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Downers Grove Sanitary District

2710 Curtiss Street
P.O. Box 1412
Downers Grove, IL 60515-0703
Phone: 630-969-0664
Fax: 630-969-0827
www.dgsd.org

General Manager
Amy R. Underwood

Legal Counsel
Michael G. Philipp

Providing a Better Environment for South Central DuPage County

March 24, 2022

Illinois Environmental Protection Agency
Division of Water Pollution Control
Sent Electronically to: EPA.PrmtSpecCondtns@Illinois.gov

Subject: IL0028380 Special Condition 17.E
Wastewater Treatment Center Phosphorus Discharge Optimization Plan
2022 Progress Report

To Whom It Concerns:

Special Condition 17 of permit IL0028380 requires the Downers Grove Sanitary District to submit an annual progress report on its Phosphorus Discharge Optimization Plan (PDOP). The PDOP, submitted in July 2017, evaluates source reduction measures, operational improvements, and minor low-cost facility modifications to optimize reductions in phosphorus discharges from the wastewater treatment center (WWTC). This letter serves as the District's 2022 PDOP annual progress report, in compliance with Special Condition 17, Paragraph E. This report is due by March 31, 2022.

WWTC Phosphorus Removal Performance

The WWTC phosphorus monitoring data for calendar year 2021 is summarized in Table 1 on the next page.

This is the fifth annual PDOP progress report. Each annual PDOP progress report has presented the monthly and annual average WWTC phosphorus monitoring data for the previous calendar year. A summary of the last five years of data is provided in Table 2 for comparison. The baseline data which was collected prior to any phosphorus removal optimization efforts is also presented.

Table 1. 2021 WWTC Phosphorus Monitoring Data

	INFLUENT		EFFLUENT		
	CONCN mg/l	LOAD lbs/day	CONCN mg/l	LOAD lbs/day	FRACTION REMOVED
Jan-21	5.35	430	2.61	191	0.56
Feb-21	5.95	455	3.14	216	0.53
Mar-21	4.03	424	1.72	191	0.55
Apr-21	6.07	414	3.21	227	0.45
May-21	5.17	369	2.91	226	0.39
Jun-21	6.09	476	3.34	294	0.38
Jul-21	5.48	335	4.21	281	0.16
Aug-21	6.17	343	4.25	274	0.20
Sep-21	6.32	341	4.56	247	0.28
Oct-21	5.06	411	3.60	294	0.28
Nov-21	6.58	398	3.40	210	0.47
Dec-21	6.35	462	3.01	210	0.55
Average	5.72	405	3.33	238	0.40
Maximum	6.58	476	4.56	294	0.56
Minimum	4.03	335	1.72	191	0.16

Table 2. Historic WWTC Phosphorus Annual Average Monitoring Data

	INFLUENT		EFFLUENT		
	CONCN mg/l	LOAD lbs/day	CONCN mg/l	LOAD lbs/day	FRACTION REMOVED
Total Baseline*	4.81	365	3.07	229	0.37
2012 Portion of Baseline	5.85	382	3.80	247	0.35
2017	5.62	414	2.99	217	0.48
2018	5.43	448	2.48	208	0.52
2019	4.68	434	2.16	201	0.53
2020	5.33	418	2.90	228	0.45
2021	5.72	405	3.33	238	0.40

*Baseline data was collected from July 2012 to July 2013

WWTC Influent Reduction Measures

The influent phosphorus load to the District's Wastewater Treatment Center (WWTC) in 2021 was consistent with the previous few years, giving the District no reason to suspect any user has significantly increased their phosphorus discharge. Therefore, no special sampling was done in 2021.

Phosphorus is a sampling parameter in the regular surcharge sampling program for the few users

that were previously tested.

