CIVE 4143

SENIOR DESIGN PROJECT

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December 5, 2017

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Introduction –Aubrey

In this report we updated the existing wastewater treatment plant in Alligator Creek, TX to meet new flow requirements and discharge permits. We evaluated the current performance of the plant systems to determine if they needed to be enhanced and designed the necessary changes. Most of the calculations for this project were followed directly from regulations from the book Wastewater Engineering: Treatment and Resource Recovery, 5th Edition, by Metcalf and Eddy. Where necessary the book is referenced for items such as examples used, as well as assumptions made. Moreover, some recommendations were also taken from the book such as for overflow or weir overflow rate. The most pertinent regulations that must be followed by law were Texas or TCEQ regulations taken from the website: www.tceq.state.tx.us. In most cases for each part of the plant, alternatives take into account advantages and disadvantages were evaluated to determine the best solution, which oftentimes was not changing anything or simply adding additional units for an already existing process. Furthermore, each segment of the project is indicated by header which also includes the team member who wrote of the section. These sections typically line up with who performed the calculations for each part as well.

Shown below are the existing parameters as well as new limits and values for the plant.

Table 1. Existing and New Permits for Each Parameter

Parameter	Existing Monthly Avg. Effluent Discharge Limit	New Monthly Avg. Effluent Discharge Limit
Flow	3.5 MGD; 8.8 MGD 2-hr peak	6 MGD; 15 MGD 2-hr peak
$cBOD_5$	10 mg/L	5 mg/L (May-Oct), 7 mg/L (Nov-Apr)
TSS	15 mg/L	15 mg/L
NH_3-N	2 mg/L (May-Sep), 3 mg/L (Oct-Apr)	2 mg/L (May-Oct), 3 mg/L (Nov-Apr)
Total Phosphorus	N/A	1 mg/L
Dissolved Oxygen	5 mg/L (May-Sep), 4 mg/L (Oct-Apr)	6 mg/L

Table 2. Influent Characteristics

Parameter	Influent Concentration
$cBOD_5$	165 mg/L
TSS	195 mg/L
NH_3	32 mg/L
Phosphorous	5.5 mg/L

Raw Wastewater Pumps –Hossein

The Alligator Creek Wastewater Treatment Plant has 4 units for pumping raw wastewater. Each unit's capacity is 3.3 MGD, so total capacity of the plant is 13.2 MGD. It is important to state that 3 units (9.9 MGD) are constant. The plant will be expanded to 15 MGD, 6 MGD AADF and 15 MGD P2hrF. So we provide 1 unit with 2 MGD capacity. Finally, the new plant will have 5 units to pump raw wastewater that 4 of them with 3.3 MGD and other one with 2 MGD.

Table 3. Wastewater Pump Values

No. of unit	Unit Capacity (MGD)	Description	Total capacity (MGD)
4	3.3	Existing Plant	13.2
1	2	New design	2

Comminutor –Aubrey

The current plant only has one comminutor to handle size reduction of coarse solids within the wastewater influent stream. We were given very little information about the comminutor. However, due to the doubling of the flow rate a second comminutor will be installed.

No Texas regulations over comminutors were found.

Aerated Grit Chamber –Matt

The influent of the current plant is processed by a single 16,300 gallon aerated grit chamber. The grit chamber currently handles 3.25 MGD of flow with a detention time of 7.2 min. This time is longer than the recommended detention time in table 5-17 in Wastewater Engineering: Treatment and Resource Recovery, 5th Edition, by Metcalf and Eddy. The table recommends a detention time of 2-5 min. In the case of the new Influent flow an average of 6 MGD must be handled. The existing grit chamber can process 6 MGD of flow with a detention time of 3.9 min, which is within the recommended time and above the 3 min minimum requirement from the TCEQ. The grit chamber is sized so that it is 8.8m long, 3.5m wide, and 2m deep. The aeration system requires 3.0 standard cubic feet per minute (scfm) per linear foot of air be delivered to the chamber. Using this standard, the chamber requires 2.6 m^3/min of air from the aeration system.

Table 4. Aerated Grit Chamber Values Compared To Regulations

Factor	TCEQ Regulation	Recommendation	Design	Unit
Detention Time	>3	2-5	3.9	Min
Aeration	N/A	0.279	0.3	m^3/min/m
Air Volume	N/A	N/A	2.6	m^3/min

Primary Clarifiers –Aubrey

The plant currently has two units with 0.32 MG capacity or a total of 0.64 MG. The various design parameters for the current plant were calculated such as the loading rate and weir overflow rate and were compared with the values calculated for the new flow rate. These current values along with pertinent guidelines and regulations are below in the table.

Table 5. Current and New Flow Rate Calculations of the Plant Compared to Regulations

Factor	Unit	Metcalf and Eddy Values	Texas Regulations	Current Flow Rate	New Flow Rate
Detention Time: Avg. Flow	hours	1.5-2.5	At least 1.8	4.43	2.60
Detention Time: Peak Flow	hours	Not listed	At least 0.9	1.47	1.03
Overflow Rate: Avg. Flow	gal/ft^2*d	800-1200	<1000	527	903
Overflow Rate: Peak Flow	gal/ft^2*d	2000-3000	<1,800	1,325	2259
Weir Loading Rate: Avg. Flow	gal/ft*d	10,0000-40,000	<30,000	8,570	14,700
Weir Loading Rate: Peak Flow	gal/ft*d	10,0000-40,000	<30,000	21,500	36,700

Here, the detention time was calculated by the total volume of all units divided by the flow rate. The overflow rate is the flowrate divided by the total area of all of the circular clarifiers. The weir overflow rate is the flowrate divided by the total circumference of all of the circular clarifiers.

As shown in the table for the existing plant the new flow rate would cause the plant to be out of regulation for both overflow rate at peak flow as well as its weir loading rate. To stay within regulations the plant will need an additional unit to handle the increased flow. Using overflow rate, weir loading rate, and detention time it was determined 1 more unit of the same dimensions should be built to meet the demands of the new flow. An additional unit should be built as a redundant unit.

