Report for

Village of Deerfield, Illinois

Phosphorus Removal Feasibility Study

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SECTION 1
INTRODUCTION

1.01 PURPOSE AND SCOPE

The Village of Deerfield (Village) operates wastewater conveyance and treatment facilities that provide service to the Village's residents and businesses as well as small portions of the Village of Bannockburn and the City of Highland Park. Wastewater facilities include a water reclamation facility (WRF) located on Hackberry Road; six sanitary lift stations; and the Deerfield Road and Warwick Road Stormwater Treatment Facilities. Forward flow treatment at the WRF consists of influent pumping, mechanical fine screening and grit removal, diffused air activated sludge in a Modified Ludzack Ettinger configuration, final clarification, and ultraviolet (UV) light disinfection before discharge to the West Fork North Branch Chicago River. Biosolids management includes gravity sludge thickening, aerobic digestion, centrifuge dewatering, and dewatered cake storage on-site.

A major renovation of the facilities was completed in 2013, including construction of the influent pumping and preliminary treatment facilities; renovation and expansion of the activated sludge treatment facilities; renovation of the existing final clarifiers and construction of a fourth final clarifier; installation of UV disinfection equipment; conversion of the existing anaerobic digesters to aerobic digestion; and renovation of existing excess flow facilities.

This Phosphorus Removal Feasibility Study report was prepared for the purpose of developing an overall plan for phosphorus compliance at the Village's WRF for the next 20 years and beyond, and for meeting the requirements of Special Condition 19 of the Village's National Pollution Discharge Elimination System (NPDES) permit. A copy of the NPDES permit is included in Appendix A.

1.02 PHOSPHORUS REGULATORY ISSUES

The Illinois Environmental Protection Agency (IEPA) has been implementing the Illinois Nutrient Loss Strategy (INLS) with the intent of reducing nutrient discharges to lakes and streams in the State of Illinois from point sources and nonpoint sources (NPS). Part of the goal of the INLS is to reduce the amount of nutrients flowing to the Gulf of Mexico to help reduce the size of the hypoxic zone in the gulf. This goal is in response to the United States Environment Protection Agency's (USEPA) 2008 Hypoxic Action Plan (Action Plan). The Action Plan and the subsequent memorandum of Recommended Elements of a State Nutrient Framework provided the basis for the INLS.

The Village's WRF is located within the North Branch Chicago River watershed. The Village was instrumental in the development of the North Branch Chicago River Watershed Workgroup (NBWW).The NBWW is a diverse coalition of stakeholders working together to improve water quality in the North Branch Chicago River watershed. The NBWW was created with the intent of assessing water quality in the watershed and developing a Nutrient Assessment Reduction Plan to meet the requirements of NPDES permit holders in the watershed. NBWW has established 25 monitoring sites within the watershed and has collected water chemistry data at these sites as well as sediment and macroinvertebrate at selected sites.

1.03 PHOSPHORUS SOURCES

The presence of phosphorus in aquatic ecosystems (streams, rivers, and lakes) is predominantly from point sources and NPSs and can also be present, though infrequently, from natural sources. Phosphorus in the aquatic environment leads to increased algae growth that results in decreased water clarity, dissolved oxygen (DO) swings, odor problems, and potential health risks when certain algae (e.g., cyanobacteria) are present. NPSs of phosphorus include agricultural fields, roads, yards, and parking lots. Point sources include discharges from WRFs and stormwater collection systems. Phosphorus introduced to WRFs is predominantly from cleaning products and from food products consumed, which is excreted in human waste. Because traditionally designed WRFs only remove a small percentage of phosphorus during biological treatment, more advanced chemical and biological treatment options must be considered to remove phosphorus to more stringent effluent levels of 1.0 milligrams per liter (mg/L) and below.

1.04 PHOSPHORUS FORMS IN WASTEWATER

Phosphorus is present in raw, untreated wastewater in inorganic forms (orthophosphate and polyphosphate) and organic forms. Organic phosphorus and polyphosphates slowly hydrolyze in wastewater and can be converted to orthophosphate forms. The orthophosphate forms (PO_4, HPO_4, H_2PO_4, and H_3PO_4) are readily available for biological metabolism in the wastewater treatment process and are incorporated into cell mass as a required growth element. Typically, phosphorus accounts for anywhere from 1 to 6 percent of the total cell mass depending on the cell age and environmental conditions.

The term total phosphorus (TP) is the sum of all phosphorus present in the wastewater. This includes phosphorus metabolized and incorporated into the cell mass as well as dissolved phosphorus. The term “dissolved phosphorus” or “soluble phosphorus” is the sum of the dissolved phosphorus forms after filtration to remove cell mass and other solids. The TP concentration in a domestically dominated wastewater typically ranges from 5 to 7 mg/L. The wastewater treatment process typically removes 30 to 50 percent of the influent TP through the standard biological treatment and clarification processes. This results in a TP concentration of 2 to 6 mg/L in the treated wastewater. Either biological phosphorus removal (BPR) or chemical phosphorus removal (CPR) processes, or both, are necessary to meet an effluent TP limit of 1.0 mg/L and lower.

Additionally, as the effluent TP limit becomes more stringent, the removal of suspended solids (TSS) in the treated effluent, consisting predominately of biological cell mass, becomes increasingly important because the cell mass includes phosphorus that would be detected in the TP test. In general, effluent TSS concentrations below 5 mg/L are necessary to consistently meet a 0.1-mg/L TP limit.

There is a specific form of dissolved phosphorus that is categorized as nonreactive that is difficult to remove cost effectively. This nonreactive phosphorus is typically present in concentrations of less than 0.1 mg/L. Given this typical concentration, the presence of soluble nonreactive phosphorus is not an issue when meeting a 1-mg/L limit. The presence of nonreactive phosphorus, however, can present challenges in meeting low TP limits of 0.1 mg/L or less.

1.05 ABBREVIATIONS AND DEFINITIONS

A/O	Anaerobic/Oxic
A_2O	Anaerobic/Anoxic/Oxic
Action Plan	2008 Hypoxic Action Plan
BNR	biological nutrient removal
BOD_5	five-day biochemical oxygen demand
BPR	biological phosphorus removal
CMAP	Chicago Metropolitan Agency for Planning
COD	chemical oxygen demand
CPR	chemical phosphorus removal
CY	cubic yards
DO	dissolved oxygen
gal	gallons
gcd	gallons per capita-day
gpd	gallons per day
gpm	gallons per minute
hrs/wk	hours per week
HVAC	heating, ventilation, and air conditioning
IEPA	Illinois Environmental Protection Agency
INLS	Illinois Nutrient Loss Strategy
kWh	kilowatt-hour
lb/d	pounds per day
mg/L	milligram per liter
MG	million gallons
MGD	million gallons per day
ML	mixed liquor
MLSS	mixed liquor suspended solids
NBWW	North Branch Chicago River Watershed Workgroup
NH_3-N	ammonia nitrogen
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
O&M	operating and maintenance
ORP	oxidation-reduction potential
PAC	polyaluminum chloride
PAO	phosphate-accumulating organisms
pcd	pounds per capita-day
ppmv	volumetric parts per million
RAS	return activated sludge
rbBOD	readily biodegradable biological oxygen demand
rbCOD	readily biodegradable chemical oxygen demand
S2EBPR	Sidestream Enhanced Biological Phosphorus Removal
SRT	solids retention time
TKN	total Kjeldahl nitrogen
TN	total nitrogen
TP	total phosphorus

TSS	total suspended solids
USEPA	United States Environmental Protection Agency
UV	ultraviolet
VFA	volatile fatty acids
Village	Village of Deerfield
WAS	waste activated sludge
WRF	Water Reclamation Facility

SECTION 2
EXISTING WASTEWATER TREATMENT FACILITIES

2.01 DESCRIPTION OF EXISTING FACILITIES

The Village operates an activated sludge WRF that discharges to the West Fork North Branch Chicago River. The design average flow for the WRF is 3.50 million gallons per day (MGD). Wastewater is conveyed to the WRF through a 48-inch pipe that discharges to the influent wet well. The wet well is split into two halves, each of which is equipped with three influent pumps. The influent pumps lift the raw wastewater to an elevated channel, providing sufficient head to allow gravity flow through the treatment processes and to the receiving stream. After pumping, raw wastewater passes through the two mechanical fine screens that remove large solids, paper, and other stringy material to protect downstream equipment. The screened raw wastewater flows to the vortex grit chamber where heavy grit settles out to the bottom of the chamber. A motorized paddle maintains sufficient velocity in the grit chamber to keeps organic material in suspension while allowing the grit to settle. The settled grit is pumped from the bottom of the chamber to a grit washer that removes additional organic material from the grit before it is conveyed to a waste container for disposal. The screened, degritted raw wastewater then flows through the influent flume for flow measurement and then to the aeration tanks for biological treatment.

There are two downward opening weir gates installed downstream of the influent flume that allow wastewater to be diverted to either the excess flow clarifier or excess flow lagoon under high flow conditions more than 9.2 MGD. This option is intended to help prevent excessive flow from washing solids out of the final clarifiers.

The activated sludge system at the Village's WRF consists of the aeration tanks, the aeration blowers, the Mixed Liquor (ML) Splitter Structure, the final clarifiers, and the return activated sludge (RAS) and the waste activated sludge (WAS) pumps that are located in the Biosolids Processing Building. There are two aeration trains each with two passes.

Screened and degritted raw wastewater flows to the southwest corner of the aeration tanks through a 30-inch pipe from the Influent Pumping Station. Raw wastewater mixes with RAS in the pipe as it flows to the aeration tanks. The mixed flow is divided in the ML Splitter Structure as it comes to the aeration tanks structure and flows over one of two sharp-crested weirs. One weir leads directly into Aeration Tank No. 1, and the other goes down the aeration tank influent channel along the south end of the aeration tanks to the Aeration Tank No. 2 inlet. Flow enters the tanks at the south end of the first tank in each train and flows in a serpentine manner through the two passes in each train, exiting at the south end into the effluent channel via a set of five stop gates and sharp-crested weirs at each tank.

Upon entering the aeration tanks, wastewater first flows into the anoxic zone. There are no aeration diffusers installed in this zone, which occupies approximately the first 30 feet of the first pass of each treatment train, approximately 11 percent of the total aeration tank volume. Mixing is provided by a floating mixer in each anoxic zone. A poured concrete baffle wall separates this zone from the first aerated zone. The top of the baffle wall is below the normal water surface elevation, allowing the passage of scum or other floatable material. The purpose of the anoxic zone is to provide a portion of the tankage in which denitrification can occur.

ML leaving the anoxic zone is then aerated. Air is supplied by four aeration blowers and distributed by aeration diffusers within each tank. The density of the diffusers is graduated along each train with a denser diffuser installation pattern at the influent end and a sparser pattern at the effluent end. The tapered approach is used because the oxygen demand is greater at the influent end where the concentration of organic waste is higher.

After activated sludge treatment, the ML flows out of the aeration tanks into the effluent channel and to the 36-inch outlet pipe. The ML flows through the outlet pipe to the ML Splitter Structure. This structure splits the ML to the four final clarifiers. ML flows to each clarifier through a 24-inch pipe.

The final clarifiers provide a quiescent zone allowing separation of the solids in the ML from the treated wastewater, producing a secondary effluent meeting permit requirement for suspended solids and five-day biochemical oxygen demand (BOD_5). Settled secondary sludge is pumped out of the bottom of the clarifiers by the RAS pumps in the Biosolids Processing Building. RAS is pumped back into the raw wastewater pipe just upstream of the aeration tanks to maintain an adequate concentration of microorganisms in the ML to provide treatment. RAS flow is metered at each RAS pump's discharge pipe.

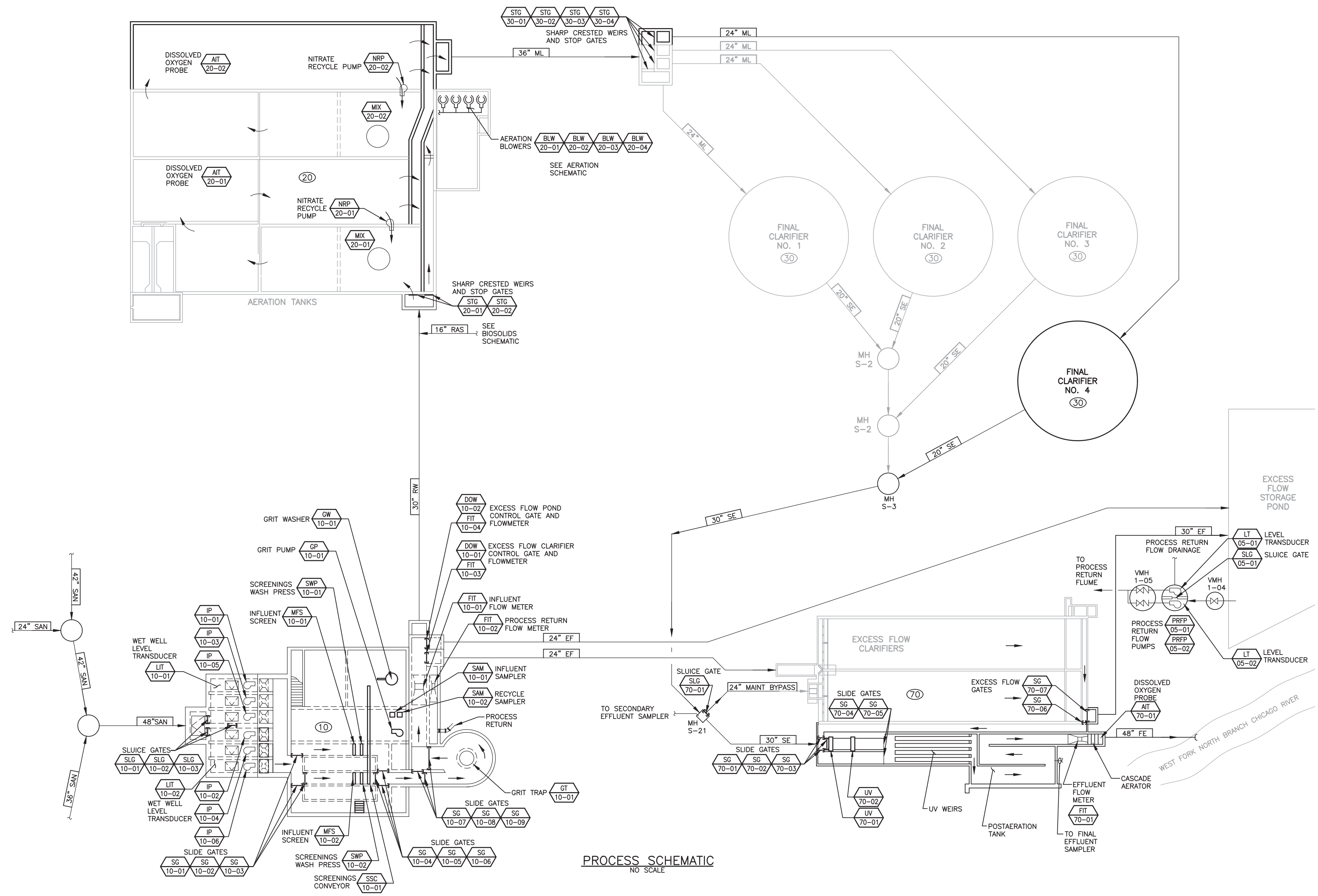
Final clarifier effluent flows to the UV disinfection equipment where pathogens in the treated wastewater are exposed to UV light to inactivate those pathogens. The UV disinfection equipment is in operation from May 1 through October 31. A cascade aerator downstream of the UV disinfection equipment adds oxygen to the effluent before discharging to the receiving stream. There is also a post aeration basis with membrane diffusers that can provide additional aeration if the cascade aeration is insufficient to meet the DO permit requirements.

A schematic of the treatment processes is shown in Figure 2.01-1.

Solids treatment at the WRF includes gravity thickening of the WAS then aerobic digestion in three aerobic digesters. Dewatering of the digested biosolids is achieved using the dewatering centrifuge. Dewatered cake is stored in the Sludge Storage Building until it is hauled for disposal on agricultural fields.

2.02 INFLUENT FLOWS AND LOADINGS

A summary of the influent flows and wastewater concentrations and loadings for BOD_5 and TSS is shown in Table 2.02-1. Influent BOD_5, TSS, and NH_3-N are tested three days per week. Table 2.02-2 shows influent and effluent flows and TP concentrations and loading. Influent and effluent TP are tested weekly.



PROCESS SCHEMATIC
NO SCALE

WASTEWATER RECLAMATION FACILITIES

WASTEWATER RECLAMATION FACILITIES
VILLAGE OF DEERFIELD
DEERFIEL, ILLINOIS

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FIGURE 2.01-1
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Table 2.02-1 Village's WRF Influent Flows and Loadings

	Influent Flow (MGD)	Influent BOD_5 Concentration (mg/L)	Influent BOD_5 Load (lb/d)	Influent TSS Concentration (mg/L)	Influent TSS Load (lb/d)
2018					
January	2.32	165	3,201	167	3,232
February	3.62	104	3,156	142	4,296
March	2.62	135	2,944	145	3,166
April	3.12	123	3,200	136	3,522
May	4.07	132	4,493	160	5,430
June	3.98	119	3,930	139	4,608
July	2.07	216	3,735	433	7,496
August	2.16	194	3,488	213	3,836
September	2.89	161	3,886	180	4,325
October	2.74	149	3,399	179	4,080
November	3.09	130	3,353	149	3,827
December	3.60	134	4,011	139	4,175
2018 Average	3.13	147	3,566	181	4,523
2019					
January	2.93	126	3,083	125	3,062
February	4.81	90	3,614	121	4,858
March	3.13	109	2,856	114	2,969
April	3.66	129	3,946	148	4,528
May	4.45	104	3,857	135	5,014
June	3.70	115	3,534	137	4,233
July	2.98	161	3,997	191	4,738
August	2.24	164	3,057	206	3,837
September	3.88	138	4,445	160	5,180
October	3.62	136	4,087	150	4,532
November	3.14	135	3,531	147	3,858
December	2.69	149	3,338	162	3,638
2019 Average	3.43	130	3,612	150	4,204
2020					
January	3.58	113	3,377	120	3,588
February	2.85	116	2,758	126	2,997
March	3.39	121	3,417	129	3,634
April	3.28	126	3,447	132	3,626
May	4.45	110	4,082	124	4,586
June	1.95	164	2,668	173	2,821
July	1.97	172	2,821	185	3,029
August	1.82	173	2,629	197	2,997
September	2.30	151	2,895	168	3,222
October	2.07	181	3,125	203	3,505
November	1.99	183	3,037	191	3,170
December	2.32	173	3,347	165	3,193
2020 Average	2.66	149	3,134	159	3,364
Overall Average	**3.04**	**139**	**3,455**	**161**	**3,989**

Note: lb/d=pounds per day

Table 2.02-2 Village's WRF Influent and Effluent Flows and Phosphorus Loadings

	Influent Flow (MGD)	Influent TP Concentration (mg/L)	Influent TP Load (lb/d)	Effluent Flow (MGD)	Effluent TP Concentration (mg/L)	Effluent TP Load (lb/d)
2018						
January	2.32	4.3	84	2.10	2.5	43.2
February	3.62	3.2	95	3.27	2.0	55.0
March	2.62	3.8	84	2.45	1.9	38.6
April	3.12	3.4	89	2.95	2.1	51.6
May	4.07	3.2	108	3.98	1.6	54.5
June	3.98	3.3	110	3.72	2.4	73.0
July	2.07	5.2	89	2.01	2.5	42.5
August	2.16	4.9	141	2.02	2.9	49.2
September	2.89	4.6	110	2.83	2.5	58.2
October	2.74	4.0	91	2.58	2.2	47.6
November	3.09	3.6	93	2.82	2.2	50.9
December	3.60	3.7	112	3.47	1.6	45.7
2018 Average	3.13	3.9	96	2.85	2.2	51
2019						
January	2.93	3.2	78	2.64	1.5	33
February	4.81	2.3	91	4.49	1.3	49
March	3.13	2.8	73	3.18	1.8	48
April	3.66	3.6	111	3.30	2.0	55
May	4.45	2.3	85	4.36	1.3	48
June	3.70	2.9	90	3.57	1.6	48
July	2.98	4.4	109	2.89	2.5	60
August	2.24	4.5	83	2.15	2.8	50
September	3.88	4.2	135	3.70	2.3	71
October	3.62	3.8	115	3.46	1.9	54
November	3.14	3.8	98	2.92	2.0	49
December	2.69	4.4	98	2.44	1.8	38
2019 Average	3.43	3.5	97	3.26	1.9	50
2020						
January	3.58	3.3	99	3.35	1.5	43
February	2.85	3.2	77	2.67	1.5	33
March	3.39	3.3	92	3.23	1.9	51
April	3.28	3.0	82	3.38	1.7	49
May	4.45	3.2	118	4.09	1.5	51
June	1.95			1.92		
July	1.97	4.7	77	1.91	3.7	58
August	1.82	5.3	80	1.74	3.9	57
September	2.30	4.4	85	2.19	3.2	58
October	2.07	5.1	87	1.91	3.6	57
November	1.99	5.5	91	1.81	3.9	59
December	2.32	4.9	95	2.14	3.1	54
2020 Average	2.66	4.2	89	2.53	2.7	52
Overall Average	**3.04**	**3.86**	**94**	**2.88**	**2.3**	**51**

There are no significant industrial dischargers within the sewer service area. The Village performed a survey of the highest water users within the sewer service area to assess the potential for high phosphorus loadings from commercial and institutional sources. These users included restaurants, hotels, grocery stores, large residential complexes, and retirement facilities. Based on responses to the survey, it is unlikely that there are significant sources of phosphorus that could be targeted for reduction.

2.03 PROJECTED FACILITY FLOWS AND LOADINGS

The development of projected wastewater flows and phosphorus loadings considers existing and future per capita flows and loadings. The sewer service area for the WRF includes small portions of the City of Highland Park and the Village of Bannockburn. The population of these areas was estimated in the 2008 WRF Design Report and is not expected to increase. Based on information from the Chicago Metropolitan Agency for Planning (CMAP), the 2020 population for the Village was 18,991 and it was expected to grow to 21,522 by 2040. Table 2.03-1 shows the current and projected populations of the sewer service area.

	2020	2040
Village Population[1]	18,991	21,522
Village of Bannockburn Service Area[2]	271	271
Village of Highland Park Service Area[2]	51	51
Total Population	19,313	21,844

[1]Forecasts from CMAP, last updated October 10, 2018.
[2]Population from 2008 WRF Design Report.

Table 2.03-1 Current and Projected Populations

A. Projected Flows

Based on the overall average influent flow of 3.04 MGD over the last three years, the per capita flow is 157 gallons per capita per day (gcd). The 2040 projected average daily flow based on this per capita flow and the population projected by CMAP is 3.44 MGD, slightly less than the design average flow of 3.50 MGD.

B. Per Capita Phosphorus Loads

Similarly, the per capita phosphorus loading based on the influent sampling presented in Table 2.02-2 and a 2020 population of 18,991, is 0.0049 pounds per capita per day (pcd). This per capita loading would equate to a facility loading of 107 pounds per day in 2040. Table 2.03-2 shows the projected flows and phosphorus loadings.

	2020	2040
Population	19,313	21,522
Flow (gcd)	157	157
Flow (MGD)	3.04	3.44
Phosphorus (pcd)	0.0049	0.0049
Phosphorus (lb/d)	94	107

Table 2.03-2 Projected Flows and Phosphorus Loadings

SECTION 3
DESCRIPTION OF PHOSPHORUS REMOVAL ALTERNATIVES

This section includes identifying preliminary alternatives to meet 0.5-mg/L and 0.1-mg/L effluent phosphorus limits at the WRF on a monthly, seasonal, and annual average basis to satisfy Special Condition 19 in the Village's NPDES permit.

3.01 CPR ALTERNATIVES

There are several metal salt solutions that can be added to wastewater that will react with soluble phosphate to produce solids that will more readily settle out in the clarifiers or be removed via filters. Ferric chloride (ferric) and aluminum sulfate (alum) are two of the most commonly used chemicals in wastewater treatment for phosphorus removal. Recently, polyaluminum chloride (PAC) has become more commonly used than alum because of its increased reactivity with phosphorus and increased cost-effectiveness. Ferrous chloride and ferric sulfate are also used, although less frequently. A new class of chemicals using rare earth compounds has recently been introduced to the market and has been showing promising results in initial testing and operations. Recent significant cost increases in these chemicals has reduced their cost-effectiveness. Implementation of a CPR alternative would include a chemical building containing chemical storage tanks, chemical dosing pumps, and other miscellaneous equipment.

CPR is an operationally simple process when meeting higher phosphorus effluent concentrations (0.5 mg/L) but can be more challenging when attempting to achieve very low effluent concentrations (0.1 mg/L). CPR can also substantially increase the amount of solids generated, potentially impacting the capacity of sludge handling and storage facilities. The amounts of additional solids generated by CPR can be estimated using influent phosphorus concentrations and projected chemical doses.

There are several possible chemical application locations that could be used to meet the various limits. The most efficient application will likely be at the drop box at the effluent from the aeration tanks. This location provides good mixing conditions with the wastewater flowing over the sharp-crested weir with a drop of approximately 1.5 feet and then flowing through approximately 82 feet of pipe with two 45-degree bends and a reducing fitting will provide sufficient mixing for the chemical. This application point would likely be the preferred location because the chemical would have a greater ability to react with the phosphorus because some of the phosphorus would have been assimilated into cell mass in the aeration tanks.

Another possible chemical application location is after the influent flume, upstream of the aeration tanks, at the point where the wastewater is flowing over the sharp-crested weir with a drop of approximately 3 feet and then flowing through approximately 344 feet of pipe with ten 45-degree bends will provide sufficient mixing for the chemical.

An orthophosphate analyzer that would measure the orthophosphate in the secondary effluent could be used to control the chemical dosing to provide more accurate and economical chemical use. Brochures and case study materials from several manufacturers are included in Appendix B.

Multipoint chemical addition may be required to meet the 0.5-mg/L effluent limit. The final design should include multiple possible application points to allow for optimization of chemical dosing. Pilot testing of the multipoint chemical addition should be performed to determine the minimum TP effluent concentration that can be achieved without the addition of an additional tertiary treatment process.

3.02 CPR JAR TESTING RESULTS

One trial of jar testing has been performed to determine the effectiveness and estimate the required doses of three chemicals: ferric, alum, and PAC. In each of the jar tests, a gang mixer with five jars containing ML was used to simultaneously test four doses of each of the CPR chemicals with one control jar that had no chemical added. The jar testing procedure was as follows:

1. Add selected chemical dose with rapid mixing.
2. Rapid mix for two minutes.
3. Slow mix for five minutes to allow flocculation.
4. Settle, unmixed, for one hour.
5. Sample jar and analyze for TP and pH.

Graphs of the jar test results are shown in Figures 3.01-1, 3.01-2, and 3.01-3. The graphs show the TP concentration of the control jar and each of the jars with chemical added at the volumetric part per million (ppmv) dose indicated. The molar ratio of the amount of metal in the chemical dose to phosphorus in the ML (Me:P ratio) is also shown on the ferric and alum graphs. It is not possible to determine the Me:P ratio for PAC because the composition of the PAC is proprietary.

The results suggest ferric and PAC are similar in their removal efficiencies, with each being slightly more effective at reducing TP concentrations than PAC. The removal efficiency of alum was considerably lower. Each chemical was able to reduce the TP concentration to below the lowest target concentration of 0.1 mg/L. Each chemical also caused a reduction in pH as the dosages were increased, but ferric appeared to have the most significant impact. Figure 3.02-4 shows a comparison of the impact on pH by the three chemicals tested. These jar test results will be used in initial sizing of equipment, projecting chemical costs, and estimating the potential additional sludge volumes expected to be generated by CPR.

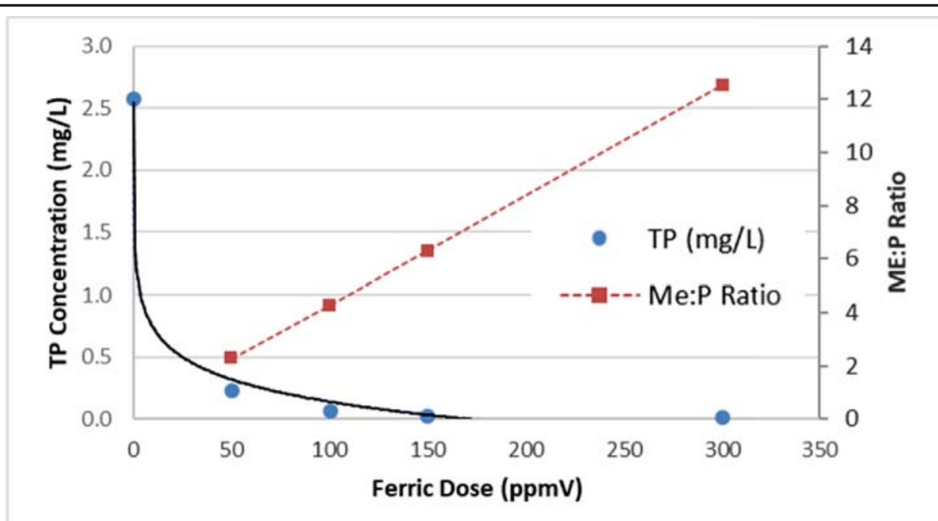


Figure 3.02-1 Ferric Jar Test Results

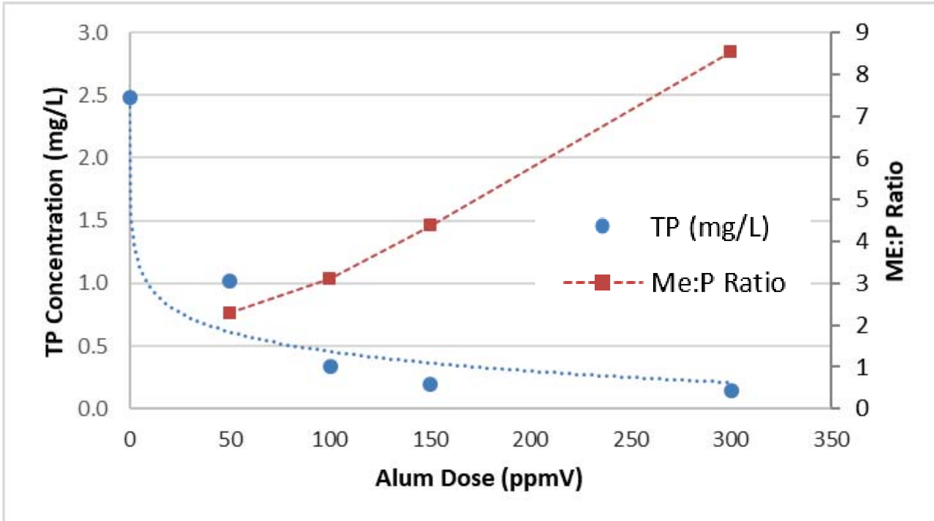


Figure 3.02-2 Alum Jar Test Results

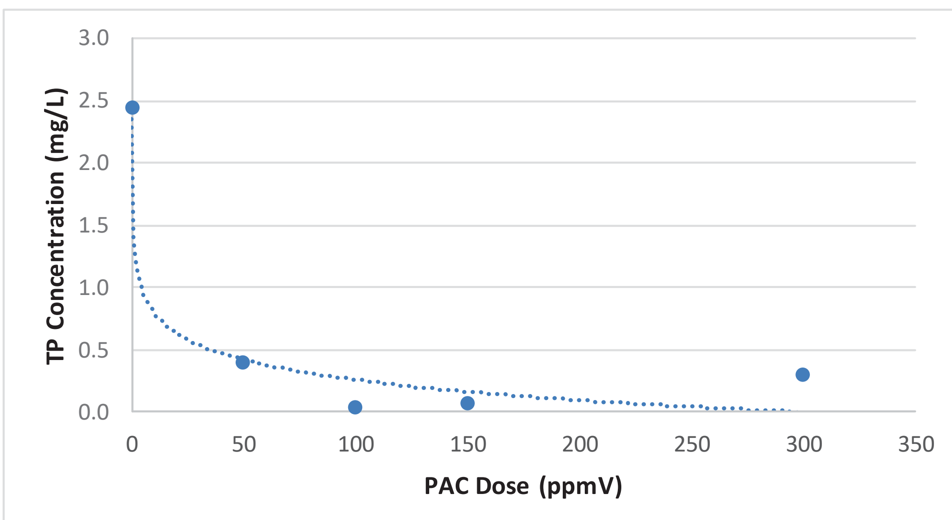


Figure 3.02-3 PAC Jar Test Results

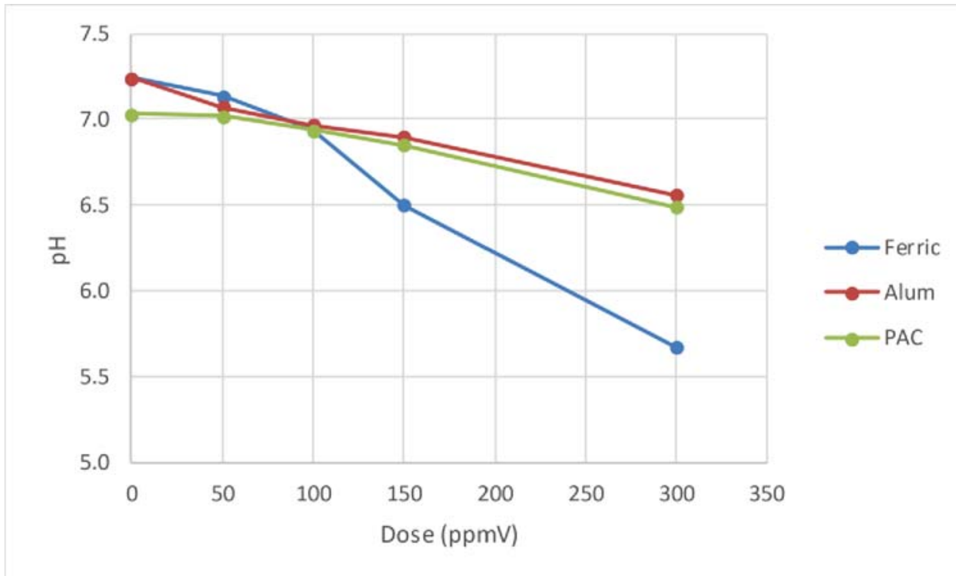


Figure 3.02-4 Impact of Chemical Dose on pH

3.03 BPR (BIOLOGICAL PHOSPHORUS REMOVAL) ALTERNATIVES

BPR is a method in which treatment conditions in the activated sludge system are manipulated in such a way as to promote growth of a specific population of microbes that uptake a greater amount of the phosphorus present in the wastewater, allowing it to be removed from the effluent when these cells are removed in the WAS. However, not all wastewater is amenable to successful BPR and there are several requirements that need to be met for BPR to function properly. BPR works by promoting the growth of phosphate-accumulating organisms (PAOs). When these organisms are exposed to anaerobic conditions they rely on volatile fatty acids (VFAs) and other easily biodegradable compounds to survive until they reach the aerobic zones where they are able to uptake phosphorus. A sufficient supply of VFAs is the key to BPR. For BPR to work, there generally needs to be a chemical oxygen demand (COD) to TP ratio of 45:1, a BOD to TP ratio of 25:1, and a readily biodegradable biological oxygen demand (rbBOD) to TP ratio of 15 or higher. Particulate BOD can sometimes be converted to rbBOD under anaerobic conditions in an influent sewer or force main or in primary clarifiers. If these ratios are not satisfied, it may be necessary to add a source of carbon upstream of the BPR process. This can also be achieved by promoting conversion of the particulate BOD present in the wastewater to VFAs and readily biodegradable chemical oxygen demand (rbCOD), which sometimes requires the use of a fermenter.

BPR potential testing was performed using the WRF’s screened and degritted influent wastewater to project whether it is likely that the components in the wastewater will support BPR. The testing uses WAS from a facility that is successfully achieving BPR, in this case the City of Janesville, Wisconsin, facility. Phosphorus release of a jar test using the Village wastewater as the BOD source is compared to the phosphorus release of a jar test using the Village wastewater with added sodium acetate, an ideal BOD source for BPR, as the BOD source. Phosphorus release is indicative of BPR activity because during the BPR process, the microbes release phosphorus when hydrolyzing polyphosphate for an energy source while they uptake VFAs during the anaerobic portion of the treatment cycle. For the BPR potential testing using the Village's wastewater, there was essentially no phosphorus release, indicative of a wastewater that will not successfully support BPR to a degree that will allow the WRF to consistently meet even a 1.0-mg/L effluent phosphorus limit. The results of the BPR potential testing are shown in Figure 3.03-1.