WWTC Effluent Reduction Measures

Sidestream Enhanced Biological Phosphorus Removal

The activated sludge portion of the plant has been operating in a configuration to attempt sidestream enhanced biological phosphorus removal (EBPR) since 2016, as originally described in the PDOP. In this configuration, a portion of the return activated sludge (RAS) is fermented in an anaerobic zone prior to being returned to the aeration tanks. (As a side note, District staff are unaware of any plant which solely has a RAS fermenter without additional process tanks dedicated to phosphorus removal. The plant in Denmark, from which the District modeled our process, had anoxic zones upstream of its aeration tanks. The District does not have the capability to install anoxic zones. Regardless, it has now come to our attention that the plant in Denmark has removed their biological phosphorus removal process and is now chemically removing phosphorus.)

The PDOP identified limitations of the sidestream EBPR as configured at the District's WWTC. Over the past five years, the District has made modifications to address some of the limitations and to attempt optimizing the performance of the sidestream EBPR. The monthly average and annual average percent phosphorus removals were used to gauge the success (or lack of success) of the modifications. At times, the conclusion made in one month or year was subsequently decided to be incorrect as reversing the modification did not reverse what had been believed to be the result.

After reviewing the 2021 data and the data over the past five years, District staff question whether the sidestream EPBR is improving phosphorus removal and if it is detrimental to the operation of the activated sludge system. The fact that both the phosphorus removal through the WWTC and the effluent phosphorus concentration have a strong relationship to the weather, regardless of any measures made to improve the performance of the sidestream process, supports the thought that the modifications and perhaps the sidestream treatment itself have not improved performance. The sidestream treatment has been detrimental by causing poor settling floc. These concepts are discussed in more detail below.

Relationship to Weather

As seen in the data provided in Table 2, the 2021 average percent phosphorus removal is the lowest in the five-year monitoring period and is almost as low as the percent removal during the baseline period. (The baseline period, as presented in the PDOP, was July 2012 – July 2013, which was prior to any phosphorus removal modifications to the WWTC.) One notable thing that stands out about 2021 was that it was a dry year. The rainfall in 2021 was the 10th lowest in the past 46 years. The data was reviewed to determine whether there was a correlation between the weather and phosphorus removal. Figures 1 and 2, which are attached at the end of this report, show that there is a direct relationship between total annual rainfall and both the annual average phosphorus removal and the annual average effluent phosphorus concentration.

The rainfall in 2012, in which part of the baseline fell, was the 6th lowest in the past 46 years. The

2012 annual rainfall total and the average percent removal from July 2012 – December 2012 are plotted in Figure 1. The 2012 annual rainfall total and the average effluent phosphorus concentration from July 2012 – December 2012 are plotted in Figure 2. These are indicated by the orange box on each figure. As can be seen in the figures, the baseline data falls on the same trend as the data which occurred while the District was attempting to optimize the sidestream EBPR process.

The influent wastewater temperature is impacted by weather. The influent wastewater temperature is higher in years with less rainfall and lower in years with higher rainfall, as shown in Figure 3. Figures 4 and 5 show that there is a direct relationship between annual average influent wastewater temperature and both the annual average phosphorus removal and the annual average effluent phosphorus concentration. The 2012 annual average influent wastewater temperature is plotted against the annual average percent phosphorus removal and annual average effluent phosphorus concentration for July 2012 – December 2012 in Figures 4 and 5. These are indicated by the orange box on each figure. As can be seen in the figures, the baseline data falls on the same trend as the data which occurred while the District was attempting to optimize the sidestream EBPR process.

In general, phosphorus removal is higher and effluent phosphorus concentrations are lower in wetter years where the resulting wastewater temperature is cooler. All five years of operation with the sidestream treatment process follow this trend, regardless of any changes made in an attempt to optimize the process. Any improvement or deterioration in phosphorus removal as noted in the PDOP or the subsequent annual PDOP progress reports may not have been due to the sidestream treatment optimization attempts as previously theorized. They may have occurred anyway due to influent conditions as impacted by weather events.

