

IMPROVEMENTS TO A WATER TREATMENT PLANT IN A DAIRY COMPANY IN AGUADILLA, PUERTO RICO

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Introduction

A dairy company has made a 40-million-dollar investment these past years in a new production line to offer new products, including UHT (ultra-high temperature) milk and juices. Besides the increase in production, this new production line resulted in a rise in expenses in facilities, maintenance, utilities and the water treatment plant. One of the problems that needs to be solved is what to do with the new amount of processed water that goes to the water treatment plant. The plant is already at its peak complying with the permits before this new production line. The purpose of this project is to improve/find a way to treat the processed water that is overcharging the water treatment plant.

Problem Statement

The purpose of this project is to design an expansion for an increase in manufacturing production in the wastewater treatment plant of the company. After the expansion, the processed wastewater characteristics and quantity changed. The objective is to design the necessary improvements to eliminate the necessity to haul wastewater and comply with current permit limitations. Previously, the existing pre-treatment plant treated around 40,000 gpd (50,000 gpd peak) on average and then discharged the effluent to the Puerto Rico Aqueduct and Sewer Authority (PRASA) system. Production lines were expanded, increasing wastewater discharges to 120,000 peak gpd. The treatment plant does not have the capacity to treat this large volume, resulting in high transportation costs and the potential for state and federal compliance violations. In addition, the existing condition of the plant must be repaired to ensure long-term operation of the system and minimize interruptions in production.

Background Review

In 2016, a dairy company made an expansion of their production line to produce UHT products. The increase of the production line also made an increase in the processed water that entered their water treatment plant. The original base production part of the plant has an effluent of 40,000 gpd (50,000 gpd peak) and is transferred to the water treatment plant by 2 pumps. The expansion part of the plant called "Vida" has an effluent of 70,000 gallons per day. Both areas run 5 days per week and have a total effluent of 120,000 gallons per day. The processed water reaches two equalization tanks of 35,000 gallons. Equalization tank 1 was part of the plant before the expansion. A second equalization tank was added for the increase in processed water that was going to enter the plant. The equalization tank 1 is the only one with screen bars and has influent from the "base" plant and equalization tank 2, while the equalization tank 2 has only influent from "Vida" plant with 70,000 gallons per day. There is a flow meter before equalization tank 1. The processed water then passes through an SBR tank. The SBR tank has a capacity of 170,000 gallons per day. After the SBR tank, it passes through a deaerator tank, which holds 35,000 gallons. Before arriving to the sludge drying beds, it passes through a mixer. The discharge permit is 80,000 gallons per day and the excess water (~40,000 gallons) is hauled. This hauling has only been permitted for one year and the cost per gallon is \$0.05.

In the month of July, 365 gallons were hauled, and the cost was \$18,290, while in August 709,044 gallons were also hauled with a total cost of \$35,452, and in September 691,200 gallons were hauled for a total of \$34,560, for a total amount of \$88,302 for three months. If we estimate that for a year, it would be a cost of \$350,000. This is money that is being lost for not having a plant with the necessary improvements to manage those 120,000 gallons per day.



Figure 2
Before "Vida" Plant Expansion Water Treatment Plant

Methodology

The improvements that will be made to the water treatment plant in Aguadilla are to add a DAF (dissolved air flotation) unit system and another SBR system. Also, the plant will need to seek permission from the Puerto Rico Aqueduct and Sewer Authority (PRASA) in order to increase the discharge permit from 80,000 gallons per day to 120,000 gallons per day. Although making this change will allow the company to comply with the permits of discharge, improvements to the plant need to be made in order to handle that amount of discharge. Dissolved air flotation is used in certain treatment plants to separate solids, oils and greases. Typical removal efficiencies are 70%-98% of total suspended solids (TSS), 40%-60% of biochemical oxygen demand (BOD), 80%-95% of oils and grease and 70%-95% of metals. Because of this, the dissolved air flotation system will lower 4,000 gallons per day of water that will go to the sequencing batch reactor because of all the typical removal efficiencies or wastes. A new SBR system will help treat the amount of water that goes into the plant to be treated. Doubling the size of the equipment will help to treat all the amount required to treat those 120,000 gallons per day. A comparison will be made to compare the cost of having another SBR tank operation and a DAF unit system to compare with the expenses of hauling the excess of water. Below are the formulas used for the design of the DAF and SBR system equipment.