Show below in the table are the new values with an additional tank of an inner radius of 32.5 ft and depth of 13 ft, exactly like the existing tanks, compared to the same regulations and recommendations.

Table 6. New Flow Rate Calculations with New Plant Units Compared to the Regulations

Factor	Unit	Metcalf and Eddy Values	Texas Regulations	New Flow Rate
Detention Time: Avg. Flow	hours	1.5-2.5	At least 1.8	3.87
Detention Time: Peak Flow	hours	Not listed	At least 0.9	1.55
Overflow Rate: Avg. Flow	gal/ft^2*d	800-1200	<1000	600
Overflow Rate: Peak Flow	gal/ft^2*d	2000-3000	<1,800	1500
Weir Loading Rate: Avg. Flow	gal/ft*d	10,0000-40,000	<30,000	9,800

Weir Loading Rate: Peak Flow	gal/ft*d	10,0000-40,000	<30,000	24,500

Primary Sludge Pumps –Hossein

To handle primary solids from the sump of the first clarifier to the aeration basins, 2 units of 90 gpm, totally 180 gpm pumps are applied. If the maximum amount of solid that must pump to aeration basin is considered as 6 % of total flow, then we need a unit to compensate the extra 70 gpm. So we can add a unit with 70 gpm capacity.

Table 7. Primary Sludge Pump Values

No. of unit	Unit Capacity (MGD)	Description	Total capacity (MGD)
2	90	Existing Plant	180
1	70	New design	70

Anaerobic Reactor: Biological Phosphorus Removal –Aubrey

The current plant currently has no regulation, but the regulations are 1 mg/L P. The influent for the plant is 5.5 mg/L.

Our team performed an alternative analysis of the various ways to remove the phosphorus and the various options are described. The Phoredox (A/O) Process is one of the more simple process consisting of an anaerobic tank the plant to remove phosphorus. The Anaerobic/Anoxic/Aerobic (A2O) Process, in addition to removing phosphorus it also performs nitrification, but is also a more complicated process. The next, process we investigated was the A2O MBR and then Modified Bardenpho Process. Both processes are again more complicated and not only perform phosphorus removal, but also other processes such as nitrate, nitrogen, and carbon removal in addition to denitrification. The previous information is taken from pages 865 to 866 of the textbook from Metcalf and Eddy.

We chose Phoredox (A/O) process as this is the most simple process, while also performing the desired phosphorus removal. The other methods, along with the many more mentioned in our textbook, although perform more processes, would add unneeded costs and complexity to the plant. If the plant at some point in relatively near future will require other contaminant removal, they should consider upgrading to one of the other methods described. In using the Phoredox (A/O) process an anaerobic tank must be added to the plant, however the same aeration used for nitrogen removal is also used for this part so if additional tanks are need for that part of the process, it is described in the Aeration Basin section of the report.

To perform our phosphorus removal calculations when using the Phoredox (A/O) process, we used Example 7-8 from the Metcalf and Eddy book. Furthermore, there are no Texas requirements for the anaerobic reactor, but as mentioned previously the achieved removal must result in a concentration less than 1 mg/L.
Furthermore, in the design of aeration tank we used parameters based off of page 873 of the Metcalf and Eddy book. According to the book the HRT of the tank must be 0.5 to 1.5 hours. This would give a needed volume for the aeration tank of about 35,000 ft^3. The exact design dimensions for this tank are below.

Table 8. Anaerobic Tank Dimensions for Construction

Number of Units	Height (ft)	Width (ft)	Length (ft)
1	15	50	50

Aeration Basin: Phosphorus and Nitrogen Removal –Matt

When performing the calculations some of the Monod coefficients changed based off of temperatures. The phosphorus concentration achieved for these variations in temperature, along with an average temperature, are shown in the table below.

These achieved phosphorus calculations were again calculated from Example 7-8 from the Metcalf and Eddy book. These values are based off different SRTs for the average and the two seasons which can be adjusted by operator changing sludge wasting rate or mixed liquor suspended solids. The same example was also used in part along with nitrogen removal determine how many additional aeration basins must be constructed. Lastly, the achieved phosphorus concentration continues to meet the requirements when a safety factor of 1.2 is used. This safety factor must be included in the calculations to ensure the plant does not exceed to phosphorus limitation.

The Monod coefficients were calculated for the temperatures expected to be seen in Texas during the winter and summer months to estimate how the microbial content of the sludge in the reactor would behave. We found that the regional average air temperatures in texas during the winter and summer are 7.2℃ and 30℃, respectively. The ambient water temperature does not vary as much as the air so we estimated an average water temperature of 15℃ in the winter and 25℃ in the summer for our calculations. The permit requirements differ during the winter and summer months so the effect of temperature is important in determining the ability of the plant to meet these permits.

The existing plant meets the current permits using 2 aerations basins with a capacity of 630,000 gallons each. The existing plant discharges effluent with a $cBOD_5$ of less than 10 mg/L and a TSS of less than 15 mg/L. It must also have an ammonia content of less than 2 mg/L in the summer and 3 mg/L in the winter. There are no current phosphorus limits for the plant.

The new plant is subject to different permit requirements. It must now reduce the effluent $cBOD_5$ to less than 5 mg/L in the winter and 7 mg/L in the summer. The TSS is still required to be below 15 mg/L in the effluent and the ammonia levels are also still 2 mg/L during the summer and 3 mg/L during the winter. The new plant must handle the amount of total phosphorus in its effluent, though. The effluent must have less than 1 mg/L of total phosphorus.