Settleability

Since starting the sidestream EPBR process in 2016, sludge settleability has decreased. This is caused by the presence of *Nocardia*, likely due to increased sludge age caused by the RAS fermenter (i.e., sidestream treatment tanks) and higher mixed liquor suspended solids (MLSS) concentrations. Under average operating conditions, operators have been able to limit the impacts of poor settleability. This is due to the intermediate clarifiers, which are not found in a typical wastewater treatment facility. Flow from the secondary clarifiers goes through the intermediate clarifiers before passing through the sand filters. Solids washed over the weirs in the secondary clarifiers due to poor settleability are typically removed in the intermediate clarifiers. When influent wastewater flow exceeds 80 MGD, all intermediate clarifiers are used for excess flow treatment, and secondary effluent goes directly to the sand filters. The solids which have washed over the secondary clarifier weirs cause the sand filters to blind and go into continuous backwash for the duration of the storm event. When this occurred in June of 2021, it resulted in an excursion of the daily maximum total suspended solids (TSS) on the main plant outfall.

In the coldest winter month, nitrification slows down, causing effluent ammonia to increase. To ensure that enough nitrifiers are present, operators need to either increase the MLSS concentration

or decrease the amount of RAS through the RAS fermenter or do both. Operators are limited on how much they can increase the MLSS concentration due to the settleability issues noted above. Since nitrifiers do not survive through the RAS fermenter, operators have been forced to decrease the amount of RAS going through the RAS fermenter. This was done in 2020 and 2022 when the wastewater temperature dropped in late winter. District staff are still evaluating whether this had a negative impact on phosphorus removal.

Conclusions

Since the PDOP was finished in 2017, the District's goal has been to optimize phosphorus removal while working within the limitations of our existing facility. Unfortunately, as noted above, this has come at the detriment of meeting our permit limits for TSS and potentially for ammonia. Should these become unmanageable, the District will need to remove the sidestream EBPR from service. Based on the data presented herein, it is not clear whether removing the sidestream EBPR from service would have a noticeable impact on biological phosphorus removal through the plant. Regardless, the District's commitment to the goals set forth in in the PDOP remain, and District staff will continue to re-evaluate phosphorus removal through our WWTC, looking for ways to optimize performance.

We trust that this letter report satisfies the requirements in Special Condition 17 for a PDOP progress report. As required by Special Condition 17, this report has been posted to the District's website.

If you have any questions or comments, please contact me at the above address and phone.

Very Truly Yours,

Amy R. Underwood, P.E.
General Manager

cc: Board of Trustees
Alex Bielawa, DGSD Staff Engineer
Marc Majewski, DGSD Operations Supervisor
Stephen McCracken, DRSCW

