NORRIS WASTEWATER TREATMENT FACILITY ENERGY REDUCTION CASE STUDY

in Norris, TN

BACKGROUND

Beginning in 2016, Norris Water Commission took initiative to learn and pursue innovative low-cost approaches to optimizing water quality and reducing energy consumption at its aging wastewater treatment plant through voluntary participation in TDEC's Wastewater Nutrient Plant Optimization Project. Norris has continued using techniques learned through its participation to achieve significant environmental and operational savings, including cost savings; nitrogen and phosphorus removal prior to discharge to surface waters; reduced electricity consumption; and production of less sludge. Two years before the changes were made, energy and nutrient data was collected and used as a baseline (monthly averages January 2014 – December 2015) for this case study.

ENERGY SAVINGS

In January 2016, Norris Wastewater Treatment staff were trained on nutrient reduction while reducing energy consumption. The process developed for this plug flow facility involved the cycling of aeration equipment[1]. With the cycling of aeration equipment, Norris Wastewater Treatment Facility reduced their average monthly kilowatt-hour usage by 17.6%[2]. This change alone reduced energy costs by 8.6%[3] while the cost of electricity increased by 11%[4] during the same time.

NUTRIENT REDUCTION

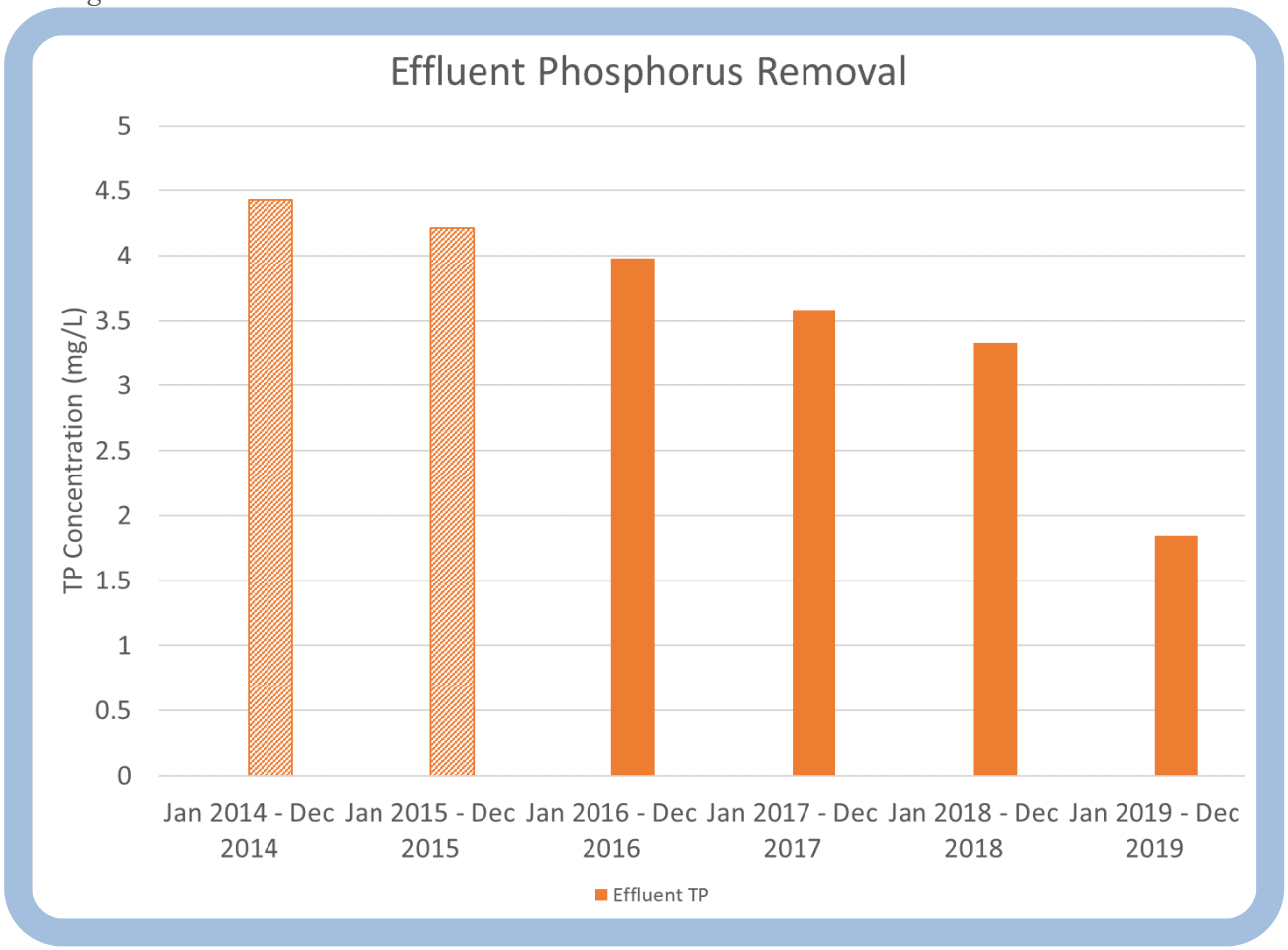
With the changes made in aeration cycling, nutrient removal has increased. Although there has been a noticeable increase in nitrogen and phosphorus removal, ammonia removal has experienced fluctuations in the effluent and may require additional investigation. The change in ammonia removal requires additional field research to determine the cause in variability and why noticeable increase occurred in 2018 and 2019.