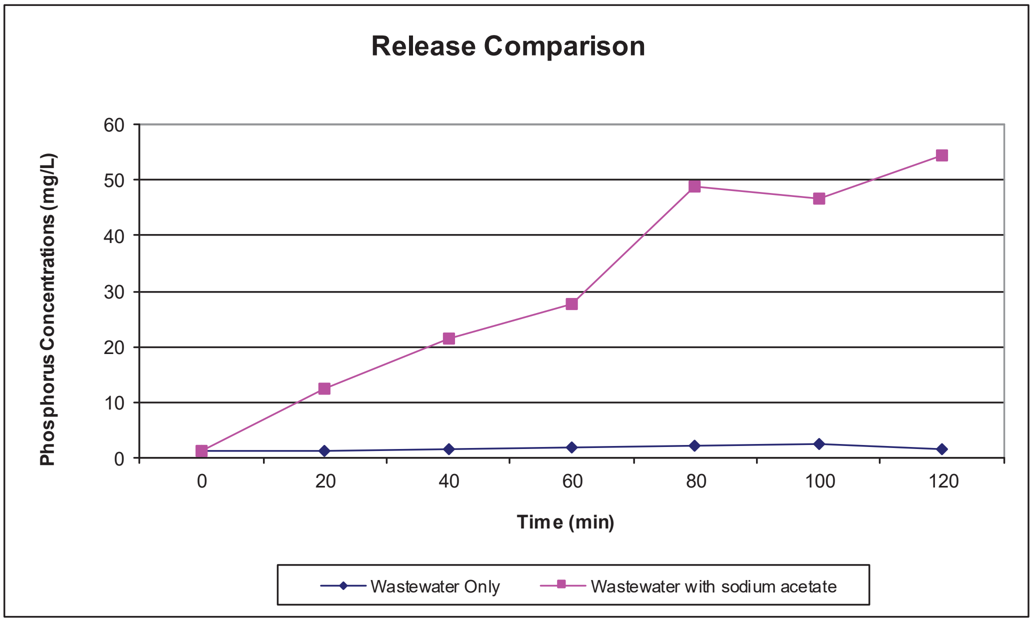


Figure 3.03-1 BPR Potential Test Results

Despite the nonideal results, several BPR and biological nutrient removal (BNR) alternatives will be evaluated to identify the best fit for the WRF. Strand Associates, Inc.® (Strand) recommends additional testing to further establish the potential for successful BPR treatment at the Village including additional BPR potential testing and analysis of flocculated and filtered COD to provide some idea of the speciation of the influent wastewater. The BPR alternatives to be considered include the following:

A. Sidestream Enhanced Biological Phosphorus Removal (S2EBPR)

Because it appears, from one sampling event, the Village's wastewater does not contain sufficient VFAs to promote BPR, a means of promoting fermentation at the WRF would be required. One alternative (S2EBPR) is to add a tank through which a portion of the RAS is routed to ferment in the absence of oxygen. A control valve and new piping would be installed in the basement of the Biosolids Control Building or a valve vault adjacent to the building to allow diversion of a portion of the RAS to the S2EBPR tank. The RAS would be fermented to produce VFAs that would be introduced to the activated sludge process. Mixers installed in this tank would be cycled to allow periodic settling of the RAS to increase the solids concentration and solids retention time within the tank. Figure 3.03-2 shows a potential layout for this treatment configuration.

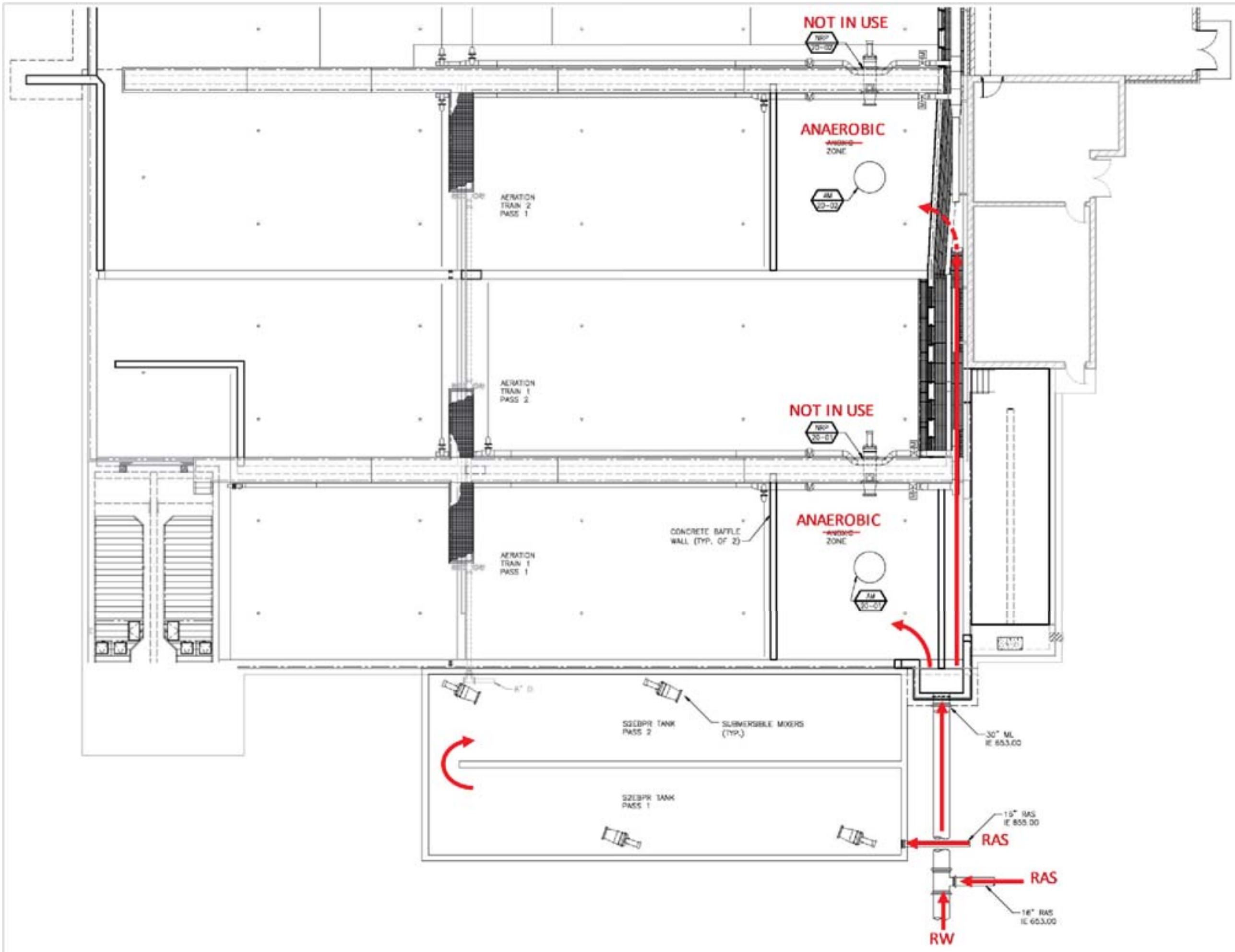


Figure 3.03-2 Potential S2EBPR Configuration

B. Anaerobic/Oxic (A/O) with RAS Denitrification

Although the BPR potential testing showed that traditional BPR methods will likely not be successful, this treatment concept and the next are presented solely for discussion purposes. This system is most likely the simplest BPR system for a facility that nitrifies. This would involve construction of a tank adjacent to the aeration tanks for RAS denitrification, followed by an anaerobic zone for BPR. The existing anoxic zones at the start of the first pass of each of two aeration tanks would serve as the anaerobic zone. The mixers installed in those zones would be used to maintain the ML in suspension. The nitrate recycle pumps installed in the wall between the second pass of each aeration tank and the existing anoxic zone would no longer be used. Ammonia converted to nitrate in the activated sludge process that would be returned to the aeration tanks in the RAS would be converted to nitrogen gas in the RAS denitrification tank. The detention time in the RAS denitrification tank would need to be approximately one hour for just the flow of RAS, equivalent to an 83,000-gallon tank at a RAS rate of 2 MGD. It is important to limit the amount of nitrate in the anaerobic zone in the BPR process because it renders the zone anoxic instead of truly anaerobic, hampering the BPR activity. Figure 3.03-3 shows potential layout for this treatment configuration. The method of introduction of the denitrified RAS into the aeration tanks would need to be a carefully considered design of this alternative to promote an even division of RAS to the two aeration tank trains.

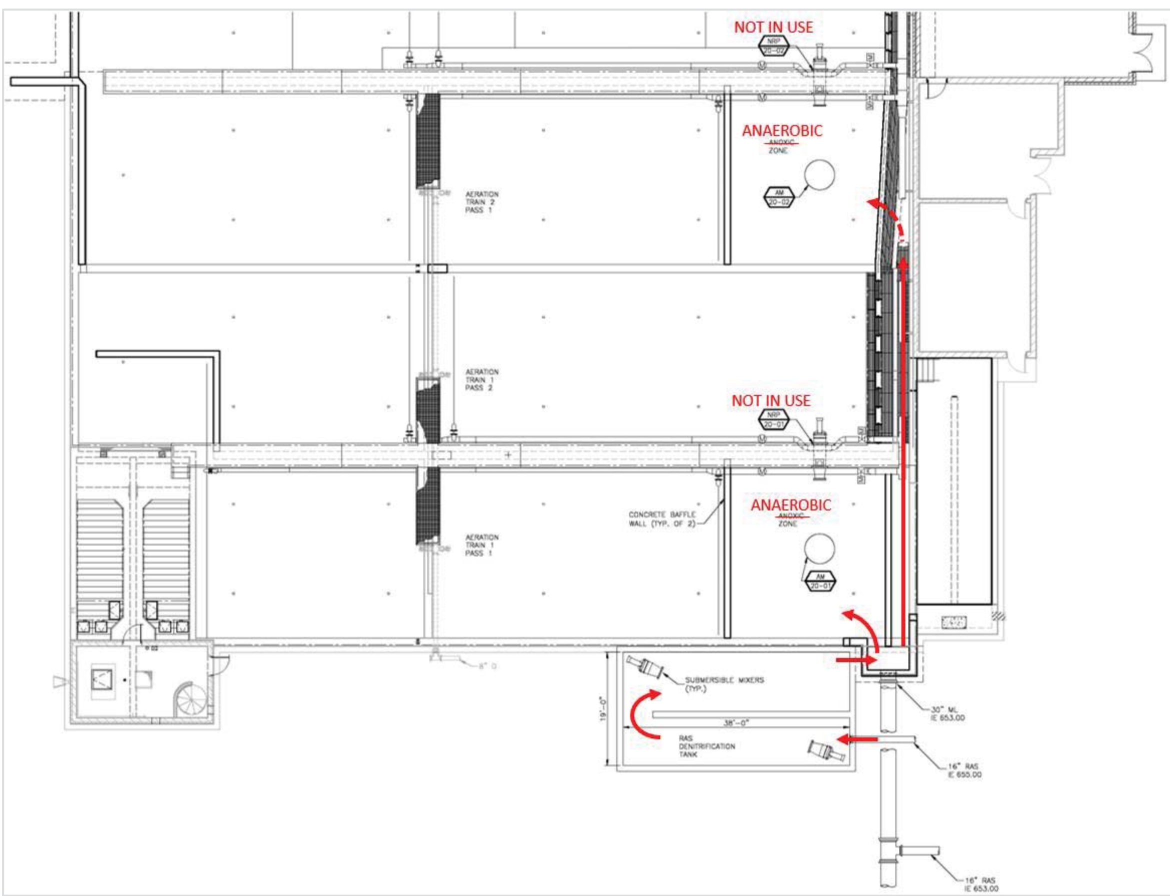


Figure 3.03-3 Potential A/O with RAS Nitrification BPR Arrangement

C. Anaerobic/Anoxic/Oxic (A_2O)

This system is more complex than the A/O process; however, it typically provides better control and performance. There is significant total nitrogen (TN) removal as well which would be advantageous if the Village were to receive TN limits in the future. This alternative would involve construction of a tank adjacent to the aeration tanks for an anaerobic zone. This tank would be sized to provide approximately one hour of detention time relative to the design average flow. The existing anoxic zones would continue to be used for their original purpose. The existing internal nitrate recycle pumps between the end of the aerated activated sludge zones and the anoxic zones would continue to be used to recycle nitrate into the anoxic zone. The purpose of this recycle is to reduce the nitrate in the ML, reducing the likelihood of nitrate inhibition the BPR process via the RAS and reducing the amount of TN discharged. Figure 3.03-4 shows a schematic of a potential configuration for this treatment process.

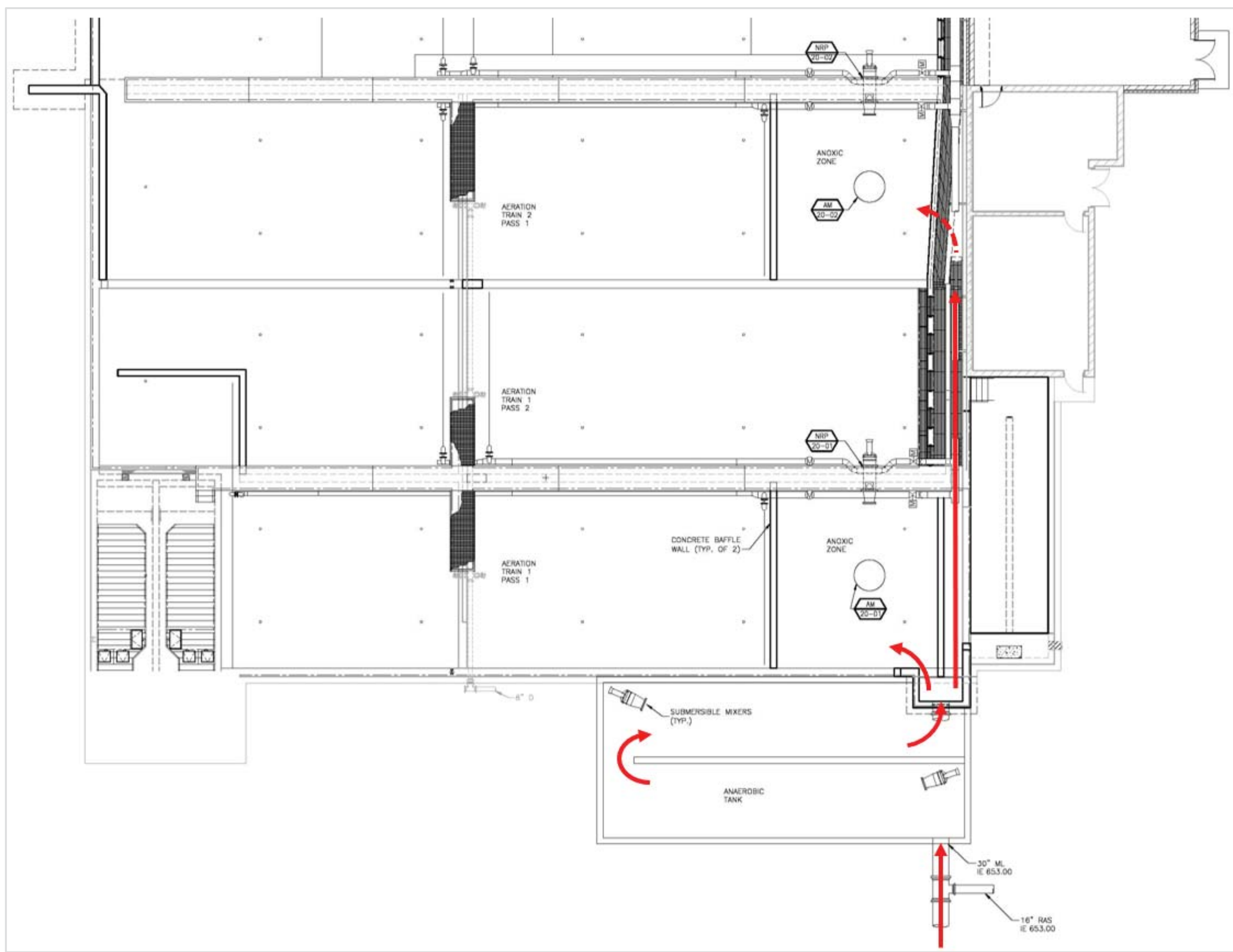


Figure 3.03-4 Potential A_2O BPR Arrangement

D. Combinations of the Above Alternatives

It would be possible to provide a tank sized for the S2EBPR RAS detention time that would also work in the A_2O arrangement to provide flexibility to the WRF in operating BPR. The tank sized for the S2EBPR would provide approximately 1.7 hours of anaerobic detention time for the forward flow, within the normal design parameters for an anaerobic zone for A_2O BPR. An example of this arrangement is shown in Figure 3.03-5.

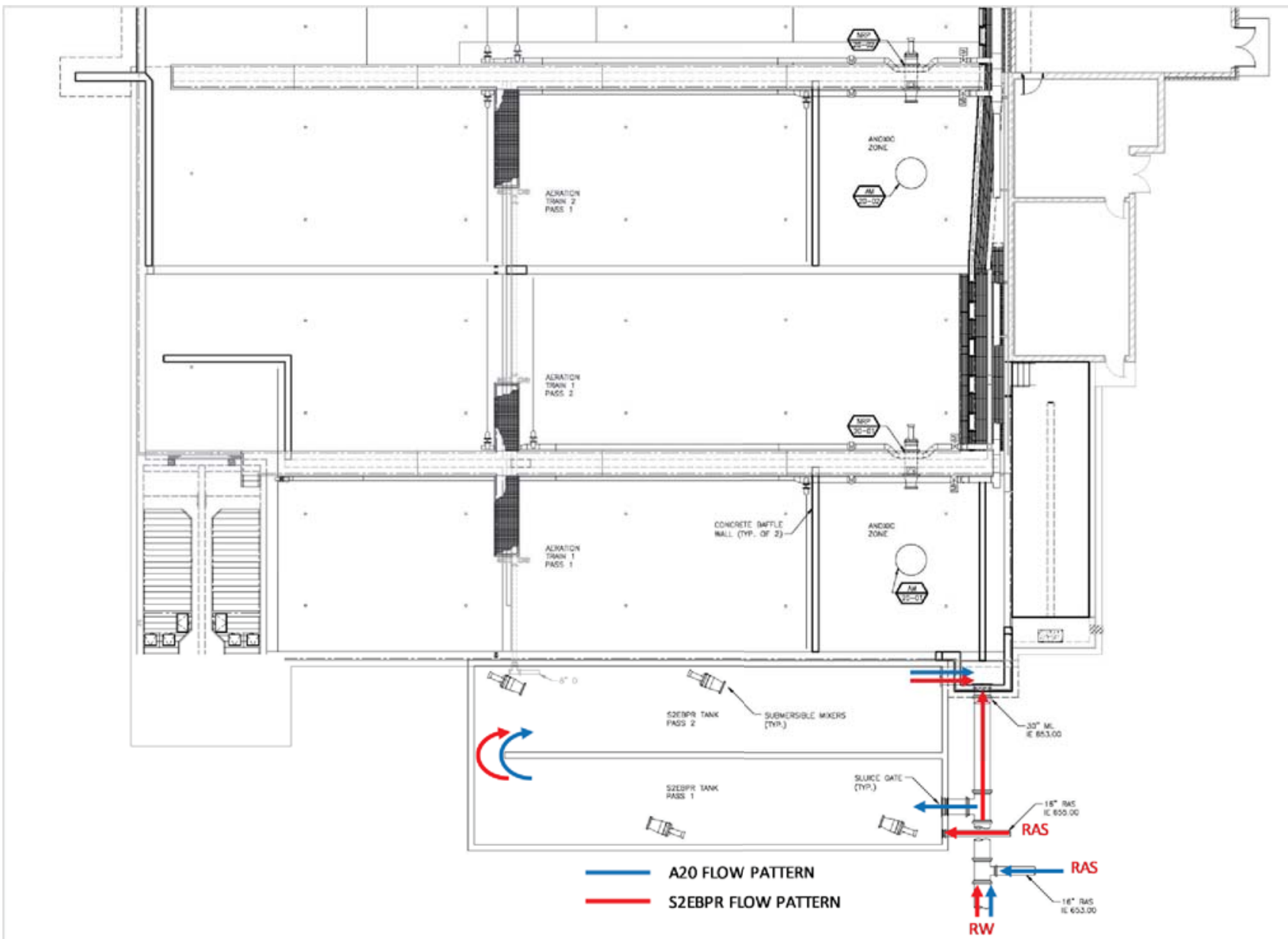


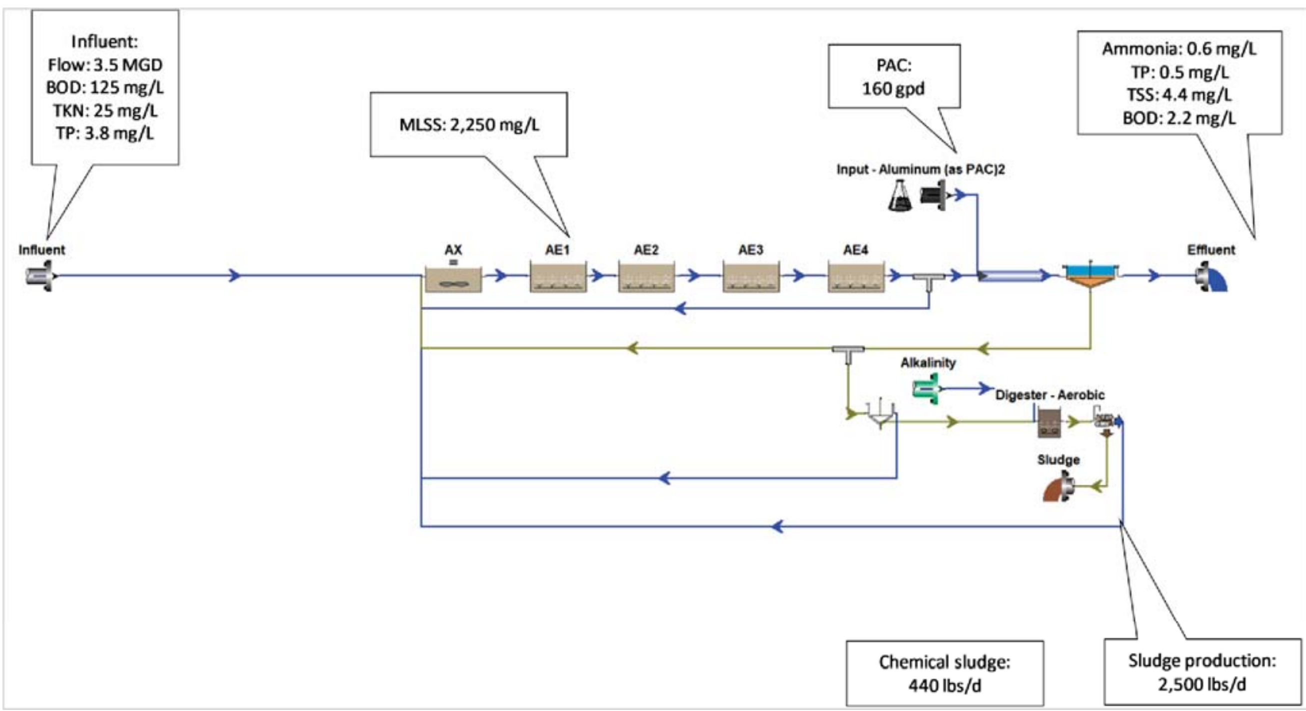
Figure 3.03-5 Combined S2EBPR and A_2O Configuration

In this configuration, A_2O BPR would be operated by closing a sluice gate on the 30-inch raw wastewater pipe in the aeration splitter box and opening a sluice gate on the 30-inch pipe into the BPR tank and a downward opening weir gate between the BPR tank and the aeration splitter box. RAS flow would be the same as the current operation during A_2O operation.

S2EBPR would be operated by directing a portion of the RAS flow to the BPR tank and opening the downward opening weir gate between the BPR tank and the aeration splitter box.

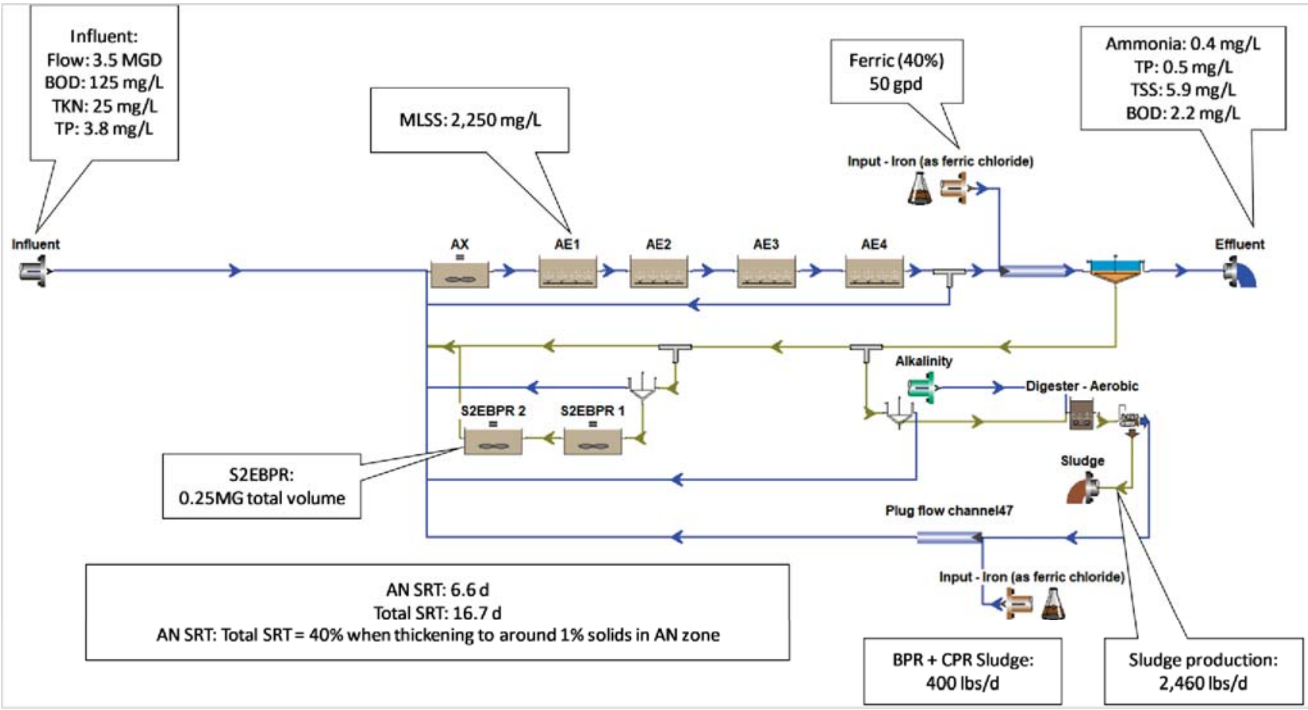
3.04 BIOWIN MODELING

BioWin modeling was performed for each of the three phosphorus removal chemicals used for jar testing and the S2EBPR configuration. The primary intent of modeling of the CPR alternatives is to project the amount of excess solids that will be generated. The chemical dose results from the CPR modeling will not be used because more accurate results were likely achieved with the jar testing that was performed on-site. Modeling of the S2EBPR configuration projects the anaerobic hydrolysis for the RAS in the anaerobic tank and the potential performance of BPR as a result of the additional VFAs produced. Figure 3.04-1 shows an example of the model for the CPR alternatives. Figure 3.04-2 shows an example of the model for the S2EBPR alternatives. That model shows addition of ferric for polishing to meet the 0.5-mg/L limit.



Note:
TKN=total Kjeldahl nitrogen
MLSS=mixed liquor suspended solids
gpd=gallons per day

Figure 3.04-1 BioWin Model Representing CPR



Notes:
AN=anaerobic
SRT=solids retention time

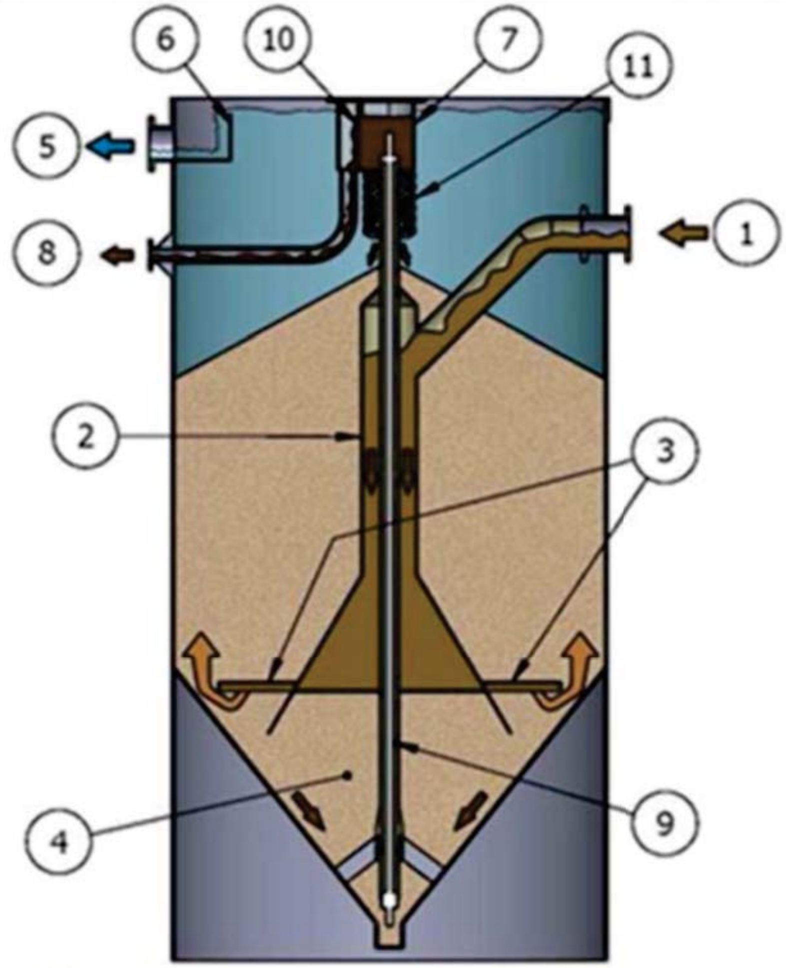
Figure 3.04-2 BioWin Model Representing S2EBPR

3.05 TERTIARY TREATMENT ALTERNATIVES

Without tertiary treatment, the WRF's treatment processes are unlikely to be able to consistently meet the potential future 0.1-mg/L phosphorus limit. Three potential treatment technologies to meet the 0.1-mg/L limit were evaluated. Each of the tertiary treatment options would require construction of an intermediate pumping station as there is not adequate head loss available in the WRF's hydraulic profile between the final clarifiers and the UV disinfection structure to accommodate the drop needed in the tertiary treatment processes.

A. Reactive Filters

The reactive filtration process involves continuously regenerating a reactive filter media while simultaneously filtering contaminants from fluid flowing through the filter media. Reactive filters are able to remove phosphorus by providing reactive surface sites within the media bed, which results in forced contact of chemical species with high adsorptive capacity. Phosphorus and solids are removed from the media bed through a backwash/reject stream. The reject stream is then recycled to the head of the WRF and the solids are eventually removed in the final clarifiers in the WAS. The reactive filter included in this alternative is the Blue PRO® process by Blue Water Technologies. This process has been used to remove phosphorous to 0.1 mg/L and lower at full-scale treatment facilities. This process has also been pilot-tested throughout the United States to determine the reliability of this process at meeting stringent limits of less than 0.1 mg/L. A cross section of a Blue PRO® reactor is shown in Figure 3.05-1.



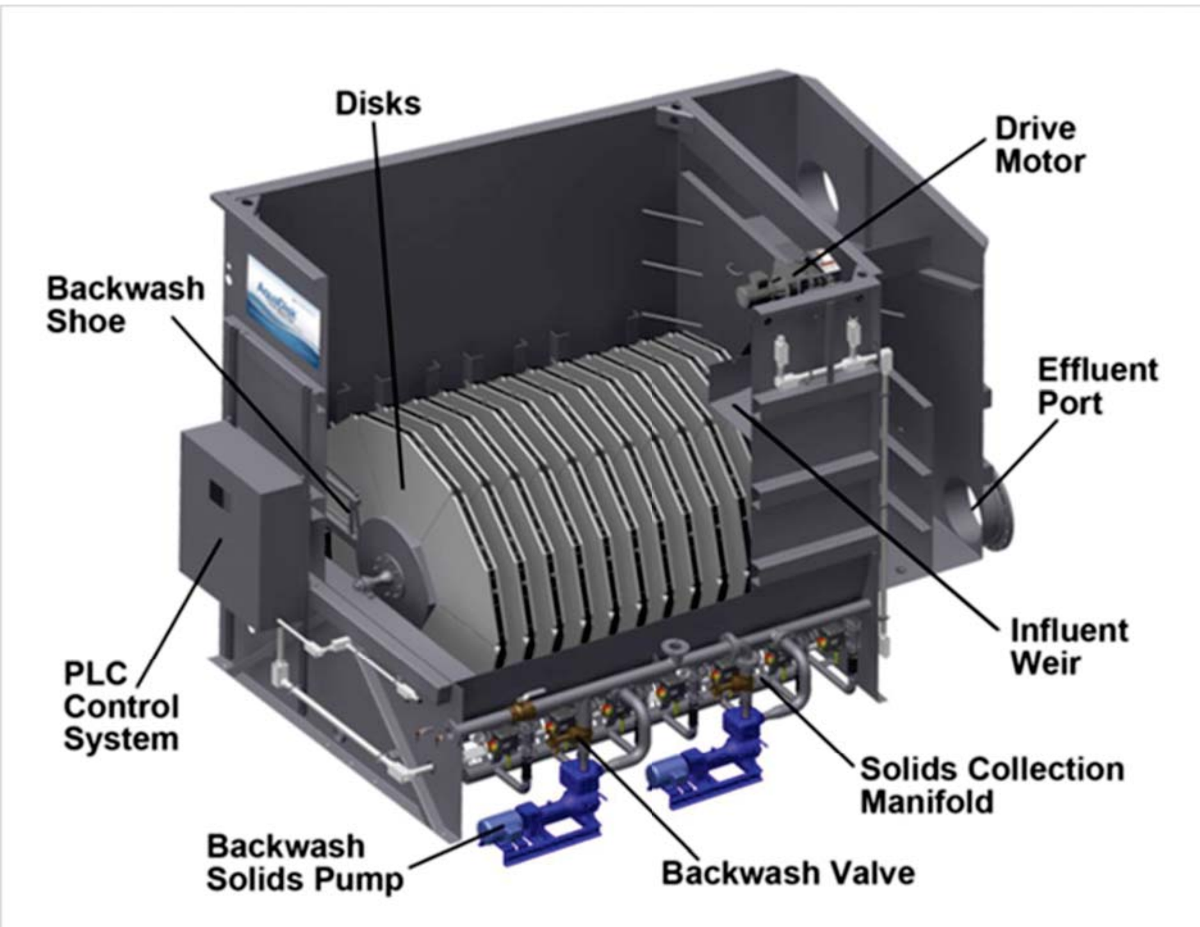
1. Influent
2. Central Feed Chamber
3. Radial Arms
4. Spherical Silica Media
5. Filtrate
6. Fixed Effluent Weir
7. Washbox
8. Reject Stream
9. Airlift
10. Adjustable Reject Weir
11. Tortuous Path

Source: Nexom

Figure 3.05-1 Blue PRO® Reactive Filtration

B. Cloth Filters

Cloth filters use disks, diamonds, or other configurations of the cloth media to remove particulate phosphorus from the secondary clarifier effluent. Depending on the manufacturer, secondary effluent can flow either from outside of the filter to the inside or from the inside out. Each filter has a mechanism for backwashing collected solids from the filter to be recycled to the head of the WRF. The filters would be installed in a new building which would also contain polymer equipment, and flocculation and coagulation tanks. There are several manufacturers of the cloth disc filters, and the Aqua-Aerobic AquaDisk system was used for this evaluation. An example of the cloth disc filter is shown Figure 3.05-2.

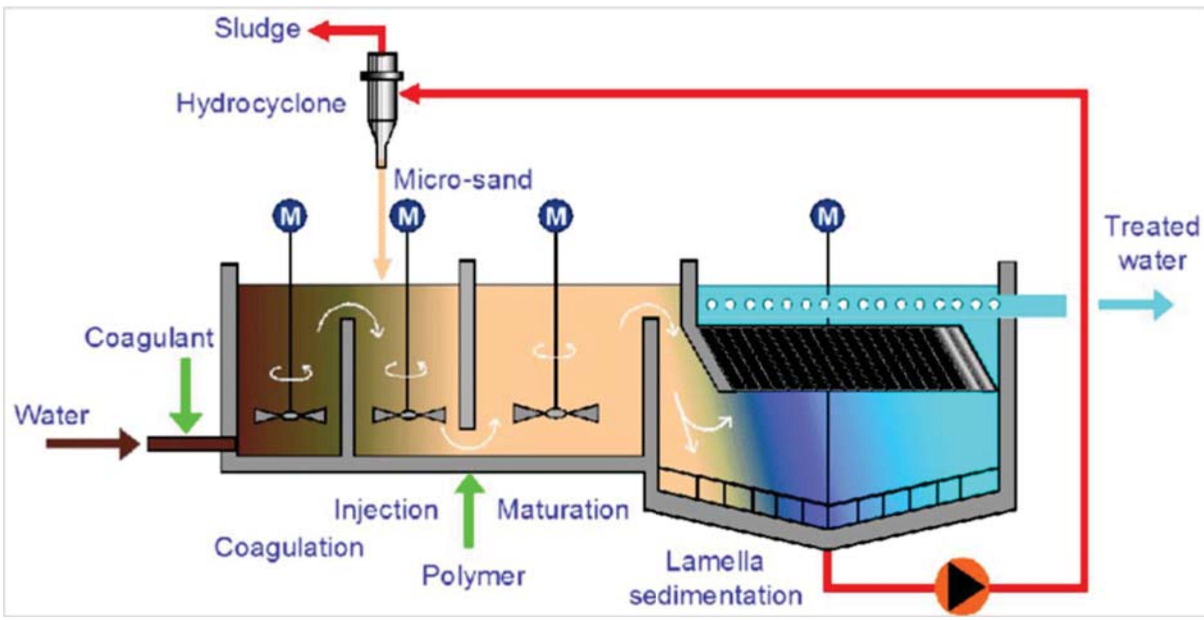


Source: Aqua Aerobic

Figure 3.05-2 Cloth Disk Filter

C. Ballasted Sedimentation

Ballasted sedimentation is a coagulation/sedimentation treatment process that uses a ballast material and the addition of a coagulant and polymer to improve the settling properties of suspended solids. The ballast material provides surface area that enhances flocculation and acts as a weight to increase settling rates. The goal of a ballasted settling system is to form microfloc particles with a specific gravity of greater than two. This high density floc enables settling rates 10 to 60 times greater than conventional clarification. The increased settling rates allow for more compact clarifier designs with high overflow rates and short detention times, which result in smaller overall system footprints. Example ballasted sedimentation technologies include CoMag® System and Actiflo®. An example of the ballasted settling process is shown in Figure 3.05-3.