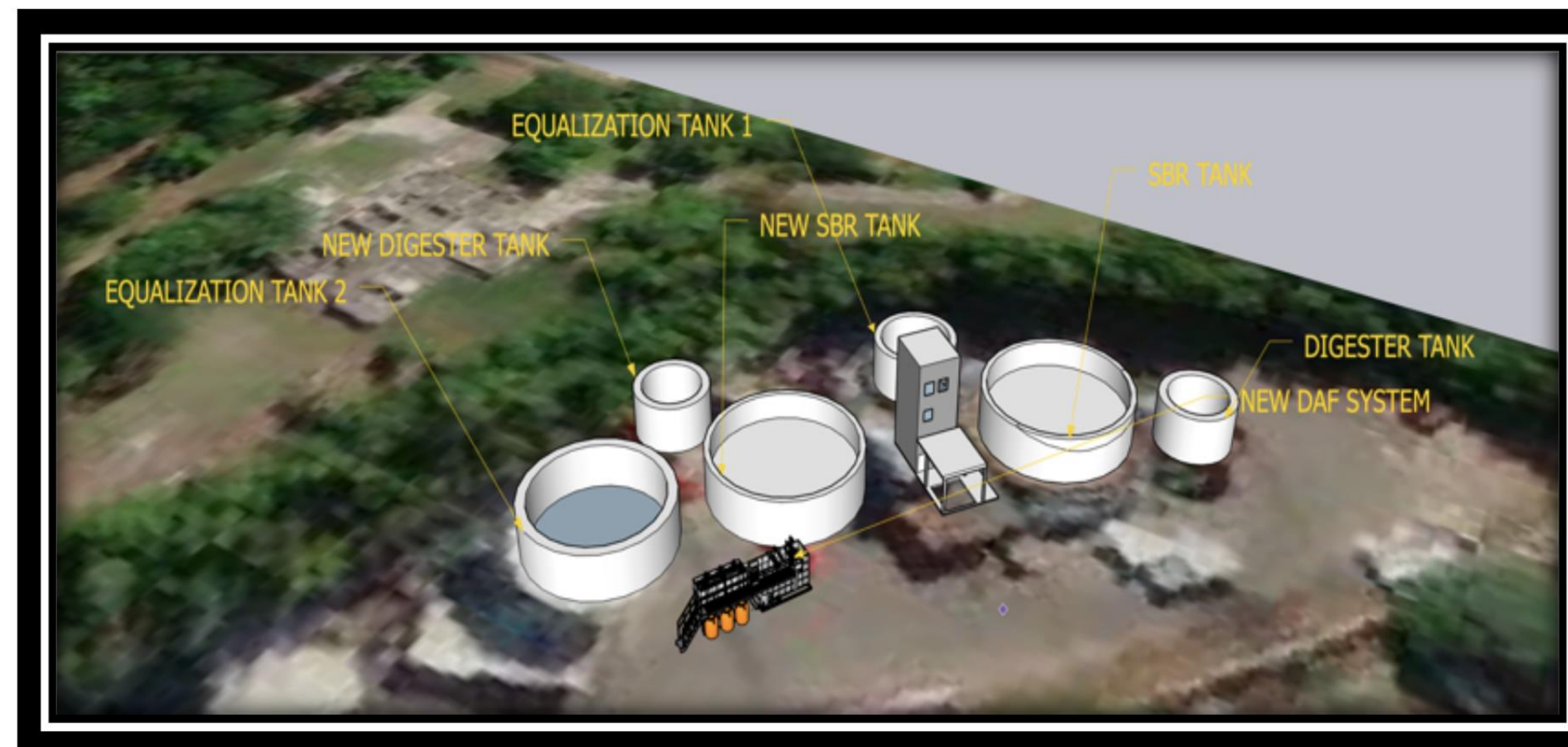


Figure 1
Diagram after Improvements of Water Treatment Plant

Discussion

After taking into consideration all the possibilities to improve the water treatment plant and after the design analysis, an SBR Tank and DAF Unit System are the best options to respond to the problem and the objective of this project. The SBR tank is going to have a liquid volume of 2,229 ft³. with a depth of 22 ft. and a diameter of 24 ft. The tank is going to be installed behind the control room and a new digester tank is going to be installed. After the equalization tank 1, the process will be running through either the existing SBR tank or the new one. The SBR tank is going to be able to treat the extra 40,000 gallons per day that need to be treated to stop hauling and avoid unnecessary expenses. Also, a DAF unit system is going to be installed following the equalization tank and water is going to go through this DAF before arriving to the SBR tanks. After the design for the DAF system, there would be a solids loading area of 6 ft² and a hydraulic loading area of 60 ft². Nevertheless, several additional costs need to be taken into consideration. A permit for increase in water discharge is going to be needed to be allowed to treat this amount of processed waters. The cost for this permit is going to be a one-time payment of approximately \$50,000. Furthermore, the plant is going to have an increase in maintenance cost, which includes additional employees, chemicals, electricity and disposal of sludge waste. There will be no increase in personnel cost for three supervisors in the plant because this will not be an additional expense, since the plant will not need another supervisor or operator to run that part of the plant. As for the chemicals, these are used in the equalization tanks and not the SBR tank and sometimes a polymer is added in the SBR tank, but this is not a significant cost to consider for this