We considered what systems we could use to meet these requirements. We decided it would be more cost efficient and sustainable to use biological treatment methods rather than chemical treatment methods. One option would be to continue to use the existing method of treatment, but it did not address the new phosphorus limits. We decided we must modify the system to one of the phosphorus treatment methods. There are various configurations that treat phosphorus. These can include aerobic tank, anoxic chambers, recycling/return lines and more. Since we only need to treat phosphorus and ammonia, we decided to design an anaerobic tank that will culture phosphorus accumulating microbes followed by a aerobic basin like the ones the plant currently uses to treat the BOD_5 and ammonia.

We designed the system of an anaerobic tank followed by aerobic treatment using example 8-3 and example 7-8 from the textbook from Metcalf and Eddy. We designed the system twice, one for summer and once for winter, adjusting factors for the temperature change.

During the summer, our design includes an SRT of 19 days. The phosphorus treatment required a longer time and controlled the length of the SRT. We designed the aeration basin to operate with a MLVSS of 2500 mg/L. The airflow rate required to maintain the reactor would be 311 m^3/min. The total phosphorus in the effluent after this process would be .69 mg/L, which complies with the phosphorous permit. The BOD_5 of the effluent leaving the tank would be 12.7 mg/L. The majority of this is made up of suspended solids and will be treated in tertiary treatment in order to comply with the permit.

During the winter, the design includes an SRT of 37 days. Again, the phosphorous controlled the SRT time and the basin operated with a MLVSS of 2500 mg/L. The airflow required would be 498 m^3/min and the total phosphorus in the effluent would be .75 mg/L, meeting the permit. The BOD_5 of the effluent would be 12.7 mg/L, which will be reduced to acceptable levels in tertiary treatment.

The design of the aeration basins is controlled by their operation in the winter because it requires a larger volume during this period. We determined that the existing tanks were not enough to handle the volume the new plants flow would require. There were a few alternative ways to solve this issue. One way would be to remove the existing tanks and design new, larger tanks. Another option would be to add additional units of the existing tanks and enhance them all with anaerobic tanks for phosphorus removal. In the interest of costs and simplicity, we decided to add additional units of the existing tanks. The new plant flow requires a total volume of 2.6 million gallons. To accomplish this, we added 2 new tanks for a total of 4 units of 630,000 gallon tanks.

Table 9. Growth Kinetics Values

Factor	Typical Range	Summer Value	Winter Value	Unit
Water Temp.	15-25	25	15	C
Y	0.4-0.6	.5	.5	g VSS/g COD used
k	4-12	8.67	4.52	g bsCOD/g

				VSS day
b	0.06-0.15	.087	.045	g VSS/g VSS day
k_s	20-60	30	30	mg/L BOD

Table 10. Aeration Basin Values

Factor	TCEQ Regulation	Recommendation	Design	Unit
SRT	-	-	Summer: 19 Winter: 37	Days
Oxygen Concentration	>2.0	-	2.0	mg/L
Air Supply Rate	-	-	Summer: 311 Winter: 498	m^3/min
Effluent BOD_5	-	-	12.7	mg/L
Total Phosphorus	-	-	Summer: 0.69 Winter: 0.75	mg/L
Microbe Content	2,000-5000	2,000-3,000	2,500	mg/L
Volume	-	-	Summer: 1,595,560 Winter: 2,486,940	gallons
BOD Loading Rate	-	-	Summer: 26 Winter: 14	g/m^3*day
BOD Loading Rate	800	-	Summer: 494 Winter: 518	g/m^3
F/M	-	-	Summer: 0.045	-

			Winter: 0.029	
OLR	< 35	-	Summer: 26.0 Winter: 14.1	lbs/day/1,000 ft^3
Detention Time	-	-	Summer: 27.7 Winter: 51.0	hours
$NaHCO_3$	-	-	Summer: 108 Winter: 337	Kg/day

Blower –Hossein

To deliver large quantities of air to aeration tanks to sustain biological activity, the Alligator Creek WWTP has 3 units of blower with 2500 cfm capacity for each. Totally these low-pressure air compressor's capacity are 7500 cfm. Based on airflow rate in grit chamber (93 cfm), aerobic sludge digester (883 cfm), and aeration tank (17562 cfm), the required air capacity is 18,549 cfm, then we need 8 blower units for this system with 2500 cfm capacity. So we can add 5 separate 2500 cfm units to existing plant to compensate the extra amount of needed air flow rate.

Table 11. Blower Values

Unit	Blower capacity (cfm)	Description
Existing blower	7500	3 units (ea. 2500 cfm)
Grit chamber	93	
Aerobic sludge digester	883	
Aeration tank	17562	
New blower	11038	5 units (ea. 2500 cfm)

Secondary Clarifiers –Hossein

The MLSS must be settled in a secondary clarifier to produce well-treated effluent. The design criteria and design procedure for solids removal systems include (1) overflow rate, (2) detention time, (3) clarifier shape and dimensions, and (4) solids loading rate. So we calculate these criteria based on new condition; moreover, the new flows (average and peak) are considered with returned flow (65% of design flow). Existing plant has 2 units, that cannot satisfy the loading flow rate, so we decided to expand this section by 1 circular tank with 90 ft diameter, 13.1 ft side water depth. We consider 5 ft as freeboard, so the total depth of these clarifiers with some safety factor is 20 ft. In the following table design information along with the book Wastewater Engineering: Treatment and Resource Recovery, 5th Edition, by Metcalf and Eddy and TEXAS regulations.