Source: Veolia Group

Figure 3.05-3 Actiflo® Ballasted Settling

3.06 IMPACT OF EXCESS FLOW DISCHARGES

Because the WRF has facilities in place to allow a portion of flows to be discharged with only clarification in the excess flow clarifiers and disinfection, it is important to consider the impact of excess flow events on average phosphorus discharges, especially at the lower effluent limits. The following are two hypothetical scenarios showing the sensitivity of the lower limits to excess flow discharges.

In the first scenario, the WRF has a seasonal (three-month) effluent phosphorus limit of 0.5 mg/L and achieves an average effluent phosphorus concentration of 0.35 mg/L at an average flow of 3.0 MGD. If the WRF experiences two excess flow events during the three-month period during which a total of 7.5 MGD of partially treated flows are discharged with a phosphorus concentration of 3 mg/L, the average effluent phosphorus concentration would be 0.51 mg/L, violating the seasonal average.

In a similar scenario with a six-month average effluent limit of 0.1 mg/L, which the WRF meets with an average discharge of 0.08 mg/L, it would only take one excess flow event with a discharge of 2.4 MGD of partially treated flows with an excess flow phosphorus concentration of 3 mg/L for the WRF to miss its six-month average limit.

Given the potential impact of excess flow discharges on the average effluent concentrations, the ability to add phosphorus removal chemical to the excess flow clarifiers is essential. In the seasonal scenario with the 0.5 mg/L TP limit described previously, if the TP concentration of the partially treated excess flow was reduced to 1 mg/L, the total excess flow that could be passed before exceeding the six-month limit would be 22.3 MGD. Likewise, in the six-month scenario with the 0.1-mg/L limit, if the TP concentration of the partially treated excess flow was reduced to 0.5 mg/L, the total excess flow that could be passed before exceeding the six-month limit would be 13.9 MGD.

3.07 EFFECT OF DIFFERENT LIMIT DURATIONS

The length of time over which the effluent limit is averaged can have an effect on the target concentration that the WRF would attempt to achieve. For a monthly limit, there is less time for a high effluent concentration value to be “averaged out” for the WRF to still be able to meet the limit. Conversely, for an annual average limit, one, or even several, high effluent samples can easily be negated by the sheer number of other values that will be included in the average calculation. USEPA provides some guidance on a statistical method for determination of limits of varying durations. Based on this guidance and typical operating experience, the target concentration used for dosing projections will be 90 percent of the annual limit, 82 percent of the seasonal limit, and 70 percent of the monthly limit.

SECTION 4
ALTERNATIVES ANALYSIS AND RECOMMENDATIONS

Previous sections of this report presented background information, described and evaluated the projected flows and loadings, and reviewed alternatives necessary to meet future effluent TP monthly average limits of 0.5 mg/L and 0.1 mg/L. This section presents a summary of the analyses of the feasible alternatives, a recommended plan, and an overall cost summary.

4.01 CAPITAL AND OPERATING AND MAINTENANCE (O&M) COST DEVELOPMENT

A. CPR to Meet 0.5-mg/L Limit

The CPR jar testing performed showed that each of the chemicals tested could be used to meet the 0.5-mg/L phosphorus limit on a monthly average basis. The results were used to project the chemical dose required to achieve a target effluent concentration of 0.35 mg/L (70 percent of the monthly limit of 0.5 mg/L), to provide a margin of safety while meeting the 0.5-mg/L limit. Table 4.01-1 shows the volumetric dose rate (gallons of chemical per MGD) and the projected daily dosages at the current daily average flow and at the design average flow. Sizing of the equipment and other components is largely independent of the chemical chosen because the dose rates are of approximately the same magnitude and the tanks are sized based on the volume of the standard delivery of approximately 4,000 gallons. Based on current costs and the projected doses of each of the chemicals, ferric chloride is the most economical choice for phosphorus removal chemical. It had the lowest projected dose rate and it has a lower per gallon cost than PAC. The next most economical choice is PAC , which is more than three times the cost of ferric chloride at current prices. Alum, because of its high dose rate, is the most expensive chemical alternative for phosphorus removal.

	Dose Rate (gal/MGD)	Dose at 3.04 MGD (gpd)	Annual Cost	Dose at 3.50 MGD (gpd)	Annual Cost
Ferric Chloride	45	136	$74,500	156	$85,700
Alum	159	485	$254,700	558	$293,300
PAC	68	206	$225,600	237	$259,500

gal=gallons

Table 4.01-1 Projected CPR Doses and Costs

The amount of additional solids to be generated by CPR was estimated using BioWin. Table 4.01-2 shows the additional weight of solids, the additional volume of digested sludge, the additional weekly run time for the centrifuge to process the additional solids, and the additional volume of dewatered cake for CPR with both ferric chloride and PAC.

	Ferric Chloride	PAC
Extra solids (lb/d)	570	440
Digested Sludge Solids[1]	2.40%	2.40%
Additional Digested Sludge (gpd)	2,850	2,200
Centrifuge Rate (gpm)	155	155
Additional Centrifuge Run time (hrs/wk)	2.1	1.7
Dewatered Cake Solids[1]	20.6%	20.6%
Additional Dewatered Cake (CY/day)	1.3	1.0

Notes:
[1]Average solids for 2020.
gpm=gallons per minute
hrs/wk=hours per week
CY=cubic yards

Table 4.01-2 Projected Additional Solids Generated by CPR

On an annual basis, the additional sludge is projected to be 104 dry tons for ferric chloride, an increase of 34.5 percent of the average over the last three years. PAC is projected to generate an additional 80 dry tons for an increase of 26.5 percent. The volume of this additional dewatered cake at 20.6 percent solids is 460 (cubic yards) CY for ferric chloride and 360 CY for PAC.

The average biosolids production from 2014 through 2017 at the WRF was 1,910 CY; however, the accumulation of biosolids before the spring and fall hauling periods is not equal. The average volume hauled during the spring was 1,160 CY, and the average volume hauled in the fall was 750 CY. The projected volume of biosolids for the spring hauling period, based on the current average production plus the projected additional chemical sludge from ferric chloride, is approximately 1,560 CY. The projected volume for PAC use is approximately 1,470 CY. Operating experience has shown that the capacity of the Biosolids Storage Building is approximately 1,200 CY. It will be assumed that the biosolids exceeding the available storage capacity will be disposed of at a landfill.

Capital costs for the CPR option include construction of an approximately 25- by 32-foot building on one of the existing drying beds. This location has the advantages of being central on the site reducing the length of pipe to the various application points. It is also along one of the site roadways, allowing easier delivery through the south gate through the public works yard. This location is also in an area without buried piping and is one of the only areas on-site that is not in the floodway or floodplain. The building will house one 5,300-gallon tank, three chemical metering pumps to allow dosing to both the forward flow and the excess flow with a redundant pump, and associated electrical and heating and ventilation equipment. Electrical equipment is assumed to be installed in a separately ventilated room with a dedicated entrance to reduce the potential for corrosion of this equipment. If there is space available in the motor control centers in other buildings it is possible that this room could be eliminated, reducing the size and cost of the building. This option will be investigated during design. The chemical facility would also be equipped with an eyewash station, emergency shower, and fire suppression equipment as required by current codes. Control of the chemical pumps through use of an online phosphorus analyzer is recommended and costs for such a unit are included in the capital costs. Recent experience using these analyzers has found that the ability to closely match chemical dose to actual real-time conditions can reduce chemical usage. This analyzer would be installed in the digester blower building (Structure 65) and it would sample from the secondary effluent to pace chemical dose on the

orthophosphate concentration of the fully treated plant effluent. The analyzer would be tied into the WRF. supervisory control and data acquisition system from which the chemical pumps would be controlled.
To allow flexibility of operation and optimization of chemical dose based on full-scale operating experience, at least three chemical application locations are recommended. The three application locations included are the drop box downstream of the weir at the end of the Influent Pumping Station (Structure 10), in the effluent channel in the aeration tanks (Structure 20), and in the drop box downstream of the excess flow weir to the excess flow clarifiers. Each of these locations appear to provide both thorough mixing and residence time in a pipe for flocculation.

The opinion of probable project cost (OPPC) for the CPR improvements to meet that 0.5-mg/L limit are shown in Table 4.01-3. Typical factors were used to project costs for electrical, site, mechanical, and electrical project components. Contractor’s general conditions are estimated at 10 percent. Contingencies and technical services are estimated at 40 percent.

Item	Cost
CPR Building	$200,000
CPR Pump Skid System	$23,500
CPR Tank	$22,400
Phosphorus Analyzer	$37,800
Subtotal	$231,700
Sitework	$42,600
Mechanical	$99,300
HVAC	$19,900
Electrical and Controls	$85,100
Subtotal	$530,600
Contractor’s General Conditions	$53,100
Construction Costs	$583,700
Contingencies and Technical Services	$233,500
Total Capital Costs	**$817,200**

HVAC=heating, ventilation, and air conditioning

Table 4.01-3 OPPC for CPR to Meet 0.5 mg/L Limit

O&M costs for CPR using ferric chloride or PAC have been projected to allow a comparison of total O&M cost, not just the chemical cost for each chemical. These costs will include chemicals, power, and handling and disposal of additional sludge generated by precipitation of the phosphorus including landfill costs for disposal of biosolids in excess available storage volume. Chemical costs are projected at the design average flow of 3.50 MGD and the dose rate determined during jar testing. Power costs are minimal, equal to the power for pumping chemical and for the heating, ventilation and air conditioning (HVAC) equipment in the chemical building as well as the additional run time for the centrifuge and related equipment. The opinion of annual O&M costs for using ferric chloride for CPR to meet 0.5 mg/L is shown in Table 4.01-4. The opinion of annual O&M costs for using PAC for CPR to meet 0.5 mg/L is shown in Table 4.01-5.

Element	Quantity	Rate	Annual Cost
Chemical Costs	136 gpd	$1.50 per gallon	$74,500
Land Application Costs	107 CY	$25.25 per CY	$2,700
Landfill Tipping Fees	303 tons	$55 per ton	$16,400
Disposal Container Costs	36 containers	$250 per 10 CY container	$9,000
HVAC and Electrical Costs	13,750 kWh/year	$0.08 per kWh	$1,100
Equipment Maintenance	---	2% of equipment cost	$1,200
Total Annual Cost			**$104,900**

Table 4.01-4 Projected Annual Operating Costs for CPR with Ferric Chloride to Meet 0.5 mg/L Monthly Average Limit

Element	Quantity	Rate	Annual Cost
Chemical Costs	206 gpd	$3.00 per gallon	$225,600
Land Application Costs	94 CY	$25.25 per CY	$2,400
Landfill Tipping Fees	225 tons	$55 per ton	$12,400
Disposal Container Costs	27 containers	$250 per 10 CY container	$6,800
HVAC and Electrical Costs	13,750 kWh/year	$0.08 per kWh	$1,000
Equipment Maintenance	---	2% of equipment cost	$1,200
Total Annual Cost			**$249,400**

Table 4.01-5 Projected Annual Operating Costs for CPR with PAC to Meet 0.5 mg/L Monthly Average Limit

Based on current chemical costs, ferric chloride appears to have the lowest projected O&M costs. The cost of the phosphorus removal chemicals is extremely volatile and a decision on the chemical to be used should be deferred until closer to implementation of the CPR system since the choice of chemical does not impact the design of the system. There are also nonmonetary factors that the Village may wish to consider when choosing a chemical. Ferric chloride is much more corrosive and has greater personal safety concerns than PAC. It also has the tendency to stain chemical loading and handling structures.

As discussed in Section 3, the duration over which the average limit is applied has an impact on the target effluent concentration. The chemical dose and amount of additional sludge generated will therefore differ for the monthly, seasonal, and annual average limits. Table 4.01-6 shows the different projected daily dosages of ferric chloride and PAC to meet a monthly, seasonal, or annual average limit. Table 4.01-7 presents the projected O&M costs to meet the 0.5-mg/L limit on a monthly, seasonal, or annual average basis, respectively.

Limit Duration	Projected Ferric Chloride Dosage (gpd)	Projected PAC Dosage (gpd)
Monthly	136	206
Seasonal	108	159
Annual	93	134

Table 4.01-6 Projected Daily Dosages to Meet 0.5-mg/L Limit

The capital costs of the system required to meet a 0.5-mg/L phosphorus limit on a monthly, seasonal, or annual average basis are the same because the pumps, tank, and building would be unchanged.

	Projected Operating Cost	
Limit Duration	Ferric Chloride	PAC
Monthly	$89,100	$237,300
Seasonal	$71,100	$183,600
Annual	$61,500	$155,000

Table 4.01-7 Projected Annual Operating Costs to Meet Limits of Varying Durations

B. BPR Treatment

Based on the results of the BPR potential testing, it appears that conventional BPR treatment will be unable to meet any phosphorus limits as the sole method of treatment. S2EPBR has been successful in achieving phosphorus removal in instances when the influent wastewater does not appear to support BPR because of the lack of soluble BOD or VFAs. Costs have been developed for implementing a BPR system that could be operated in either a conventional A_2O configuration or an S2EBPR configuration.

As described in Section 3, a tank would be constructed adjacent to the existing aeration tanks. Four mixers would be installed to keep the tank contents in suspension. A cover would be installed over the tank to contain potential odors. Table 4.01-8 shows the OPPC for implementation of BPR treatment using this treatment configuration. These costs include construction of the CPR facilities described above to serve as a backup to the BPR system.

O&M costs for the BPR system include processing and disposal of a small amount of additional solids generated by BPR, power for the mixers and HVAC in the Chemical Building, and equipment maintenance. These costs are presented in Table 4.01-9. These costs assume no chemical addition for polishing to meet the 0.5-mg/L limit.

Item	Cost
CPR Subtotal	$231,700
S2EBPR Tank	$361,700
Slide Gates	$28,000
Grating, Stairs	$16,000
Four Mixers	$116,300
Tank Cover	$123,200
Valve Vault	$22,800
ORP Probe	$5,500
Subtotal	$957,200
Sitework	$95,700
Mechanical	$239,300
HVAC	$19,900
Electrical and Controls	$143,600
Subtotal	$1,455,700
Contractors General Conditions	$145,600
Construction Costs	$1,601,300
Contingencies and Technical Services	$640,500
Total Capital Costs	**$2,241,800**

ORP=oxidation-reduction potential

Table 4.01-8 OPPC for BPR Treatment

Element	Quantity	Rate	Annual Cost
Sludge Disposal Costs	116 CY/year	$25.25 per CY	$2,900
HVAC and Electrical Costs	53,750 kWh/year	$0.08 per kWh	$4,300
Equipment Maintenance	---	2% of equipment cost	$3,700
Total Annual Cost			**$10,900**

Table 4.01-9 Projected Annual Operating Costs for BPR to Meet 0.5 mg/L Monthly Average Limit

Table 4.01-10 present the total present worth costs, considering both capital and O&M costs for the next 20 years, of the CPR, with ferric chloride, and BPR alternatives.

	CPR	BPR
Opinion of Capital Costs	$817,200	$2,241,800
Annual O&M Costs		
Chemicals	$74,500	$0
Sludge Disposal	$28,100	$2,900
Electrical	$1,100	$4,300
Maintenance	$1,200	$3,700
Opinion of Annual O&M Costs	$104,900	$10,900
Present Worth of O&M[1]	$1,597,000	$166,000
Total Opinion of Present Worth Costs	**$2,414,200**	**$2,407,800**

[1]Project life = 20 years. Discount rate = 2.75 percent.

Table 4.01-10 Total Present Worth Costs for Treatment Alternatives to Meet a 0.5 mg/L TP Limit

The OPCC of the CPR alternative is the lowest of the two alternatives, approximately, 36.5 percent of the OPCC for the BPR alternative. The opinion of the total present worth cost is approximately equal for the two alternatives.

C. Tertiary Treatment to Meet 0.1 mg/L Limit

1. Blue PRO Reactive Filtration

A proposal for the costs of the reactive filtration equipment was received from the manufacturer and is included in Appendix C. The CPR system previously described is included with each of the tertiary treatment alternatives as each will require an influent phosphorus concentration of 1 mg/L or less before tertiary treatment. A separate chemical feed system is included in the reactive filtration equipment scope for the reactive filtration. It may be possible to combine these two systems as a cost savings measure. This concept would be investigated during design.

2. Cloth Disk Filters

A proposal for the costs of the cloth disk filter equipment was received from the manufacturer and is included in Appendix C. The filters would be installed in concrete tanks inside of a new building that would also house the rapid mix, flocculation, and coagulation tanks as well as the polymer system and electrical equipment. Costs would also include the CPR system and the intermediate pumping station.

3. Ballasted Clarification

A proposal for the costs of the Actiflo® ballasted clarification equipment was received from the manufacturer and is included in Appendix C. Based on costs provided by the manufacturer and the OPPC for the concrete tanks, it appears that the steel tanks have a lower capital costs. A proposal for the costs of the equipment was received from the manufacturer and is included in Appendix C. The proposal included steel tanks as well as the sand recirculation pumps, mixers, valves, polymer feed system, settling tank equipment, and controls and electrical equipment. Costs also include the CPR system and the intermediate pumping station.

The OPPC for the tertiary treatment alternatives to meet the 0.1-mg/L TP effluent limit is shown in in Table 4.01-11.

	Reactive Filtration	**Cloth Filters**	**Ballasted Settling**
Equipment	$1,859,000	$1,447,000	$1,725,000
Control Building	$961,000	$815,000	$1,186,000
Intermediate Pumping Station	$328,200	$328,200	$328,200
CPR Subtotal	$283,700	$283,700	$283,700
Subtotal	$3,431,900	$2,873,900	$3,522,900
Sitework	$343,200	$287,400	$528,400
Mechanical	$686,400	$574,800	$880,700
HVAC	$103,000	$86,200	$246,600
Electrical and Controls	$686,400	$574,800	$704,600
Subtotal	$5,250,900	$4,397,100	$5,883,200
Contractors General Conditions (10%)	$525,100	$439,700	$588,300
Construction Costs	$5,776,000	$4,836,800	$6,471,500
Contingencies and Technical Services (40%)	$2,310,400	$1,934,700	$2,588,600
Total Capital Costs	**$8,086,400**	**$6,771,500**	**$9,060,100**

Table 4.01-11 OPCC for Tertiary Treatment Alternatives to Meet 0.1-mg/L TP Limit

O&M costs for the three alternatives to meet the monthly limit of 0.1-mg/L are presented in Table 4.01-12. Projected costs for chemicals were provided by the manufacturers for reactive filtration and ballasted clarification. The ballasted clarification chemical costs include polymer and replacement sand in addition to the phosphorus removal chemical. Chemical costs for the cloth filters were assumed to be the same as for reactive filtration with regard to the phosphorus removal chemical. The projected polymer costs for cloth filters was provided by the cloth filter manufacturer. Electrical costs included projected equipment costs from the equipment manufacturers and projected intermediate pumping costs. Projected maintenance costs included maintenance costs provided by the equipment manufacturers plus 2 percent of the costs of the intermediate pumping equipment.

Element	Reactive Filtration	Cloth Media Filters	Ballasted Clarification
Chemical Costs	$85,000	$99,000	$103,000
Sludge Disposal Costs	$16,700	$16,700	$16,700
HVAC and Electrical Costs	$48,000	$25,000	$34,000
Equipment Maintenance	$18,000	$21,000	$14,000
Total Annual Cost	**$167,700**	**$161,700**	**$167,700**

Table 4.01-12 Projected Annual Operating Costs for CPR to Meet a 0.1 mg/L Monthly Limit

The total present worth of the three alternatives are presented in Table 4.01-13. The cloth media filter alternative has the lowest present worth cost. Reactive filtration has the second lowest total present worth, 115 percent of the total present worth of the cloth media filters.

	Reactive Filtration	Cloth Media Filter	Ballasted Clarification
OPPC	$8,086,400	$6,771,500	$9,060,100
Annual O&M Costs			
Chemicals	$85,000	$99,000	$103,000
Sludge Disposal	$16,700	$16,700	$16,700
Electrical	$48,000	$25,000	$34,000
Maintenance	$18,000	$21,000	$14,000
Opinion of Annual O&M Costs	$167,700	$161,700	$167,700
Present Worth of O&M[1]	$2,554,000	$2,462,000	$2,554,000
Total Opinion of Present Worth Costs	**$10,640,400**	**$9,233,500**	**$11,614,100**

Note: [1] Project life = 20 years. Discount rate = 2.75 percent.

Table 4.01-13 Total Present Worth Costs for Treatment Alternatives to Meet a 0.1 mg/L TP Limit

4.02 NONMONETARY CONSIDERATIONS

Each of the treatment alternatives presented has nonmonetary advantages and disadvantages. BPR treatment, being a solely biological treatment process, can be susceptible to upsets. As stated previously, a back-up chemical system is required. It does have the advantages of generating less additional sludge and not requiring frequent chemical deliveries and potential exposure of WRF staff to corrosive chemicals. CPR is a straightforward process to operate and is generally very reliable. Ferric chloride is also corrosive and can pose safety concerns for WRF personnel.

4.03 RECOMMENDATIONS

Because the OPCC of CPR is less than that of BPR, and the total present worth of the alternatives is approximately the same, and given the uncertainty of the success of BPR based on the initial jar testing, Strand recommends implementation of CPR to meet the future limit. Strand recommends incorporating the ability to dose chemical before and after the aeration tanks, as well as immediately downstream of the excess flow downward opening weir gate to allow treatment of excess flows.

After implementation of CPR to meet the 0.5-mg/L limit, Strand recommends full-scale trials to better understand chemical dosages that may be required to meet lower limits. Strand also recommends thorough sampling and analytical testing to determine the nature of the phosphorus speciation at the WRF. As discussed in Section 1, the WRF's ability to meet very low limits will be, in part, determined by the nature of the phosphorus at the WRF and how much of the phosphorus is nonreactive. Strand also recommends pilot testing of the technologies evaluated to meet the potential 0.1-mg/L limit to better assign site-specific factors to the capital and O&M costs of these technologies.

APPENDIX A
VILLAGE NPDES PERMIT

NPDES Permit No. IL0028347

Notice No. GY:16020801.bah

Public Notice Beginning Date: **March 19, 2020**

Public Notice Ending Date: **April 20, 2020**

National Pollutant Discharge Elimination System (NPDES)
Permit Program

PUBLIC NOTICE/FACT SHEET
of
Draft Reissued NPDES Permit to Discharge into Waters of the State

Public Notice/Fact Sheet Issued By:

Illinois EPA
Division of Water Pollution Control
Permit Section
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276
217/782-0610

Name and Address of Discharger:

Village of Deerfield
465 Elm Street
Deerfield, Illinois 60015

Name and Address of Facility:

Deerfield Wastewater Reclamation Facility
1045 Hackberry Road
Deerfield, Illinois 60015
(Lake County)

The Illinois Environmental Protection Agency (IEPA) has made a tentative determination to issue a NPDES Permit to discharge into the waters of the state and has prepared a draft Permit and associated fact sheet for the above named discharger. The Public Notice period will begin and end on the dates indicated in the heading of this Public Notice/Fact Sheet. All comments on the draft Permit and requests for hearing must be received by the IEPA by U.S. Mail, carrier mail or hand delivered by the Public Notice Ending Date. Interested persons are invited to submit written comments on the draft Permit to the IEPA at the above address. Commentors shall provide his or her name and address and the nature of the issues proposed to be raised and the evidence proposed to be presented with regards to those issues. Commentors may include a request for public hearing. Persons submitting comments and/or requests for public hearing shall also send a copy of such comments or requests to the Permit applicant. The NPDES Permit and notice numbers must appear on each comment page.

The application, engineer's review notes including load limit calculations, Public Notice/Fact Sheet, draft Permit, comments received, and other documents are available for inspection and may be copied at the IEPA between 9:30 a.m. and 3:30 p.m. Monday through Friday when scheduled by the interested person.

If written comments or requests indicate a significant degree of public interest in the draft Permit, the permitting authority may, at its discretion, hold a public hearing. Public notice will be given 45 days before any public hearing. Response to comments will be provided when the final Permit is issued. For further information, please call Getie Yilma at 217/782-0610.

The following water quality and effluent standards and limitations were applied to the discharge:

Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board and the Clean Water Act were applied in determining the applicable standards, limitations and conditions contained in the draft Permit.

The applicant is engaged in treating domestic and industrial wastewater for the Village of Deerfield.

The length of the Permit is approximately 5 years.

The main discharge number is B01. The seven day once in ten year low flow (7Q10) of the receiving stream, West Fork of the North Branch of the Chicago River is 0 cfs.

The design average flow (DAF) for the facility is 3.5 million gallons per day (MGD) and the design maximum flow (DMF) for the facility is 8.0 MGD. Treatment consists of screening, grit removal, activated sludge, final clarifiers, UV disinfection, excess flow treatment, aerobic digestion, sludge dewatering and sludge holding tanks.

This Reissued Permit does not increase the facility's DAF, DMF, concentration limits, and/or load limits.

The Permittee is currently participating in the North Branch Chicago River Watershed Workgroup (NBWW). The Permittee shall work with other watershed members of the NBWW to determine the most cost effective means to remove dissolved oxygen (DO) and offensive condition impairments in the North Branch Chicago River Watershed to the extent feasible. The Permittee shall participate in the NBWW for the completion of the Bioassessment Monitoring Program Plan of the North Branch Chicago River Watershed Bioassessment Quality.

Federal law requires that permits for excess flow discharges include the 7-day and 30-day SS and BOD5 concentration limitations and 85 percent removal requirements (unless the IEPA reduces or eliminates the percent removal requirements in accordance with 133.103(a) or (d)) specified in 40 CFR 133.102. IEPA is using an alternative effluent concentration limit based on the intermittent nature of the discharge. EPA is exercising its discretion to not object to this permit, but that EPA expects that future permits will include the 7-day SS and BOD5 concentration limits; and also the 85 percent removal requirements (unless the IEPA reduces or eliminates the percent removal requirements in accordance with 133.103(a) or (d)) for any excess flow discharge to receiving waters.

Application is made for the existing discharge(s) which are located in Lake County, Illinois. The following information identifies the discharge point, receiving stream and stream classifications:

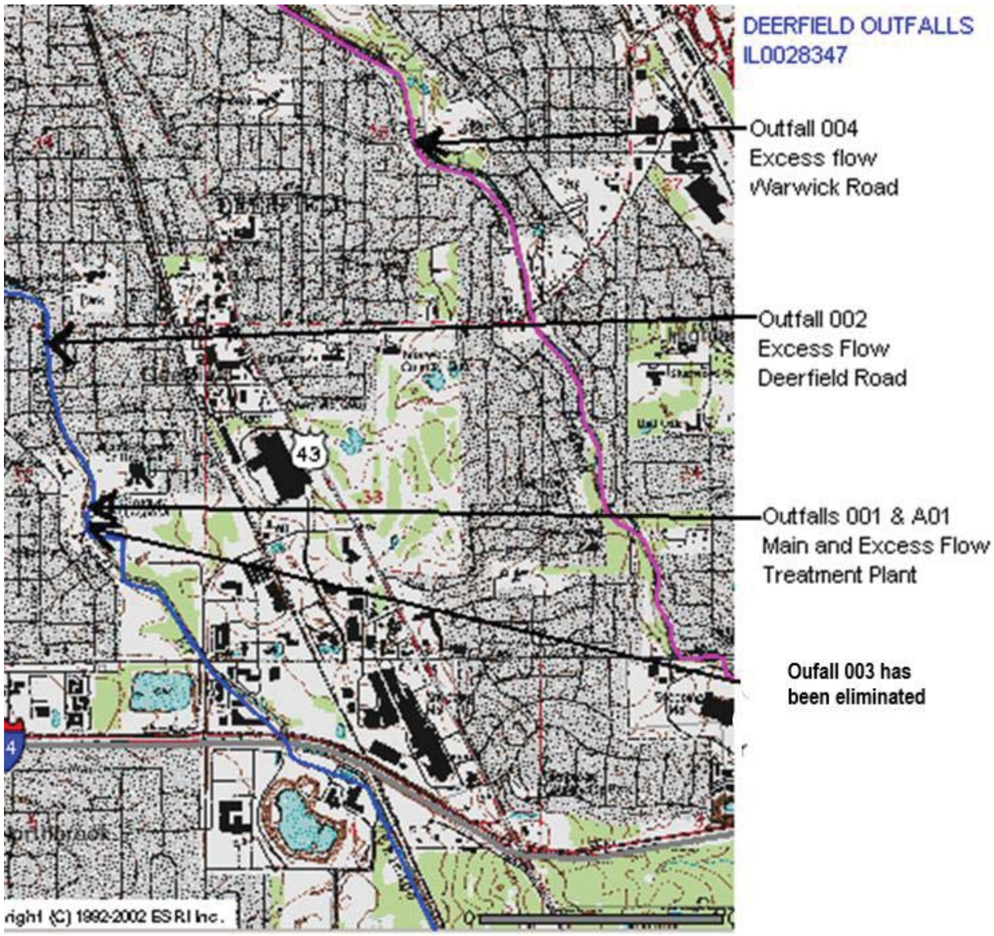
Discharge Number	Receiving Stream	Latitude	Longitude	Stream Classification	Integrity Rating
B01 (STP Outfall)	West Fork of the North Branch of the Chicago River	42° 09′ 31″ North	87° 51′ 17″ West	General Use	E
A01 (Excess Flow)	West Fork of the North Branch of the Chicago River	42° 09′ 31″ North	87° 51′ 17″ West	General Use	E
001 (Combined Outfall)	West Fork of the North Branch of the Chicago River	42° 09′ 31″ North	87° 51′ 17″ West	General Use	E
002 (Deerfield Road)	West Fork of the North Branch of the Chicago River	42° 10′ 02″ North	87° 51′ 26″ West	General Use	E
004 (Warwick Road)	Middle Fork of the North Branch of the Chicago River	42° 10′ 29″ North	87° 50′ 09″ West	General Use	D

To assist you further in identifying the location of the discharge(s) please see the map on next page.

The stream segment (Waterbody segment HCCB-05) receiving the discharge from outfall(s) B01 is on the 303(d) list of impaired waters.

The following parameters have been identified as the pollutants causing impairment:

Potential Causes	Uses Impaired
Aldrin, alteration in stream-side or littoral vegetative cover (non-pollutant), changes in stream depth and velocity (non-pollutant), chloride, DDT, endrin, hexochlorobenzine, dissolved oxygen (non-pollutant), phosphorus and total suspended solids (TSS)	Aquatic life
Fecal coliform	Primary contact recreation


DEERFIELD OUTFALLS
IL0028347
Outfall 004
Excess flow
Warwick Road
Outfall 002
Excess Flow
Deerfield Road
Outfalls 001 & A01
Main and Excess Flow
Treatment Plant
Oufall 003 has
been eliminated
43
right (C) 1992-2002 ESRI Inc.

The discharge(s) from the facility is (are) proposed to be monitored and limited at all times as follows:

Discharge Number(s) and Name(s): B01 STP Outfall

Load limits computed based on a design average flow (DAF) of 3.5 MGD (design maximum flow (DMF) of 8.0 MGD).

The effluent of the above discharge(s) shall be monitored and limited at all times as follows:

	LOAD LIMITS lbs/day DAF (DMF)*			CONCENTRATION LIMITS mg/L			
Parameter	Monthly Average	Weekly Average	Daily Maximum	Monthly Average	Weekly Average	Daily Maximum	Regulation
$CBOD_5$**	292 (667)		584 (1334)	10		20	35 IAC 304.120 40 CFR 133.102
Suspended Solids**	350 (801)		701 (1601)	12		24	35 IAC 304.120 40 CFR 133.102
pH	Shall be in the range of 6 to 9 Standard Units						35 IAC 304.125
Fecal Coliform	Daily Maximum shall not exceed 400 per 100 mL (May through October)						35 IAC 304.121
Chlorine Residual						0.05	35 IAC 302.208
Ammonia Nitrogen: March	76 (173)	155 (354)	234 (534)	2.6	5.3	8.0	35 IAC 355 and 35 IAC 302
April-October	44 (100)		88 (200)	1.5		3.0	
Nov.-Feb.	117 (267)		234 (534)	4.0		8.0	
Total Phosphorus (as P)	29 (67)			1.0			35 IAC 309.146
Total Nitrogen (as N)	Monitor only						35 IAC 309.146
Chloride	Monitor only						35 IAC 309.146
Dissolved Phosphorus	Monitor Only						35 IAC 309.146
Nitrate/Nitrite	Monitor Only						35 IAC 309.146
Total Kjeldahl Nitrogen (TKN)	Monitor Only						35 IAC 309.146
Alkalinity	Monitor Only						35 IAC 309.146
Temperature	Monitor Only						35 IAC 309.146
Specific Conductivity	Monitor Only						35 IAC 309.146
				Monthly Avg. not less than	Weekly Avg. not less than	Daily Minimum	
Dissolved Oxygen March-July				N/A	6.0	5.0	35 IAC 302.206
August-February				5.5	4.0	3.5	

*Load Limits are calculated by using the formula: 8.34 x (Design Average and/or Maximum Flow in MGD) x (Applicable Concentration in mg/L)

**BOD_5 and Suspended Solids (85% removal required): In accordance with 40 CFR 133, the 30-day average percent removal shall not be less than 85 percent.

This Permit contains an authorization to treat and discharge excess flow as follows:

Discharge Number(s) and Name(s): A01 Excess Flow Outfall (Flow in excess of 5,556 gpm)

	CONCENTRATON LIMITS (mg/L)		
Parameter	Daily Maximum		Regulation
BOD_5	Monitor Only		35 IAC 309.146
Suspended Solids	Monitor Only		35 IAC 309.146
Ammonia Nitrogen (as N)	Monitor Only		35 IAC 309.146
Total Phosphorus (as P)	Monitor Only		35 IAC 309.146

Discharge Number(s) and Name(s): 001 Combined Discharge from A01 and B01 outfall

The effluent of the above discharge(s) shall be monitored and limited at all times a follows:

	CONCENTRATION LIMITS (mg/L)		
Parameter	Monthly Average	Weekly Average	Regulation
Fecal Coliform	Daily maximum shall not exceed 400 per 100 mL		35 IAC 304.121
BOD_5	30	45	40 CFR 133.102
Suspended Solids	30	45	40 CFR 133.102
pH	Shall be in the range of 6 to 9 standard units		35 IAC 304.125
Chlorine Residual	0.75		35 IAC 302.208
Ammonia Nitrogen (as N)	Monitor only		35 IAC 355 and 35 IAC 302
Total Phosphorus (as P)	Monitor only		35 IAC 309.146
Dissolved Oxygen	Monitor only		35 IAC 302.206

This Permit contains an authorization to treat and discharge excess flow as follows:

Discharge Number(s) and Name(s): 002 - Deerfield Road Excess Flow Discharge
004 - Warwick Road Excess Flow Discharge

	CONCENTRATION LIMITS (mg/L)		
arameter	Monthly Average		Regulation
CBOD5	*		40 CFR 133.102
Suspended Solids	*		40 CFR 133.102
Fecal Coliform	Daily Maximum Shall Not Exceed 400 per 100 mL		35 IAC 304.121
pH	Shall be in the range of 6 to 9 Standard Units		35 IAC 304.125
Chlorine Residual	0.75		35 IAC 304.208
Ammonia Nitrogen (N)	Monitor Only		35 IAC 309.146
Total Phosphorus (as P)	Monitor Only		35 IAC 309.146
Dissolved Oxygen	Monitor Only		35 IAC 309.146

Discharge Number(s) and Name(s): 002 - Deerfield Road Excess Flow Discharge (continued from the previous Page)
004 - Warwick Road Excess Flow Discharge

*Concentration Limits (L) shall be determined by the following equation:

$L = -15/23\ (D) + 49.565$

Where D = number of days of discharge per month

L = monthly average effluent limitations for BOD5 and Suspended Solids in mg/L

This draft Permit also contains the following requirements as special conditions:

1. Reopening of this Permit to include different final effluent limitations.

2. Operation of the facility by or under the supervision of a certified operator.

3. Submission of the operational data in a specified form and at a required frequency at any time during the effective term of this Permit.

4. More frequent monitoring requirement without Public Notice.

5. Prohibition against causing or contributing to violations of water quality standards.

6. Recording the monitoring results on Discharge Monitoring Report Forms using one such form for each outfall each month and submitting the forms to IEPA each month.