analysis. As for the disposal of material, there will be an increase from \$2,000 to \$3,000 for the new 40,000 gal/day that will need to be treated. Three pumps for the blowers, one for the agitator and one to pass the water from equalization tank 1 to SBR is going to be needed, therefore there will be an increase in energy consumption. The cost for the blower pump (1) will be \$160,000 per year, the cost for the agitator pump will be \$60,000 per year and the cost for the pump that will send water from equalization tank 1 to the new SBR tank will be \$10,000. DAF electricity cost is going to be \$20,000 per year. Nevertheless, the cost for overhauling a year is around \$350,000, not counting the potential penalties the plant could get for not complying. Taking into account the expenses considered by adding this equipment and the savings generated by eliminating the overhauling, there will be a net savings of \$103,000.

Conclusion

After these improvements, the maintenance cost will increase in the area of electricity, water, operations, chemicals and disposals for the new equipment. Nevertheless, this will lower the amount of overhauling and the company will be able to comply with local agencies to discharge the amount approved for discharge. The overhauling is a temporary solution that local agencies allow while you improve the water treatment plant. The new DAF unit system will also remove a high percentage of suspended solids, BOD, oils, grease and metals.

After Improvements to the Plant (DAF and SBR Installation)

$$(\$0/\text{Overhauling} + \$13,333 + \$5,000 + \$833 + \$1,666) = \$20,832$$

| MONTH | BEFORE IMPROVEMENTS | AFTER IMPROVEMENTS |
|-----------------------------|---------------------|--------------------|
| JULY 2020 | \$18,290 | \$20,832 |
| AUGUST 2020 | \$35,452 | \$20,832 |
| SEPTEMBER 2020 | \$34,560 | \$20,832 |
| TOTAL 3 MONTHS | \$88,302 | \$62,496 |
| TOTAL ESTIMATED (12 MONTHS) | \$353,208 | \$249,984 |