Table 12. Secondary Clarifier Information

Factor	Unit	Each Clarifier	The Book	Texas Regulations
Overflow rate (AVG)	gal/ft2/d	519	600-800	<1000
Overflow rate (PEAK)	gal/ft2/d	1297	1200-1600	<1800
Detention time (AVG)	hr	0.5	-	-
Detention time (PEAK)	hr	0.2	-	-
Diameter	ft	90	-	-
Side water depth	ft	13.1	13-18	<10
Total height	ft	20	-	-
Weir loading rate	gal/ft/d	4081.6	30000	30000
Solids loading rate (AVG)	lb/ft2/h	0.45	1.0-1.5	-
Solids loading rate (PEAK)	lb/ft2/h	1.2	2.0	-

We provide 90 degree standard V-notches on the weir plate that shall be installed on one side of the effluent launder. The width of launder is 2 ft, and we provide 3 inches deep V-notches at 1.5 ft center to center, so our clarifiers have 270 notches. Based on page 912, Wastewater Engineering: Treatment and Resource Recovery, 5th Edition, by Metcalf and Eddy, weir loading at peak flow is acceptable. Finally, a new extra clarifier is appropriate for the design flow rate, thus the new plant should have 3 secondary clarifiers with mentioned information.

RAS/WAS Pumps –Hossein

To return recycled/waste activated sludge to system, the currently plant has 5 units of pumps with 910 gpm capacity, 4550 gpm in total. Based on the book Wastewater Engineering: Treatment and Resource Recovery, 5th Edition, by Metcalf and Eddy, the design average capacity is typically 100-150 percent of average flow rate, so we consider the recycle ratio 1.25 for RAS/WAS pumps, and the plant need 1 extra unit with 700 cfm capacity.

Table 13. RAS/WAS Pump Values

No. of unit	Unit Capacity (gpm)	Description	Total capacity (gpm)
5	910	Existing Plant	4550
6	700	New design	700

Disinfection: Chlorine Contact Tank –Matt

The plant currently uses chlorine contact tanks as disinfection and we chose to expand the same system to meet the flow requirements of the new plant. There are currently 2 chlorine contact units each with a 32,825 gallon capacity. This is not adequate the meet the new flow while maintaining an adequate contact time. We propose to expand the capacity by adding more tank volume.

We had two different alternatives to designing the additional tanks. The first option would add 5 new 32,825 gallon tanks. The second option would add only 1 new 150,000 gallon tank. Both options meet the minimum contact time requirement and have similar capacity. We decided to go forward with an addition of the single 150,000 gallon tank. The new total capacity of the disinfection system would be 215,650 gallons with an average contact time of 51 min and a peak contact time of 20 min. We calculated that the plant will require 1000.8 lb of chlorine per day for disinfection.

Table 14. Chlorine Contact Tank

Factor	TCEQ Regulation	Recommendation	Design	Unit
Average Contact Time	-	30-120	51.8	min
Peak Contact Time	20	15-90	20.8	min
Chlorine Dosage	8	-	8	mg/L
Peak Factor	-	-	2.5	-
Capacity	-	-	215650	gal
Chlorine Required	8.34 x Flow x Dose	-	1000.8	lb/day

Aerobic Sludge Digesters –Matt

We chose to continue using the existing system of aerobic sludge digesters to treat the sludge from the plant because of the safety and economic convenience of already possessing a working reactor in the plant. We assessed the current capacity of the aerobic digesters in the plant to determine if more units would be needed. We found that the current digester infrastructure was enough to handle the sludge produced in the new flow if run according to design parameters. Because of this, it is financially beneficial to keep the current system rather than consider switching to another, such as an anaerobic system. The current system can be operated in the summer with a VSS reduction of 55% with an air flow rate of 48.7 m^3/min and effluent sludge production rate of 697 kg/day. In the winter, a VSS reduction of 45% with an air flow rate of 39.8 m^3/min and effluent sludge production rate of 851 kg/day can be achieved.

Table 15. Aerobic Sludge Digester

Factor	TCEQ Regulation	Recommendation	Design	Unit
Air Flow Rate	-	-	Summer: 48.7 Winter: 39.8	m^3/min
Effluent Sludge	-	-	Summer: 697 Winter: 851	kg/day
Oxygen Requirement	-	2.3	2.3	kg O2/kg VSS
VSS Reduction	-	38-50	Summer: 55 Winter: 45	%
Volatile Solids Loading	-	1.6-4.8		lb/ft^3*d
Winter volatile solids reduction	-	>40	45-55	%

Sludge Drying Beds –Aubrey

The sludge drying beds consist of eight units with a total capacity of 52,000 ft^2. The units have a width of 65 ft and length of 100 ft each. From the aerobic sludge digesters calculations we determined the weight of the sludge for the new flow rate will be around 440 kg/day and this value converts to a yearly rate of of about 161,000 kg. Using a standard drying rate of 80 kg/m^2 as taken from the book, it was determined with overall area needed for drying will be nearly 22,000 ft^2. Because the units right now provide a total capacity of 52,000 ft^2 we can determine that no new units need to be built. Even taking into consideration of a typically safety factor of 1.2, the are needed for the sludge drying beds would still only be 26,000 ft^2, which is still well within the requirements

However, we did investigate the current drying beds positives and disadvantages as well as for the alternatives to determine if it was still going to be the best option for the plan. From pg 1588 of the book, these type of traditional sludge drying beds are used for small and medium sized communities. For larger communities the cost of the beds include initial costs and maintenance make the drying beds no longer the best option, but for the case of this community we can assume the community to still not be considered a large. Other general problem of the drying beds are the large area this process takes up, the fact it is highly dependent on weather, odors are common, and oftentimes it might attract insects to the plant. Furthermore, because we do not know where the plant is exactly located and no complaints about the drying beds were mentioned in the problem statement documents, we can assume the climate in the town is sufficient for sludge drying.

The options we investigated to perhaps replace the drying beds are a rotary press, belt filter press, and centrifugation. While these options certainly have their benefits such as quicker dry time, lower amounts of odor, and less space, these options would also require additional funding for the overall project as buying new types of units will be expensive. Because of these reasons we have determined that we should not build any more units, and stick with the sludge drying beds in place as they meet the requirements for the plant and require no additional funding.

Other Texas Regulations the drying beds must meet are listed in the table below.