1. Aeration equipment was set on an on/off cycle instead of running continuously.
2. Average kWh/month percent change from baseline (Jan 2014 – Dec 2015) and Jan 2016 – Dec 2019
3. Monthly energy cost percent change from baseline (Jan 2014 – Dec 2015) and Jan 2016 – Dec 2019
4. Cost of electricity ($/kWh) from baseline (Jan 2014 – Dec 2015) and Jan 2016 – Dec 2019

PHOSPHORUS

During 2016, several methods were tested to increase phosphorus removal including biological phosphorus removal techniques and the inclusion of separate vessels used for overnight fermentation and re-introduction back into the aeration tanks. After the changes were implemented, total phosphorus effluent decreased by 25%[5]. Figure 1 below shows the reduction of effluent total phosphorus from years 2014 to 2019. The hashed bars in the graph below indicate baseline years before any changes were made.

Figure 1

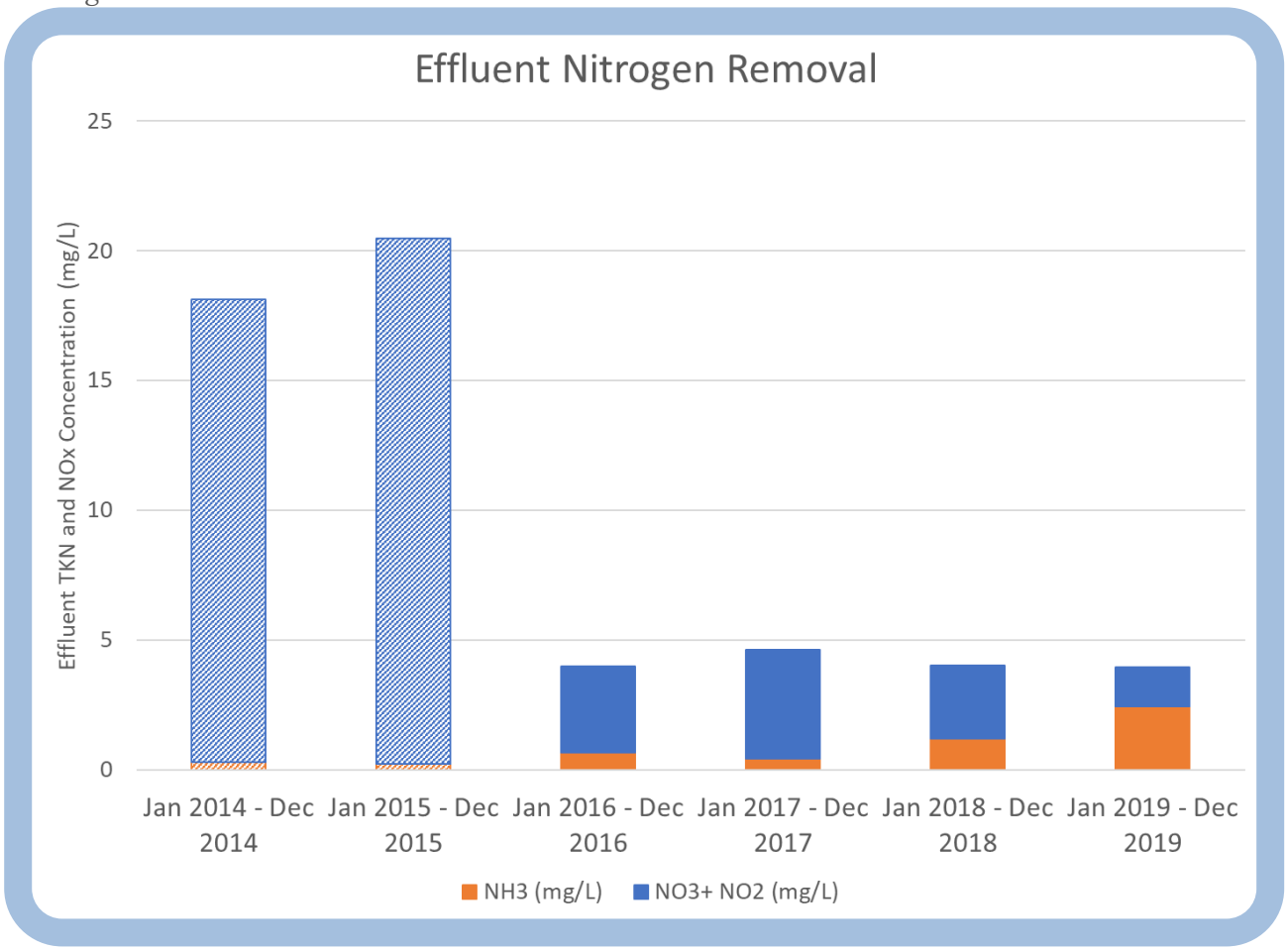


5. Average effluent total phosphorus (mg/L) from baseline (Jan 2014 – Dec 2015) and Jan 2016 – Dec 2019

TOTAL NITROGEN

During the training period, staff gained a strong understanding of nitrogen removal and continues to keep nitrogen effluent levels low. Average effluent compared to the baseline year has dropped by 84%[6]. The increase in nitrogen removal can be associated with creating low dissolved oxygen environment during the cycling of aerations equipment. Figure 2 below shows the reduction of effluent total nitrogen from years 2014 to 2019. The hashed bars in the graph below indicate baseline years before any changes were made.

Figure 2



6. Average effluent total nitrogen (mg/L) from baseline (Jan 2014 – Dec 2015) and Jan 2016 – Dec 2019

CHALLENGES AND LESSONS LEARNED

