$ 100,000.00	$ 50,000.00	$ 150,000
Chemical Systems Instrumentation	1	LS	$ 200,000.00	$ 100,000.00	$ 300,000
Building Instrumentation - Safety Systems	1	LS	$ 50,000.00	$ 25,000.00	$ 75,000
Low Voltage Power Wiring	25000	LF	$ 0.10	$ 0.35	$ 11,250
Motor Control Panel	10	EA	$ 1,000.00	$ 500.00	$ 15,000
Low Voltage Control Wiring	50000	LF	$ 0.10	$ 0.35	$ 22,500
Testing, Commissioning, Startup	1	LS		$ 98,950.00	$ 98,950
Electrical System Studies (Arc Flash, Coordination)	1	LS		$ 10,000.00	$ 10,000
Miscellaneous	5%				$ 56,185
		Subtotal Division 26			**$ 1,179,885**
Division 31 - Earthwork					
Excavation	3000	CY	$ 15.00		$ 45,000
Structure Backfill, Native	900	CY	$ 20.00		$ 18,000
Granular Fill	500	CY	$ 45.00		$ 22,500
Spoils Offsite Disposal	2100	CY	$ -		$ -
Shoring		SF	$ 50.00		$ -
Miscellaneous	5%				$ 4,275
		Subtotal Division 31			**$ 89,775**
Division 40 - Process Integration					
Chem Feed piping and Valve Allowance	1	LS	$ 1,000,000.00		$ 1,000,000
Pipe Supports	5%				$ 50,000
Miscellaneous	10%				$ 105,000
		Subtotal Division 40			**$ 1,155,000**
Division 43 - Process Gas & Liquid Handling					
Alum Bulk Tanks	5	EA	$ 45,000.00	$ 13,500.00	$ 292,500
Hypo Bulk Tanks	3	EA	$ 40,000.00	$ 12,000.00	$ 156,000
LAS Bulk Tanks	3	EA	$ 30,000.00	$ 9,000.00	$ 117,000
Caustic Bulk Tanks	2	EA	$ 35,000.00	$ 10,500.00	$ 91,000
Acid Bulk Tank	2	EA	$ 30,000.00	$ 9,000.00	$ 78,000
Orthophosphate Bulk Tank	2	EA	$ 10,000.00	$ 3,000.00	$ 26,000
Flouride Bulk Tank	2	EA	$ 25,000.00	$ 7,500.00	$ 65,000

				$ -		$ -
Alum Day Tanks	2	EA	$ 10,000.00	$ 3,000.00		$ 26,000
Hypo Day Tanks	2	EA	$ 10,000.00	$ 3,000.00		$ 26,000
LAS Day Tanks	2	EA	$ 5,000.00	$ 1,500.00		$ 13,000
Caustic Day Tanks	2	EA	$ 5,000.00	$ 1,500.00		$ 13,000
Acid Day Tank	2	EA	$ 5,000.00	$ 1,500.00		$ 13,000
Orthophosphate Day Tank	2	EA	$ 5,000.00	$ 1,500.00		$ 13,000
Flouride Day Tank	2	EA	$ 5,000.00	$ 1,500.00		$ 13,000
Miscellaneous	5%					$ 47,125
		Subtotal Division 43				**$ 989,625**
Division 44 - Pollution Control Equipment						
Transfer Pumps	14	EA	$ 35,000.00	$ 10,500.00		$ 637,000
Feed Skids	11	EA	$ 35,000.00	$ 10,500.00		$ 500,500
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
				$ -		$ -
Miscellaneous	5%					$ 56,875
		Subtotal Division 44				**$ 1,194,375**
Division 46 - Water and Wastewater Equipment						
Miscellaneous	5%					$ -
		Subtotal Division 46				**$ -**
Subtotal This Facility						**$ 9,216,000**
Contingency					**30%**	**$ 2,765,000**
Mobilization					**5%**	**$ 600,000**
Contractor's Overhead and Profit					**18%**	**$ 2,157,000**
Total Estimated Facility Costs						**$ 14,738,000**