7. Provisions of 40 CFR Section 122.41 (m) & (n).

8. Effluent sampling point location.

9. Controlling the sources of infiltration and inflow into the sewer system.

10. Seasonal fecal coliform limits.

11. Monitoring for arsenic, barium, cadmium, hexavalent chromium, total chromium, copper, available cyanide, total cyanide, fluoride, dissolved iron, total iron, lead, manganese, mercury, nickel, oil, phenols, selenium, silver and zinc is required to be conducted semi-annually beginning 3 months from the effective date.

12. Submission of annual fiscal data.

13. Submission of semi annual reports indicating the quantities of sludge generated and disposed.

14. Reopening of this Permit to include revised effluent limitations based on a Total Maximum Daily Load (TMDL) or other water quality study.

15. The Permittee is required to perform biomonitoring tests in the 18th, 15th, 12th and 9th months prior to the expiration date of the permit, and to submit the results of such tests to the IEPA within one week of receiving the results from the laboratory.

16. A requirement for participation in the North Branch Chicago River Watershed Workgroup (NBWW).

17. Monitoring for total phosphorus, dissolved phosphorus, nitrate/nitrite, total kjeldahl nitrogen (TKN), ammonia, total nitrogen (calculated), alkalinity, specific conductivity, chloride and temperature once a month.

18. Capacity, Management, Operations and Maintenance (CMOM) requirements..

19. Submission of a Phosphorus Removal Feasibility Study (PRFS).

20. Reasonable potential analysis and mixing study plan.

21. Submission of a Phosphorus Discharge Optimization Plan.

22. Compliance Schedule for meeting 1.0 mg/L phosphorus limit.

23. Requirement to meet 0.5 mg/L phosphorus limit by January 1, 2030.

24. Nutrient Assessment Reduction Plan Requirements.

25. BOD_5 and Suspended Solids Effluent Report.

NPDES Permit No. IL0028347

Illinois Environmental Protection Agency

Division of Water Pollution Control

1021 North Grand Avenue East

Post Office Box 19276

Springfield, Illinois 62794-9276

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Reissued (NPDES) Permit

Expiration Date:

Issue Date:
Effective Date:

Name and Address of Permittee:

Village of Deerfield
65 Elm Street456789
Deerfield, Illinois 60015-+

Facility Name and Address:

Deerfield Wastewater Reclamation Facility
1045 Hackberry Road
Deerfield, Illinois 60015
(Lake County)

Receiving Waters: West Fork of the North Branch of the Chicago River

In compliance with the provisions of the Illinois Environmental Protection Act, Title 35 of the Ill. Adm. Code, Subtitle C, Chapter I, and the Clean Water Act (CWA), the above-named Permittee is hereby authorized to discharge at the above location to the above-named receiving stream in accordance with the Effluent Limitations, Monitoring, and Reporting requirements; Special Conditions and Attachment H Standard Conditions attached herein.

Permittee is not authorized to discharge after the above expiration date. In order to receive authorization to discharge beyond the expiration date, the Permittee shall submit the proper application as required by the Illinois Environmental Protection Agency (IEPA) not later than 180 days prior to the expiration date.

Amy L. Dragovich, P.E.
Manager, Permit Section
Division of Water Pollution Control

ALD:16020802.bah

NPDES Permit No. IL0028347

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Name(s): B01 STP Outfall

Load limits computed based on a design average flow (DAF) of 3.5 MGD (design maximum flow (DMF) of 8.0 MGD).

From the effective date of this Permit until the expiration date, the effluent of the above discharge(s) shall be monitored and limited at all times as follows:

	LOAD LIMITS lbs/day DAF (DMF)*			CONCENTRATION LIMITS mg/L				
Parameter	Monthly Average	Weekly Average	Daily Maximum	Monthly Average	Weekly Average	Daily Maximum	Sample Frequency	Sample Type
Flow (MGD)							Continuous	
$CBOD_5$**,[1]	292 (667)		584 (1334)	10		20	1 Day/Week	Composite
Suspended Solids[1]	350 (801)		701 (1601)	12		24	1 Day/Week	Composite
pH	Shall be in the range of 6 to 9 Standard Units						1 Day/Week	Grab
Fecal Coliform***	Daily Maximum shall not exceed 400 per 100 mL (May through October)						1 Day/Week	Grab
Chlorine Residual						0.05	***	Grab
Ammonia Nitrogen: As(N) March	76 (173)	155(354)	234 (534)	2.6	5.3	8.0	1 Day/Week	Composite
April –October	44 (100)		88 (200)	1.5		3.0	1 Day/Week	Composite
Nov.-Feb.	117 (267)		234 (534)	4.0		8.0	1 Day/Week	Composite
Total Phosphorus (as P)	29 (67)			1.0			1 Day/ Month[2]	Composite
Total Nitrogen	Monitor only						1 Day/ Month	Composite
Chloride	Monitor only						1 Day/Month	Composite
Dissolved Phosphorus	Monitor Only						1 Day/Month	Composite
Nitrate/Nitrite	Monitor Only						1 Day/Month	Composite
Total Kjeldahl Nitrogen (TKN)	Monitor Only						1 Day/Month	Composite
Alkalinity	Monitor Only						1 Day/Month	Grab
Temperature	Monitor Only						1 Day/Month	Grab
Specific Conductivity	Monitor Only						1 Day/Month	Grab
				Monthly Average not less than	Weekly Average not less than	Daily Minimum		
Dissolved Oxygen March-July				N/A	6.0	5.0	1 Day/Week	Grab
August-February				5.5	4.0	3.5	1 Day/Week	Grab

*Load limits based on design maximum flow shall apply only when flow exceeds design average flow.
**Carbonaceous BOD_5 ($CBOD_5$) testing shall be in accordance with 40 CFR 136.
***See Special Condition 10.

NPDES Permit No. IL0028347

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Name(s): B01 STP Outfall (Continued)

[1]BOD_5 and Suspended Solids (85% removal required): In accordance with 40 CFR 133, the 30-day average percent removal shall not be less than 85 percent. The percent removal need not be reported to the IEPA on DMRs but influent and effluent data must be available, as required elsewhere in this Permit, for IEPA inspection and review. For measuring compliance with this requirement, 5 mg/L shall be added to the effluent $CBOD_5$ concentration to determine the effluent BOD_5 concentration.

Percent removal is a percentage expression of the removal efficiency across a treatment plant for a given pollutant parameter, as determined from the 30-day average values of the raw wastewater influent concentrations to the facility and the 30-day average values of the effluent pollutant concentrations for a given time period.

[2]Upon the effective date of the phosphorus effluent limits, the sampling frequency shall increase to 1 day/week.

Flow shall be reported on the Discharge Monitoring Report (DMR) as monthly average and daily maximum.

Fecal Coliform shall be reported on the DMR as a daily maximum value.

pH shall be reported on the DMR as minimum and maximum value.

Chlorine Residual shall be reported on DMR as daily maximum value.

Dissolved oxygen shall be reported on the DMR as a minimum value.

Total Phosphorus shall be reported on the DMR as a daily maximum and monthly average value.

Total Nitrogen shall be reported on the DMR as a daily maximum value. Total Nitrogen is the sum total of Total Kjeldahl Nitrogen, Nitrate, and Nitrite.

NPDES Permit No. IL0028347

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Name(s): A01 Excess Flow Outfall (flows in excess of 5,556 gpm)

These flow facilities shall not be utilized until the main treatment facility is receiving its design maximum flow (DMF)* (flow in excess of 5,556 gpm).

From the effective date of this Permit until the expiration date, the effluent of the above discharge(s) shall be monitored and limited at all times as follows:

	CONCENTRATION LIMITS (mg/L)		
Parameter	Daily Maximum	Sample Frequency	Sample Type
Total Flow (MG)		Daily When Discharging	Continuous
BOD_5	Monitor Only	Daily When Discharging	Grab
Suspended Solids	Monitor Only	Daily When Discharging	Grab
Ammonia Nitrogen (As N)	Monitor Only	Daily When Discharging	Grab
Total Phosphorus (as P)	Monitor Only	Daily When Discharging	Grab

*An explanation shall be provided in comments section of the DMR should these facilities be used when the main treatment facility is not receiving Design Maximum Flow (DMF). The explanation shall identify the reasons the main facility is at a diminished treatment capacity. Additionally, the Permittee shall comply with the provisions of Special Condition 7.

The duration of each A01 discharge and rainfall event (i.e., start and ending time) including rainfall intensity shall be provided in the comment section of the DMR.

Total flow in million gallons shall be reported on the Discharge Monitoring Report (DMR) in the quantity maximum column. The main treatment facility flows at the time that A01 Excess Flow facilities are first utilized shall be reported in the comment section of the DMR in gallons per minute.

Fecal Coliform shall be reported on the DMR as daily maximum value.

BOD_5 and Suspended Solids shall be reported on the DMR as a daily maximum value.

Ammonia Nitrogen shall be reported on the DMR as a daily maximum value.

Total Phosphorus shall be reported on the DMR as a monthly average and daily maximum value.

NPDES Permit No. IL0028347

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Names(s): 001 Combined Discharge from A01 and B01 Outfall*

From the effective date of this Permit until the expiration date, the effluent of the above discharge(s) shall be monitored and limited at all time as follows:

	CONCENTRATION LIMITS (mg/L)			
Parameter	Monthly Average	Weekly Average	Sample Frequency	Sample Type
Total Flow (MG)			Daily When A01 is Discharging	Continuous
Fecal Coliform	Daily maximum shall not exceed 400 per mL		Daily When A01 is Discharging	Grab
BOD **	30	45	Daily When A01 is Discharging	Grab
Suspended Solids **	30	45	Daily When A01 is Discharging	Grab
pH	Shall be in the range of 6 to 9 Standard Units		Daily When A01 is Discharging	Grab
Chlorine Residual	0.75		****	Grab
Ammonia Nitrogen (as N)***	Monitor only		Daily When A01 is Discharging	Grab
Total Phosphorus (as P)	Monitor only		Daily When A01 is Discharging	Grab
Dissolved Oxygen***	Monitor only		Daily When A01 is Discharging	Grab

*An explanation shall be provided in comment section of the DMR should these facilities be used when the main treatment facility is not receiving Design Maximum Flow (DMF). The explanation shall identify the reasons the main facility is at a diminished treatment capacity. Additionally, the Permittee shall comply with the provisions of Special Condition 7.

** BOD_5 and Suspended Solids (85% removal required) For Discharge No. 001: In accordance with 40 CFR 133, the 30-day average percent removal shall not be less than 85 percent. The percent removal need not be reported to the IEPA on DMRs but influent and effluent data must be available, as required elsewhere in this Permit, for IEPA inspection and review. For measuring compliance with this requirement, 5 mg/L shall be added to the effluent $CBOD_5$ concentration to determine the effluent BOD_5 concentration.

Percent removal is a percentage expression of the removal efficiency across a treatment plant for a given pollutant parameter, as determined from the 30-day average values of the raw wastewater influent concentrations to the facility and the 30-day average values of the effluent pollutant concentrations for a given time period.

***See Special Condition 20.

****Any use of chlorine to control slime growths, odors or as an operational control, etc. shall not exceed the limit of 0.75 mg/L (daily maximum) total residual chlorine in the effluent. Sampling is required on a daily grab basis during the chlorination process.

Total flow in million gallons shall be reported on the Discharge Monitoring Report (DMR) in the quantity maximum column.
Report the number of days of discharge in the comments section of the DMR.
BOD_5 and Suspended Solids shall be reported on the DMR as a monthly and weekly average concentration.
pH shall be reported on the DMR as a minimum and a maximum.
Chlorine Residual shall be reported on the DMR as monthly average.
Total Phosphorus shall be reported on the DMR as a monthly average and daily maximum value.

A monthly average value for ammonia shall be computed for each month that A01 discharges beginning one month after the effective date of the permit. A monthly average concentration shall be determined by combining data collected from 001 and B01 (only B01 data from days when A01 is not discharging) for the reporting period. These monitoring results shall be submitted to the Agency on the DMR. Ammonia Nitrogen shall also be reported on the DMR as a maximum value.

A monthly and weekly average value for Dissolved Oxygen (DO) shall be computed for each month that A01 discharges beginning one month after the effective date of the permit. The monthly and weekly average concentrations for 001 shall be determined by combining data collected from 001 and B01 (only B01 data from days when A01 is not discharging) for the reporting period. These monitoring results shall be submitted to the Agency on the DMR. DO shall also be reported on the DMR as a minimum value.

NPDES Permit No. IL0028347

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Name(s): 002 Deerfield Road Excess Flow Discharge*
004 Warwick Road Excess Flow Discharge*

From the effective date of this Permit until the expiration date, the effluent of the above discharge(s) shall be monitored and limited at all time as follows:

	CONCENTRATION LIMITS (mg/L)		
Parameter	Monthly Average	Sample Frequency	Sample Type
Total Flow (MG)		Daily When Discharging	Continuous
BOD_5	**	Daily When Discharging	Grab
Suspended Solids	**	Daily When Discharging	Grab
Fecal Coliform	Daily Maximum shall not exceed 400 per 100 mL	Daily When Discharging	Grab
pH	Shall be in the range of 6 to 9 Standard Units	Daily When Discharging	Grab
Chlorine Residual***	0.75	Daily When Discharging	Grab
Ammonia Nitrogen (as N)[(1)]	Monitor only	Daily When Discharging	Grab
Total Phosphorus (as P)	Monitor only	Daily When Discharging	Grab
Dissolved Oxygen	Monitor only	Daily When Discharging	Grab

* These flow facilities shall not be utilized until the weir elevations below are met during wet weather events. The weir elevation for each station is as follows:
002 Deerfield Rd. Excess Flow Station Discharge - 641.92 ft
004 Warwick Rd. Excess Flow Station Discharge - 650.50 ft
Activation Points elevations are relative to sea level.
Additionally, the Permittee shall comply with the provisions of Special Condition 7.

[(1)] See Special Condition 20.

**Concentration Limits (L) shall be determined by the following equation:

$L = -15/23 (D) + 49.565$
Where D = number of days of discharge per month
L = monthly average effluent limitations for BOD5 and Suspended Solids in mg/L

***Any use of chlorine to control slime growths, odors or as an operational control, etc. shall not exceed the limit of 0.75 mg/L (daily maximum) total residual chlorine in the effluent. Sampling is required on a daily grab basis during the chlorination process.

Total flow in million gallons shall be reported on the Discharge Monitoring Report (DMR) in the quantity maximum column. The main treatment facility flows at the time that A01 excess Flow facilities are first utilized shall be reported in the comment section of the DMR in gallons per minute (gpm).
Report the number of days of discharge in the comments section of the DMR.
BOD_5 and Suspended Solids shall be reported on the DMR as a monthly and weekly average concentration.
pH shall be reported on the DMR as a minimum and a maximum.
Fecal Coliform shall be reported on the DMR as daily maximum value.
Chlorine Residual shall be reported on the DMR as monthly average.
Total Phosphorus shall be reported on the DMR as a monthly average and daily maximum value.
Ammonia Nitrogen shall be reported on the DMR as a monthly average and daily maximum value.
Dissolved Oxygen shall be reported on the DMR as a minimum value.

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Influent Monitoring, and Reporting

The influent to the main plant discharging to Outfalls B01 and 001 shall be monitored as follows:

Parameter	Sample Frequency	Sample Type
Flow (MGD)	Continuous	
BOD_5	1 Day/Week And daily when A01 is discharging	Composite
Suspended Solids	1 Day/Week And daily when A01 is discharging	Composite
Total Phosphorus (as P)	1 Day/month And daily when A01 is discharging	Composite

Influent samples shall be taken at a point representative of the influent.

Flow (MGD) shall be reported on the Discharge Monitoring Report (DMR) as monthly average and daily maximum.

BOD_5 and Suspended Solids shall be reported on the DMR as a monthly average concentration.

The influent to the Deerfield and Warwick Road facilities discharging to Outfalls 002 and 004 shall be monitored as follows:

Parameter	Sample Frequency	Sample Type
Flow (MGD)	Continuous	
BOD_5	Daily when discharging	Grab
Suspended Solids	Daily when discharging	Grab

Influent samples shall be taken at a point representative of the influent.

Flow (MGD) shall be reported on the Discharge Monitoring Report (DMR) as monthly average and daily maximum.

BOD_5 and Suspended Solids shall be reported on the DMR as a monthly average concentration.

Special Conditions

SPECIAL CONDITION 1. This Permit may be modified to include different final effluent limitations or requirements which are consistent with applicable laws and regulations. The IEPA will public notice the permit modification.

SPECIAL CONDITION 2. The use or operation of this facility shall be by or under the supervision of a Certified Class 1 operator.

SPECIAL CONDITION 3. The IEPA may request in writing submittal of operational information in a specified form and at a required frequency at any time during the effective period of this Permit.

SPECIAL CONDITION 4. The IEPA may request more frequent monitoring by permit modification pursuant to 40 CFR § 122.63 and Without Public Notice.

SPECIAL CONDITION 5. The effluent, alone or in combination with other sources, shall not cause a violation of any applicable water quality standard outlined in 35 Ill. Adm. Code 302 and 303.

SPECIAL CONDITION 6. The Permittee shall record monitoring results on Discharge Monitoring Report (DMR) electronic forms using one such form for each outfall each month.

In the event that an outfall does not discharge during a monthly reporting period, the DMR Form shall be submitted with no discharge indicated.

The Permittee is required to submit electronic DMRs (NetDMRs) instead of mailing paper DMRs to the IEPA unless a waiver has been granted by the Agency. More information, including registration information for the NetDMR program, can be obtained on the IEPA website, https:www2.illinois.gov/epa/topics/water-quality/surface-water/netdmr/pages/quick-answer-guide.aspx.

The completed Discharge Monitoring Report forms shall be submitted to IEPA no later than the 25th day of the following month, unless otherwise specified by the permitting authority.

Permittees that have been granted a waiver shall mail Discharge Monitoring Reports with an original signature to the IEPA at the following address:

Illinois Environmental Protection Agency
Division of Water Pollution Control
Attention: Compliance Assurance Section, Mail Code # 19
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

SPECIAL CONDITION 7. The provisions of 40 CFR Section 122.41(m) & (n) are incorporated herein by reference.

SPECIAL CONDITION 8. Samples taken in compliance with the effluent monitoring requirements shall be taken:

A. For Outfall Number B01 shall be taken at a point:
   1. Representative of the discharge of fully treated wastewater effluent, and
   2. When discharges are occurring from Outfall Number A01, prior to admixture with discharges from Outfall Number A01.

B. For Outfall Number A01 shall be taken at a point:
   1. Representative of the discharge from the excess flow treatment unit(s) to Outfall Number 001, and
   2. Prior to admixture with discharges from Outfall Number B01.

C. For Outfall Number 001 shall be taken at a point:
   1. Representative of the discharge from Outfall Number 001 but prior to entry into the receiving water; and
   2. Representative of the admixture of all flow from Outfall Numbers A01 and B01.
      a. On days when there are no discharges through Outfall Number A01 samples for all effluent limitations and monitoring parameters applicable to Outfall Number 001 can be taken at the location of sampling for Outfall Number B01. When this occurs, sample results for Outfall Number B01 must be reported on the DMRs for Outfall Number B01 and Outfall Number 001.
      b. On days when there are discharges through Outfall A01, samples for all effluent limitations and monitoring parameters applicable to Outfall 001 shall be representative of the discharge through Outfall 001 to the receiving water; and shall be taken at a point representative of the admixture of flows from Outfall Numbers A01 and B01.

D. For Outfall Number 002 and 004 shall be taken at a point representative of the discharge, but prior to the receiving stream.

Special Conditions

SPECIAL CONDITION 9. Consistent with permit modification procedures in 40 CFR 122.62 and 63, this Permit may be modified to include requirements for the Permittee on a continuing basis to evaluate and detail its efforts to effectively control sources of infiltration and inflow into the sewer system and to submit reports to the IEPA if necessary.

SPECIAL CONDITION 10. Fecal Coliform limits for Discharge Number B01 are effective May thru October. Sampling of Fecal Coliform is only required during this time period.

Any use of chlorine to control slime growths, odors or as an operational control, etc. shall not exceed the limit of 0.05 mg/L (daily maximum) total residual chlorine in the effluent. Sampling is required on a daily grab basis during the chlorination process. Reporting shall be submitted on the DMRs on a monthly basis.

SPECIAL CONDITION 11. The Permittee shall conduct semi-annual monitoring of the effluent and report concentrations (in mg/L) of the following listed parameters. Monitoring shall begin three (3) months from the effective date of this permit. The sample shall be a 24-hour effluent composite except as otherwise specifically provided below and the results shall be submitted on Discharge Monitoring Report Forms to IEPA unless otherwise specified by the IEPA. The parameters to be sampled and the minimum reporting limits to be attained are as follows:

STORET CODE	PARAMETER	Minimum reporting limit
01002	Arsenic	0.05 mg/L
01007	Barium	0.5 mg/L
01027	Cadmium	0.001 mg/L
01032	Chromium (hexavalent) (grab)	0.01 mg/L
01034	Chromium (total)	0.05 mg/L
01042	Copper	0.005 mg/L
00720	Cyanide (total) (grab)***	5.0 µg/L
00722	Cyanide (grab) (available**** or amenable to chlorination)***	5.0 µg/L
00951	Fluoride	0.1 mg/L
01045	Iron (total)	0.5 mg/L
01046	Iron (Dissolved)	0.5 mg/L
01051	Lead	0.05 mg/L
01055	Manganese	0.5 mg/L
71900	Mercury (grab)**	1.0 ng/L*
01067	Nickel	0.005 mg/L
00556	Oil (hexane soluble or equivalent) (Grab Sample only)	5.0 mg/L
32730	Phenols (grab)	0.005 mg/L
01147	Selenium	0.005 mg/L
01077	Silver (total)	0.003 mg/L
01092	Zinc	0.025 mg/L

The minimum reporting limit for each parameter is specified by Illinois EPA as the regulatory authority.

The minimum reporting limit for each parameter shall be greater than or equal to the lowest calibration standard and within the acceptable calibration range of the instrument.

The minimum reporting limit is the value below which data are to be reported as non-detects.

The statistically-derived laboratory method detection limit for each parameter shall be less than the minimum reporting limit required for that parameter.

All sample containers, chemical and thermal preservation, holding times, analyses, method detection limit determinations and quality assurance/quality control requirements shall be in accordance with 40 CFR Part 136.

Unless otherwise indicated, concentrations refer to the total amount of the constituent present in all phases, whether solid, suspended or dissolved, elemental or combined, including all oxidation states.

*1.0 ng/L = 1 part per trillion.
**Utilize USEPA Method 1631E and the digestion procedure described in Section 11.1.1.2 of 1631E.
***Analysis for cyanide (available or amenable to chlorination) is only required if cyanide (total) is detected at or above the minimum reporting limit.
****USEPA Method OIA-1677 or Standard Method SM 4500-CN G.

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The Permittee shall provide a report briefly describing the permittee's pretreatment activities and an updated listing of the Permittee's significant industrial users. The list should specify which categorical pretreatment standards, if any, are applicable to each Industrial User. Permittees who operate multiple plants may provide a single report. Such report shall be submitted within six (6) months of the effective date of this Permit to the following addresses:

U.S. Environmental Protection Agency
Region 5
77 West Jackson Blvd.
Chicago, Illinois 60604
Attention: Water Assurance Branch Enforcement and Compliance

Illinois Environmental Protection Agency
Division of Water Pollution Control
Attention: Compliance Assurance Section, Mail Code #19
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

SPECIAL CONDITION 12. During January of each year the Permittee shall submit annual fiscal data regarding sewerage system operations to the Illinois Environmental Protection Agency/Division of Water Pollution Control/Compliance Assurance Section. The Permittee may use any fiscal year period provided the period ends within twelve (12) months of the submission date.

Submission shall be on forms provided by IEPA titled "Fiscal Report Form For NPDES Permittees".

SPECIAL CONDITION 13. For the duration of this Permit, the Permittee shall determine the quantity of sludge produced by the treatment facility in dry tons or gallons with average percent total solids analysis. The Permittee shall maintain adequate records of the quantities of sludge produced and have said records available for U.S. EPA and IEPA inspection. The Permittee shall submit to the IEPA, at a minimum, a semi-annual summary report of the quantities of sludge generated and disposed of, in units of dry tons or gallons (average total percent solids) by different disposal methods including but not limited to application on farmland, application on reclamation land, landfilling, public distribution, dedicated land disposal, sod farms, storage lagoons or any other specified disposal method. Said reports shall be submitted to the IEPA by January 31 and July 31 of each year reporting the preceding January thru June and July thru December interval of sludge disposal operations.

Duty to Mitigate. The Permittee shall take all reasonable steps to minimize any sludge use or disposal in violation of this Permit.

Sludge monitoring must be conducted according to test procedures approved under 40 CFR 136 unless otherwise specified in 40 CFR 503, unless other test procedures have been specified in this Permit.

Planned Changes. The Permittee shall give notice to the IEPA on the semi-annual report of any changes in sludge use and disposal.

The Permittee shall retain records of all sludge monitoring, and reports required by the Sludge Permit as referenced in Standard Condition 25 for a period of at least five (5) years from the date of this Permit.

If the Permittee monitors any pollutant more frequently than required by this permit or the Sludge Permit, the results of this monitoring shall be included in the reporting of data submitted to the IEPA.

The Permittee shall comply with existing federal regulations governing sewage sludge use or disposal and shall comply with all existing applicable regulations in any jurisdiction in which the sewage sludge is actually used or disposed.

The Permittee shall comply with standards for sewage sludge use or disposal established under section 405(d) of the CWA within the time provided in the regulations that establish the standards for sewage sludge use or disposal even if the permit has not been modified to incorporate the requirement.

The Permittee shall ensure that the applicable requirements in 40 CFR Part 503 are met when the sewage sludge is applied to the land, placed on a surface disposal site, or fired in a sewage sludge incinerator.

Special Conditions

Monitoring reports for sludge shall be reported on the form titled "Sludge Management Reports" to the following address:

Illinois Environmental Protection Agency
Bureau of Water
Compliance Assurance Section
Mail Code #19
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

SPECIAL CONDITION 14. This Permit may be modified to include alternative or additional final effluent limitations pursuant to an approved Total Maximum Daily Load (TMDL) Study, an approved Nutrient Assessment Reduction Plan, or an approved trading program.

SPECIAL CONDITION 15. The Permittee shall conduct biomonitoring of the effluent from Discharge Number(s) B01.

Biomonitoring

A. Acute Toxicity - Standard definitive acute toxicity tests shall be run on at least two trophic levels of aquatic species (fish, invertebrate) representative of the aquatic community of the receiving stream. Testing must be consistent with Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms (Fifth Ed.) EPA/821-R-02-012. Unless substitute tests are pre-approved; the following tests are required:

    1. Fish 96-hour static LC_{50} Bioassay using fathead minnows (*Pimephales promelas*).

    2. Invertebrate 48-hour static LC_{50} Bioassay using *Ceriodaphnia*.

B. Testing Frequency - The above tests shall be conducted using 24-hour composite samples unless otherwise authorized by the IEPA. Sample collection and testing must be conducted in the 18th, 15th, 12th, and 9th month prior to the expiration date of this Permit. When possible, bioassay sample collection should coincide with sample collection for metals analysis or other parameters that may contribute to effluent toxicity.

C. Reporting - Results shall be reported according to EPA/821-R-02-012, Section 12, Report Preparation, and shall be mailed to IEPA, Bureau of Water, Compliance Assurance Section or emailed to EPA.PrmtSpecCondtns@Illinois.gov within one week of receipt from the laboratory. Reports are due to the IEPA no later than the 16th, 13th, 10th, and 7th month prior to the expiration date of this Permit.

D. Toxicity – Should a bioassay result in toxicity to >20% of organisms tested in the 100% effluent treatment, the IEPA may require, upon notification, six (6) additional rounds of monthly testing on the affected organism(s) to be initiated within 30 days of the toxic bioassay. Results shall be submitted to IEPA within one (1) week of becoming available to the Permittee. Should any of the additional bioassays result in toxicity to ≥50% of organisms tested in the 100% effluent treatments, the Permittee must contact the IEPA within one (1) day of the results becoming available to the Permittee and begin the toxicity identification and reduction evaluation process as outlined below.

E. Toxicity Identification and Reduction Evaluation - Should any of the additional bioassays result in toxicity to ≥50% of organisms tested in the 100% effluent treatment, the Permittee must contact the IEPA within one (1) day of the results becoming available to the Permittee and begin the toxicity identification evaluation process in accordance with Methods for Aquatic Toxicity Identification Evaluations, EPA/600/6-91/003. The IEPA may also require, upon notification, that the Permittee prepare a plan for toxicity reduction evaluation to be developed in accordance with Toxicity Reduction Evaluation Guidance for Municipal Wastewater Treatment Plants, EPA/833B-99/002, which shall include an evaluation to determine which chemicals have a potential for being discharged in the plant wastewater, a monitoring program to determine their presence or absence and to identify other compounds which are not being removed by treatment, and other measures as appropriate. The Permittee shall submit to the IEPA its plan for toxicity reduction evaluation within ninety (90) days following notification by the IEPA. The Permittee shall implement the plan within ninety (90) days or other such date as contained in a notification letter received from the IEPA.

    The IEPA may modify this Permit during its term to incorporate additional requirements or limitations based on the results of the biomonitoring. In addition, after review of the monitoring results, the IEPA may modify this Permit to include numerical limitations for specific toxic pollutants. Modifications under this condition shall follow public notice and opportunity for hearing.

SPECIAL CONDITION 16. The Permittee shall participate in the North Branch Chicago River Watershed Workgroup (NBWW). The Permittee shall work with other watershed members of the NBWW to determine the most cost-effective means to remove dissolved oxygen (DO) and offensive condition impairments in the North Branch Chicago River Watershed to the extent feasible.

A. The NBWW will conduct the following activities in accordance with the Plan during the term of this permit:

Special Conditions

1. Develop an Integrated Prioritization System (IPS) and supporting tools consisting of in-depth analysis of all chemical, physical and biological data collected in past watershed assessments to develop a library of data analysis tools and prioritization mechanisms related to future impairment restoration activities.
2. Develop a Nutrient Assessment Reduction Plan (NARP) sequenced as follows:
   a. Develop Preliminary NARP Workplan to be utilized to plan and budget the multiyear development and completion of a NBWW NARP. The Preliminary NARP Workplan shall be completed by December 31, 2021. The Workplan shall be submitted with the annual progress report per Section (B) below.
   b. Develop NBWW NARP in accordance with the requirements in Special Condition 24.
3. Continue comprehensive water quality monitoring program consisting of bioassessment monitoring, flow monitoring, and water column and sediment chemistry sampling and analysis; modify these programs as necessary to meet NARP objectives.

B. The Permittee shall submit an annual progress report on the activities identified in (A) above, which includes the monitoring data from the previous year, to the Agency by March 31st of each year. The Permittee may work cooperatively with the NBWW to prepare a single annual progress report that is common among NBWW members.

C. In its application for renewal of this permit, the Permittee shall consider and incorporate recommended NBWW activities listed in any annual progress report or Nutrient Assessment Reduction Plan that the Permittee will implement during the next permit term.

SPECIAL CONDITION 17. The Permittee shall monitor the wastewater effluent for Total Phosphorus, Dissolved Phosphorus, Nitrate/Nitrite, Total Kjeldahl Nitrogen (TKN), Ammonia, Total Nitrogen (calculated), Alkalinity, Specific Conductivity, Chloride and Temperature at least once a month beginning on the effective date of this permit. The Permittee shall monitor the wastewater influent for Total Phosphorus at least once a month. The results shall be submitted on electronic Discharge Monitoring Report Forms (NetDMRs) to IEPA unless otherwise specified by the IEPA.

SPECIAL CONDITION 18. The Permittee shall work towards the goals of achieving no discharges from sanitary sewer overflows or basement back-ups and ensuring that overflows or back-ups, when they do occur do not cause or contribute to violations of applicable standards or cause impairment in any adjacent receiving water. Overflows from sanitary sewers are expressly prohibited by this permit and by Ill. Adm. Code 306.304. In order to accomplish these goals of complying with this prohibition and mitigating the adverse impacts of any such overflows if they do occur, the Permittee shall (A) identify and report to IEPA all SSOs that do occur, and (B) develop, implement and submit to the IEPA a Capacity, Management, Operations, and Maintenance (CMOM) plan which includes an Asset Management strategy within twenty-four (24) months of the effective date of this Permit or review and revise any existing plan accordingly. The Permittee shall modify the Plan to incorporate any comments that it receives from IEPA and shall implement the modified plan as soon as possible. The Permittee should work as appropriate, in consultation with affected authorities at the local, county, and/or state level to develop the plan components involving third party notification of overflow events. The Permittee may be required to construct additional sewage transport and/or treatment facilities in future permits or other enforceable documents should the implemented CMOM plan indicate that the Permittee's facilities are not capable of conveying and treating the flow for which they are designed.
The CMOM plan shall include the following elements:

A. Measures and Activities:

   1. A complete map and system inventory for the collection system owned and operated by the Permittee;
   2. Organizational structure; budgeting; training of personnel; legal authorities; schedules for maintenance, sewer system cleaning, and preventative rehabilitation; checklists, and mechanisms to ensure that preventative maintenance is performed on equipment owned and operated by the Permittee;
   3. Documentation of unplanned maintenance;
   4. An assessment of the capacity of the collection and treatment system owned and operated by the Permittee at critical junctions and immediately upstream of locations where overflows and backups occur or are likely to occur; use flow monitoring as necessary;
   5. Identification and prioritization of structural deficiencies in the system owned and operated by the Permittee;
   6. Operational control, including documented system control procedures, scheduled inspections and testing;
   7. The Permittee shall develop and implement an Asset Management strategy to ensure the long-term sustainability of the collection system. Asset Management shall be used to assist the Permittee in making decisions on when it is most appropriate to repair, replace or rehabilitate particular assets and develop long-term funding strategies; and
   8. Asset Management shall include but is not limited to the following elements:
      a. Asset Inventory and State of the Asset;
      b. Level of Service;
      c. Critical Asset Identification;
      d. Life Cycle Cost; and
      e. Long-Term Funding Strategy.

Special Conditions

B. Design and Performance Provisions:

1. Monitor the effectiveness of CMOM;
2. Upgrade the elements of the CMOM plan as necessary; and
3. Maintain a summary of CMOM activities.

C. Overflow Response Plan:

1. Know where overflows and back-ups within the facilities owned and operated by the Permittee occur;
2. Respond to each overflow or back-up to determine additional actions such as clean up; and
3. Locations where basement back-ups and/or sanitary sewer overflows occur shall be evaluated as soon as practicable for excessive inflow/infiltration, obstructions or other causes of overflows or back-ups as set forth in the System Evaluation Plan.

D. System Evaluation Plan:

1. Summary of existing SSO and Excessive I/I areas in the system and sources of contribution;
2. Evaluate plans to reduce I/I and eliminate SSOs;
3. Special provisions for Pump Stations and force mains and other unique system components; and
4. Construction plans and schedules for correction.

E. Reporting and Monitoring Requirements:

1. Program for SSO detection and reporting; and
2. Program for tracking and reporting basement back-ups, including general public complaints.

F. Third Party Notice Plan:

1. Describes how, under various overflow scenarios, the public, as well as other entities, would be notified of overflows within the Permittee's system that may endanger public health, safety or welfare;
2. Identifies overflows within the Permittee's system that would be reported, giving consideration to various types of events including events with potential widespread impacts;
3. Identifies who shall receive the notification;
4. Identifies the specific information that would be reported including actions that will be taken to respond to the overflow;
5. Includes a description of the lines of communication; and
6. Includes the identities and contact information of responsible POTW officials and local, county, and/or state level officials.

For additional information concerning USEPA CMOM guidance and Asset Management please refer to the following web site addresses.
http://www.epa.gov/npdes/pubs/cmom_guide_for_collection_systems.pdf and
http://water.epa.gov/type/watersheds/wastewater/upload/guide_smallsystems_assetmanagement_bestpratices.pdf

SPECIAL CONDITION 19. The Permittee shall, within 24 months of the effective date of this permit, prepare and submit to the Agency a Phosphorus Removal Feasibility Study (PRFS) that identifies the method, timeframe, and costs of reducing phosphorus levels in its discharge to a level consistently meeting a potential future effluent limit of 0.5 mg/L or 0.1 mg/L. The study shall evaluate the construction and O & M costs of the application of this limit on a monthly, seasonal and annual average basis. The feasibility report shall also be shared with the North Branch Chicago River Watershed Workgroup. Previously submitted feasibility studies that did not include an alternative effluent limit of 0.5 mg/L or 0.1 mg/L may be amended to identify supplemental treatment technologies necessary to achieve 0.5 mg/L or 0.1 mg/L.

SPECIAL CONDITION 20. The Agency shall consider all monitoring data submitted by the discharger in accordance with the monitoring requirements of this permit for all parameters, including but not limited to data pertaining to ammonia and dissolved oxygen for discharges from Discharge Numbers 001, 002 and 004, to determine whether the discharges are at levels which cause, have the reasonable potential to cause or contribute to exceedances of water quality standards; and, if so, to develop appropriate water quality based effluent limitations. If the discharger wants the Agency to consider mixing when determining the need for and establishment of water quality based effluent limitations, the discharger shall submit a study plan on mixing to the Agency for the Agency's review and comment within two (2) months of the effective date of this Permit.