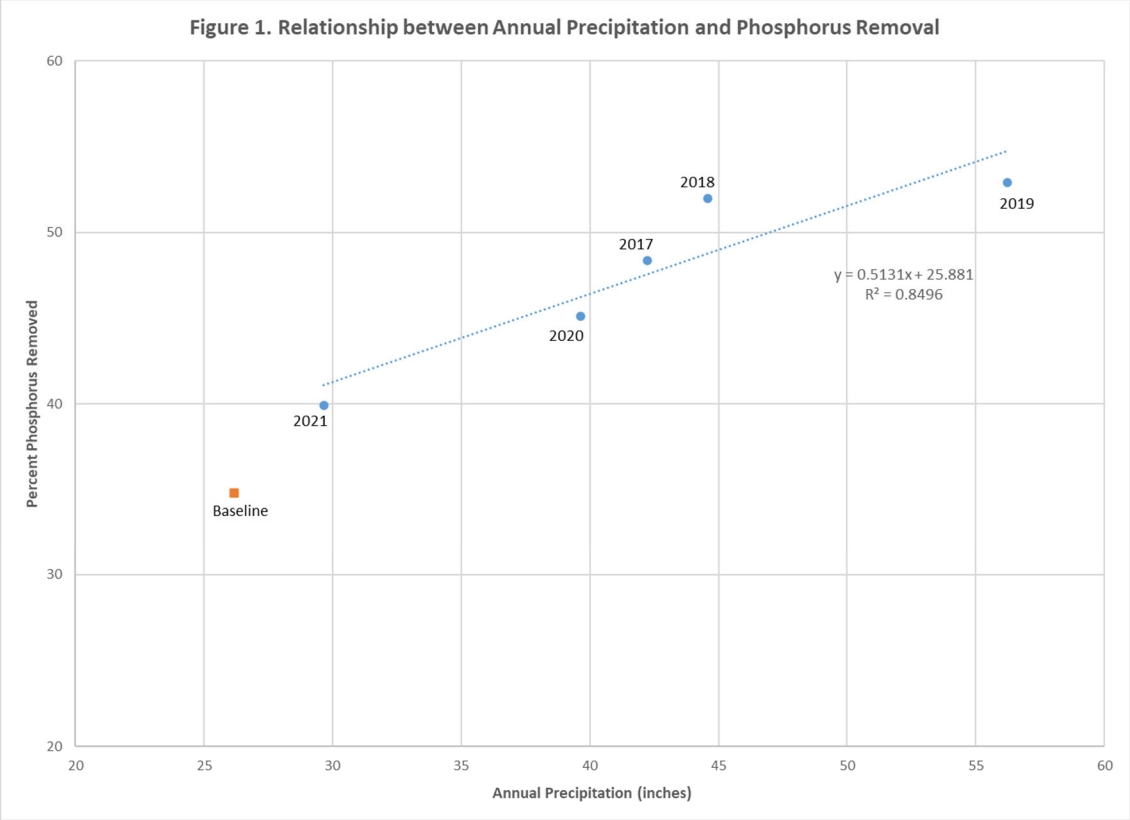
Figure 1. Relationship between Annual Precipitation and Phosphorus Removal
Percent Phosphorus Removed
Annual Precipitation (inches)
60
50
40
30
20
20
25
30
35
40
45
50
55
60
Baseline
2021
2020
2017
2018
2019
y = 0.5131x + 25.881
R² = 0.8496

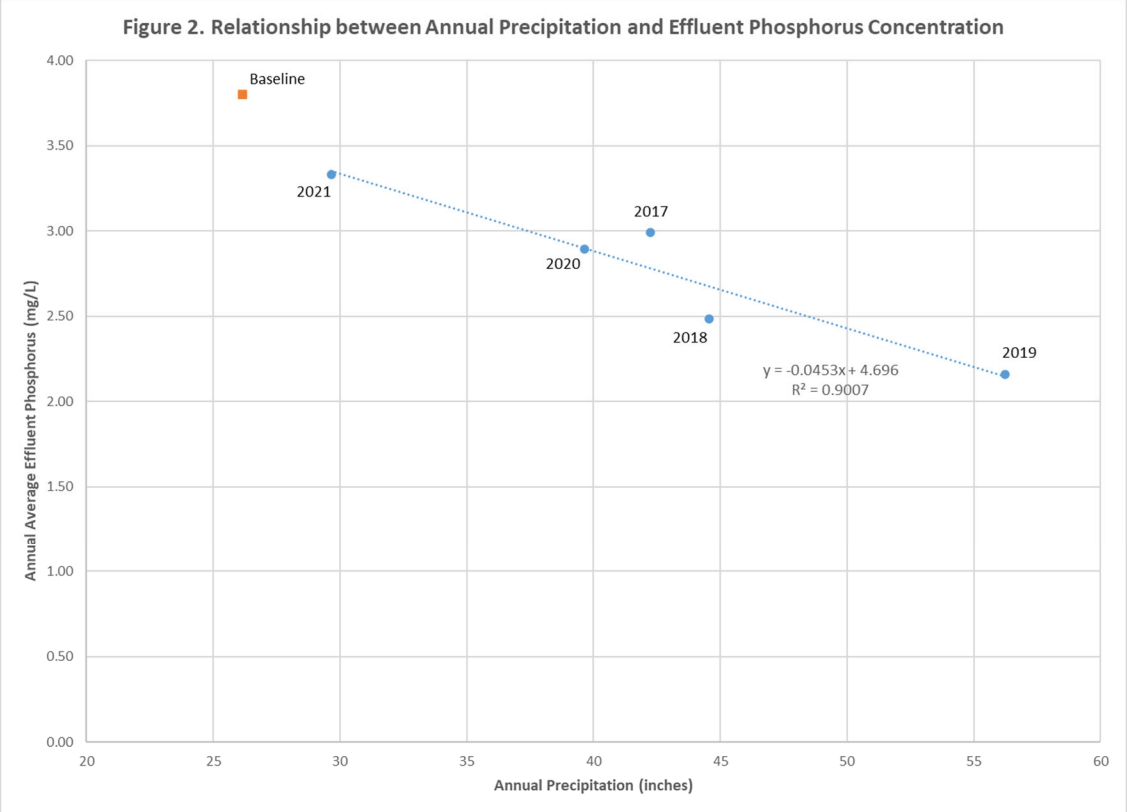
Figure 2. Relationship between Annual Precipitation and Effluent Phosphorus Concentration
Annual Average Effluent Phosphorus (mg/L)
Annual Precipitation (inches)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
20
25
30
35
40
45
50
55
60
Baseline
2021
2017
2020
2018
2019
y = -0.0453x + 4.696
R² = 0.9007