GARVER - Pflugerville WTP Expansion

City of Pflugerville

19W07185

Take Me Back to the Summary Sheet

Facility Number: 82

Facility Description: Gravity Thickener

Description	Qty	Unit	Unit Cost	Labor	Total Cost
Division 2 - Existing Conditions					
Miscellaneous	5%				$ -
		Subtotal Division 2			**$ -**
Division 3 - Concrete					
Circular Footing, 6' x 36"	10	CY	$ 350.00		$ 3,500
Circular Base Slab	440	CY	$ 400.00		$ 176,000
Center Pier, 30"	10	CY	$ 1,000.00		$ 10,000
Circular sidewall, >8' High	300	CY	$ 800.00		$ 240,000
Launder Wall, <8' High	80	CY	$ 800.00		$ 64,000
Launder Slab	50	CY	$ 1,200.00		$ 60,000
Floor Grout	40	CY	$ 300.00		$ 12,000
Trough Grout	10	CY	$ 300.00		$ 3,000
					$ -
PRVs	20	EA	$ 750.00		$ 15,000
Miscellaneous	5%				$ 29,175
		Subtotal Division 3			**$ 612,675**
Division 5 - Metals					
Alum Guardrail - Two Rail w/ Posts	136	LF	$ 60.00		$ 8,170
Stairs	23	Riser	$ 600.00		$ 13,800
Stair landing	4	LF	$ 150.00		$ 650
AL Grating	389	SF	$ 60.00		$ 23,340
Allowance for Aluminum Framing	2000	LBS	$ 4.00		$ 8,000
					$ -
					$ -
Miscellaneous	5%				$ 2,698
		Subtotal Division 5			**$ 56,658**
Division 6 - Wood & Plastics					
FRP Weir Plate	377	LF	$ 150.00	$ 19.50	$ 63,902
Miscellaneous	5%				$ 3,195
		Subtotal Division 6			**$ 67,097**
Division 9 - Finishes					
Coating - Concrete	13572	SF	$ 3.00		$ 40,716
Coating - Mechanisms	2	EA	$ 25,000.00		$ 50,000
Miscellaneous	5%				$ 4,536
		Subtotal Division 9			**$ 95,252**
Division 26 - Electrical					
20A Feeder to Thickener #1 - 1" Conduit	1000	LF	$ 3.46	$ 5.45	$ 8,910
20A Feeder to Thickener #1 - #10	8000	LF	$ 0.12	$ 0.40	$ 4,160
20A Feeder to Thickener #2 - 1" Conduit	1000	LF	$ 3.46	$ 5.45	$ 8,910
20A Feeder to Thickener #2 - #10	8000	LF	$ 0.12	$ 0.40	$ 4,160
20A Feeder to Control Valve #1 - 1" Conduit	1000	LF	$ 3.46	$ 5.45	$ 8,910
20A Feeder to Control Valve #1 - #10	8000	LF	$ 0.12	$ 0.40	$ 4,160
20A Feeder to Control Valve #1 - 1" Conduit	1000	LF	$ 3.46	$ 5.45	$ 8,910
20A Feeder to Control Valve #1 - #10	8000	LF	$ 0.12	$ 0.40	$ 4,160
Thickener Control Panel	2	EA	$ 10,000.00	$ 5,000.00	$ 30,000
Lighting	2	EA	$ 1,000.00	$ 500.00	$ 3,000
Low Voltage Power Wiring	1000	LF	$ 0.10	$ 0.35	$ 450
Low Voltage Control Wiring	10000	LF	$ 0.10	$ 0.35	$ 4,500
Testing, Commissioning, Startup	1	LS		$ 9,023.00	$ 9,023
Electrical System Studies (Arc Flash, Coordination)	1	LS		$ 1,000.00	$ 1,000