SPECIAL CONDITION 21. The Permittee shall develop and submit to the Agency a Phosphorus Discharge Optimization Plan within 24 months of the effective date of this permit. The plan shall include a schedule for the implementation of these optimization measures. Annual progress reports on the optimization of the existing treatment facilities shall be submitted to the Agency by March 31 of each year beginning 12 months from the effective date of the permit. In developing the plan, the Permittee shall evaluate a range of measures for

Special Conditions

reducing phosphorus discharges from the treatment plant, including possible source reduction measures, operational improvements, and minor facility modifications that will optimize reductions in phosphorus discharges from the wastewater treatment facility. The Permittee's evaluation shall include, but not be limited to, an evaluation of the following optimization measures:

A. WWTF influent reduction measures.
    1. Evaluate the phosphorus reduction potential of users.
    2. Determine which sources have the greatest opportunity for reducing phosphorus (i.e., industrial, commercial, institutional, municipal and others).
        a. Determine whether known sources (i.e., restaurant and food preparation) can adopt phosphorus minimization and water conservation plans.
        b. Evaluate implementation of local limits on influent sources of excessive phosphorus.
B. WWTF effluent reduction measures.
    1. Reduce phosphorus discharges by optimizing existing treatment processes.
    a. Adjust the solids retention time for either nitrification, denitrification, or biological phosphorus removal.
    b. Adjust aeration rates to reduce dissolved oxygen and promote simultaneous nitrification-denitrification.
    c. Add baffles to existing units to improve microorganism conditions by creating divided anaerobic, anoxic, and aerobic zones.
    d. Change aeration settings in plug flow basins by turning off air or mixers at the inlet side of the basin system.
    e. Minimize impact on recycle streams by improving aeration within holding tanks.
    f. Reconfigure flow through existing basins to enhance biological nutrient removal.
    g. Increase volatile fatty acids for biological phosphorus removal.

SPECIAL CONDITION 22. A phosphorus limit of 1.0 mg/L (monthly average) shall become effective four (4) years from the effective date of this Permit.

In order for the Permittee to achieve the above limit, it will be necessary to modify existing treatment facilities to include phosphorus removal, reduce phosphorus sources or explore other ways to prevent discharges that exceed the limit. The Permittee must implement the following compliance measures consistent with the schedule below:

A. Progress Report on Construction	Every 6 months from the effective date of this permit
B. Complete Construction	36 months from the effective date of this permit
C. Achieve Annual Concentration and Loading Effluent Limitations for Total Phosphorus	48 months from the effective date of this Permit

Compliance dates may be modified based on the results of the Phosphorus Removal Feasibility Report required by Special Condition 19 of this Permit. All modifications of this Permit must be in accordance with 40 CFR 122.62 or 40 CFR 122.63.

Reporting shall be submitted on the NetDMR's on a monthly basis.

REPORTING

The Permittee shall submit reports for items A, B, and C of the compliance schedule indicating: a) the date the item was completed, or b) that the item was not completed, the reasons for non-completion and the anticipated completion date to the Agency Compliance Section.

SPECIAL CONDITION 23.

A. Subject to paragraph B below, an effluent limit of 0.5 mg/L Total Phosphorus 12 month rolling geometric mean (calculated monthly) basis (hereinafter "Limit"), shall be met by the Permittee by January 1, 2030, unless the Permittee demonstrates that meeting such Limit is not technologically or economically feasible in one of the following manners:
    1. the Limit is not technologically feasible through the use of biological phosphorus removal (BPR) process(es) at the treatment facility; or
    2. the Limit would result in substantial and widespread economic or social impact. Substantial and widespread economic impacts must be demonstrated using applicable USEPA guidance, including but not limited to any of the following documents:
        a. Interim Economic Guidance for Water Quality Standards, March 1995, EPA-823-95-002;
        b. Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development, February 1997, EPA-832—97-004;
        c. Financial Capability Assessment Framework for Municipal Clean Water Act Requirements, November 24, 2014; and
        d. any additional USEPA guidance on affordability issues that revises, supplements or replaces those USEPA guidance documents; or
    3. the Limit can only be met by chemical addition for phosphorus removal at the treatment facility in addition to those processes currently contemplated; or

Special Conditions

4. the Limit is demonstrated not to be feasible by January 1, 2030, but is feasible within a longer timeline, then the Limit shall be met as soon feasible and approved by the Agency; or
5. the Limit is demonstrated not to be achievable, then an effluent limit that is achievable by the Permittee (along with associated timeline) will apply instead, except that the effluent limit shall not exceed 0.6 mg/L Total Phosphorus 12 month rolling geometric mean (calculated monthly).

B. The Limit shall be met by the Permittee by January 1, 2030, except in the following circumstances:
1. If the Permittee develops a written plan, preliminary engineering report or facility plan no later than January 1, 2025, to rebuild or replace the secondary treatment process(es) of the treatment facility, the Limit shall be met by December 31, 2035; or
2. If the Permittee decides to construct/operate biological nutrient removal (BNR) process(es), incorporating nitrogen reduction, the Limit shall be met by December 31, 2035; or
3. If the Permittee decides to use chemical addition for phosphorus removal instead of BPR, the Limit and the effluent limit of 1.0 mg/L Total Phosphorus monthly average shall be met by December 31, 2025; or
4. If the Permittee has already installed chemical addition for phosphorus removal instead of BPR, and has a 1.0 mg/L Total Phosphorus monthly average effluent limit in its permit, or the Permittee is planning to install chemical addition with an IEPA construction permit that is issued on or before July 31, 2018, the 1.0 mg/L Total Phosphorus monthly average effluent limit (and associated compliance schedule) shall apply, and the Limit shall not be applicable.
5. The NARP determines that a limit lower than the Limit is necessary and attainable. The lower limit and timeline identified in the NARP shall apply to the Permittee.
6. If the Permittee is covered by any of the following scenarios:
   a. maintains a membership and participates in the DuPage River Salt Creek Workgroup or the Lower DuPage Watershed Coalition; or
   b. it participates in a watershed group that is developing a NARP for an impairment related to phosphorus or a risk eutrophication, and IEPA determines that the group has the financial and structural capability to develop the NARP by the deadline specified in the NARP provisions below; or
   c. it is covered by the 2017 Settlement Agreement between the Metropolitan Water Reclamation District of Greater Chicago and various environmental groups;[1] or
   d. it is covered by the Memorandum of Understanding, executed as of October 5, 2016, between the City of Joliet, Prairie Rivers Network, and the Illinois Chapter of Sierra Club concerning expansion of the City's Aux Sable Wastewater Treatment Plant.

[1]Those groups are: NRDC, Friends of the Chicago River, Gulf Restoration Network, the Environmental Law and Policy Center, Sierra Club, and Prairie Rivers Network.

C. The Permittee shall identify and provide adequate justification of any exception identified in paragraph A or circumstance identified in paragraph B, regarding meeting the Limit. The justification shall be submitted to the Agency at the time of renewal of this permit or by December 31, 2024, whichever date is first. Any justification or demonstration performed by the Permittee pursuant to paragraph A or circumstance pursuant to paragraph B must be reviewed and approved by the Agency. The Agency will renew or modify the NPDES permit as necessary. No date deadline modification or effluent limitation modification for any of the exceptions or circumstances specified in paragraphs A or B will be effective until it is included in a modified or reissued NPDES Permit.

D. For purposes of this permit, the following definitions are used:
1. BPR (Biological Phosphorus Removal) is defined herein as treatment processes which do not require use of supplemental treatment processes at the treatment facilities before or after the biological system, such as but not limited to, chemical addition, carbon supplementation, fermentation, or filtration. The use of filtration or additional equipment to meet other effluent limits is not prohibited, but those processes will not be considered part of the BPR process for purposes of this permit; and
2. BNR (Biological Nutrient Removal) is defined herein as treatment processes used for nitrogen and phosphorus removal from wastewater before it is discharged. BNR treatment processes, as defined herein, do not require use of supplemental treatment processes at the treatment facilities before or after the biological system, such as but not limited to, chemical addition, carbon supplementation, fermentation or filtration. The use of filtration or additional equipment to meet other effluent limits is not prohibited, but those processes will not be considered part of the BNR process for purposes of this permit.

E. The 0.5 mg/L Total Phosphorus 12 month rolling geometric mean (calculated monthly) effluent limit applies to the effluent from the treatment plant.

Special Conditions

SPECIAL CONDITION 24. The Agency has determined that the Permittee's treatment plant effluent is located upstream of a waterbody or stream segment that has been determined to have a phosphorus related impairment. This determination was made upon reviewing available information concerning the characteristics of the relevant waterbody/segment (such as extent of aquatic habitat and nature of the biological community) and the relevant facility (such as quantity of discharge flow and nutrient load relative to the stream flow).

A phosphorus related impairment means that the downstream waterbody or segment is listed by the Agency as impaired due to dissolved oxygen and/or offensive condition (algae and/or aquatic plant growth) impairments that is related to excessive phosphorus levels.

The Permittee shall develop, or be a part of a watershed group that develops, a Nutrient Assessment Reduction Plan (NARP) that will meet the following requirements:

A. The NARP shall be developed and submitted to the Agency by December 31, 2024. This requirement can be accomplished by the Permittee, by participation in an existing watershed group or by creating a new group. The NARP shall be supported by data and sound scientific rationale. Annual Progress Reports shall be submitted to the Agency starting 12 months from the effective date of the Permit and every 12 months thereafter until the completion of the NARP.

B. The Permittee shall cooperate with and work with other stakeholders in the watershed to determine the most cost-effective means to address the phosphorus related impairment. If other stakeholders in the watershed will not cooperate in developing the NARP, the Permittee shall develop its own NARP for submittal to the Agency to comply with this condition.

C. In determining the target levels of various parameters necessary to address the phosphorus related impairment, the NARP shall either utilize the recommendations by the Nutrient Science Advisory Committee or develop its own watershed-specific target levels.

D. The NARP shall identify phosphorus input reductions by point source discharges and non-point source discharges in addition to other measures necessary to remove phosphorus related impairments in the watershed. The NARP may determine, based on an assessment of relevant data, that the watershed does not have an impairment related to phosphorus, in which case phosphorus input reductions or other measures would not be necessary. Alternatively, the NARP could determine that phosphorus input reductions from point sources are not necessary, or that phosphorus input reductions from both point and nonpoint sources are necessary, or that phosphorus input reductions are not necessary and that other measures, besides phosphorus input reductions, are necessary.

E. The NARP shall include a schedule for the implementation of the phosphorus input reductions by point sources, non-point sources and other measures necessary to remove phosphorus related impairments. The NARP schedule shall be implemented as soon as possible, and shall identify specific timelines applicable to the Permittee.

F. The NARP can include provisions for water quality trading to address the phosphorus related impairments in the watershed. Phosphorus/Nutrient trading cannot result in violations of water quality standards or applicable antidegradation requirements.

G. The Permittee shall request modification of the permit within 90 days after the NARP has been completed to include necessary phosphorus input reductions identified within the NARP. The Agency will modify the NPDES permit, if necessary.

H. If the Permittee does not develop or assist in developing the NARP, and such a NARP is developed for the watershed, the Permittee will become subject to effluent limitations necessary to address the phosphorus related impairments. The Agency shall calculate these effluent limits by using the NARP and any applicable data. If no NARP has been developed, the effluent limits shall be determined for the Permittee on a case-by-case basis, so as to ensure that the Permittee's discharge will not cause or contribute to violations of the dissolved oxygen or narrative water quality standards.

SPECIAL CONDITION 25. On or before March 31 of each year, the Permittee shall submit a report to IEPA that summarizes the effluent data for BOD_5 and Suspended Solids (SS) from Excess Flow Outfall 002 (Deerfield Road Excess Flow Discharge) and Excess Flow Outfall 004 (Warwick Road Excess Flow Discharge) during the preceding year. Each report shall include a statement as to how often and by how much the effluent exceeded the levels of 30 mg/l BOD_5 and 30 mg/l SS on a monthly average basis, 45 mg/l BOD_5 and 45 mg/l SS on a weekly average basis, and 85% removal for both parameters monthly. If the effluent exceeds any of these levels or percentage removals, then the Permittee shall also include in the report a description of the measures that the Permittee would need to implement so that discharges from Excess Flow Outfall 002 and Excess Flow Outfall 004 would either (a) be eliminated or (b) be sufficiently treated so that such discharges would comply with such limitations. The report shall also include an estimate of the costs of the measures.

APPENDIX B
PHOSPHOROUS ANALYZER PRODUCT INFORMATION AND CASE STUDIES

ChemScan® mini oP

ORTHO-PHOSPHATE ANALYZER

Monitor Your Process with Real-time Data and Control Costs!

The new single parameter in-line analyzer family utilizes years of ChemScan experience and proven technology to provide reliable and accurate analysis of water and wastewater. This device has been designed from the ground up to reduce maintenance requirements, includes large ID sample tubing to minimize plugging and only needs quarterly reagent refills.

FEATURES

- Automatic Analysis Utilizing ChemScan's Proven VMo Method
- Low Maintenance
- Proven Sample Handling with Large I.D. Flow Paths
- Simple Field Adjustable Calibration
- Sample Blank to Eliminate Backgound Interference
- Automatic Cleaning

CAPABILITIES

- Automatic Analysis
- Continuous Output
- Multiple Data Communication Interface Options

APPLICATIONS

- Potable Water
- Wastewater Effluent

BENEFITS

- High Reliability
- Low Capital Cost
- High Accuracy
- Low Operating Cost
- EPA Recognized Analysis Method

SPECIFICATIONS

Range (as PO_4):	0.1 - 9.0 mg/L (Method 1005), 0.3 - 18.0 mg/L (Method 1006)
Range (as PO_4 - P):	0.03 - 3.0 mg/L (Method 1003), 0.1 - 6.0 mg/L (Method 1004) Additional Ranges Available
Accuracy:	2% of value or 2x detection limit (whichever greater)
Cycle Interval:	5 minutes to 9999 minutes (field programmable)
Environment:	5 - 50 degrees C (method dependent)
Power:	100 - 240 VAC, 50 W
Enclosure:	NEMA 4X
Safety Approval:	CSA-US
Sample Requirements:	0.5 - 1 Liter/analysis, pressure 2 to 10 psi, <150 mg/L TSS, <60 NTU
Maintenance:	Reagent replacement every 3 months, pump kit yearly
Relay Contacts:	1 SPDT Concentration, 1 SPDT Programmable
Serial Interface:	RS-232 Maintenance Port
Analog Output:	Isolated 4-20 mA

ChemScan®
An In-Situ Brand

"Monitoring a World of Water"

ChemScan, Inc.
2325 Parklawn Drive, Suite I, Waukesha, WI 53186
262-717-9500, Fax 262-717-9530

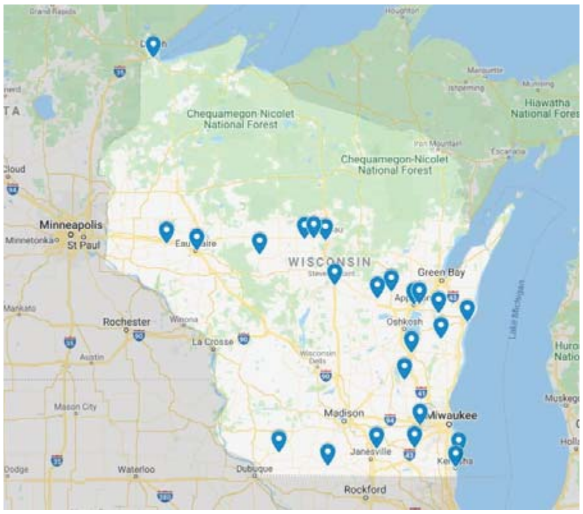
Published 4/4/18

ChemScan.com

Success Stories

Smaller Wisconsin Wastewater Plants Meet Phosphorous Limits Using ChemScan mini oP

Customer Profile



Multiple ChemScan mini oP analyzers are installed in Wisconsin

Featured Product

ChemScan mini oP Analyzer

Overview

Phosphorous has long been recognized as a controlling factor in plant and algae growth. In 2010 Wisconsin became one of the first states to require all NPDES discharge permits to require limits on Phosphorous, regardless of the size of the plant or the location of the receiving watershed. It is currently one of the few states to have achieved the benchmark where 100% of the treatment plants have permit limits for Phosphorous.

Challenge

Phosphorous limits pose a difficult challenge for smaller wastewater plants, especially those treating under 1 million gallons per day. These plants have limited resources, usually have variable load and flow contributions from local industries, but do not have very much operational flexibility beyond their original design capacity to allow for new discharge requirements. Some plants turned to chemical treatment by adding a metal salt (ferric or alum) that combines with dissolved Phosphorous, forming a precipitate which settles out in the final clarification or filtration step. But these plants soon learned that feeding the chemical at a fixed rate was expensive because, if the feed rate was adequate during peak demand, it was excessive the rest of the time. Flow pacing the chemical was not an improvement, because the Phosphorous concentration does not synchronize very well with the flow rate.

Solution

A solution was needed that would allow the treatment chemical to be fed based on the Phosphorous demand. More than 30 small wastewater treatment plants in Wisconsin now use the ChemScan mini oP to help them meet their discharge limits for Phosphorous. The mini oP analyzer can be set up to directly detect ortho (dissolved) Phosphorous in final effluent or at a sample point downstream from the final settling/filtration step, without a sample filter. This allows an analysis of residual ortho-Phosphorous every few minutes, with a signal fed back to the chem feed controller or SCADA, allowing the chemical feed rate to be automatically adjusted. The analyzer can be configured to detect at a normal (0.1 to 6.0 mg/l) or extra low (0.03 to 3.0 mg/l) concentration limit, with the lower detection limit of the analyzer well below the discharge limit for the plant. This allows operation within a control band for continuous compliance. At some treatment plants the analyzer has been installed in a special outdoor enclosure that includes a sample filter, thus allowing analysis of samples to be fed forward from the aeration basin or other upstream sample point where high solids concentrations are typical.

Tom Pluess, Superintendent at the East Troy WWTP has a ChemScan mini oP that has been in operation for about 10 years. He says that the analyzer helps control the feed rate, helps pinpoint the time of Phosphorous contributions to the plant and is also helping during the evaluation of new treatment chemicals by providing real time information during experiments. He says, “ChemScan works really well for us. I cannot say enough about their customer service.” Another plant manager in central Wisconsin, where the analyzer has been in operation for more than 10 years, said that ChemScan helps save thousands in annual chemical costs.

Chris August, Superintendent at the Kiel WWTP says that ChemScan “has helped us save a lot of money and helps control and operate our facility.” He is one of many who note that the ChemScan mini oP analyzer “paid for itself within the first year of operation”.

“ChemScan has helped us save a lot of money and helps control and operate our facility.”

Phosphax sc
Online Phosphate Analyzer

Applications
- Wastewater
- Drinking Water

The Phosphax sc online analyzer provides reliable and accurate PO_4 measurements

Multiple measurement ranges for a variety of wastewater applications

With detection limits as low as 0.05 mg/L and as high as 50 mg/L, the Phosphax sc phosphate analyzer can be used anywhere in the wastewater treatment process, from the influent or start of the phosphorus removal process where phosphate levels may be high to the effluent where phosphate levels are at their lowest.

Low cost of operation with proven yellow method

The Phosphax sc analyzer determines ortho-phosphate concentration using the molybdovanadate yellow colorimetric method which optimizes reagent consumption and helps save on operating costs.

Generate actionable insights from measurement data

The Phosphax sc is Claros enabled so you can leverage the Hach Water Intelligence System to collect, manage and analyse data from your instrument.

Easy installation at the measurement point

Hach's Phosphax sc phosphate analyzer is designed to be installed at the measurement point (indoor and outdoor options). The housing is weatherproof and lockable for installation at the basin, even in the toughest climates. Mounting options include: wall, rail, or standing. The unit comes complete and assembled; no separate housing is required.

Low maintenance

Several features make the Phosphax sc phosphate analyzer easy to use and maintain:

1. Automatic cleaning at customized intervals.
2. Automatic zero-calibration at each measuring cycle.
3. Prognosys Predictive Diagnostics alerts you to upcoming instrument issues and guides you on whether the changes in your measurements are due to your instrument or your water.
4. Easy access to reagents and wear parts.

Claros Enabled

Service Protected

HACH® Be Right™

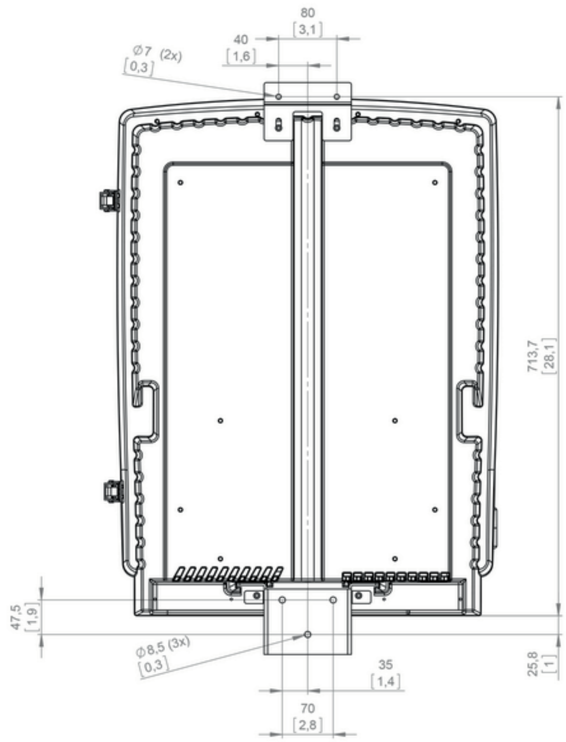
Technical Data*

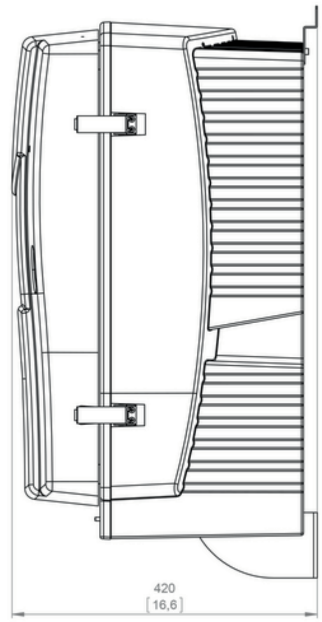
	Low Range	High Range
Range	0.05 - 15.0 mg/L PO_4-P	1 - 50 mg/L PO_4-P
Lower Limit of Detection (LOD)	0.05 mg/L PO_4-P	1.0 mg/L PO_4-P
Accuracy	Using standard solutions: 2% ± 0.05 mg/L	Using standard solutions: 2% ± 1.0 mg/L
Reproducibility	2% + 0.05 mg/L	2% + 1.0 mg/L
Reagent Consumption	500 mL/month	1000 mL/month
Response Time	< 5 minutes	
Measurement Method	Photometric method using vanadate-molybdate	
Measuring Interval	5 - 120 min, adjustable per 5 min.	
pH Range	5 - 9 pH	
Pressure Range	-30 - 50 mbar with continuous sample preparation; at overflow vessel	
Permissible Chloride Range	Max. Cl^- concentration: 1000 mg/L	
Operating Conditions	Indoor model: 5 - 40 °C; 95% relative humidity, non-condensing Outdoor model: -20 - 45 °C; 95% relative humidity, non-condensing	
Sample Temperature	4 - 40 °C	
Sample Quality	Ultra filtrated or comparable	
Flow	1 - 20 L/h sample (free of suspended solids)	
Power Requirements (Voltage)	115 - 230 VAC, 50/60 Hz, power provided by SC controller or power box	
Dimensions (H x W x D)	Indoor model: 720 mm x 540 mm x 370 mm Outdoor model: 720 mm x 540 mm x 390 mm	
Cable Length	2 m fixed data cable at analyzer	
Weight	Without sample preparation system and without chemicals: 29 kg (ndoor model) or 31 kg (outdoor model)	
Material	ASA/PC UV-resistant	
Enclosure Rating	Indoor model: IP54 Outdoor model: IP55	

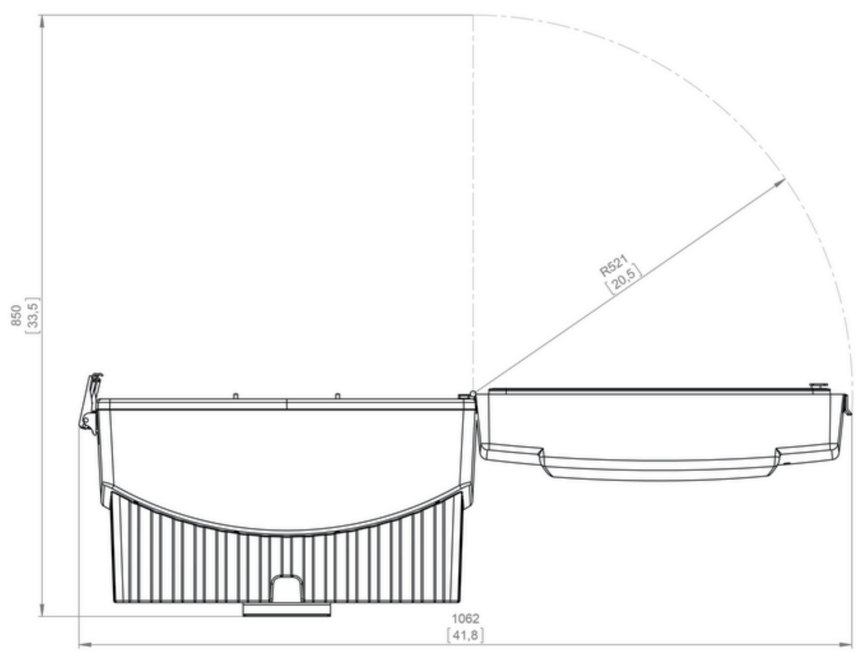
**Subject to change without notice.*

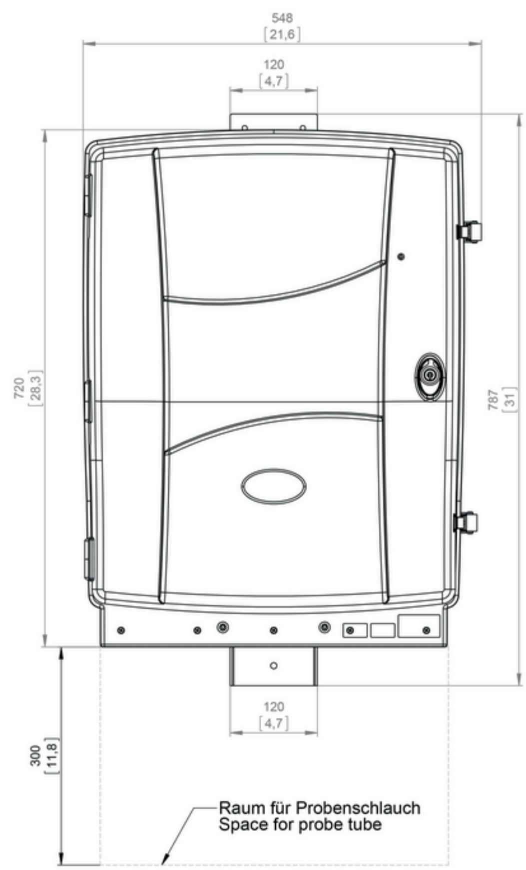
Dimensions

The Phosphax sc phosphate analyzer is designed for wall mounting, outdoor or indoor. Rail- and stand-mounting options are available. The enclosure is rated to IP55 (outdoor model) or IP54 (indoor model), is weatherproof and lockable.









Order Information

Analyzers

6159600	Phosphax sc Phosphate analyzer, 0.05-15 mg/L PO_4-P, one channel continuous sample, 115-230 VAC
6159700	Phosphax sc Phosphate analyzer, 0.05-15 mg/L PO_4-P, two channel continuous sample, 115-230 VAC
6159800	Phosphax sc Phosphate analyzer, 1-50 mg/L PO_4-P, one channel continuous sample, 115-230 VAC
6159900	Phosphax sc Phosphate analyzer, 1-50 mg/L PO_4-P, two channel continuous sample, 115-230 VAC

There are additional options available (indoor versions), please contact Hach for more information.

Please note: An SC controller is required for operation of the Phosphax sc.

Mounting Hardware

LZY287	Stand mounting kit for SC analyzer without SC controller
LZY286	Stand mounting kit for SC analyzer with SC controller
LZY316	Rail mounting kit for SC analyzer without SC controller
LZY285	Rail mounting kit for SC analyzer with SC controller

Reagents

2825253	Reagent for Phosphax sc analyzer (high range and low range), 1000 mL
2825254	Reagent for Phosphax sc analyzer (high range and low range), 2000 mL
2825353	Cleaning solution for Phosphax sc analyzer (high range and low range), 1000 mL

Accessories

LZY302	Heated drain/connecting hose, 2 m, 230 V
LZY303	Heated drain/connecting hose, 2 m, 115 V
LZY431	Power extension cable for SC1000/SC1500, 5 m, 115-230 VAC
LQV155.99.00002	Power box without power connection cable
LQV155.99.00012	Power box with power connection cable

To order a digital SC controller or a Filtrax sample preparation system please contact Hach.

Claros Enabled

This instrument connects to Claros, Hach's innovative Water Intelligence System. Claros allows you to seamlessly connect and manage instruments, data, and process – anywhere, anytime. The result is greater confidence in your data and improved efficiencies in your operations. To unlock the full potential of Claros, insist on Claros Enabled instruments.

Service Protected

With Hach Service, you have a global partner who understands your needs and cares about delivering timely, high-quality service you can trust. Our Service Team brings unique expertise to help you maximize instrument uptime, ensure data integrity, maintain operational stability, and reduce compliance risk.

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Improving Compliance Through Real-Time Phosphorus Control

Executive Summary

Levels of phosphorus, a chemical element that promotes organic growth, must be controlled in wastewater coming from beverage, food and dairy processing plants. Failure to control phosphorus accurately has a negative impact on water quality and can lead to large fines. The widespread practice of manually testing effluent only at set time intervals often leads to overdosing or underdosing with chemical control. Overdosing occurs when control continues at the same rate even when phosphorus levels are low. Underdosing happens when phosphorus levels spike in the interval between tests. This sends excess phosphorus into the stream before control measures can be adjusted.

Real-time control offers continuous monitoring to allow accurate dosing, giving plants better control over operations, regulatory compliance and costs. This white paper will describe a system for real-time control and the benefits it offers, specifically for plants that are controlling phosphorus by chemical dosing with ferric chloride ($FeCl_3$).

The phosphorus problem

The element phosphorus is essential to life and so it is present in plants and animals. The most common food processing sources of phosphorus or phosphates include meat, milk, soy and cleaning agents. Derivatives like phosphoric acid make their way into soft drinks, baking powder, and even toothpaste. Phosphorus promotes growth, which is good for a fertilizer, but bad for wastewater effluent.

When phosphorus is discharged in wastewater from beverage, food and dairy processing plants, usually in the form of PO_4, it "fertilizes" algae and aquatic plants so they multiply and deplete the oxygen in streams, rivers and bays, ultimately choking out larger organisms and disrupting the healthy balance of the ecosystem.

Regulations exist to protect water, wildlife and people from uncontrolled amounts of phosphorus in wastewater, and these regulations have an economic impact on beverage, food and dairy processors. There are costs associated with removing phosphorus from wastewater, but there are higher costs associated with failing to remove it adequately or reliably. Most immediate are fines levied by state and EPA regulators. The highest profile are fish kills or algae blooms that impact community water sources. Most lasting are the impacts on the reputation of the beverage or food processor as a neighbor employer and brand.

Clearly, phosphorus must be controlled and discharge limited to safe levels.

Manual monitoring, manual dosing

Wastewater from beverage, food or dairy processing plants usually goes one of two places: directly back into a natural waterway, or to a municipal wastewater treatment plant for further treatment. Permits and regulations vary between the two, and the upper limit for phosphorus depends on location as well.

Traditionally, regulatory agencies test for phosphorus by setting up a water sampler downstream from a processing plant and taking samples at set intervals; for example once per hour. Then this composite sample is tested once a day, and if it exceeds the permitted level of phosphorus, the agency levies a fine. In order to avoid fines, plant operators test their own effluent periodically. The more often they can draw samples, the more accurately they can measure phosphorus over time and dose control agents more precisely. However, the labor cost of manual sampling is multiplied as the number of samples increases, so most sites choose a testing interval and hope that it is frequent enough to detect changes. To compensate, the sites overdose with $FeCl_3$ to provide a safety margin.

The result of this approach is that sites often use too much or too little chemical and that is when they get fined. If, for example, their allowable limit is 1.0 mg/L, a site may set their dosing levels to achieve 0.8 mg/L based on the average phosphorus content of their effluent, hoping this will be sufficient to control variations. The intent is to reduce risk and uncertainty, but this does not really improve controllability. This strategy uses 20% too much ferric chloride most of time while not controlling sudden phosphorus spikes. Spikes can occur for various reasons. A process changeover or increase in process speed increases water flow, discharging more phosphorus. Cleaning operations might use phosphate-containing detergents and high pressure, high temperature water that can suddenly send higher than average amounts of phosphorus downstream.

In short, plant operators are hit with costs two ways – paying too much for dosing chemicals while still being fined for excess phosphorus.

Real-time Control

Increasing frequency of grab sampling improves the chances of detecting changes in phosphorus levels, but these grab samples only provide a snapshot in time of stream conditions. Dosing rates are based on composites of grab samples over a previous time period, so operators are dosing for past discharges, not the current one.

Fortunately, there is proven technology for automating real-time monitoring and dosing control that can give beverage, food and dairy plant operators the data and control they need to meet regulations without overspending on chemicals. A system of compatible, integrated sample analyzers and dosing controllers all managed from a central control unit takes the guesswork and human error out of phosphorus treatment.

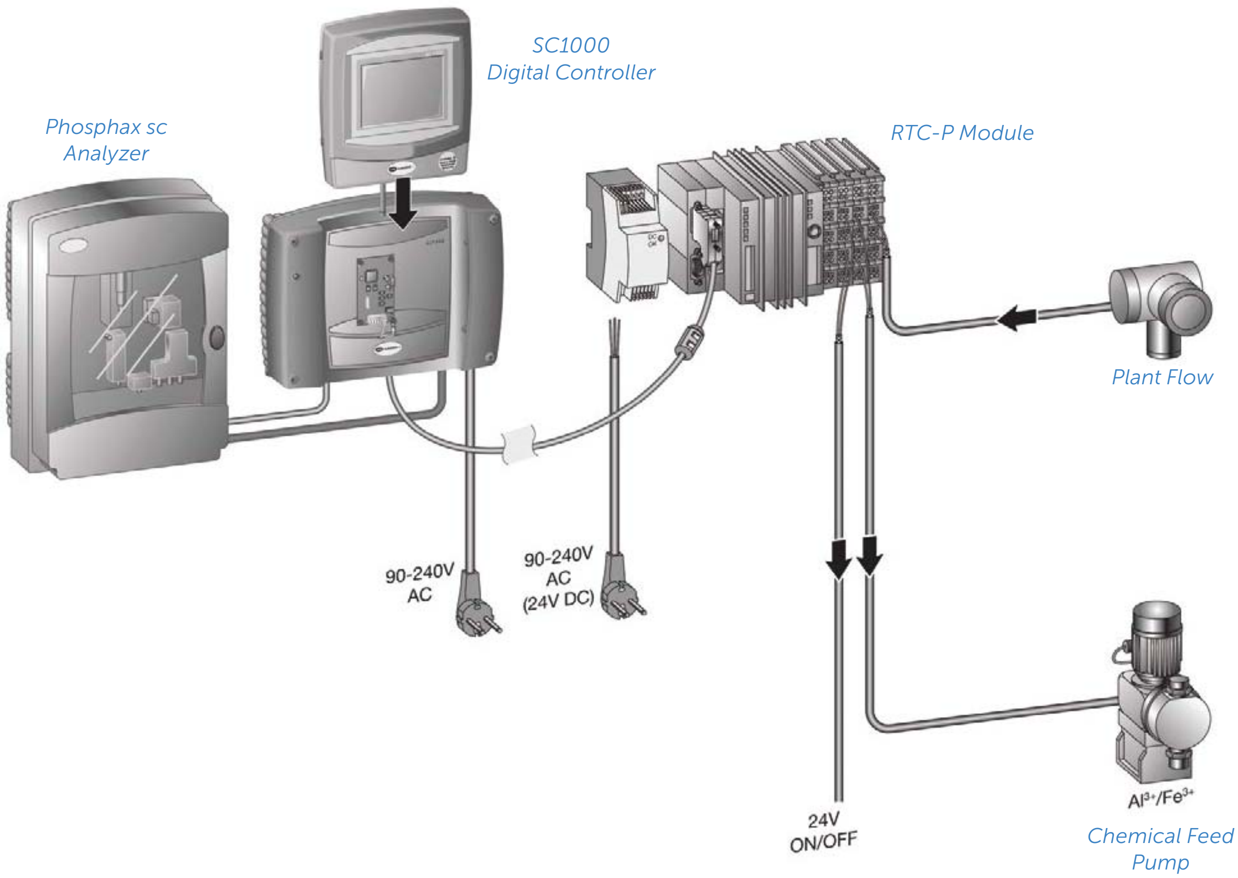
A complete, integrated real-time control system starts with an automatic analyzers. The Phosphax sc Digital Phosphate Analyzer from Hach® can prepare and analyze a sample in under five minutes. Set in a ruggedized weatherproof housing it can be set right at the tank to provide continual, highly precise measurements of phosphorus levels with detection limits as low as 0.05 mg/L. It is designed to use minimal amounts of reagent. Multiple output options are available, making it easily compatible with existing systems.