While operating with side-stream fermenters, Norris plant also experienced the growth of filamentous bacteria in the treatment tank, which has not been seen before. The purpose of the fermentation zone is to create volatile fatty acids to facilitate the growth of the Phosphate Accumulating Organisms, but certain types of filamentous bacteria thrive on low molecular weight carbon sources such as volatile fatty acids. Norris, much like may other plants in Tennessee, experiences problems with inflow and infiltration during significant rain events, necessitating a change in operations in order to maintain the fermentation zone and solids within the biological treatment tank. Additionally, changes in operation to manage settling appear to also affect nitrification and ammonia removal.

CONCLUSION

The Norris wastewater treatment operators were able to reduce phosphorus in effluent by 25% and maintain levels of effluent nitrogen below 5 mg/L while reducing energy consumption. These improvements also reflected in the water quality of the receiving stream. Biological monitoring of Buffalo Creek in 2018 showed that the receiving stream improved and met regional goals for biological integrity. Achievement of these results would not have been possible without the commitment of Norris Water Commission's leadership and plant operator's dedication to the voluntary Tennessee Plant Optimization Program. Norris Water Commission received a Governor's Environmental Stewardship Award in 2019 for their work on reducing nutrient loading to Tennessee streams. This success story is a great example of how even small systems can improve nutrient reduction while reducing energy costs.

CONTACT INFORMATION

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