Miscellaneous	5%				$ 5,013
		Subtotal Division 26			**$ 105,266**
Division 31 - Earthwork					
Excavation	3866	CY	$ 15.00		$ 57,997
Structure Backfill, Native	1144	CY	$ 20.00		$ 22,875
Granular Fill	446	CY	$ 45.00		$ 20,076
3" Concrete Mud Mat	6842	SF	$ 1.20		$ 8,211
Miscellaneous	5%				$ 5,458
		Subtotal Division 31			**$ 114,616**
Division 40 - Process Integration					
6" Buried Ductile Iron Pipe	69	LF	$ 36.75	$ 18.38	$ 3,804
12" Buried Ductile Iron Pipe	167	LF	$ 56.44	$ 28.22	$ 14,101
12 Wall Collar	6	EA	$ 240.00	$ 120.00	$ 2,160
12" FBE UPC BEND: 90° MJ	4	EA	$ 486.00	$ 243.00	$ 2,916
12" FBE UPC BEND: 45° MJ	8	EA	$ 402.00	$ 201.00	$ 4,824
12" FBE UPC BEND: 22-1/2° MJ	2	EA	$ 351.00	$ 175.50	$ 1,053
Concrete Encasement	30	CY	$ 350.00	$ 175.00	$ 15,973
12" Electric Plug Valve	3	EA	$ 7,000.00	$ 3,500.00	$ 31,500
Miscellaneous	5%				$ 3,817
		Subtotal Division 40			**$ 80,147**
Division 43 - Process Gas & Liquid Handling					
Miscellaneous	5%				$ -
		Subtotal Division 43			**$ -**
Division 46 - Water and Wastewater Equipment					
60 ft Gravity Thickener Mechanisms	2	EA	$ 128,000.00	$ 38,400.00	$ 15,973
Miscellaneous	5%				$ 799
		Subtotal Division 46			**$ 16,771**
Subtotal This Facility					**$ 1,148,481**
Contingency				**30%**	**$ 345,000**
Mobilization				**5%**	**$ 75,000**
Contractor's Overhead and Profit				**18%**	**$ 269,000**
Total Estimated Facility Costs					**$ 1,838,000**

GARVER - Pflugerville WTP Expansion
City of Pflugerville
19W07185

Take Me Back to the Summary Sheet

Facility Number: 85
Facility Description: Backwash Clarifiers

Description	Qty	Unit	Unit Cost	Labor	Total Cost
Division 3 - Concrete					
Circular Footing, 6' x 36"	10	CY	$ 350.00	$ 105.00	$ 4,550
Circular Base Slab, 18" Thick	540	CY	$ 400.00	$ 120.00	$ 280,800
Center Pier, 30"	10	CY	$ 1,000.00	$ 300.00	$ 13,000
Circular sidewall, >8' High	230	CY	$ 800.00	$ 240.00	$ 239,200
Floor Grout	60	CY	$ 300.00	$ 90.00	$ 23,400
					$ -
					$ -
PRVs	30	EA	$ 750.00	$ 225.00	$ 29,250
Miscellaneous	5%				$ 29,510
			Subtotal Division 3		**$ 619,710**
Division 4 - Masonry					
Miscellaneous	5%				$ -
			Subtotal Division 4		**$ -**
Division 5 - Metals					
Alum Guardrail - Two Rail w/ Posts	50	LF	$ 60.00	$ 18.00	$ 3,900
Stairs	12	Riser	$ 600.00	$ 180.00	$ 9,360
Stair landing	4	LF	$ 150.00	$ 45.00	$ 780
AL Grating	54	SF	$ 60.00	$ 18.00	$ 4,212
Miscellaneous	5%				$ 913
			Subtotal Division 5		**$ 19,165**
Division 6 - Wood & Plastics					
FRP Weir Plate	440	LF	$ 150.00		$ 66,000
Miscellaneous	5%				$ 3,300
			Subtotal Division 6		**$ 69,300**
Division 26 - Electrical					
20A Feeder to Tank #1 - 1" Conduit	1000	LF	$ 3.46	$ 5.45	$ 8,910
20A Feeder to Tank #1 - #10	8000	LF	$ 0.12	$ 0.40	$ 4,160
20A Feeder to Tank #2 - 1" Conduit	1000	LF	$ 3.46	$ 5.45	$ 8,910
20A Feeder to Tank #2 - #10	8000	LF	$ 0.12	$ 0.40	$ 4,160
Tank Control Panel	2	EA	$ 10,000.00	$ 5,000.00	$ 30,000
Lighting	2	EA	$ 1,000.00	$ 500.00	$ 3,000
Low Voltage Power Wiring	1000	LF	$ 0.10	$ 0.35	$ 450
Low Voltage Control Wiring	10000	LF	$ 0.10	$ 0.35	$ 4,500
Testing, Commissioning, Startup	1	LS		$ 6,409.00	$ 6,409
Electrical System Studies (Arc Flash, Coordination)	1	LS		$ 1,000.00	$ 1,000
Miscellaneous	5%				$ 3,575
			Subtotal Division 26		**$ 75,074**
Division 31 - Earthwork					
Excavation	2405	CY	$ 15.00		$ 36,071
Structure Backfill, Native	441	CY	$ 20.00		$ 8,824
Granular Fill	601	CY	$ 45.00		$ 27,053
3" Concrete Mud Mat	10306	SF	$ 1.20		$ 12,367
Miscellaneous	5%				$ 4,216
			Subtotal Division 31		**$ 88,531**
Division 40 - Process Integration					
36" Buried Ductile Iron Pipe	98	EA	$ 200.00	$ 60.00	$ 25,480
36 Wall Collar	2	EA	$ 900.00	$ 270.00	$ 2,340
36" FBE UPC BEND: 90° MJ	2	EA	$ 6,694.00	$ 2,008.20	$ 17,404
Concrete Encasement	66	CY	$ 350.00	$ 105.00	$ 30,140
6" Buried Ductile Iron Pipe	98	EA	$ 36.75	$ 11.03	$ 4,682
6" FBE UPC BEND: 90° MJ	2	EA	$ 157.00	$ 47.10	$ 408
12" EMO Butterfly Valve	6	EA	$ 10,799.47	$ 3,239.84	$ 84,236
12" Buried Ductile Iron Pipe	34	LF	$ 56.44	$ 16.93	$ 2,504
12" FBE UPC BEND: 90° MJ	2	EA	$ 486.00	$ 145.80	$ 1,264