The analyzer sends data to a central controller, the Hach SC1000 Multi-Parameter Universal Controller. This solid-state, modular controller can monitor up to eight sensors directly or be networked to monitor 32 sensors, each analyzing different parameters. A large color touchscreen lets operators observe system status quickly. Parameters can be adjusted easily when processes change.

The central controller receives data from the analyzer and sends commands to a Phosphorus Real-Time Controller (RTC-P) that manages the coagulant (typically $FeCl_3$) dosage in real time. It signals the feed pump to discharge the appropriate amount into the effluent stream.

The Hach RTC-P also includes PROGNOSYS™ software for predictive diagnostics. This subsystem continually monitors the RTC-P system and delivers status alerts so operators can take proactive troubleshooting, maintenance and repair action.

HACH®
Be Right™



Benefits of real-time control

The main benefit of using real-time control to monitor phosphorus is maintaining compliance with permits thanks to more accurate chemical dosing. Being able to control changing phosphorus levels, even when the concentration fluctuates widely and unexpectedly, reduces risk and variability in effluent discharge.

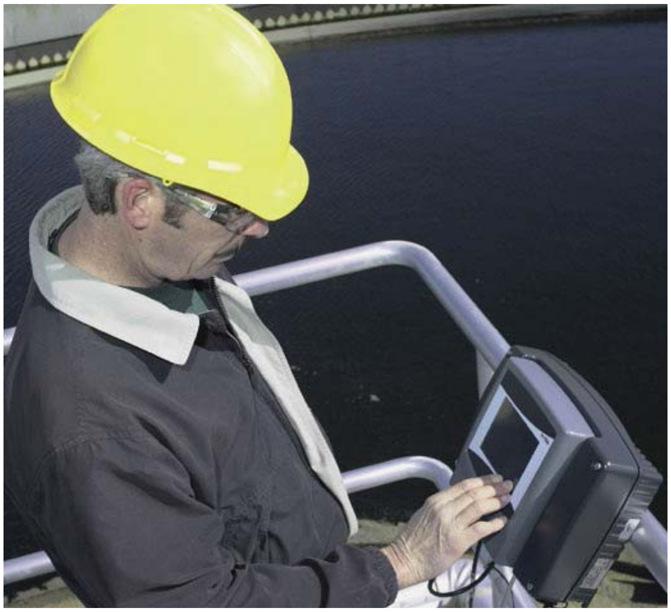
One dairy plant was able to maintain phosphorus compliance without overdosing ferric chloride. This had the added benefit of reducing dosing by an average of 33%, saving $1863 per month. A soft drinks manufacturer was able to meet their compliance limits. Their phosphate discharge values are now controlled at less than 2 parts per million total phosphorus.

Total suspended solids (TSS) and turbidity readings are also reduced by approximately 10%.

Other savings come from reducing labor costs associated with manual sampling and coagulant pump setting changes. Also, more accurate dosing reduces sludge creation.

Additional benefits come from using a prepackaged, turnkey integrated system composed of proven components. In contrast with house-built solutions that string together various pieces, a turnkey system saves staff resources and time while building on its expertise. It ensures continuity of institutional support rather than relying on one person or a department that will eventually turn over. It also ensures the interoperability and optimization of the components and software. An automated RTC-P system helps plants reduce operational complexity.

In short, automated real-time phosphorus control reduces variability and makes outcomes more predictable and controllable. This is better for both the environment and the bottom line.



How 2 plants stayed compliant and brought chemical costs down

A cheese processing facility with high phosphorus output that varied widely was challenged to stay below the 1.0 mg/L limit required. Peaks as high as more than 4 mg/L were often detected too slowly to manually adjust chemical dosing. Installing real-time control brought stability to the process by dosing the right amount of $FeCl_3$ at the right time. This kept output under the limit while reducing chemical consumption by 33%. Average savings in chemical costs alone are $1863 per month, not including the savings created by avoiding fines.

A soft drinks manufacturer was able to meet their compliance limits. Their phosphate discharge values are now controlled at less than 2 ppm total phosphorus.

TSS and turbidity readings are also reduced by approximately 10%.

DOC183.53.30340.Aug16

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Outside United States:	970-669-3050 tel	970-461-3939 fax	int@hach.com

hach.com

Measuring low limit values for ortho-phosphate using the Phosphax sc Low Range

Problem

Due to a tightening of the phosphate effluent limit values, much lower concentrations will be mandated in the future and the demand for precipitants will increase as a result. The online measurement technology deployed is subject to exacting requirements in order to ensure that the low limit values can be reliably adhered to at all times while maintaining the economical use of precipitants.

Two photometric methods are normally used for continuous orthophosphate analysis: the molybdenum blue method and the vanadate-molybdate method (yellow method).

Solution

In order to increase the measurement accuracy in the low measuring range and to eliminate the influence of self-colouration, Hach® has refined the measurement method with a new measuring instrument, the Phosphax sc LR (Low Range). The main changes made compared with the previous measuring instrument are as follows: The mixed reagent used in the medium and high measuring range has been divided and the dosing sequence has been changed. In the low measuring range, the acid is dosed first, after which a zeroing process is performed; only then is the colour reagent dosed (Yellow Method 2.0). This eliminates the influence of any possible self-colouration of the wastewater. There is also a standard solution and the photometric unit has been redesigned and now has a longer path length.

Benefits

The Yellow Method 2.0 offers advantages over the molybdenum blue method. The required chemicals can be stored for several months and do not require cooling. In addition, maintenance costs are comparatively low. As yellowish substances in water can influence the measured value when this measurement method is used, the effect is compensated for through automatic calibration procedures. The molybdenum blue process had previously been considered the more accurate measurement method at low concentrations.

Claros Enabled

The Phosphax sc LR connects to Claros, Hach's innovative Water Intelligence System, enabling you to seamlessly connect and manage instruments, data, and process – anywhere, anytime. To unlock the full potential of Claros, insist on Claros-Enabled instruments

*Learn more at **hach.com/claros***

Background

A large, regional wastewater partnership operates a total of 59 wastewater treatment plants, with numerous measurement technologies being used across the facilities they operate. In-depth testing of technical equipment that will subsequently be used in the plants is a must, in order to ensure that the latest requirements for wastewater treatment are always satisfied. Hach has been collaborating with this partnership for many years, with a recent initiative being a beta test of the new Phosphax sc LR analyser.

The Solution in Three Different Locations

Over a period of three months, a number of parallel measurements using various measuring instruments were carried out at three different wastewater treatment plants; there were also laboratory-based comparative measurements for the blue method and the yellow method.

Treatment Plant 1:

A Phosphax sc is used at the first wastewater treatment plant in the in-depth testing project, focussing on the PO_4-P concentration in the effluent from the aeration tank. Samples are pre-treated using Filtrax-type filtration.

The new Phosphax sc LR was installed parallel to this measurement. The following chart plots the measurement results against each other. The graph from the Phosphax sc LR shows a lower fluctuation range and provides slightly lower measurement results in the very low concentration range.

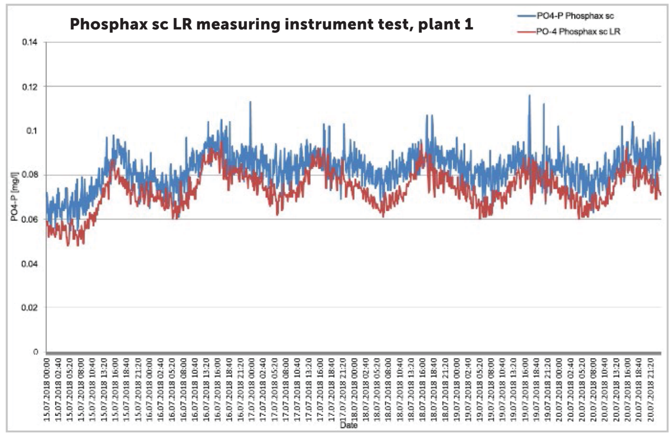

Figure 1: Graph of the PO_4-P concentration in mg/L from JULY 15, 2018 to JULY 20, 2018

Treatment Plant 2:

The second plant is the location for a test to determine the phosphate concentration in the effluent. The Phosphax sigma uses the molybdenum blue method (blue method) to determine the total phosphorus concentration (P_{tot}) and the orthophosphate concentration (PO_4-P) at intervals. The P_{tot} value is determined with the solids that are still in the sample being taken into account, which means there is no sample filtration. As the PO_4-P concentration can be distorted by particles in the sample, an additional Phosphax sigma was installed for this test and Filtrax filtration was connected upstream. This allowed the blue and yellow methods to be tested directly next to each other. The following chart plots the measurement results against each other.

Figure 2 shows the comparatively balanced curve of the PO_4-P concentration as measured by the Phosphax sc LR. The PO_4-P concentration measured using the blue method is comparable, but the curve is slightly more uneven. No advantage in the precision of the blue method compared with the yellow method could be identified. The sample is analysed unfiltered by the measuring instrument at the wastewater treatment plant. Here, the influence of the turbidity included in the measurement is clearly visible. The higher the proportion of turbidity, the higher the deviation of the measured PO_4-P concentration compared with the measuring instruments with upstream sample filtration.

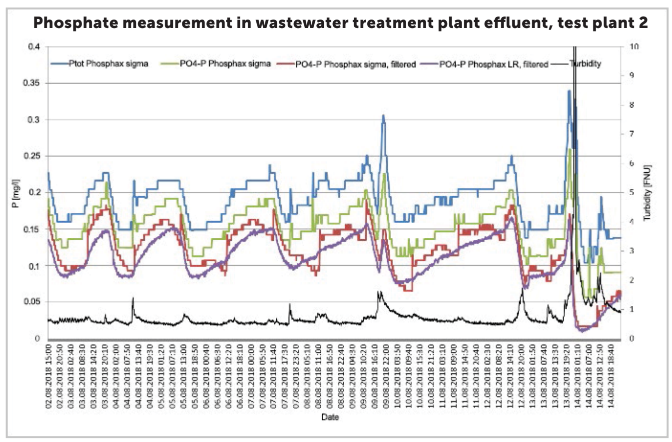

Figure 2: Graph of the PO_4-P concentration in mg/L from Aug. 2-14, 2018

Treatment Plant 3:

At the third plant total-P is measured in the effluent with the Phosphax Sigma (blue method). Ortho-P is measured with a tried-and-tested Phosphax inter (yellow method) measuring instrument. The sample is filtered using Filtrax sample conditioning for this purpose. The Phosphax sc LR was placed immediately next to this instrument and supplied with the same sample.

The measured values from the PO_4-P analysers correlate very well with each other (see chart information). It can also be seen here that the graph for the Phosphax sc LR has a more stable progression. The total phosphorus concentration is correspondingly higher due to the co-determination of the undissolved phosphorus content in the sample.

During cleaning work several days after the testing period began, particles entered the sample inlet in the sample receiver. This led to a short-term increase in the phosphorus concentration measured (see Fig 3) but had no effect on the effluent from the wastewater treatment plant.

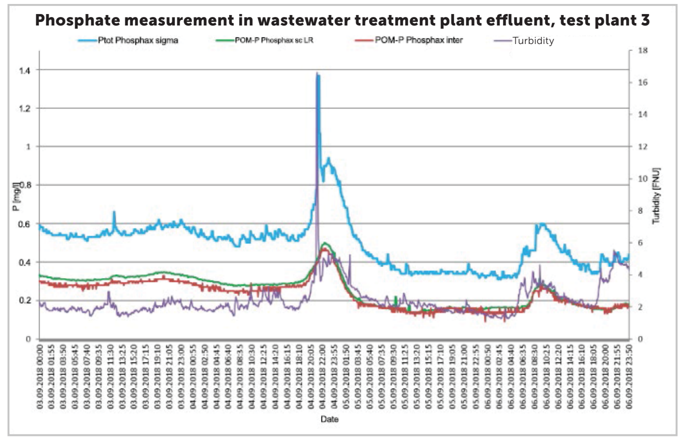

Figure 3: Graph of the PO_4-P concentration in mg/L from Sept 3-9, 2018

Assessment of the measurement results

During the test phase, comparative measurements were taken in the laboratory by conducting Hach cuvette tests in accordance with the standard method: DIN 38405 D11-4 (blue method). The chart in Figure 4 illustrates how well the measured values compare to the results of the cuvette tests. Figures 5 and 6 show the measured values in scatter diagrams. The charts illustrate that the linear regression line for the new Phosphax sc LR measuring instrument features better congruence with the laboratory results with a coefficient of determination of R^2 = 0.98 than the previous measurement method, where R^2 = 0.90.

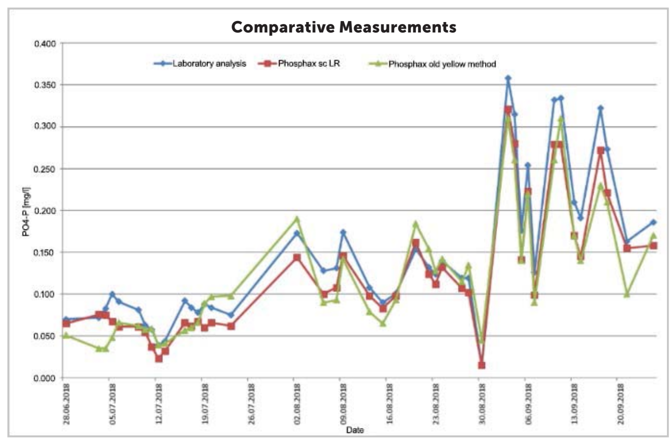

Figure 4: Comparative measurements in the laboratory using cuvette tests, in mg/L

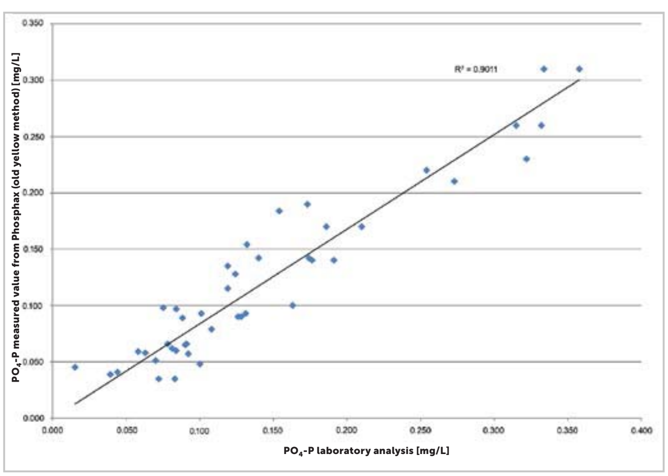

Figure 5: Scatter diagram of measured values from the laboratory and Phosphax sc (old yellow method), in mg/L

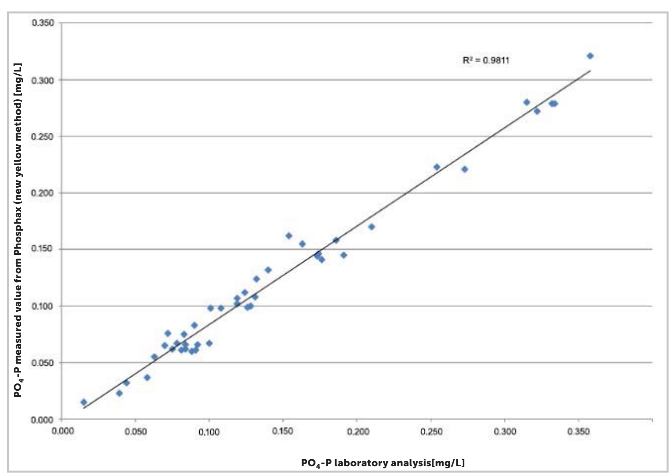

Figure 6: Scatter diagram of measured values from the laboratory and Phosphax sc LR (new yellow method), in mg/L

Be Right™

Maintenance and operating supplies

During the test period of approx. three months, no maintenance work was performed on the analyser except for visual inspections. Refilling or replacement of reagents and wear parts was not required. The chemical consumption can be used to estimate an annual consumption of two reagent sets at a measurement interval of ten minutes. The new process analyser is approximately 20% more expensive than the Phosphax sc; the cost of a reagent set and the chemical consumption rate have also increased. The molybdenum blue method is significantly more expensive by comparison. In contrast to the yellow method, the Phosphax sigma can also be used to determine the total phosphate concentration in the effluent from the wastewater treatment plant. However, the total phosphate concentration is not relevant for phosphate precipitation.

	Phosphax sc	Phosphax sc LR	Phosphax sigma (P_{tot} or PO_4-P)
Measurement method	Double-beam photometer, yellow method		Molybdenum blue method acc. to DIN
Measuring range	0.05 - 15 mg/L	0.015 - 2 mg/L	0.01 - 5.0 mg/L
Meas. interval	5 - 120 mins	10 - 120 mins	Approx. 10 mins
Measurement uncertainty	2% + 0.05 mg/L	2% + 0.015 mg/L	2% + 0.02 mg/L
Annual wear parts	approx $255		$727
Reagent set	approx $171	$383	$645
Reagents per year	approx $227	$766	$2700

Table 1: Technical data and costs, as of December 2018

Conclusion

In the future, operators of wastewater treatment plants will have to adjust their operations to comply with lower limit values for the discharge of phosphate into bodies of water. This places more stringent demands on the cleaning processes as well as on the accuracy of the measurement technology. Accurate measuring instruments for low measuring ranges are required in order to achieve economical dosing of the precipitants. With this in mind, Hach has developed a new PO_4-P online process analyser for the low measuring range using the yellow method. This measuring instrument has now been tested at a number of wastewater treatment plants.

The new measuring instrument exhibited lower deviations from the comparative values from the laboratory testing than the existing measuring instruments, which use the yellow method. There was also a consistently lower fluctuation range in the graph. The maintenance burden is very low; no faults occurred. The Phosphax sc LR measuring instrument is recommended for monitoring and adhering to low PO_4-P effluent concentrations. Due to the strong measurement accuracy and the low fluctuation range of the measurement results, the precipitant can be used more economically, as the dosing threshold values can be more narrowly defined.

Despite the slightly higher outlay to cover purchase costs and chemicals, there is a cost advantage over a process analyser based on the blue method.

DOC043.53.30496.Feb19

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xylem
Let's Solve Water

YSI Alyza IQ Analyzers

THE SIMPLE CHOICE FOR ORTHOPHOSPHATE AND AMMONIUM ANALYZERS

YSI
a xylem brand

ALYZA ANALYZER BROCHURE
W138-01

Meet Alyza IQ. It Just Works.

The innovative Alyza IQ analyzers are YSI's reliable, low-maintenance solution for wastewater monitoring and control. Easy to maintain with reliable measurements, IQ analyzers just work... and work... and work.

Low Reagent Use

Uses 5µL (PO4) or 15 µL (NH4) reagent per sample, saving you time and money.

Simple Service

Reagent bag design makes replacing reagents easier and safer than ever.

Reliable Measurements

Real-time monitoring of reagent levels helps keep your analyzer in operation.

Automatic Calibration

Routine self calibration ensures accurate measurements.

Quick, Easy Exchange Service

Built with service in mind, all consumables can be quickly and easily exchanged without expensive service contracts or calling a service technician.

Long-life Reagent

Long-lasting no-drip replacement pouches are easier and safer to use.

ysi.com/PO4 ysi.com/NH4

Applications

The Alyza PO4 and NH4 instruments are cabinet-style, wet chemistry analyzers with built-in sample delivery systems. Available in single- or dual-channel versions, Alyza features self-cleaning and calibration for reliable measurements. In addition, Alyza uses very little reagents, lowering your cost per measurement.

Orthophosphate measurement

Method | Molybdate-Vanadate method (Yellow method)

- Monitor and control chemical phosphorus removal, reducing dosing chemicals and sludge production
- Monitor biological phosphorus removal
- Effluent monitoring to ensure compliance
- Low measuring range for lowering effluent limits

Ammonium measurement

Method | Indophenol method (Berthelot method)

- Monitor and control ammonia-based aeration
- Effluent monitoring to ensure compliance

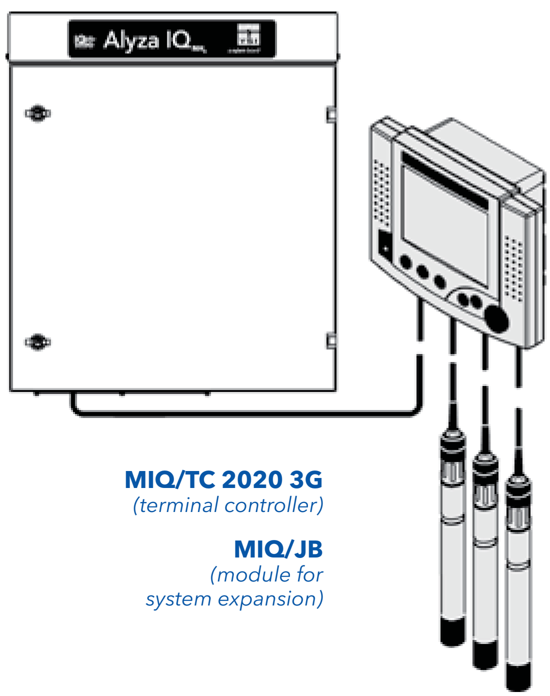
Networking

IQ SENSOR NET

Integration

The Alyza IQ is fully integrated into the IQ SensorNet as a sensor. The new analyzer connects to IQ SensorNet 2020 or 282/284 controllers.

ysi.com/IQSN

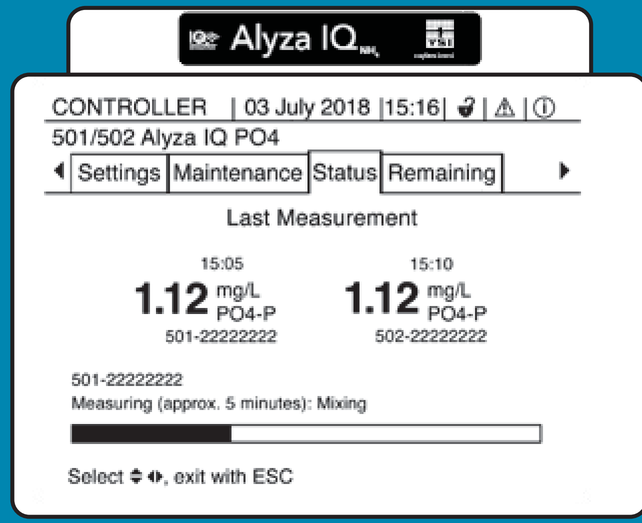


Benefits of Alyza IQ

- Minimum maintenance with automatic cleaning
- High accuracy at low measuring ranges
- New MultiPort mixing valve dramatically reduces chemical consumption
- Connects to IQ SensorNet controllers (provides 10W power)
- Easy installation - analyzers can be installed directly at the basin
- 1- or 2- channel versions; 2-channel allows for sampling from two locations
- Optimized user interface and self-diagnostics
- Serviceable - safe and easy replacement of reagents
- One- or two-point automatic calibration at user-defined intervals
- Ammonium or orthophosphate units available

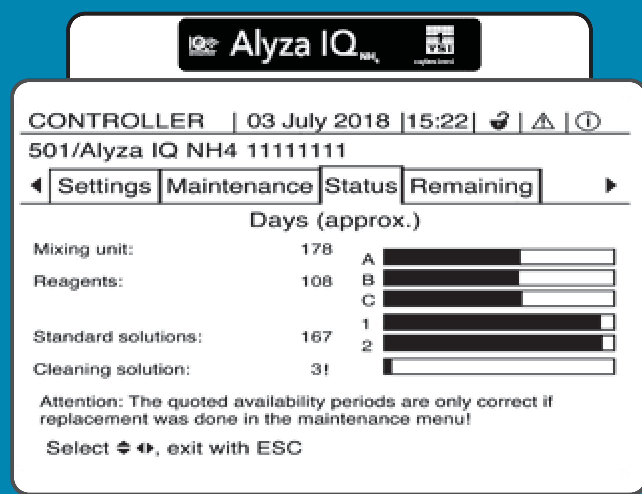
New Filter Accessory

Rectangle filter and slide mount, with more robust membrane material and a stronger filter construction.



Precision

Measurement Status of Alyza IQ showing last reading and time remaining until next measurement.



Innovation

Real-time monitoring of reagent levels. No more guessing the number of days left before reagents need changed.

Revolutionary

MultiPort Mixing Valve

Technical data

Model	**Alyza IQ NH4 (Ammonium)**	**Alyza IQ PO4 (Orthophosphate)**
Measurement method	Berthelot method (Indophenol method)	Moybdate-Vanadate method (Yellow method)
Measurement range	Two measuring ranges	Measuring range is instrument dependent
	NH4 MR1: 0.02 to 5.00 mg/l NH_4-N Displayed: 0.00 to 5.00 mg/l NH_4-N Resolution: 0.01 mg/l NH_4-N Accuracy: ± 2 %, ± 0.02 mg/l	**PO4 – 111/112** MR1: 0.02 to 15.00 mg/l PO_4-P Displayed: 0.00 to 15.00 mg/l PO_4-P Resolution: 0.01 mg/l PO_4-P Accuracy: ± 2 %, ± 0.05 mg/l
	NH4 MR2: 0.10 to 20.00 mg/l NH_4-N Displayed: 0.00 to 20.00 mg/l NH_4-N Resolution: 0.01 mg/l NH_4-N Accuracy: ± 3 %, ± 0.10 mg/l	**PO4 – 121/122** MR2: 0.2 to 50.0 mg/l PO_4-P Displayed: 0.0 to 50.0 mg/l PO_4-P Resolution: 0.05 mg/l PO_4-P Accuracy: ± 2 %, ± 1.0 mg/l
Sample Time Intervals	1 channel: 10 minutes; 2 channel: 20 minutes	1 channel: 10 minutes; 2 channel: 20 minutes
Sample streams/channels	1- and 2-channel versions available	
Cleaning	Automatic cleaning with cleaning solutions	
Calibration	Automatic 1– and 2-point calibrations	
Operational temperature	-4 to 104 °F (-20 to +40 °C)	
pH range	5 to 9	
Warranty	2 years	
Solids content	< 6 g/l before filtration	

Order information

Model	Description	Order no.
Alyza IQ for Ammonium measurement		
Alyza IQ NH4-111	NH4 analyzer, 1-channel, with 2 measuring ranges, Indophenol method, connects to 2020 and 282/284 controllers, provides 10 W to the IQ Sensor Net; includes 2 meter SNCIQ cable. Controller, reagent sets, filter and mounting hardware need to be ordered separately.	825011Y
Alyza IQ NH4-112	NH4 analyzer, 2-channel, with 2 measuring ranges, Indophenol method, connects to 2020 and 282/284 controllers, provides 10 W to the IQ Sensor Net; includes 2 meter SNCIQ cable. Controller, reagent sets, filter and mounting hardware need to be ordered separately.	825012Y
Reagent sets		
R-Set NH4/1-1	Reagents for Alyza IQ NH4, when using MR1	827540Y
R-Set NH4/1-2	Reagents for Alyza IQ NH4, when using MR2	827541Y
SC-Set NH4/1-1_0/1	Calibration standards and cleaning solution for Alyza IQ NH4, when using MR1; Calibration standards with 0 mg/l and 1 mg/l	827545Y
SC-Set NH4/1-1_0/4	Calibration standards and cleaning solution for Alyza IQ NH4, when using MR1; Calibration standards with 0 mg/l and 4 mg/l	827546Y
SC-Set NH4/1-2_0/16	Calibration standards and cleaning solution for Alyza IQ NH4, when using MR2; Calibration standards with 0 mg/l and 16 mg/l	827547Y
Alyza IQ for Orthophosphate measurement		
Alyza IQ PO4-111	PO4 analyzer, 1-channel, with MR1, yellow method, connects to 2020 and 282/284 controllers, provides 10 W to the IQ Sensor Net; includes 2 meter SNCIQ cable. Controller, reagent sets, filter and accessories need to be ordered separately.	825511Y
Alyza IQ PO4-112	PO4 analyzer, 2-channel, with MR1, yellow method, connects to 2020 and 282/284 controllers, provides 10 W to the IQ Sensor Net; includes 2 meter SNCIQ cable; Controller, reagent sets, filter and accessories need to be ordered separately.	825512Y
Alyza IQ PO4-121	PO4 analyzer, 1-channel, with MR2, yellow method, connects to 2020 and 282/284 controllers, provides 10 W to the IQ Sensor Net; includes 2 meter SNCIQ cable. Controller, reagent sets, filter and mounting hardware need to be ordered separately.	825521Y
Alyza IQ PO4-122	PO4 analyzer, 2-channel, with MR2, yellow method, connects to 2020 and 282/284 controllers, provides 10 W to the IQ Sensor Net; includes 2 meter SNCIQ cable. Controller, reagent sets, filter and mounting hardware need to be ordered separately.	825522Y
Reagent sets		
R-Set PO4/1-1	Reagents for Alyza IQ PO4-X1X with MR1	827550Y
R-Set PO4/1-2	Reagents for Alyza IQ PO4-X2X with MR2	827551Y
SC-Set PO4/1-1_0/1	Calibration standards and cleaning solution for Alyza IQ PO4-X1X with MR1; Calibration standards with 0 mg/l and 1 mg/l	827555Y
SC-Set PO4/1-1_0/10	Calibration standards and cleaning solution for Alyza IQ PO4-X1X with MR1; Calibration standards with 0 mg/l and 10 mg/l	827556Y
SC-Set PO4/1-2_10/40	Calibration standards and cleaning solution for Alyza IQ PO4-X2X with MR2; Calibration standards with 10 mg/l and 40 mg/l	827557Y

Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

We're a global team unified in a common purpose: creating advanced technology solutions to the world's water challenges. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. Our products and services move, treat, analyze, monitor and return water to the environment, in public utility, industrial, residential and commercial building services settings. Xylem also provides a leading portfolio of smart metering, network technologies and advanced analytics solutions for water, electric and gas utilities. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise with a strong focus on developing comprehensive, sustainable solutions.

For more information on how Xylem can help you, go to www.xylem.com

DOCUMENT W138-01 | 0220

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APPENDIX C
MANUFACTURER EQUIPMENT PROPOSALS

Nexom™

DEERFIELD WI

Preliminary Proposal for Design, Supply and Installation Inspection of the Wastewater Treatment System Upgraded with

BluePRO

April 29th, 2021

technologies for cleaner water 323 N. Spokane St. Suite 200 · Post Falls ID · 83854
888·710·2583 • **www.nexom.com**

Project Overview

Nexom is pleased to propose a Blue PRO® reactive filtration system for Strand Project# 1545.037 in Deerfield, WI. The proposed system design would consist of the following processes and technologies:

- Blue PRO® continuous backwash up-flow sand filtration system for TSS removal and total phosphorus (TP) polishing to <0.1 mg/L TP.
    - Chemical dosing systems and PLC dose control
    - BluePRO sand filter internals and media
    - System PLC controls, control valves and instrumentation
    - Filter covers.

Included:

☑	Detailed Blue PRO phosphorus removal system	
☑	Detailed space requirements	See drawings
☑	Detailed head loss requirements	Page 3
☑	Equipment price	Page 8
☑	Projected annual operating costs for chemical, power and maintenance	Page 6
☑	Include testing, start-up, one-year warranty	

System Design Parameters

Preliminary design loads, flow, and effluent objectives are presented in the following table:

	Units	Influent	Effluent
Design Average Daily Flow (ADF)	MGD	3.5	
Future ADF Day Flow (PDF)	MGD	9.2	
Peak Hour Flow (PHF)	MGD	9.2	
Alkalinity	mg/L	50 - 150	
pH	S.U.	6 - 7.5	
Temperature	°C	5-25	
Total suspended solids (TSS)	mg/L	< 15	< 10
Total phosphorus (TP)	mg/L	< 2.2	< 0.1
Non-reactive phosphorus (NRP)	mg/L	< 0.025	< 0.025

Filtration design parameters are presented in the following table:

Configuration	Units	Design Parameter
Filter model		3-CF64-60
Headloss profile	in	48
Total number of filter cells duty + standby		5 + 1
Filtration area per filter cell	ft^2	256
Duty filtration area	ft^2	1,280
Total filtration area	ft^2	1,536
Hydraulic loading at ADF, PHF[1]	gpm/ft^2	< 5.0
Surface solids loading rate (SSLR) at ADF, PHF[1]	lb/ft^2d	< 1.8

1. SSLR includes assumed chemical solids; backwash is 33 gpm per filter cell
2. Filter cells will duty cycle with diurnal flow to maintain the filter loading between 1 and 4 gpm/ft^2 on average.

Treatment Processes

BluePRO® Reactive Filtration

The Blue PRO® Reactive Filtration process utilizes a patented reactive filtration process within Centra-flo® continuous-backwash media filter to accomplish low levels of TSS, phosphorus, and many other trace elements. With the efficiency of reactive filtration, Blue PRO® uses 30% less chemical than comparative technologies for ultra-low phosphorus results, thereby also producing less chemical sludge.

The reactive filtration cycle starts with influent water distributed across almost the entire cross-sectional area of the filter at the bottom of the media column. Water flows upward, carrying hydrous ferric oxide (HFO) and coating the media with it. Media now covered by HFO coating attracts and reacts with the phosphorus and metals while moving downward by gravity in a countercurrent flow to an airlift pump. As the filtered water exits from the top of the filter, the airlift transports the TSS and the phosphorus- or metals-laden media up into the washbox where the discharged HFO coating and adsorbed contaminants are separated from the media. Water velocities in the washbox are carefully designed to carry away the contaminants while allowing the media to fall to the filter bed. The cycle restarts with freshly scrubbed media from the washbox recoated with HFO (regenerated) as the continuous influent flows upward.

A Blue PRO® system will waste almost no media in its lifetime, meaning that in a 20-year period, topping up is unlikely to be required, and the media should never need to be replaced.

Blue PRO® reactive filtration can be installed into concrete tanks or purpose-built fiberglass or stainless tanks.

The Blue PRO® Reactive Filtration process overcomes a critical process obstacle of achieving efficient phosphorus and contaminant removal by providing a very large reactive surface area within the media bed, resulting in guaranteed contact of contaminant with HFO and its high adsorptive capacity.

Waste HFO, phosphorus, and solids are removed from the filter through the backwash or reject stream. Recycling this backwash upstream provides the added benefit of phosphorus pre-treatment in primary or secondary treatment systems, further guaranteeing the achievement of the effluent phosphorus target as well as lowering the overall plant chemical ratio. The phosphorus is chemically bound, exiting the site with the plant sludge. The integration of the Blue PRO® technology does not require a change in the plant's sludge handling system.

Operation & Maintenance

Anticipated operation and maintenance costs for the filtration system are presented in the following table:

Annual Average Conditions	Quantity	Motor Power		Monthly Cost	Unit Cost	Annual Cost*
		bhp	kW			
Duty compressor motors	1	30	22.4	$588	-	$7,058
Filter airlifts	24	-	-	-	$1,800	$6,171
Compressor maintenance	2	-	-	-	$500	$1,000
Total O&M						**$14,229**

* Electrical Rate (estimated by Nexom): **0.08** $/kW-h

The estimated chemical costs are presented in the following table:

	Units	Unit Cost	Monthly Cost	Annual Cost
PAC, 80% basicity, gal/d	78	$1.35	$3,169	$38,026

The anticipated duty run time for compressor motors are presented in the following table:

Compressor air capacity FAD, ACFM	148.7
Air required for all filters, ACFM	129.9
Peak operating demand	87%
Duty factor, actual	45%

The sand filter system will require one operator approximately 15 minutes per day for routine inspection & maintenance.

Budgetary Capital Cost

Included in the wastewater treatment system capital cost are:

GENERAL

- Nexom system process design, CAD drawings and specifications, and O&M manuals
- Equipment inspection, start-up, commissioning, and training
  - Four (4) trips including up to fifteen (15) days onsite.

EQUIPMENT SCOPE

- Twenty-four (24) Model CF64 FRP filter cones
- Twenty-four (24) Model CF64-60 FRP filter central assemblies
- Twenty-four (24) HDPE airlifts and filter washboxes
- One (1) filter system control panel including PLC and HMI
- Six (6) airlift control panels
- One (1) pneumatic system including duty and duty standby VFD driven rotary screw compressors, filtration, and refrigerated dryer
- One (1) chemical feed system with online duty and duty-standby pumps
- One (1) lot of instrumentation:
  - One (1) headloss transmitter
  - Eight (8) filter level switches
- Six (6) air-actuated filter influent isolation valves
- One (1) lot aluminum covers
- One (1) lot sand media.

TWO-YEAR SPARES

None required.

BUDGETARY COST FOR EQUIPMENT SCOPE:

$ 1,377,000 USD

Shipping allowed to the job site, plus applicable taxes.

All prices are subject to final design review.

The quote being provided will be in effect only for a period of 60 days. Should the company be awarded a purchase order during that 60-day period, it is understood that shipment of the product will be allowed within a period of 180 days from the date of the purchase order. Should the goods not be required to be delivered until after that time horizon, the company reserves the right to adjust pricing to reflect inflationary changes incurred and expected until the shipment date is reached.

Items Specifically Not Included:

- Material offloading and secure on-site storage
- Equipment installation
- Civil works including power hookup
- Interconnecting process piping, valves, wiring/control wiring of all supplied components and equipment
- Chemicals procurement, storage, injectors and mixing
- Filter influent flow signal, required.