Table 16. Texas Regulations for Open Sludge Drying Beds

Texas Regulations for Open Sludge Drying Beds	
Aerobic Digestion	Climate which allows for at least 20 lbs/ft^2*year
Number of Units	At least 2

Media Filters –Matt

The existing plant does not currently have any tertiary filtration to treat the effluent from the plant. The current total suspended solids of the plant are higher than desired and must be lowered in order to meet the effluent BOD_5 permit. The BOD_5 leaving the aeration tank in the new plant is around 12.7 mg/L, much higher than the limit. The majority of this is from the suspended solids still in the effluent. To meet the new $cBOD_5$ permit, we must reduce the suspended solids by half to below 5 mg/L in the summer and 7 mg/L in the winter.

To accomplish this, our plan includes adding 4 units of a 33 m^3 sand filter. This filter will be a simple single media sand filter that is 5.8 m wide, 5.8 m long, and 1 m deep. The area required was calculated by dividing the average flow rate by the max filtration/flow rate of the sand filter keeping in mind the state regulations. The dimensions of the units were found by matching the required area to the size of each side of the square filter. The depth was determined by the minimum depth requirements set forth by the state regulations.

Table 17. Sand Filter Regulations Compared to Design

Factor	TCEQ Regulation	Recommendation	Design	Unit
Max Flow Rate	0.122	0.08-0.40	0.12	$m^3/min/m^2$
Depth	0.61	-	1	m
Side Length	-	-	5.8	m
Area	-	-	132	m^2

Hydraulic Profile

Based off of values from table 4-10 from the book, our calculations show for the addition of each unit the head loss will not cause a hydraulic deficiency within the plant. The table below shows the head loss for each process as well as the total. The pumps being added to the plant are more than enough to make up for this loss in head loss.

Table 18. Head Loss Values for Each Additional Unit

Unit	Total Head Loss (ft)
Comminutor	1.5
Primary Clarifiers	4
Anaerobic Reactor	0.7
Aeration Basin	3
Secondary Clarifier	2
Chlorine Contact Tank	2
Total	13.2

Construction Plan

The units will be built while keeping most the existing processes running to prevent a need to shut down the plant at any time. If a process must absolutely be shut off to install another unit, this will have to be done in a quick and very efficient manner to prevent large delays in wastewater treatment by the plant.

A list of the new units and additional units to be built are summarized below.

Table 19. Additional Units to Be Constructed and Costs

Unit	Number of Units to Be Constructed	Cost ($)	Cost Reference

	Including Redundancies		
Raw Wastewater Pumps	1	50,000	EPA, Wastewater Technology Fact Sheet In-Plant Pump Stations
Comminutor	1	10,000	USABlueBook
Aerated Grit Chamber	None	None	None
Primary Clarifiers	2	90,000	EPA, NSCEP
Primary Sludge Pumps	1	6,500	EPA, NSCEP
Anaerobic Reactor	1	198,000	University of Colorado, A Summary of Cost
Aeration Basin	3	1,260,000	University of Colorado, A Summary of Cost
Blower	5	23,500	University of Colorado, A Summary of Cost
Secondary Clarifier	1	45,000	EPA, NSCEP
RAS/WAS Pumps	1	6,500	University of Colorado, A Summary of Cost Information
Chlorine Contact Tank	1	162,000	University of Colorado, A Summary of Cost Information
Aerobic Sludge Digesters	None	None	None
Sludge Drying Beds	None	None	None