12" FBE UPC TEE MJxMJ	4	EA	$ 676.00	$ 202.80	$	3,515
12 Wall Collar	6	EA	$ 240.00	$ 72.00	$	1,872
Miscellaneous	5%				$	8,692
	Subtotal Division 40				**$**	**182,537**
Division 46 - Water and Wastewater Equipment						
75' Mechanisms	2	EA	$ 160,000.00	$ 48,000.00	$	416,000
Miscellaneous	5%				$	20,800
	Subtotal Division 46				**$**	**436,800**

Subtotal This Facility		**$**	**1,491,117**
Contingency	**30%**	**$**	**448,000**
Mobilization	**5%**	**$**	**97,000**
Contractor's Overhead and Profit	**18%**	**$**	**350,000**
Total Estimated Facility Costs		**$**	**2,387,000**

GARVER - Pflugerville WTP Expansion

City of Pflugerville

19W07185

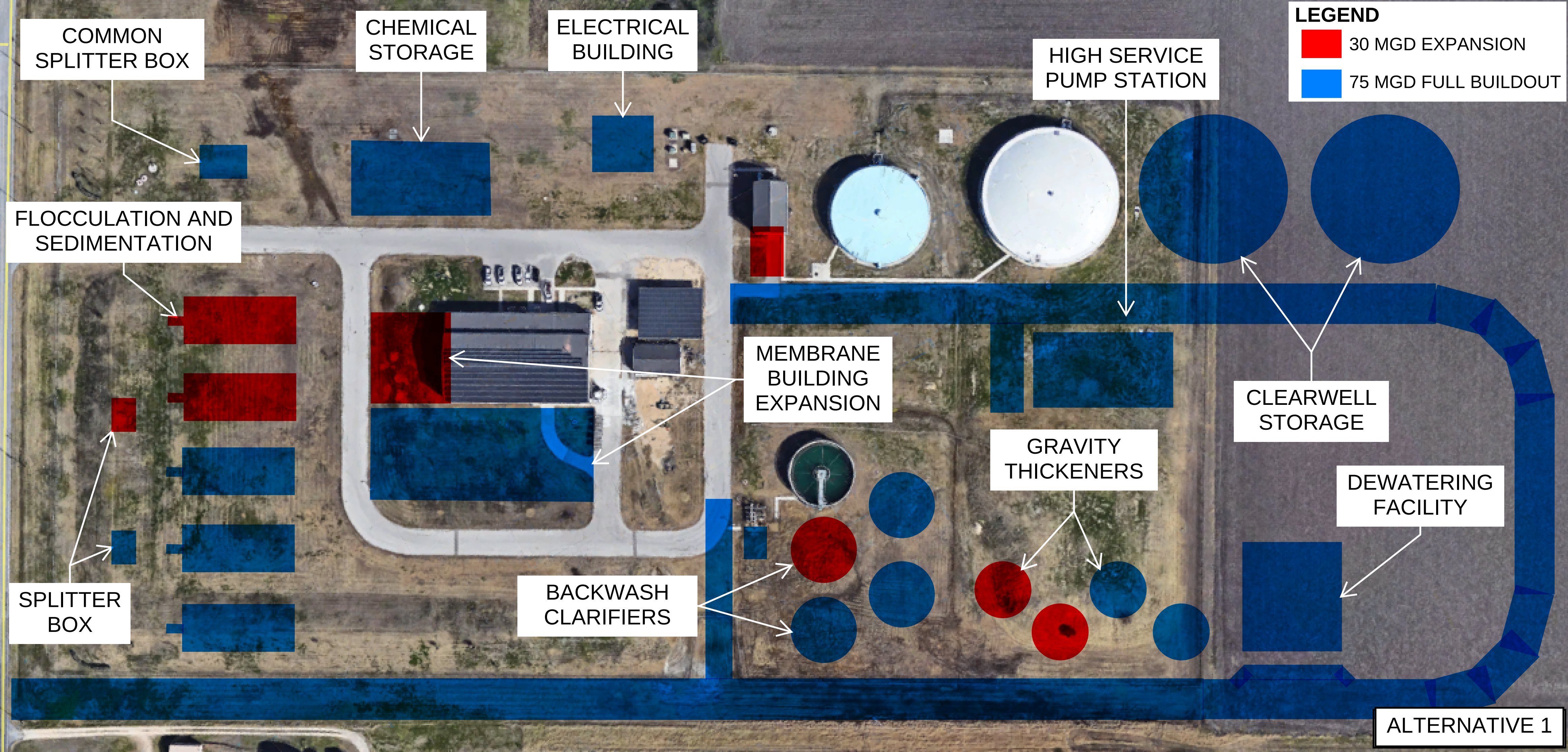
Take Me Back to the Summary Sheet

Facility Number: 90

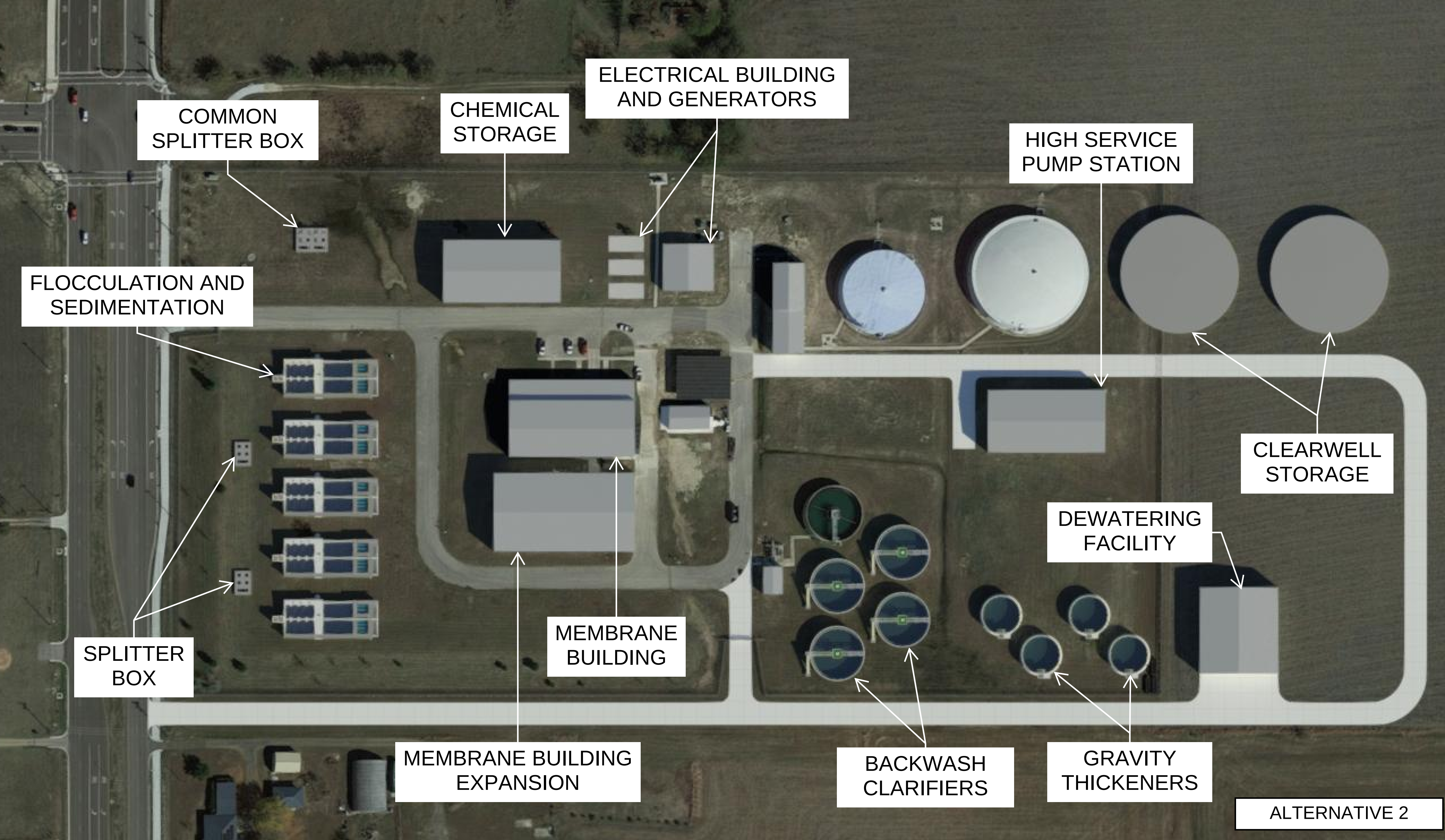
Facility Description: SCADA Systems and Controls