Questions or Comments?

Any questions or comments can be directed to:

Nexom
Info@nexom.com
888-710-2583
323 N. Spokane St. Suite 200, Post Falls ID 83854

www.nexom.com

PIPING SYMBOLS

- PRIMARY PROCESS FLOW PATH
- SECONDARY FLOW PATH
- HEAT TRACE
- INSULATED PIPELINE
- INFLUENT
- EFFLUENT
- REJECT
- SYSTEM EXTENTS

INSTRUMENT LINE SYMBOLS

- PNEUMATIC LINE
- CONTROL LOGIC
- ELECTRIC SIGNAL
- UNDEFINED SIGNAL
- INTERNAL SYSTEM LINK SOFTWARE OR DATA
- CAPILLARY TUBE

PIPE LINE DESIGNATION

6"-S04P1-101A

- BRANCH
- LINE NUMBER
- PRESSURE RATING (1 OR 2 DIGITS)
- LINE TYPE
- MATERIAL
- SIZE

VALVE ACTUATOR SYMBOLS

(NO SYMBOL) = MANUAL FOR ON/OFF SERVICE	HANDWHEEL (MANUAL OVERRIDE)	ELECTRIC
SOLENOID (WITHOUT)	DIAPHRAGM AIR TO AIR (WITHOUT)	DIAPHRAGM & SPRING TO OPEN (WITHOUT)
SOLENOID (WITH) =MANUAL OVERRIDE	DIAPHRAGM AIR TO AIR (WITH)=POSITIONER	DIAPHRAGM & SPRING TO CLOSE (WITH)=POSITIONER
DOUBLE-ACTING CYLINDER (WITHOUT)	CYLINDER & SPRING TO OPEN	
DOUBLE-ACTING CYLINDER (WITH)=POSITIONER	CYLINDER & SPRING TO CLOSE	

SYMBOLS FOR VALVE ACTION IN THE EVENT OF ACTUATOR POWER FAILURE

SYMBOL LOCATED BY VALVE- USED ONLY WHERE NECESSARY TO INCREASE UNDERSTANDING OF THE SYSTEM.

FO

- FO = FAIL OPEN
- FC = FAIL CLOSED
- FL = FAIL LOCKED
- FI = FAIL INDETERMINATE (LAST POSITION)
- F = USED WITH 3 WAY & 4 WAY VALVE- ARROWS SHOW PATHS OPEN TO FLOW ON POWER FAILURE.

MATERIAL DESIGNATION

BRZ - BRASS/BRONZE
CIR - CAST IRON
CST - CARBON STEEL
CPR - COPPER
FRP - FIBERGLASS
GCS - GALVANIZED CARBON STEEL
LCS - LINED CARBON STEEL
TEF - TEFLON
PU - POLYURETHANE
PET - POLYETHYLENE
POP - POLYPROPYLENE
PVC - POLYVINYL CHLORIDE
RUB - RUBBER
S04 - 304 STAINLESS STEEL
S4L - 304L STAINLESS STEEL
S16 - 316 STAINLESS STEEL
S6L - 316L STAINLESS STEEL
VIT - VITON
CVC - CHLORINATED POLYVINYL CHLORIDE

SYMBOLS FOR SELF-ACTUATED REGULATORS

PRESSURE REDUCING REGULATOR SELF CONTAINED	BACK PRESSURE REGULATOR SELF CONTAINED	RUPTURE DISC OR SAFETY HEAD PRESSURE RELIEF
PRESSURE REDUCING REGULATOR EXTERNAL TAP	BACK PRESSURE REGULATOR EXTERNAL TAP	RUPTURE DISC OR SAFETY HEAD VACUUM RELIEF
PRESSURE RELIEF ANGLE	VACUUM RELIEF ANGLE	PRESSURE VACUUM RELIEF
PRESSURE RELIEF STRAIGHT	VACUUM RELIEF STRAIGHT WITH WELL	TEMPERATURE REGULATOR FILLED SYSTEM
LEVEL REGULATOR FLOAT OPERATED MECHANICAL LINKAGE	TRAP CONTINUOUS DRAINER BALL FLOAD TYPE	TANK TRAP WITH EQUALIZING CONNECTION

DIFFERENTIAL PRESSURE REDUCING REGULATOR - SHOWN WITH INTERNAL AND EXTERNAL PRESSURE TAPS.

HEAT EXCHANGER SYMBOLS

SHELL & TUBE HEAT EXCHANGER		ELECTRICAL HEATING ELEMENT
AIR COOLED HEAT EXCHANGER	GENERAL HEAT EXCHANGER	DIRECT CONTACT JET MIXER

PRIME MOVERS FOR MOTOR DRIVEN EQUIPMENT

ELECTRIC MOTOR	PNEUMATIC ROTARY MOTOR

MOTOR DRIVEN EQUIPMENT

CENTRIFUGAL PUMP	ROTARY BLOWER OR COMPRESSOR	FAN / BLOWER
VERTICAL CENTRIFUGAL PUMP	SUBMERSIBLE PUMP	CHEMICAL FEED PUMP
VERTICAL TURBINE	PERISTALTIC PUMP	PROGRESSIVE CAVITY PUMP
DIAPHRAGM CHEMICAL FEED PUMP W/ INTERNAL RELIEF VALVE		LIQUID RING VACUUM PUMP
VENT FAN	AGITATOR OR MIXER	DIAPHRAGM PUMP (PNEUMATIC OPER.)
AIR COMPRESSOR	DUPLEX AIR COMPRESSOR	

TYPE

D = DUCT P = PIPE
H = HOSE T = TUBE

GENERAL NOTES:

1. FOR INSTRUMENTATION SYMBOLS AND LIST OF RELAY FUNCTIONS SEE NEXOM DRAWING NO. PID-B.

THIS DRAWING IS PROVIDED FOR INFORMATION ONLY.

PIPING ACCESSORIES & DETAILS

Y STRAINER	CONE STRAINER	SCREEN STRAINER OR STATIC MIXER
MIXING SECTION	EJECTOR	BACKFLOW PREVENTER
SPRAY NOZZLE OR SPARGER	CHEMICAL SEAL	EXPANSION JOINT
FLEX HOSE		STRAIGHTENING VANES
FILTER	SCOPE LIMITS	THERMOWELL
SIMPLEX BASKET STRAINER	DUPLEX BASKET STRAINER	AIR FILTER
AIR DRYER	MIST ELIMINATOR	PULSATION DAMPER
SIGHT GLASS	RESTRICTION ORIFICE	DU INSULATED FLANGE OR DIELECTRIC UNION
QUICK DISCONNECT ASSEMBLY	SUMP/DRAIN	CALIBRATION COLUMN
VARIABLE AREA FLOW INDICATOR WITH INTEGRAL NEEDLE VALVE	ORIFICE FLANGE	CONCENTRIC REDUCER
ECCENTRIC REDUCER FLAT ON TOP	ECCENTRIC REDUCER FLAT ON BOTTOM	

VALVE SYMBOLS

GATE	GLOBE	BALL
PLUG	3 WAY PLUG	BUTTERFLY
CHECK	DIAPHRAGM	PINCH
NEEDLE	3 WAY	4 WAY
ANGLE	KNIFE GATE	WEIGHTED RELIEF
VALVE (UNDEFINED TYPE)	V-PORT BALL VALVE	AIR RELEASE

TANK AND ACCESSORIES

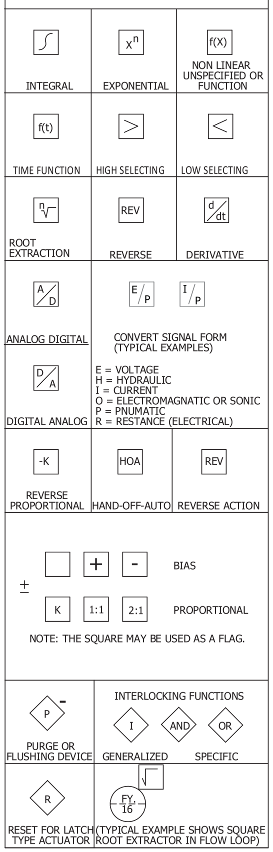
MANHOLE/ACCESS	COUPLING (HALF OR FULL)	FLANGED NOZZLE
RECEIVER TANK		INSULATION

Nexom

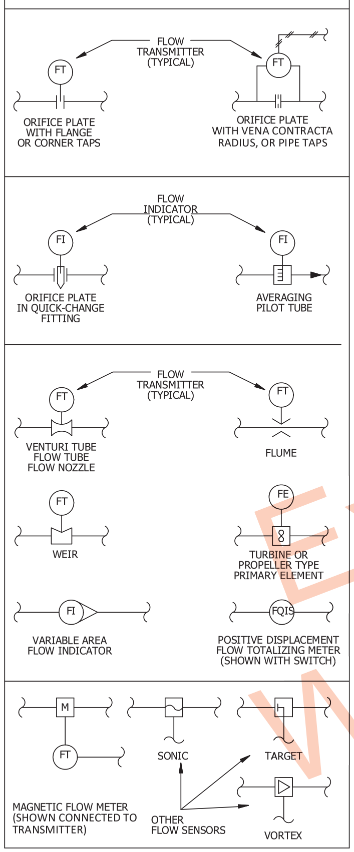
UNLESS OTHERWISE SPECIFIED	
TOLERANCES:	
FRACTIONAL	± 1/16"
ONE DECIMAL	± .125"
TWO DECIMAL	± .0625"
ANGULAR	± 2.0°

LOCATION: Spencer, MA		SCALE 1:1
DESCRIPTION: Piping and Instrumentation Diagram		
NUMBER: cd3440.01-PID	REV. 1/23/20	PAGE 1/3

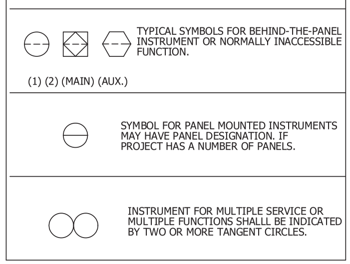
MISCELLANEOUS SYMBOLS



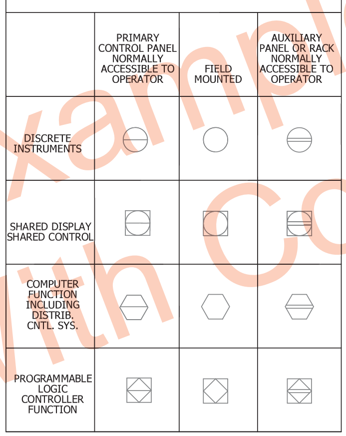
SYMBOLS FOR FLOW MEASUREMENT



SYMBOLS FOR LOGIC CONTROL



INSTRUMENT SYMBOLS



INSTRUMENT IDENTIFICATION LETTERS

FIRST LETTER

MEASURE OR INIATING VARIABLE	MODIFIER
A = ANALYSIS	
B = BURNER, COMBUSTION	
C = USER'S CHOICE	
D = USER'S CHOICE	DIFFERENTIAL
E = VOLTAGE	
F = FLOW RATE	RATIO (FRACTION)
G = USER'S CHOICE	
H = HAND	
I = CURRENT (ELECTRICAL)	
J = POWER	SCAN
K = TIME, TIME SCHEDULE	TIME RATE OF CHANGE
L = LEVEL	
M = USER'S CHOICE	MOMENTARY
N = USER'S CHOICE	
O = USER'S CHOICE	
P = PRESSURE, VACUUM	
Q = QUANTITY	INTERGRATE, TOTALIZE
R = RADIATION	
S = SPEED, FREQUENCY	SAFETY
T = TEMPERATURE	
U = MULTIVARIABLE	
V = VIBRATION, MECH. ANALYSIS	
W = WEIGHT, FORCE	
X = UNCLASSIFIED	X AXIS
Y = EVENT, STATE OR PRESENCE	Y AXIS
Z = POSITION, DIMENSION	Z AXIS

SUCCEEDING LETTERS

LETTER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ALARM		
B	USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C		CONTROL	
D			
E	SENSOR (PRIMARY ELEMENT)		
F			
G	GLASS, VIEWING DEVICE		
H			HIGH
I	INDICATE		
J			
K		CONTROL STATION	
L	LIGHT		
M			MIDDLE, INTERMEDIATE
N	USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	ORIFICE, RESTRICTION		
P	POINT (TEST) CONNECTION		
Q			
R	RECORD		
S		SWITCH	
T		TRANSMIT	
U	MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V		VALVE, DAMPER, LOUVER	
W	WELL		
X	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y		RELAY, COMPUTE, CONVERT	
Z		DRIVE, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

NOTES:
1. ANY FIRST LETTER COMBINED WITH MODIFIER REPRESENTS A NEW AND SEPARATE MEASURED VARIABLE. EXAMPLES: PD = DIFFERENTIAL PRESSURE FQ = TOTALIZED OR INTEGRATED FLOW. EXCEPTION IS THE MODIFIER "J" FOR MULTIPOINT SCANNING.
2. FOR ANALYSIS NOT IDENTIFIED BY A SPECIFIC LETTER IN THE TABLE, USE THE LETTER "A" NEAR THE INSTRUMENT SYMBLOL, SPECIFY THE NATURE OF THE ANALYSIS. EXAMPLE: PH
3. MEANING OF A "USER CHOICE" LETTER SHALL BE CONSISTENT THROUGHOUT A PROJECT AND SHALL BE SPECIFIED IN THE DRAWING LEGEND.
4. UNCLASSIFED LETTERS MAY HAVE A FEW DIFFERENT MEANINGS ON A PROJECT, THE MEANING SHALL BE SPCIFIED NEAR EACH INSTRUMENT SYMBOL USING THE UNCLASSIFIED LETTER.
5. THE MODIFIER "SCAN" APPLIES TO MULTIPOINT PRINTING INSTRUMENTS, SUCH AS CJRS (MULTIPOINT CONDUCTIVITY RECORDER WITH ALARM SWITHCES).

GENERAL NOTES:

1. FOR MECHANICAL SYMBOLS AND ADDITONAL NOTES, SEE NEXOM DRAWING NO. PID-A.

THIS DRAWING IS PROVIDED FOR INFORMATION ONLY.

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UNLESS OTHERWISE SPECIFIED

TOLERANCES:

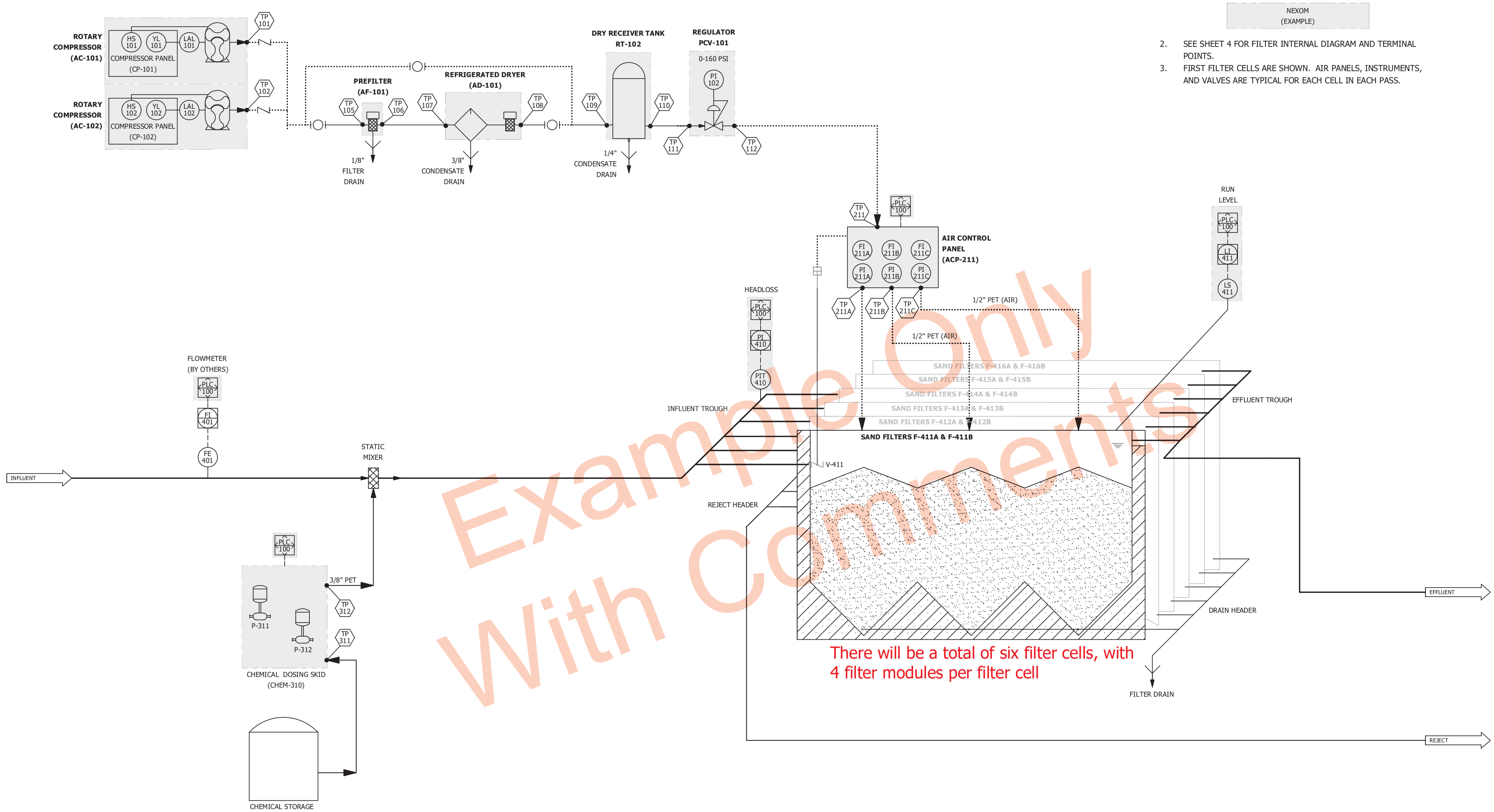
FRACTIONAL	± 1/16"
ONE DECIMAL	± .125"
TWO DECIMAL	± .0625"
ANGULAR	± 2.0°

LOCATION: Spencer, MA | SCALE 1:1

DESCRIPTION: Piping and Instrumentation Diagram

NUMBER: cd3440.01-PID | REV. 1/23/20 | PAGE 2/3

NOTES:
1. SHADED AREAS ARE IN NEXOM'S TYPICAL SCOPE OF SUPPLY.
   NEXOM (EXAMPLE)
2. SEE SHEET 4 FOR FILTER INTERNAL DIAGRAM AND TERMINAL POINTS.
3. FIRST FILTER CELLS ARE SHOWN. AIR PANELS, INSTRUMENTS, AND VALVES ARE TYPICAL FOR EACH CELL IN EACH PASS.



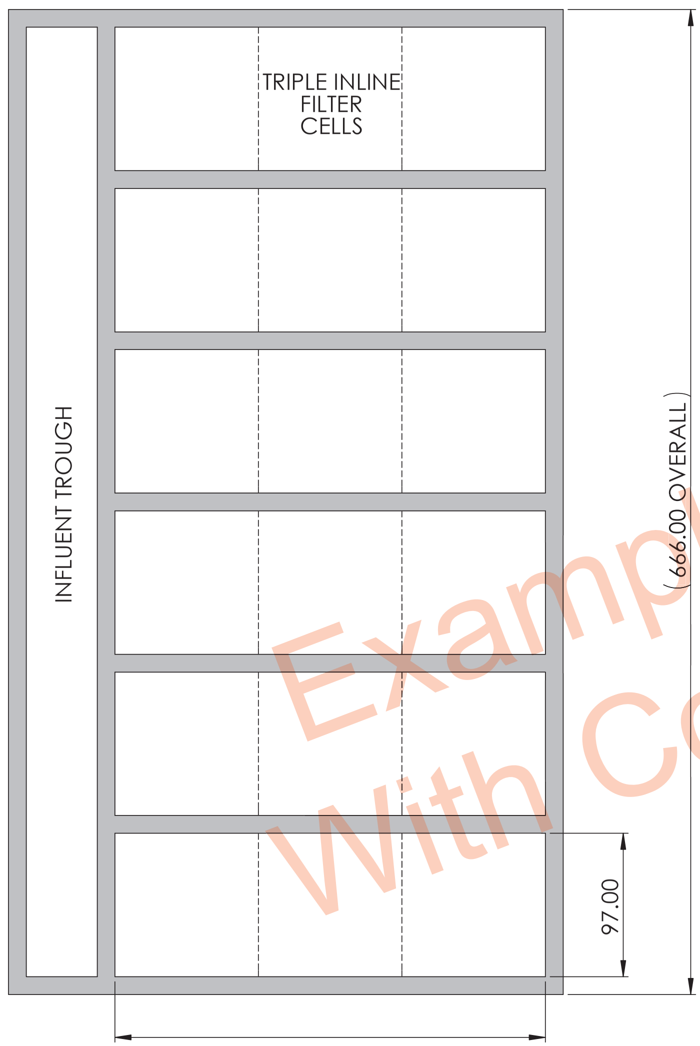
Nexom® technologies for cleaner water

REVISIONS

REV.	DESCRIPTION	ENGINEER	DATE
01	Released to Sales	LBP	1/23/20

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ± 1/16"
ONE DECIMAL ± .125"
TWO DECIMAL ± .0625"
ANGULAR ± 2.0°
THIRD ANGLE PROJECTION

LOCATION: Spencer, MA
SCALE 1:1
DESCRIPTION:
Piping and Instrumentation Diagram
AUTH. LBP, 12/3/20
CHKD. ,
NUMBER: cd3440.01-PID
REV. 1/23/20
PAGE 3/3



Cell dimension is 388" x 97" to accomodate a 4th module per cell

NOTES:

1. INFLUENT TROUGH DIMENSIONS MAY VARY
2. CONCRETE DESIGN BY OTHERS
3. CONCRETE THICKNESS IS SHOWN AS 12 INCHES

Nexom® technologies for cleaner water

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:

FRACTIONAL	± 1/16"
ONE DECIMAL	± .125"
TWO DECIMAL	± .0625"
ANGULAR	± 2.0°

THIRD ANGLE PROJECTION

LOCATION: Spencer, MA			SCALE 1:84
DESCRIPTION: Layout Drawing			
AUTH.	LBP, 12/3/20	CHKD.	,
NUMBER: cd3440.01		REV. 00	PAGE 1/1

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Process Design Report

DEERFIELD IL

Design# 164038
Option: Tertiary Filter design

AquaDisk®

Cloth Media Filter

April 30, 2021
Designed By: Jonathon Kelsey

6306 N. Alpine Rd Loves Park, IL 61111
(815) 654-2501 www.aqua-aerobic.com

Process/Site

- The total phosphorous infuent has been assumed, as displayed on the design (engineer to verify).

- Chemical addition for coagulation/flocculation must be added upstream of the filter. In addition, rapid mixing and a flocculation tank with at least 5 minutes retention time must be provided. The chemical dosage should be flow-paced and controlled to avoid over-dosing.

- To achieve the effluent monthly average total phosphorus limit, the biological process, chemical feed systems, and Cloth Media Filters need to be designed to facilitate optimum performance.

- A minimum of twelve (12) daily composite samples per month (both influent and effluent) shall be obtained for total phosphorus analysis.

- Secondary effluent phosphorus shall be in a reactive phosphate form and/or a filterable particulate form.

- Chemical addition (i.e. metal salts, and/or polymer) shall be furnished prior to the filter. Adequate rapid mixing must be provided as part of the chemical feed system. The chemical dosage should be flow-paced and controlled to avoid overdosing. Jar testing with various metal salts and polymers is recommended to determine the most effective metal salt and polymer as well as the optimum dosages of each, and to estimate the degree of phosphorus removal that can be achieved. In addition, a pilot study may be required to verify the actual performance capability.

- The cloth media filter will only remove TP that is associated with the TSS removed by the filter. Since only insoluble, particle-associated phosphorous is capable of being removed by filtration, phosphorous speciation shall be provided by the owner to substantiate the concentrations of soluble and insoluble phosphorous in the filter influent. If the proportions of soluble (unfilterable) and insoluble phosphorous are such that removal to achieve the desired effluent limit is not practical, the owner will provide for proper conditioning of the wastewater, upstream of the filter system, to allow for the required removal.

- The average and maximum design flow and loading conditions, shown within the report, are based on maximum month average and peak hour conditions, respectively.

Filtration

- The cloth media filter recommendation and anticipated effluent quality are based upon influent water quality conditions as shown under "Design Parameters" of this Process Design Report.

- The filter influent should be free of algae and other solids that are not filterable through a nominal 5 micron pore size media. Provisions to treat algae and condition the solids to be filterable are the responsibility of others.

- The cloth media filter has been designed to handle the maximum design flow at a hydraulic loading rate no greater than 5 gpm/ft² while maintaining one unit out of service.

Equipment

- Scope of supply includes freight, installation supervision and start-up services.

- Equipment selection is based upon the use of Aqua-Aerobic Systems' standard materials of construction and electrical components, suitable for non-classified electrical environments.

- Aqua-Aerobic Systems, Inc. is familiar with various “Buy American” Acts (i.e. AIS, ARRA, Federal FAR 52.225, EXIM Bank, USAid, PA Steel Products Act, etc.). As the project develops Aqua-Aerobic Systems can work with you to ensure full compliance of our goods with various Buy American provisions if they are applicable/required for the project. When applicable, please provide us with the specifics of the project’s “Buy American” provisions.

- If the cloth media filter will be offline for extended periods of time, protection from sunlight is required.

AquaDISK Tertiary Filtration - Design Summary

DESIGN INFLUENT CONDITIONS

Pre-Filter Treatment:	Secondary		
Avg. Design Flow	= 3.50 MGD	= 2430.56 gpm	= 13248.94 m^3/day
Max Design Flow	= 9.20 MGD	= 6388.89 gpm	= 34825.79 m^3/day

DESIGN PARAMETERS			Effluent			
	Influent	**mg/l**	**Required**	**<= mg/l**	**Anticipated**	**<= mg/l**
Avg. Total Suspended Solids:	TSSa	5	TSSa	5	TSSa	5
Max. Total Suspended Solids:	TSSm	10	--	--	--	--
Phosphorus:	Total P	0.50	Total P	0.10	Total P	0.10

AquaDISK FILTER RECOMMENDATION

Qty Of Filter Units Recommended	= 3
Number Of Disks Per Unit	= 12
Total Number Of Disks Recommended	= 36
Total Filter Area Provided	= 1936.8 ft² = (179.93 m²)
Filter Model Recommended	= AquaDisk Package: Model ADFSP-54 x 12E-PC
Filter Media Cloth Type	= OptiFiber PES-14

AquaDISK FILTER CALCULATIONS

Filter Type:

Vertically Mounted Cloth Media Disks featuring automatically operated vacuum backwash . Tank shall include a rounded bottom and solids removal system.

Average Flow Conditions:

Average Hydraulic Loading
= Avg. Design Flow (gpm) / Recommended Filter Area (ft²)
= 2430.6 / 1936.8 ft²
= 1.25 gpm/ft² (3.07 m/hr) at Avg. Flow

Maximum Flow Conditions:

Maximum Hydraulic Loading
= Max. Design Flow (gpm) / Recommended Filter Area (ft²)
= 6388.9 / 1936.8 ft²
= 3.30 gpm/ft² (8.07 m/hr) at Max. Flow

Solids Loading:

Solids Loading Rate
= (lbs TSS/day at max flow and max TSS loading) / Recommended Filter Area (ft²)
= 767.3 lbs/day / 1936.8 ft²
= 0.40 lbs. TSS /day/ft² (1.93 kg. TSS/day/m²)

The above recommendation is based upon the provision to maintain a hydraulic surface loading less than 5 gpm/ft2 with (1) one unit of service. The resultant hydraulic loading rate at the Maximum Design Flow is: 5 gpm / ft² = (12.1 m/hr)

Cloth Media Filters

AquaDisk Tanks/Basins

3 AquaDisk Model # ADFSP-54x12E-PC Package Filter Painted Steel Tank(s) consisting of:

- 12 Disk painted steel tank(s).
- 3" ball valve(s).

AquaDisk Centertube Assemblies

3 Centertube(s) consisting of:

- 304 stainless steel centertube weldment(s).
- Centertube driven sprocket(s).
- Dual wheel assembly(ies).
- Rider wheel bracket assembly(ies).
- Effluent seal plate weldment.
- Centertube bearing kit(s).
- Effluent centertube lip seal(s).
- Pile cloth media and non-corrosive support frame assemblies.
- Disk segment 304 stainless steel support rods.
- Media sealing gaskets.

3 Cloth set(s) will have the following feature:

- Cloth will be OptiFiber PES-14.

AquaDisk Drive Assemblies

3 Drive System(s) consisting of:

- Gearbox with motor.
- Drive sprocket(s).
- Drive chain(s) with pins.
- Stationary drive bracket weldment(s).
- Adjustable drive bracket weldment(s).
- Chain guard weldment(s).
- Warning label(s).

AquaDisk Backwash/Sludge Assemblies

3 Backwash System(s) consisting of:

- Backwash shoe assemblies.
- Backwash shoe support weldment(s).
- 1 1/2" flexible hose.
- Stainless steel backwash shoe springs.
- Hose clamps.

3 Backwash/Solids Waste Pump(s) consisting of:

- Backwash/waste pump(s).
- Stainless steel anchors.
- 0 to 15 psi pressure gauge(s).
- 0 to 30 inches mercury vacuum gauge(s).
- Throttling gate valve(s).
- 3" ball valve(s).

AquaDisk Instrumentation

3 Pressure Transmitter(s) consisting of:

- Level transmitter(s).

3 Float Switch(es) consisting of:

- Float switch(es).

3 Vacuum Transmitter(s) consisting of:

- Vacuum transmitter(s).

AquaDisk Valves

3 Set(s) of Backwash Valves consisting of:

- 2" full port, three piece, stainless steel body ball valve(s), grooved end connections with single phase electric actuator(s). Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork).
- 2" flexible hose.
- Victaulic coupler(s).

3 Solids Waste Valve(s) consisting of:

- 2" full port, three piece, stainless steel body ball valve(s), grooved end connections with single phase electric actuator(s). Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork).
- 2" flexible hose.
- Victaulic coupler(s).

AquaDisk Controls w/Starters

3 Conduit Installation(s) consisting of:

- PVC conduit and fittings.

3 Control Panel(s) consisting of:

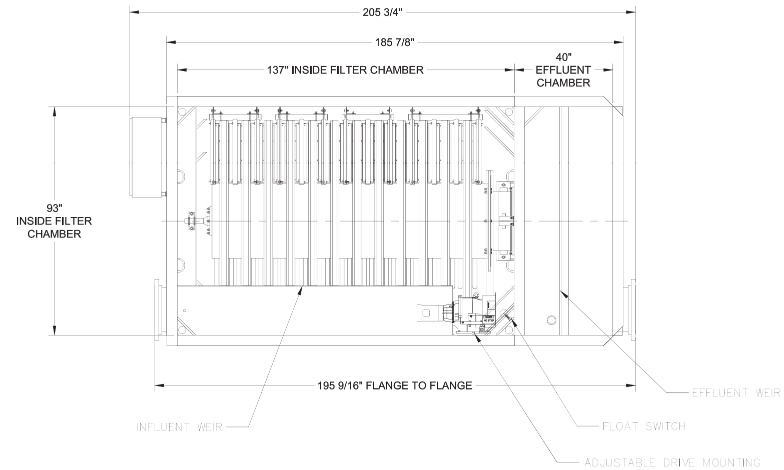
- NEMA 4X fiberglass enclosure(s).
- Circuit breaker with handle.
- Transformer(s).
- Fuses and fuse blocks.
- Line filter(s).
- GFI convenience outlet(s).
- Control relay(s).
- Selector switch(es).
- Indicating pilot light(s).
- MicroLogix 1400 PLC(s).
- Ethernet switch(es).
- Power supply(ies).
- Operator interface(s).
- Motor starter(s).
- Terminal blocks.
- UL label(s).

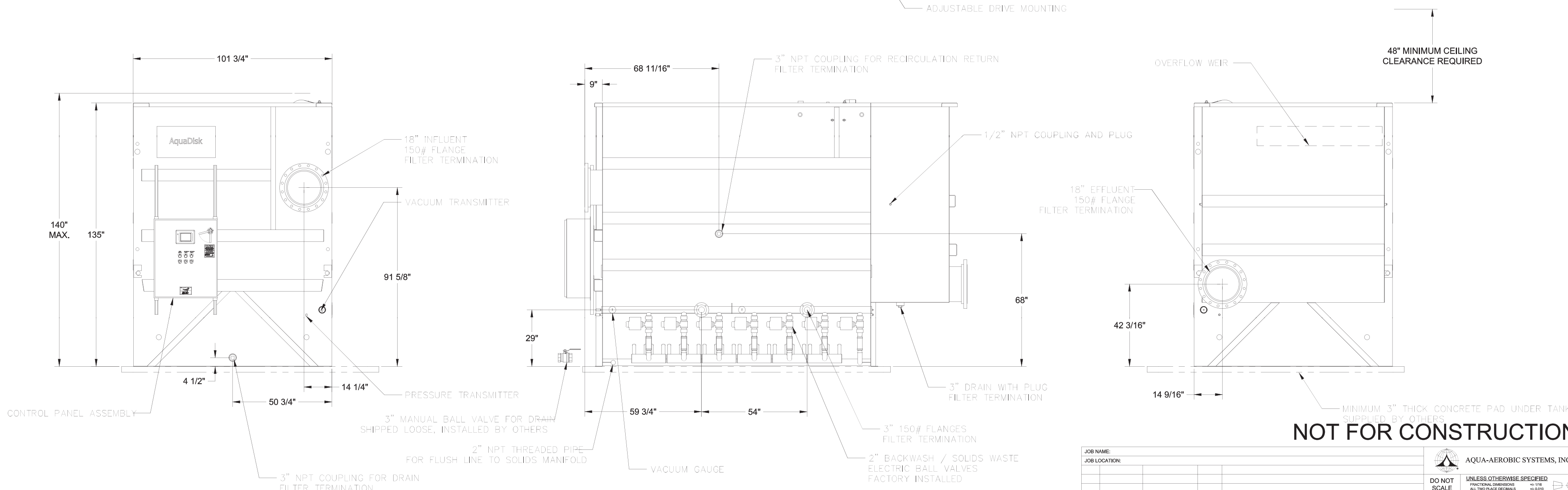
1. IF FREEZING IS A CONCERN AQUA-AEROBIC SYSTEMS RECOMMENDS THE FILTERS BE PLACED IN A HEATED BUILDING. IF A BUILDING IS NOT PROVIDED, ANY NECESSARY PROTECTION, INCLUDING BUT NOT LIMITED TO, HEAT TRACING AND INSULATION OF PUMPS AND PIPING, AS WELL AS PROTECTION AGAINST INTERNAL TANK FREEZING, SHALL BE PROVIDED BY THE INSTALLING CONTRACTOR.

2. THE FILTER CONTROL PANEL IS SHOWN IN THE STANDARD LOCATION. IF THE FILTER IS LOCATED OUTSIDE, THE CONTROL PANEL MAY BE RELOCATED TO THE SIDE OF THE FILTER FACING NORTH, TO LIMIT EXPOSING THE H.M.I. TO DIRECT SUNLIGHT.

3. THE GRAPHIC ELEMENTS OF THIS COMPUTER GENERATED DRAWING ARE DRAWN FULL SIZE. THE DIMENSIONS ARE ASSOCIATIVE. IF THE SIZE OF THE GRAPHIC ELEMENTS IS CHANGED THE DIMENSIONS WILL NOT BE CORRECT.

4. AN INFLUENT VALVE IS REQUIRED FOR ISOLATION / MAINTENANCE OF THE FILTER UNIT. THE INFLUENT VALVE SHALL BE PROVIDED BY OTHERS AND INSTALLED BY OTHERS.