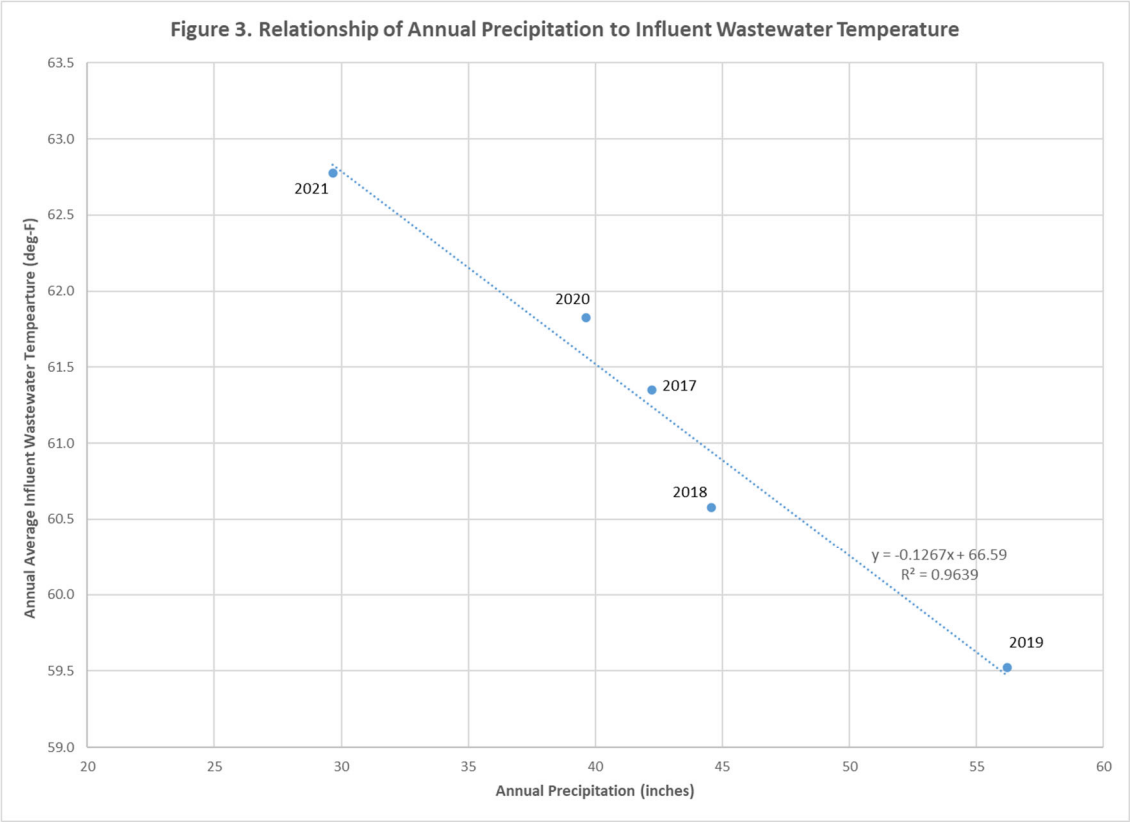
Figure 3. Relationship of Annual Precipitation to Influent Wastewater Temperature
Annual Average Influent Wastewater Tempearture (deg-F)
Annual Precipitation (inches)
2021
2020
2017
2018
2019
y = -0.1267x + 66.59
R² = 0.9639
63.5
63.0
62.5
62.0
61.5
61.0
60.5
60.0
59.5
59.0
20
25
30
35
40
45
50
55
60