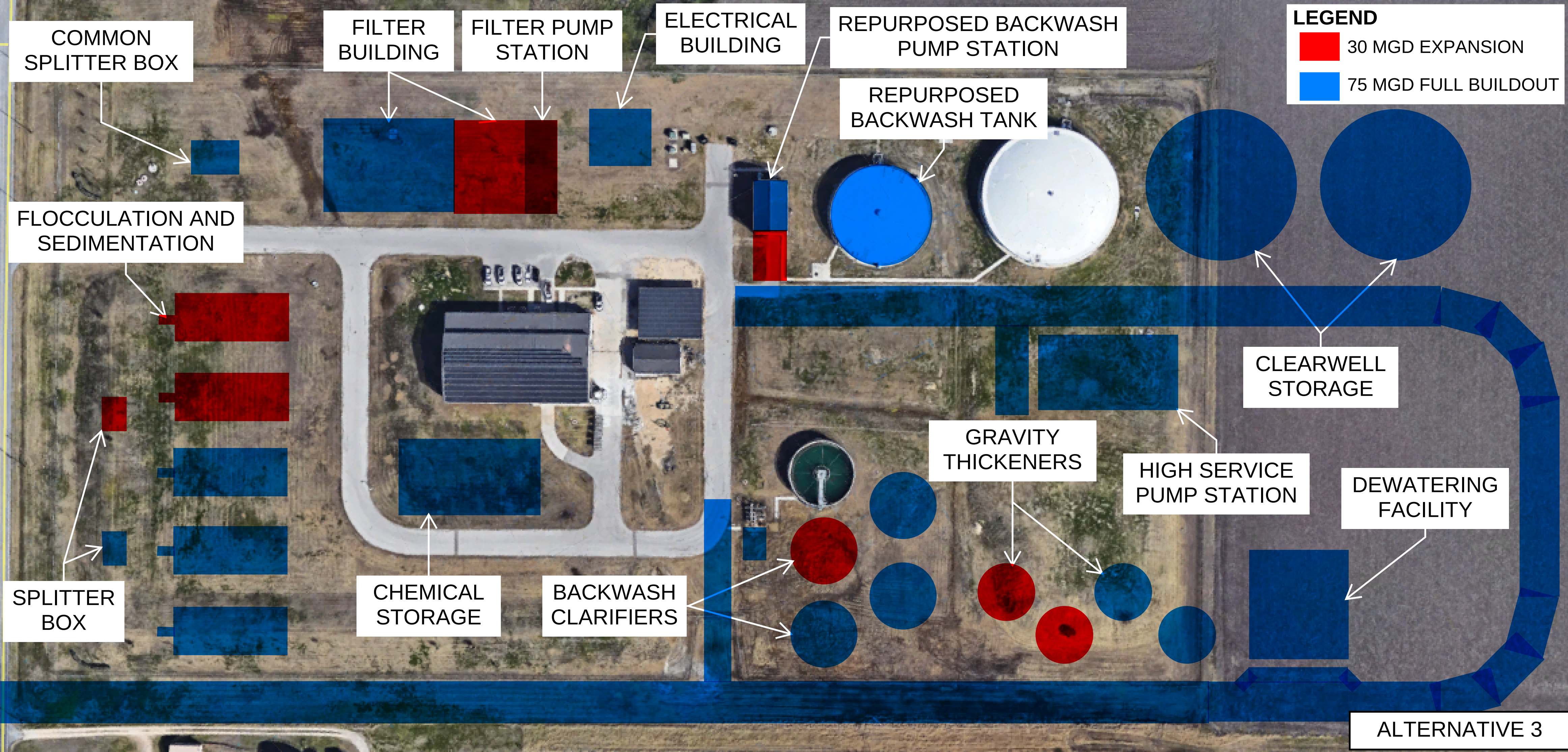
Description	Qty	Unit	Unit Cost	Labor	Total Cost
Division 26 - Electrical					
PLC Control Panels	5	EA	$ 60,000.00	$ 30,000.00	$ 450,000
SCADA Servers	2	EA	$ 5,000.00	$ 2,500.00	$ 15,000
Networking Components	1	LS	$ 25,000.00	$ 25,000.00	$ 50,000
SCADA Workstations	4	EA	$ 2,500.00	$ 25,001.00	$ 110,004
SCADA Software Licensing	1	LS	$ 50,000.00	$ -	$ 50,000
Programming/Integration	1	LS		$ 600,000.00	$ 600,000
Generator and Building Expansion Allowance	1	LS	$ 2,000,000.00		$ 2,000,000
Miscellaneous	5%				$ 163,750
			Subtotal Division 26		**$ 3,438,754**
Division 27 - Communication					
Miscellaneous	5%				$ -
			Subtotal Division 27		**$ -**
Subtotal This Facility					**$ 3,438,754**
Contingency				**30%**	**$ 1,032,000**
Mobilization				**5%**	**$ 224,000**
Contractor's Overhead and Profit				**18%**	**$ 805,000**
Total Estimated Facility Costs					**$ 5,500,000**