Construction Costs		1,000,000	Estimation
Total		2,851500	

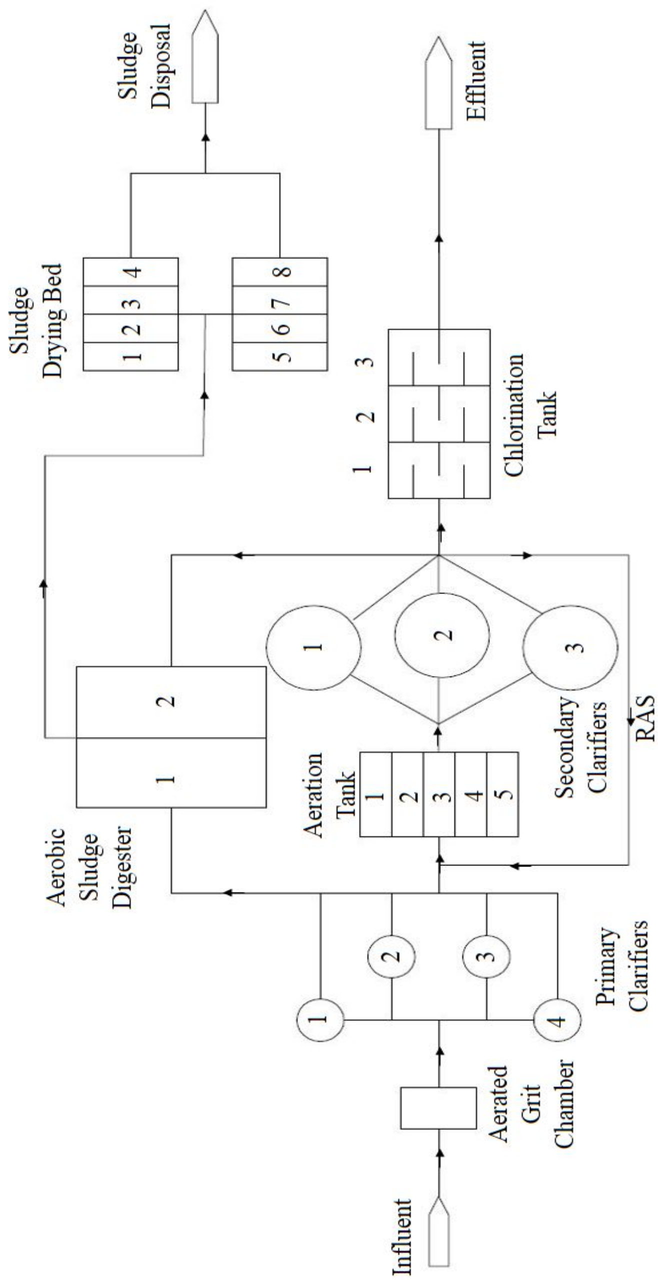

Figure 1. Alligator Creek WWTP Flow Diagram

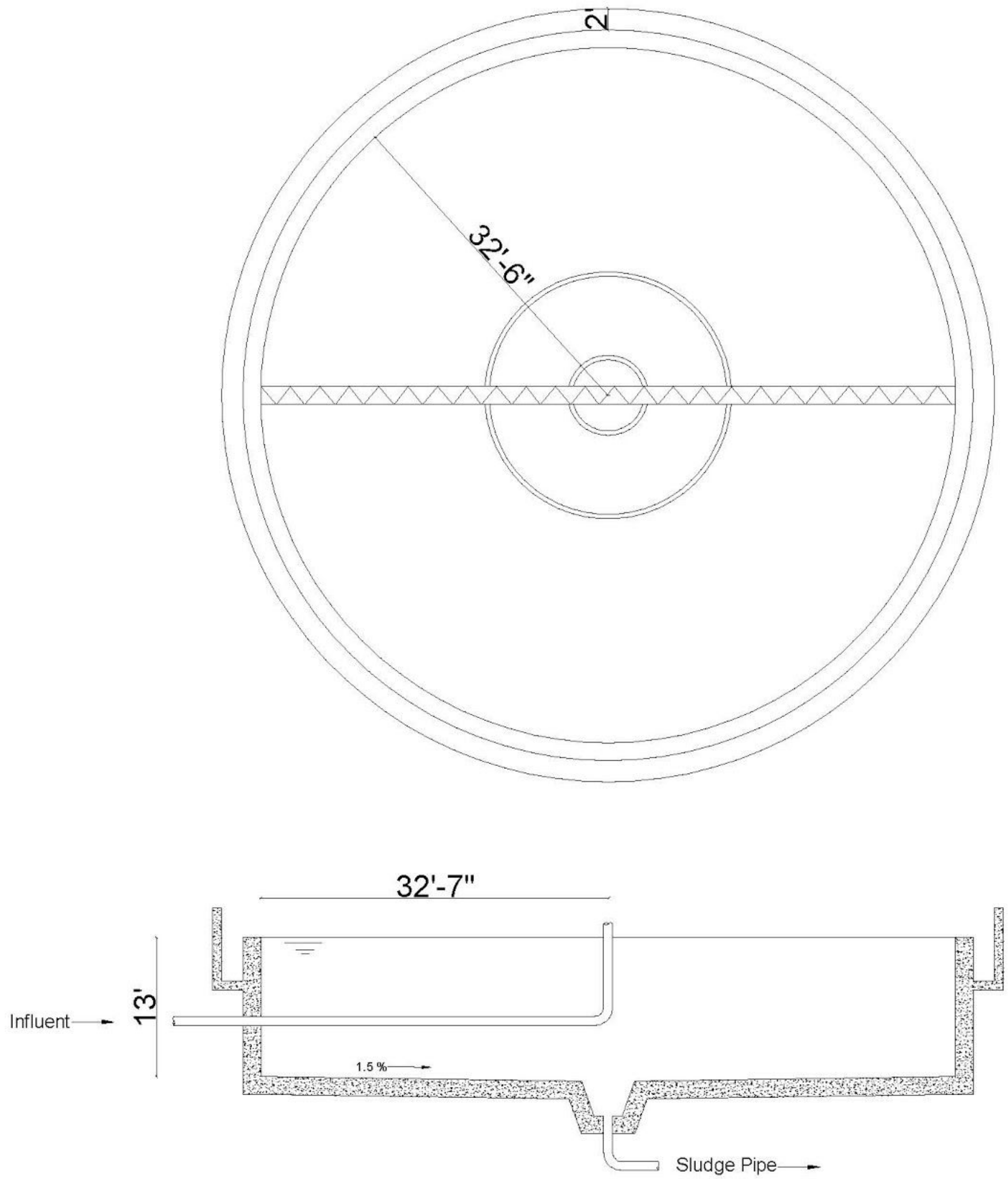

Figure 2. Primary Clarifier Plan and Section

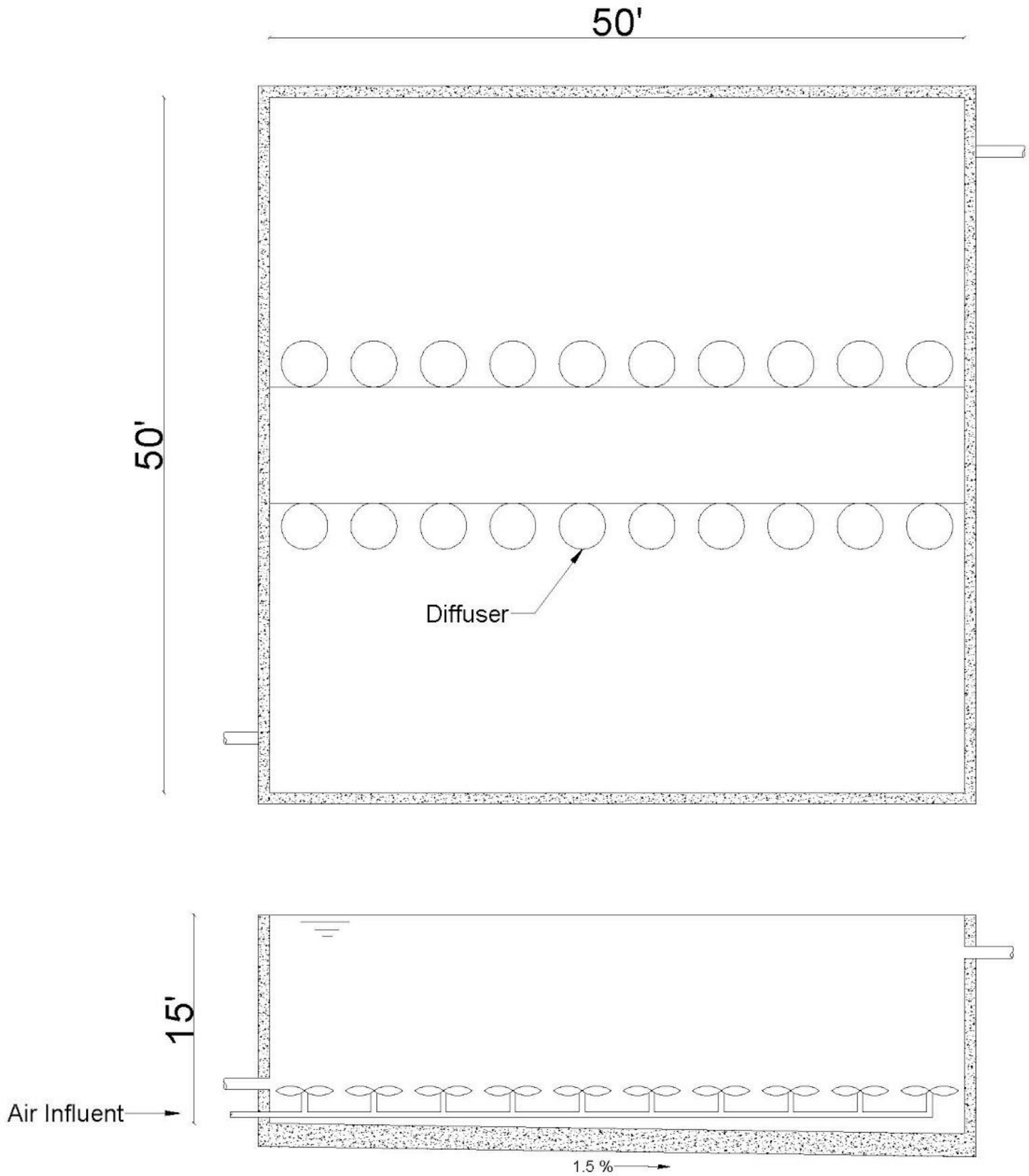

Figure 3. Aeration Tank Plan and Section

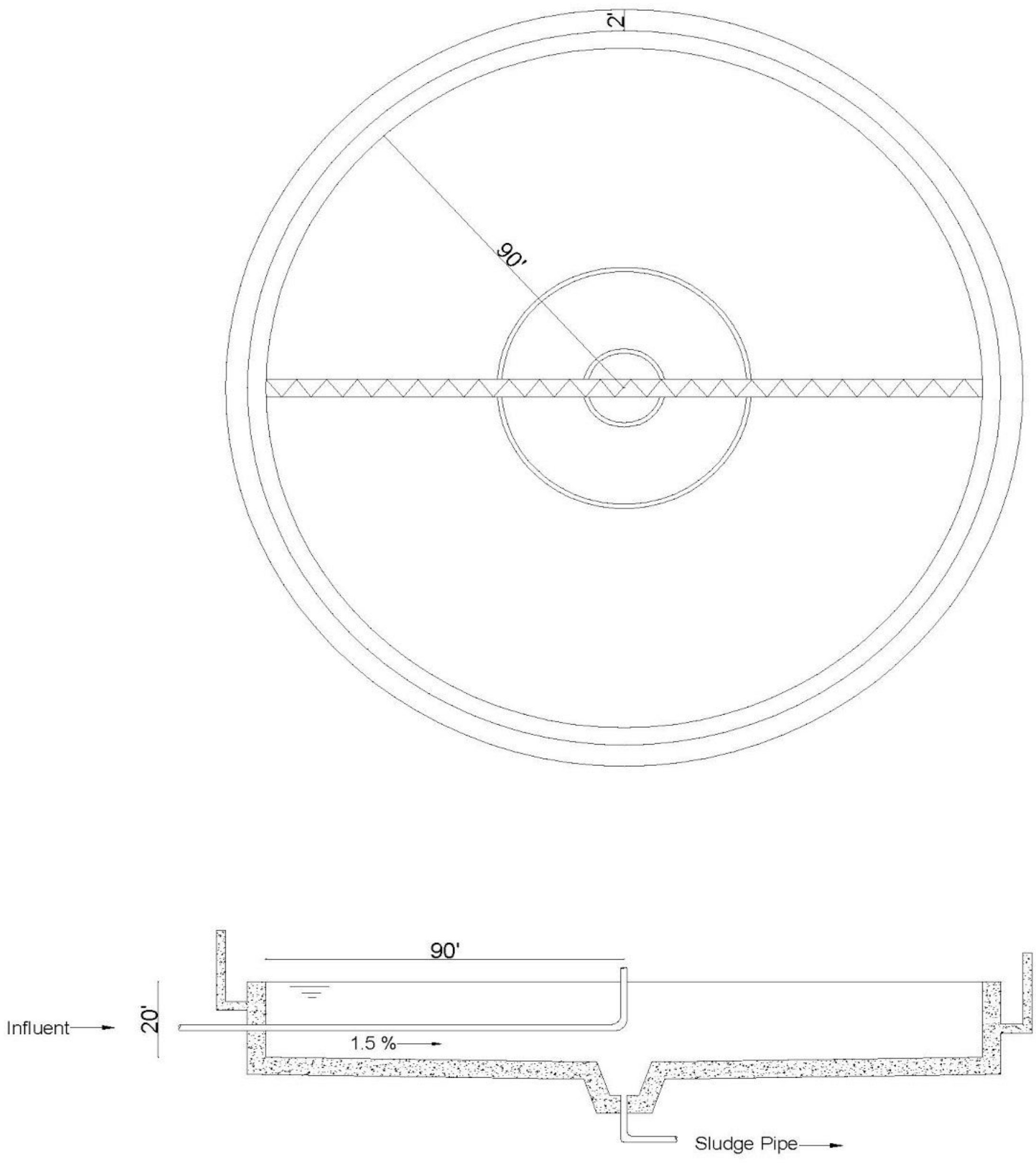

Figure 4. Secondary Clarifier Plan and Section

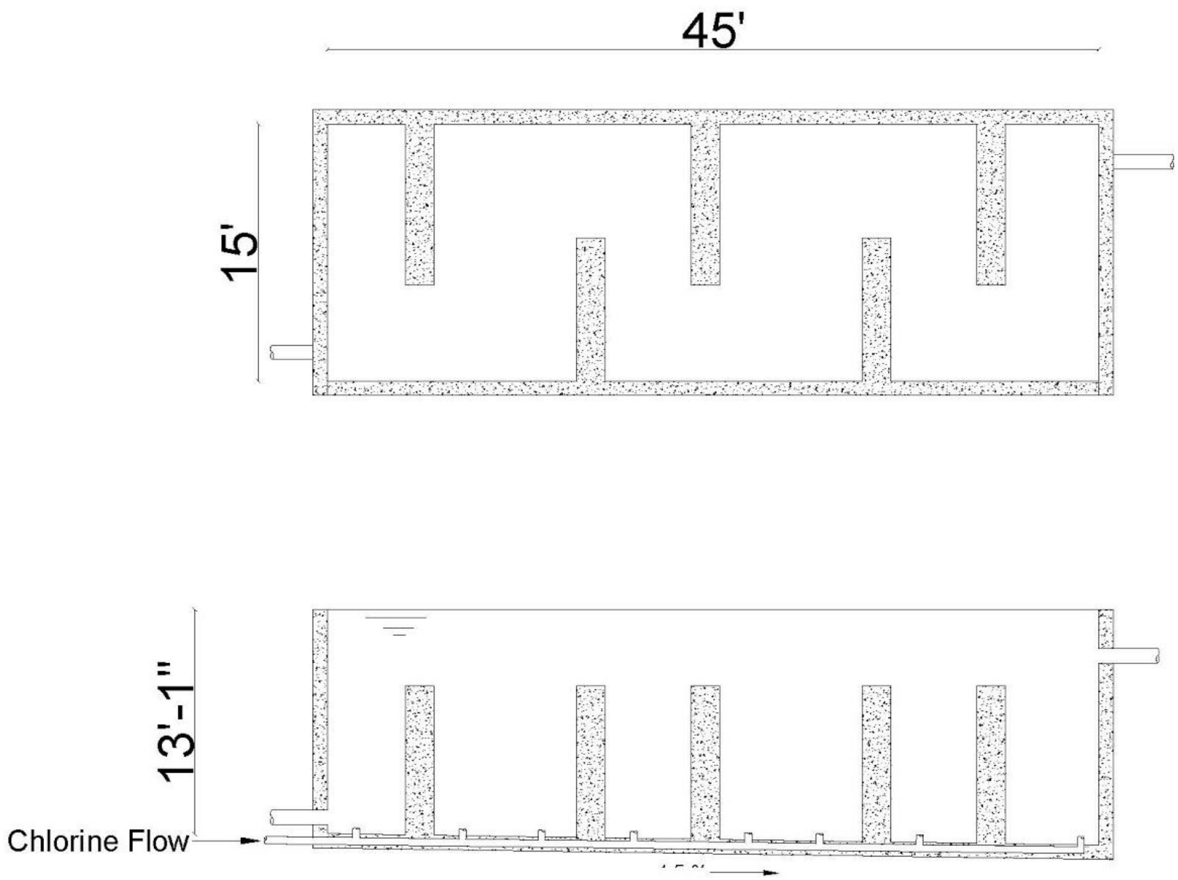

Figure 5. Chlorination Tank Plan and Section

Timesheet

Name	Date	Activity	Time (hrs)
Aubrey	9-28-17	Established work that needs done.	1
	10-3-17	Worked on finding Texas water laws.	.5
	10-27-17	Worked on solving current design parameter values such as SRT.	2
	10-31-17	Clarified questions about the plant.	1