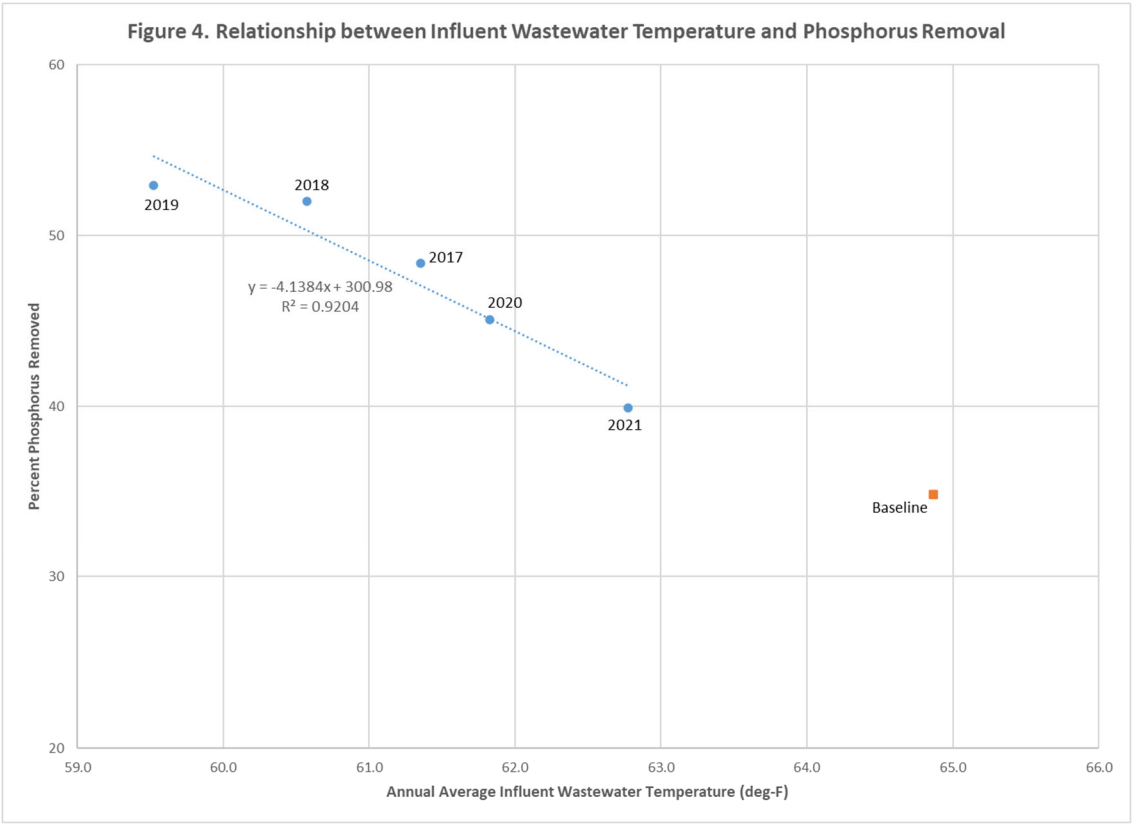
Figure 4. Relationship between Influent Wastewater Temperature and Phosphorus Removal
Percent Phosphorus Removed
Annual Average Influent Wastewater Temperature (deg-F)
2019
2018
2017
2020
2021
Baseline
y = -4.1384x + 300.98
R² = 0.9204
60
50
40
30
20
59.0
60.0
61.0
62.0
63.0
64.0
65.0
66.0