Appendix B: Full Buildout Filtration Alternative Site Layouts



LEGEND
30 MGD EXPANSION
75 MGD FULL BUILDOUT
COMMON SPLITTER BOX
CHEMICAL STORAGE
ELECTRICAL BUILDING
HIGH SERVICE PUMP STATION
FLOCCULATION AND SEDIMENTATION
MEMBRANE BUILDING EXPANSION
CLEARWELL STORAGE
GRAVITY THICKENERS
DEWATERING FACILITY
SPLITTER BOX
BACKWASH CLARIFIERS
ALTERNATIVE 1


COMMON SPLITTER BOX
CHEMICAL STORAGE
ELECTRICAL BUILDING AND GENERATORS
HIGH SERVICE PUMP STATION
FLOCCULATION AND SEDIMENTATION
CLEARWELL STORAGE
DEWATERING FACILITY
SPLITTER BOX
MEMBRANE BUILDING
MEMBRANE BUILDING EXPANSION
BACKWASH CLARIFIERS
GRAVITY THICKENERS
ALTERNATIVE 2


COMMON SPLITTER BOX
FILTER BUILDING
FILTER PUMP STATION
ELECTRICAL BUILDING
REPURPOSED BACKWASH PUMP STATION
REPURPOSED BACKWASH TANK
LEGEND
30 MGD EXPANSION
75 MGD FULL BUILDOUT
FLOCCULATION AND SEDIMENTATION
CLEARWELL STORAGE
GRAVITY THICKENERS
HIGH SERVICE PUMP STATION
DEWATERING FACILITY
SPLITTER BOX
CHEMICAL STORAGE
BACKWASH CLARIFIERS
ALTERNATIVE 3