	11-2-17	Worked on design for both the comminutor and primary clarifier.	2
	11-9-17	Clarified questions about the project.	1.5
	11-14-17	Worked on the write up for the anaerobic reactor.	2
	11-19-17	Worked on calculations and writing the primary clarifier section.	4
	11-28-17	Clarified questions we had about the project.	1
	11-30-17	Worked on writing the sludge drying beds section.	1.5
	12-3-17	Worked on writing additional sections of the report.	3.5
	12-4-17	Worked on finishing written sections of the report.	4
Matt	9-28	Outlined initial tasks	1
		Tabulated existing components	
	10-5	work breakdown	1
	10-16	Typical Monod Values and avg temp	
	10-27-17	Worked on solving current design parameter values such as SRT	2
	10-31-17	Clarified SRT values and identified new plant systems needing adjustment	1
	11-2-17	Grit chamber calculations	2
	11-9-17	Checked TCEQ compliance	1.5
	11-14-17	Aeration tank design	2
	11-19-17	Aeration tank design	4
	11-26-17	Finished Aeration tank and oxygen demand design	2
	12-2-17	Oxygen requirements	1

	12-3-17 12-4-17	Writing report and filling tables Report editing	7 3
Hossein	9-28-17 10-3-17 10-27-17 10-31-17 11-2-17 11-9-17 11-14-17 11-19-17 11-24-17 12-3-17 12-4-17	Established work that needs done Worked on finding Texas water laws Worked on solving current design parameter values such as SRT Asked and solved the questions Worked on Raw Wastewater, Primary Sludge, and RAS/WAS pumps. The Secondary Clarifier calculation Revise the previous calculations Control the calculations Drawing	1 0.25 2 1 2 1.5 2 1 2 2 5