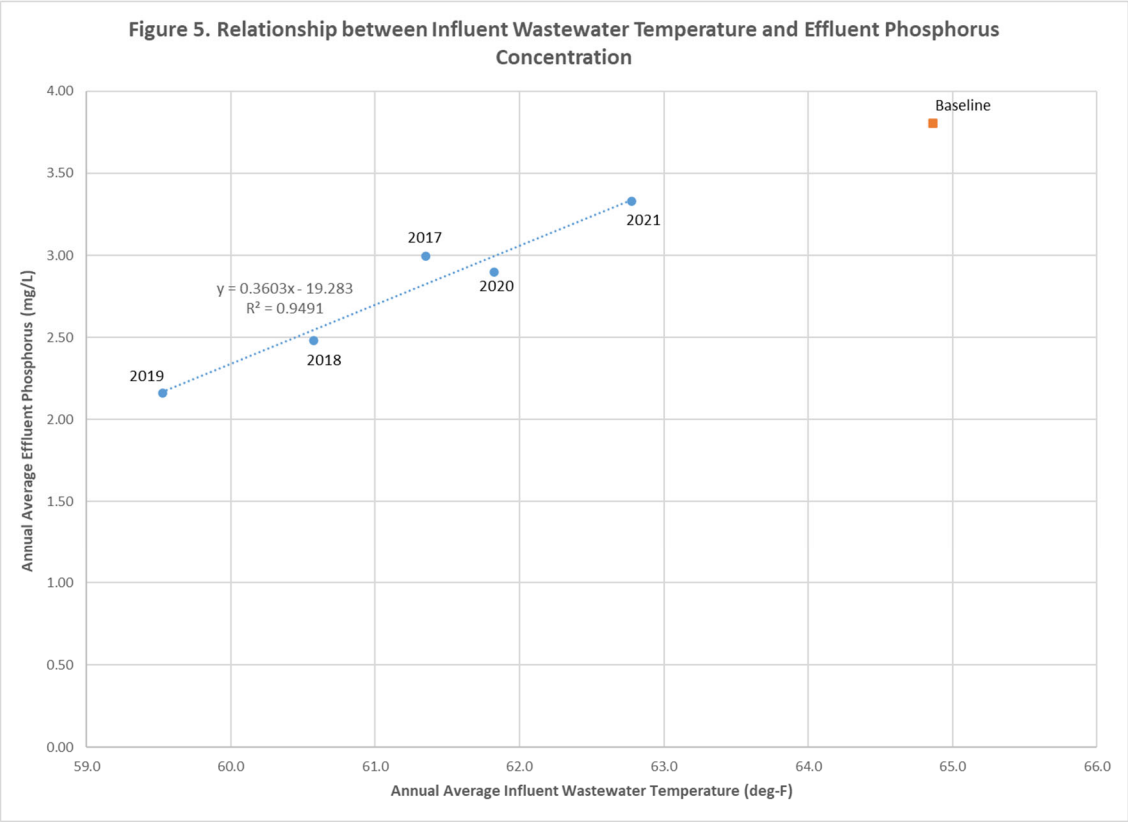
Figure 5. Relationship between Influent Wastewater Temperature and Effluent Phosphorus Concentration
Annual Average Effluent Phosphorus (mg/L)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
59.0
60.0
61.0
62.0
63.0
64.0
65.0
66.0
Annual Average Influent Wastewater Temperature (deg-F)
Baseline
2021
2017
2020
2018
2019
y = 0.3603x - 19.283
R² = 0.9491