Savings by DAF and SBR Installation = \$103,224

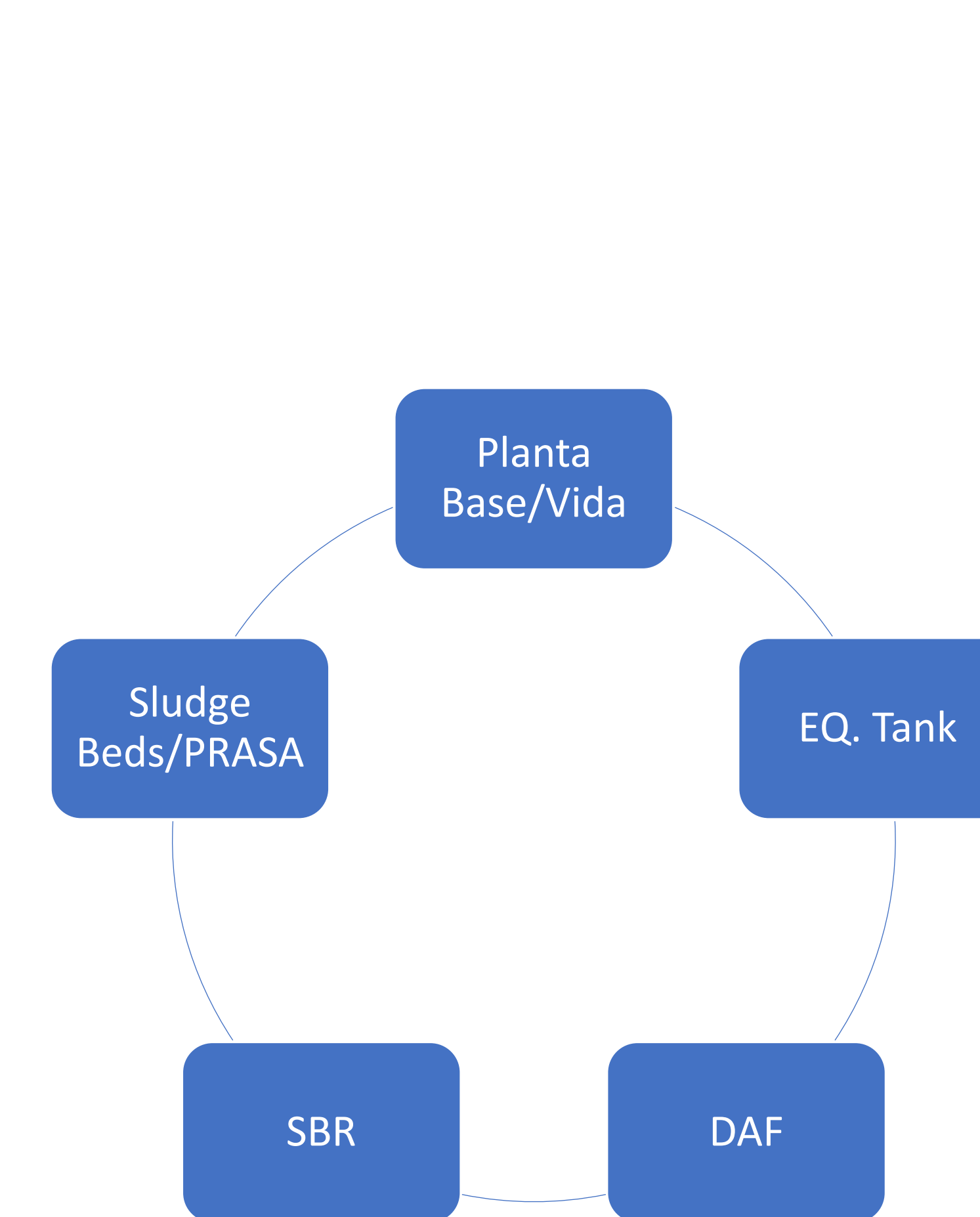


Figure 3
Diagram after Improvements of Water Treatment Plant