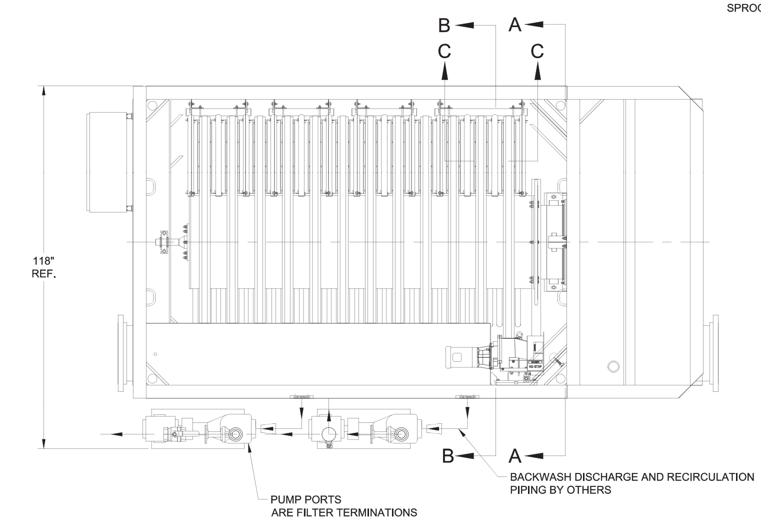


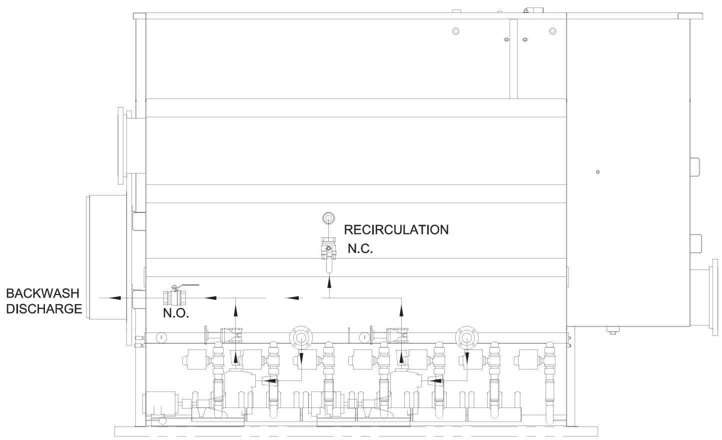


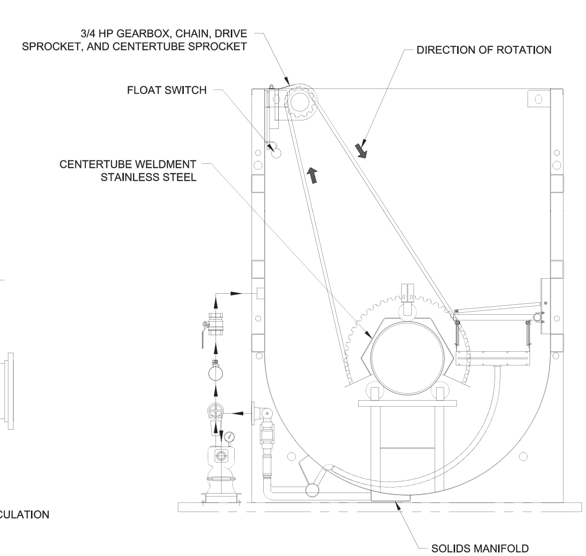
DRY WT (LBS)	OPER. WT. (LBS)
13,000	60,500

NOT FOR CONSTRUCTION

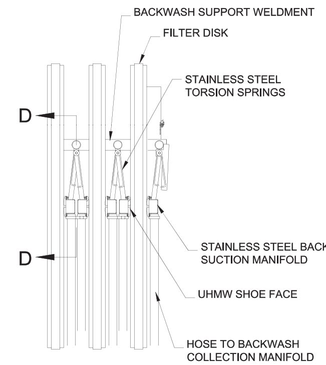
JOB NAME:	
JOB LOCATION:	
REV / ERN / ECO / DATE / BY / REVISION DESCRIPTION	
DRAWING NAME:	AQUADISK FILTER MODEL ADFSP-54 X 12E-PC - RH
AQUA-AEROBIC SYSTEMS, INC.	
DO NOT SCALE DRAWING	UNLESS OTHERWISE SPECIFIED: FRACTIONAL DIMENSIONS +/- 1/16; ALL TWO PLACE DECIMALS +/- 0.010; ALL THREE PLACE DECIMALS +/- 0.005; ALL ANGLES +/- 1/2° ANSI
MATERIAL:	
SIMILAR TO:	
TYPE:	
DRAWN BY: SLT	DATE: 3-29-2011
CHECKED BY:	DATE:
WEIGHT:	SHEET: 1 OF 4
DRAWING NUMBER: 2801907	SCALE: SIZE: D



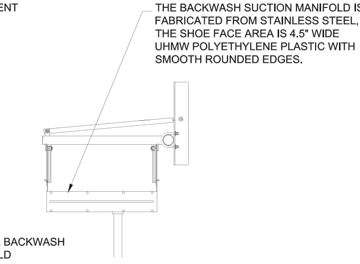




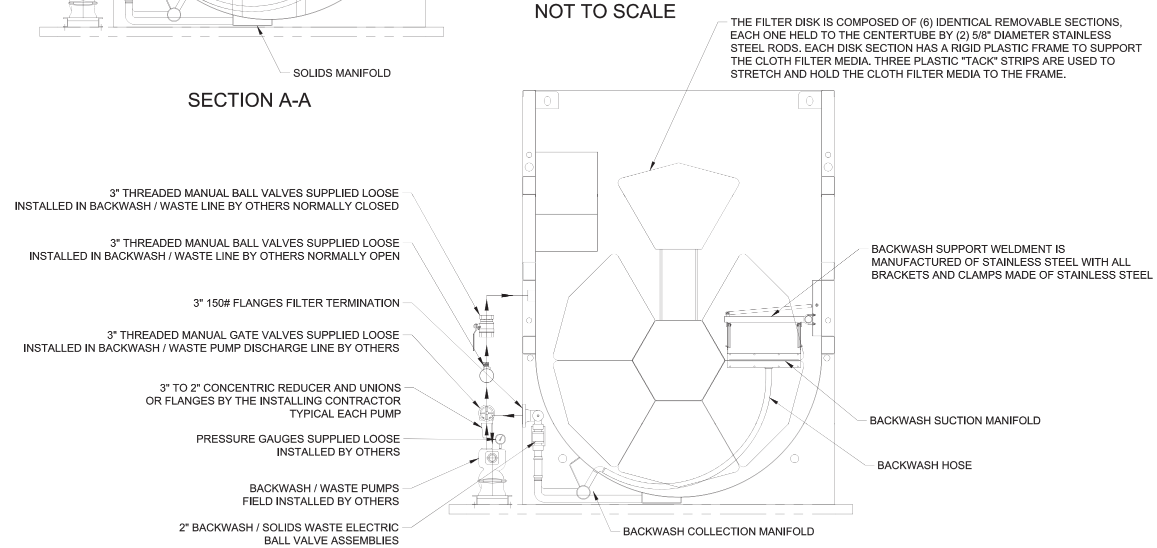
SECTION A-A



SECTION C-C
NOT TO SCALE



SECTION D-D
NOT TO SCALE



SECTION B-B

1. ALL EXTERNAL PIPING AND FITTINGS SHALL BE PROVIDED BY OTHERS ACTUAL PIPING LAYOUT AND PUMP LOCATION TO BE DETERMINED BY OTHERS WHEN THREADED OR WELDED PIPE IS USED IN LIEU OF FLANGED PIPE, UNIONS SHALL BE USED AT EACH PUMP AND VALVE CONNECTION TO FACILITATE SERVICE.

2. 2 H.P. BACKWASH / WASTE PUMP CONNECTIONS ARE 2" N.P.T. BACKWASH / WASTE PIPING IS 3" DIAMETER. 3" TO 2" CONCENTRIC REDUCER FITTINGS SHALL BE PROVIDED AND INSTALLED BY OTHERS AT EACH PUMP PORT.

3. THE BACKWASH / WASTE PUMP CAPABILITIES ARE AS FOLLOWS:

- HORSEPOWER: 2 HP
- FLOW: 130 GPM
- TOTAL DYNAMIC HEAD: 23.2 FT
- ALLOWABLE DISCHARGE HEAD, AFTER FILTER LOSSES: 12 FT

FOR INSTALLATIONS THAT REQUIRE MORE DISCHARGE HEAD, ALTERNATIVE PUMPS ARE AVAILABLE. PLEASE CONSULT ENGINEERING TO VERIFY THE SUITABILITY OF THE DISCHARGE PIPING OR FOR SPECIAL PUMP REQUIREMENTS.

NOT FOR CONSTRUCTION

JOB NAME:
JOB LOCATION:

REV	ERN / ECO	DATE	BY	REVISION DESCRIPTION

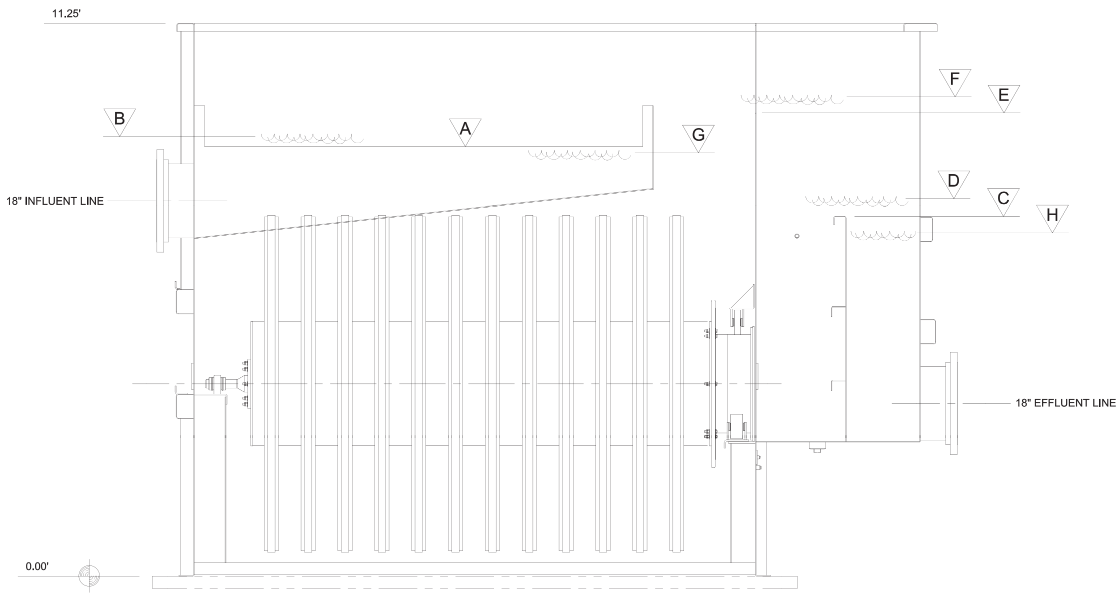
DRAWING NAME: AQUADISK FILTER MODEL ADFSP-54 X 12E-PC - RH

AQUA-AEROBIC SYSTEMS, INC.

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
FRACTIONAL DIMENSIONS +/- 1/16
ALL TWO PLACE DECIMALS +/- 0.010
ALL THREE PLACE DECIMALS +/- 0.005
ALL ANGLES +/- 1/2°
ANSI

MATERIAL:
SIMILAR TO:
TYPE:
DRAWN BY: SLT | DATE: 3-29-2011
CHECKED BY: | DATE:
WEIGHT: | SHEET: 2 OF 4
DRAWING NUMBER: 2801907 | SCALE: | SIZE: D



ELEVATION

A	8.74'	INFLUENT WEIR ELEVATION
B	9.03'	NAPPE OVER INFLUENT WEIR AVERAGE FLOW
	9.20'	NAPPE OVER INFLUENT WEIR MAXIMUM FLOW
C	7.32'	EFFLUENT WEIR ELEVATION
D	7.64'	NAPPE OVER EFFLUENT WEIR AVERAGE FLOW
	7.83'	NAPPE OVER EFFLUENT WEIR MAXIMUM FLOW
E	9.42'	OVERFLOW WEIR ELEVATION
F	9.82'	NAPPE OVER OVERFLOW WEIR AVERAGE FLOW
	10.06'	NAPPE OVER OVERFLOW WEIR MAXIMUM FLOW
G	8.70'	BACKWASH INITIATE LEVEL
H	6.82'	MAXIMUM AVAILABLE LIQUID LEVEL FOR EFFLUENT CONVEYANCE

HYDRAULIC PROFILE
BASED UPON AVERAGE FLOW RATE OF 3.25 GPM PER SQUARE FOOT (3.0 MGD)
BASED UPON MAXIMUM FLOW RATE OF 6.5 GPM PER SQUARE FOOT (6.0 MGD)

WEIR LENGTHS
INFLUENT = 8.92'
EFFLUENT = 7.75'
OVERFLOW = 5.33'

NOT FOR CONSTRUCTION

JOB NAME:
JOB LOCATION:

REV	ERN / ECO	DATE	BY	REVISION DESCRIPTION

AQUA-AEROBIC SYSTEMS, INC.

DO NOT SCALE DRAWING

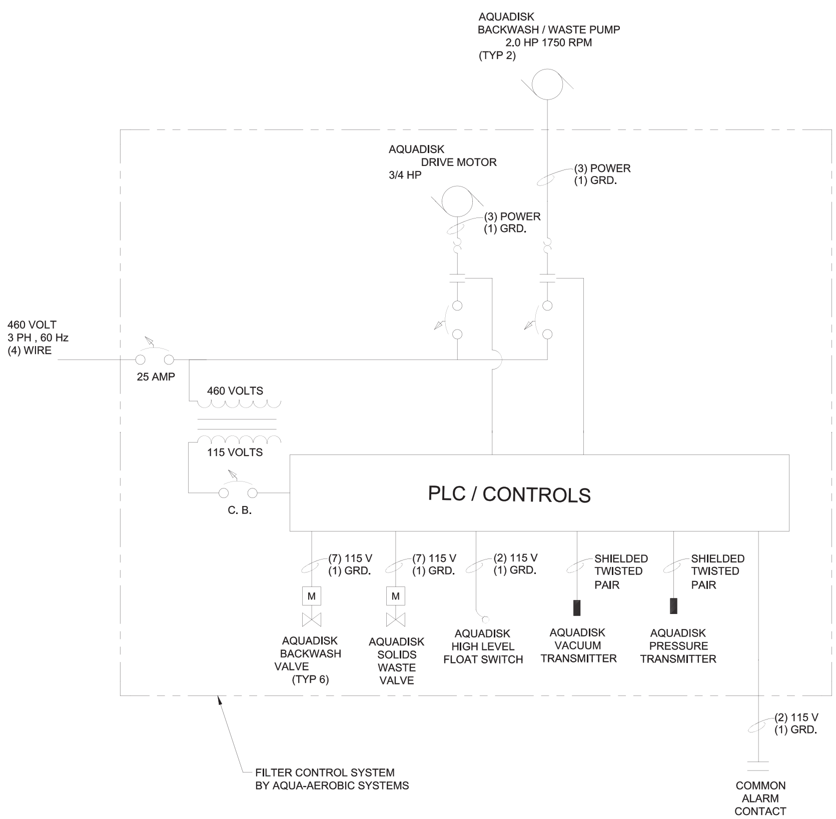
UNLESS OTHERWISE SPECIFIED
FRACTIONAL DIMENSIONS +/- 1/16
ALL TWO PLACE DECIMALS +/- 0.010
ALL THREE PLACE DECIMALS +/- 0.005
ALL ANGLES +/- 1/2°
ANSI

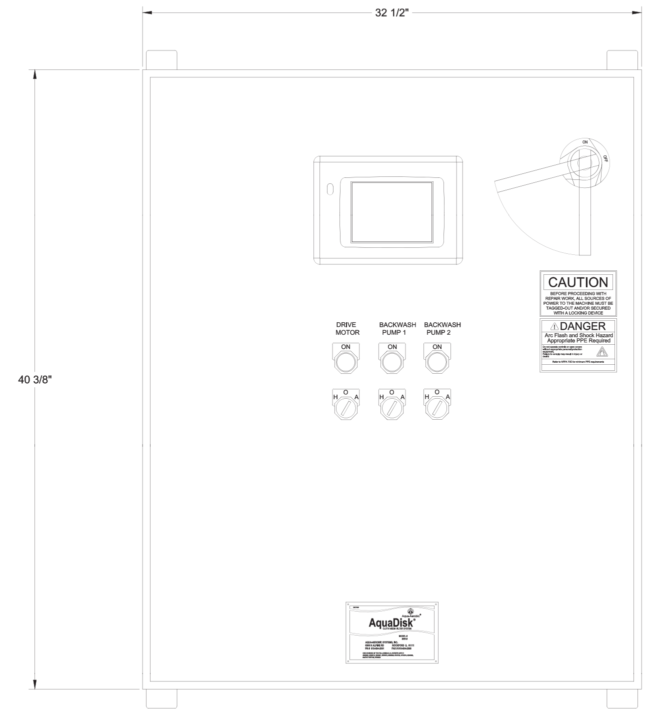
MATERIAL:
SIMILAR TO:
TYPE:
DRAWN BY: SLT — DATE: 3-29-2011
CHECKED BY: — DATE:
WEIGHT: — SHEET: 3 OF 4
DRAWING NAME: AQUADISK FILTER MODEL ADFSP-54 X 12E-PC - RH
DRAWING NUMBER: 2801907 — SCALE: — SIZE: D

SYMBOL KEY

	MOTOR		CIRCUIT BREAKER		ELECTRICAL DISCONNECT	VFD	VARIABLE FREQUENCY DRIVE		TRANSDUCER		STARTER CONTACTOR
M	MOTOR OPERATED VALVE		TRANSFORMER		MOTOR OVERLOAD	P	PNEUMATIC OPERATED VALVE		FUSE		FLOAT SWITCH

NOTE: SOME SYMBOLS MAY NOT BE APPLICABLE





1 CONTROL PANEL
ENCLOSURE NEMA 4X WALL MOUNTED TYPE FIBERGLASS
FACTORY ASSEMBLED ON THE FILTER, DISASSEMBLED AND SHIPPED LOOSE.
REASSEMBLED ON-SITE BY CONTRACTOR.
IF THE FILTER IS LOCATED OUTSIDE, THE CONTROL PANEL
MAY BE RELOCATED TO THE SIDE OF THE FILTER
FACING NORTH TO LIMIT THE H.M.I. EXPOSURE TO DIRECT SUNLIGHT.

2 STANDARD CONTROL PANEL SIZE
40" HEIGHT X 32" WIDE X 12" DEEP

3 (1) CONTROL PANEL PER FILTER

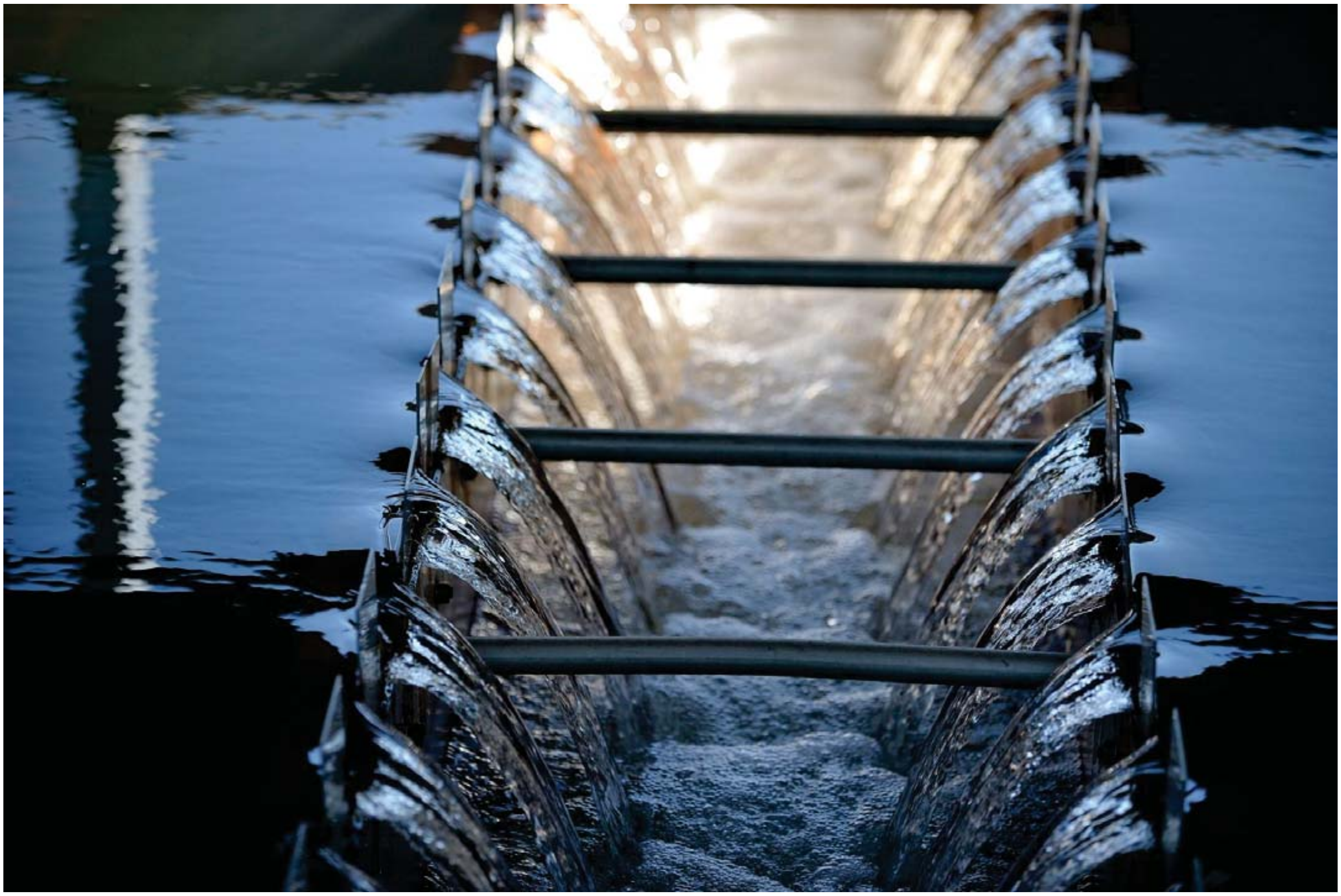
NOT FOR CONSTRUCTION

JOB NAME:	
JOB LOCATION:	
AQUA-AEROBIC SYSTEMS, INC.	
DO NOT SCALE DRAWING	UNLESS OTHERWISE SPECIFIED
MATERIAL:	
SIMILAR TO:	
TYPE:	
DRAWN BY: SLT	DATE: 3-29-2011
CHECKED BY:	DATE:
WEIGHT:	SHEET: 4 OF 4
DRAWING NAME: AQUADISK FILTER MODEL ADFSP-54 X 12E-PC - RH	
DRAWING NUMBER: 2801907	SCALE: SIZE: D

REV	ERN / ECO	DATE	BY	REVISION DESCRIPTION

Veolia Water Technologies, Inc. dba Kruger
4001 Weston Parkway, Cary, NC 27513

ACTIFLO ACP2
Preliminary Proposal



Project: Deerfield IL AFS 5700113003
Client: Strand Associates, Inc.®
Date: 5/4/2021

RSM Contact: Andy Szekeress
Phone: (715) 432-6852
Representative Contact: Peterson & Matz

Kruger is pleased to propose the ACTIFLO system for this potential Tertiary project. Enclosed you will find the preliminary design summary, scope of supply, procurement schedule, and price estimate.

We appreciate the opportunity to provide this proposal to you. If you have any questions or need further information, please contact our local representative or our Regional Sales Manager

The system design is based on the information listed in the following tables and will be supplied according to Kruger design standards:

Design Parameters		
ACTIFLO ACP2 System Trains	2	#
Total Flow per ACTIFLO ACP2 Train	4.6	MGD
Total Flow per ACTIFLO ACP2 System	9.2	MGD
Average Influent TP	2.18	mg/L
Target Effluent TP	0.1	mg/L
Target Effluent Alkalinity	> 40	mg/L

Single Train Design Parameters		
Pre-Coagulation Tank HRT	1.5	min
Coagulation Tank HRT	1.5	min
Maturation Tank HRT	4.3	min
Settling Tank HLR	22.6	gpm/sf
Sand Recirculation Flow (per pump) +/- 10%	154	gpm
Estimated Total Sludge Waste Flow +/- 10%	123	gpm
ACTIFLO ACP2 Train Dimensions	See GA DWG	--

Equipment Scope of Supply	
Process Tank Assembly	
Welded carbon steel multi-tank assembly with interior and exterior epoxy coating. Assembly to include the following tanks: - Coagulation - Flocculation - Settling	2 (ACP2-70)
Influent Equipment	
Rapid Mixer: TEFC 460/3/60 premium efficient - inverter duty - AC induction motor, 316 SS shaft and impeller	1 TBD HP
Inlet Butterfly Valve: Lug style, Coated Cast iron body, SS stem, EPDM seat, electrically actuated for modulating service. Shipped separately and installed by others.	1 Per Train
Pre-Coagulation Tank Equipment	
Coagulation Mixer: TEFC 460/3/60 high efficiency - severe duty - AC induction motor, 304 SS shaft and impeller. All components shipped separately and installed by others	2 2 HP
Coagulation Tank Equipment	
Coagulation Mixer: TEFC 460/3/60 high efficiency - severe duty - AC induction motor, 304 SS shaft and impeller. All components shipped separately and installed by others	2 2 HP
Mixer Support: Epoxy coated carbon steel, factory assembled	2
Drain Valve: Ductile iron body, ANSI Flange connection, Manual. Shipped separately and installed by others	2
Maturation Tank Equipment	
Maturation Mixer: TEFC 460/3/60 high efficiency - inverter duty - AC induction motor, 304 SS shaft and impeller. All components shipped separately and installed by others	2 5 HP
TURBOMIX Draft Tube: 304 SS w/ supports, flux converter cells, factory assembled	2
Mixer Support: Epoxy coated carbon steel, factory assembled	2
Draft Tube Anti-Bypass Baffle Set: 304 SS, factory assembled	2
Drain Valve: Ductile iron body, ANSI Flange connection, Manual. Shipped separately and installed by others	2

Settling Tank Equipment	
Scraper Drive: TEFC 460/3/60 severe duty - AC induction motor, motor starter, speed reducer, torque indication and overload protection. All components shipped separately and installed by others	2 0.75 HP
Scraper Mechanism: 304L SS drive shaft, rake arms and blades. All components factory assembled	2
Scraper Support Bridge: Epoxy Coated CS, factory assembled	2
Lamella Settler Assembly: Polystyrene tubes, factory assembled	2
Lamella Settler Support Set: 304 SS tube type supports, factory assembled	2
Lamella Tube Tie-down Assembly: Appurtenances including wire rope, clips	2
Effluent Collection Trough Set: 304 SS troughs and supports, factory assembled	2
Partial Drain Valve: butterfly valve, manual, factory assembled	2
Microsand Recycle Circuits	
Microsand Recirculation Pumps: TEFC, 460/3/60 premium efficient – severe duty – AC induction & inverter duty motor, centrifugal, cast iron body, with rubber-lined volute and impeller, dry gland seal, drip pan, with V-belt and pulley drive. Pump(s) are factory pre-wired, to be installed and reconnected on site by others.	1 duty + 1 standby (Per Train) 10 HP
Pump Isolation Valves: Ductile iron body, ANSI flange connection, Manual. Shipped separately and installed by others	4 4 inch
Flush Connection Valve(s): Manual ball type, 304 SS. Shipped separately and installed by others for ACP2-45 and above	2 1.5 inch
Microsand Pump Pressure Transmitter Isolation Valves: Manual ball type, 304 SS. Shipped separately and installed by others for ACP2-45 and above	4 0.5 inch
Hydrocyclone Recycle Equipment	
Hydrocyclones: Urethane. Factory assembled to support stand	1 duty + 1 standby (Per Train)
Hydrocyclone Support Stand: 304 SS. Shipped separately and installed by others	2
Sand Concentration Sampling Device: Plastic graduated tank. Shipped separately	2
Handrails	
Provided at the perimeter of the ACTIFLO tank. One point of entry/egress shall be provided with 30" min width, and the location shall be per the ACTIFLO system supplier drawings. Welded rectangular tube 42" above top of grating and designed per OSHA guidelines.	2
Ladder	
Galvanized steel, meets or exceed 450lb load limit, OSHA 1910.29, ANSI A14.7 standards.	2
Grating (FRP Molded)	
FRP Molded Grating shall be Fibergrate or approved equal. Non-slip surface, integrally applied grit to the top of each bar providing maximum slip resistance.	2
Commissioning Consumables	
Microsand Ballast (Tons)	14
Polymer Flocculant (gal)	200

ACTIFLO ACP2 System Instrumentation	
Control Panel	
NEMA 12 Painted Steel (for indoor use only) Panel, to control the ACTIFLO® System based on operator setpoints, completely assembled, tested, and programmed for the required functionality	1
PLC Processor - CompactLogix ALLEN BRADLEY	1
460VAC IEC FVNR Motor Starter/Protector TeSys U (ACTIFLO ACP2 Inline Mechanical Mixer)	1
460VAC IEC FVNR Motor Starter/Protector TeSys U (ACTIFLO ACP2 Pre-Coagulation Mixer)	1
460VAC IEC FVNR Motor Starter/Protector TeSys U (ACTIFLO ACP2 Coagulation Mixer)	1

460VAC IEC FVNR Motor Starter/Protector TeSys U (ACTIFLO ACP2 Maturation Mixer)	1
460VAC IEC FVNR Motor Starter/Protector TeSys U (ACTIFLO ACP2 Scraper)	1
460VAC IEC FVNR Motor Starter/Protector TeSys U (ACTIFLO ACP2 Sand Pump)	2
ACTIFLO ACP2 Train Remote I/O Panel	
NEMA 12 Stainless Steel Panel, to control the ACTIFLO® System based on operator setpoints, completely assembled, tested, and programmed for the required functionality	1
PLC Flex I/O Ethernet Module - ALLEN BRADLEY	1
460VAC IEC FVNR Motor Starter/Protector TeSys U (ACTIFLO ACP2 Pre-Coagulation Mixer)	1
460VAC IEC FVNR Motor Starter/Protector TeSys U (ACTIFLO ACP2 Coagulation Mixer)	1
460VAC IEC FVNR Motor Starter/Protector TeSys U (ACTIFLO ACP2 Maturation Mixer)	1
460VAC IEC FVNR Motor Starter/Protector TeSys U (ACTIFLO ACP2 Scraper)	1
460VAC IEC FVNR Motor Starter/Protector TeSys U (ACTIFLO ACP2 Sand Pump)	2
Instrumentation	
Influent Flowmeter: Magnetic flowmeter (E+H) with Controller	2
Influent Pipe Turbidity (pre-chem feed): NTU Sensor, Pipe Insertion Mounting (Hach Solitax NTU Analyzer), Controller (SC200), SS spool piece included	1
Influent Pipe pH (pre-chem feed): pH Sensor Pipe Insertion Mounting (Hach), Controller (SC200)	1
Settling Tank Turbidity (post chem feed): NTU Sensor, Tank Immersion Mounting (Hach Solitax NTU Analyzer), Controller (SC200)	2
Settling Tank pH (post-chem feed): pH Sensor, Immersion Mounting (Hach), Controller (SC200)	2
Sand Recirculation Pumps Pressure Indicating Transmitter: Ceramic Diaphragm (E+H)	4
Sand Recirculation Pump Discharge Flowmeter: Magnetic flowmeter (E+H), Controller	4
System Level Switch: Dwyer or equal	2

Chemical Feed Equipment	
Auto Liquid Polymer Prep System	
Liquid polymer processing system, skid mounted packaged assembly, complete with peristaltic pump, support stand, calibration columns, dilution water controls, motorized mixing chamber, piping and fittings	2 duty + 1 standby
Auto Coagulant Metering Pumps	
Volumetric metering pumps, Diaphragm type, corrosion resistant skid mounted, complete with pump bases, variable speed drives, pressure relief valves, back pressure valves, check valves, calibration columns, isolation ball valves, flush connections, strainers, electric motors, piping and fittings.	1 duty + 1 standby
Chemical Feed Remote I/O Panel	
NEMA 12 Stainless Steel Panel, wall mount, to communicate to the ACTIFLO System Control panel, completely assembled, tested, and programmed for the required functionality	1

Process and Design Engineering

Kruger provides process engineering and design support for the system as follows:

- Equipment specifications for equipment supplied by Kruger.
- Technical instructions for operation and start-up of the system.
- Equipment location drawings and installation plans.
- Project specific O&M manuals.

Field Services

Kruger will furnish a Service Engineer at the time of start-up to inspect the installation of the completed system, place the system in initial operation, and to instruct operating personnel on the proper use of the equipment.

Extended Support Services

Kruger's offer also includes the Hubgrade Assist extended support services Advanced plan. This service will be in effect for one (1) year following start-up, at which time the Owner will have the option to continue the service as is, or modify the service, under a service contract with Kruger, or discontinue the service. Several plan levels are available, details of which may be found in the included Hubgrade Assist Performance and Maintenance Support Package.

Estimated Pricing

The estimated pricing for the ACTIFLO system, as defined herein, including process and design engineering, field services, and equipment supply is:

$2,047,678

Estimated Pricing for a 2 x 4.6 MGD System, constructed in Concrete (Tanks by Others): **$1,277,692**

Please note that the above pricing is expressly contingent upon the items in this proposal and are subject to Kruger Standard Terms of Sale detailed herein. Due to current market conditions for fabricated metal items (e.g. steel and aluminum) this price is subject to change based on actual fabricated metal prices at time of order placement.

This pricing is FOB shipping point, with freight allowed to the job site. This pricing does not include any sales or use taxes. In addition, pricing is valid for ninety (90) days from the date of issue and is subject to negotiation of a mutually acceptable contract.

The terms of payment are as follows: 10% on receipt of fully executed contract, 15% on submittal of shop drawings, and 75% on the delivery of equipment to the site. Payment shall not be contingent upon receipt of funds by the Contractor from the Owner, and there shall be no retention in payments due to Kruger. All payment terms are net 30 days from the date of invoice. Final payment shall not exceed 120 days from delivery of equipment. All other terms are per the Kruger Standard Terms of Sale.

Estimated Schedule

- Shop drawings: submitted within 6-8 weeks of receipt of an executed contract by all parties.
- Equipment: delivered within 18-24 weeks of receipt of written approval of the shop drawings.
- Installation manuals will be furnished upon delivery of equipment.
- Operation & Maintenance Manuals: submitted within 90 days of receipt of approved shop drawings.

Kruger Standard Terms of Sale

1. Applicable Terms. These terms govern the purchase and sale of the equipment and related services, if any (collectively, "Equipment"), referred to in Seller's purchase order, quotation, proposal or acknowledgment, as the case may be ("Seller's Documentation"). Whether these terms are included in an offer or an acceptance by Seller, such offer or acceptance is conditioned on Buyer's assent to these terms. Seller rejects all additional or different terms in any of Buyer's forms or documents.

2. Payment. Buyer shall pay Seller the full purchase price as set forth in Seller's Documentation. Unless Seller's Documentation provides otherwise, freight, storage, insurance and all taxes, duties or other governmental charges relating to the Equipment shall be paid by Buyer. If Seller is required to pay any such charges, Buyer shall immediately reimburse Seller. All payments are due within 30 days after receipt of invoice. Buyer shall be charged the lower of 1 ½% interest per month or the maximum legal rate on all amounts not received by the due date and shall pay all of Seller's reasonable costs (including attorneys' fees) of collecting amounts due but unpaid. All orders are subject to credit approval.

3. Delivery. Delivery of the Equipment shall be in material compliance with the schedule in Seller's Documentation. Unless Seller's Documentation provides otherwise, Delivery terms are F.O.B. Seller's facility.

4. Ownership of Materials. All devices, designs (including drawings, plans and specifications), estimates, prices, notes, electronic data and other documents or information prepared or disclosed by Seller, and all related intellectual property rights, shall remain Seller's property. Seller grants Buyer a non-exclusive, non-transferable license to use any such material solely for Buyer's use of the Equipment. Buyer shall not disclose any such material to third parties without Seller's prior written consent.

5. Changes. Seller shall not implement any changes in the scope of work described in Seller's Documentation unless Buyer and Seller agree in writing to the details of the change and any resulting price, schedule or other contractual modifications. This includes any changes necessitated by a change in applicable law occurring after the effective date of any contract including these terms.

6. Warranty. Subject to the following sentence, Seller warrants to Buyer that the Equipment shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship. The foregoing warranty shall not apply to any Equipment that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. If Buyer gives Seller prompt written notice of breach of this warranty within 18 months from delivery or 1 year from beneficial use, whichever occurs first (the "Warranty Period"), Seller shall, at its sole option and as Buyer's sole remedy, repair or replace the subject parts or refund the purchase price therefore. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Equipment in accordance with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller). THE WARRANTIES SET FORTH IN THIS SECTION ARE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND ARE SUBJECT TO SECTION 10 BELOW. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

7. Indemnity. Seller shall indemnify, defend and hold Buyer harmless from any claim, cause of action or liability incurred by Buyer as a result of third party claims for personal injury, death or damage to tangible property, to the extent caused by Seller's negligence. Seller shall have the sole authority to direct the defense of and settle any indemnified claim. Seller's indemnification is conditioned on Buyer (a) promptly, within the Warranty Period, notifying Seller of any claim, and (b) providing reasonable cooperation in the defense of any claim.

8. Force Majeure. Neither Seller nor Buyer shall have any liability for any breach (except for breach of payment obligations) caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, delay of carriers, failure of normal sources of supply, act of government or any other cause beyond such party's reasonable control.

9. Cancellation. If Buyer cancels or suspends its order for any reason other than Seller's breach, Buyer shall promptly pay Seller for work performed prior to cancellation or suspension and any other direct costs incurred by Seller as a result of such cancellation or suspension.

10. LIMITATION OF LIABILITY. NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE EQUIPMENT SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE EQUIPMENT. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

11. Miscellaneous. If these terms are issued in connection with a government contract, they shall be deemed to include those federal acquisition regulations that are required by law to be included. These terms, together with any quotation, purchase order or acknowledgement issued or signed by the Seller, comprise the complete and exclusive statement of the agreement between the parties (the "Agreement") and supersede any terms contained in Buyer's documents, unless separately signed by Seller. No part of the Agreement may be changed or cancelled except by a written document signed by Seller and Buyer. No course of dealing or performance, usage of trade or failure to enforce any term shall be used to modify the Agreement. If any of these terms is unenforceable, such term shall be limited only to the extent necessary to make it enforceable, and all other terms shall remain in full force and effect. Buyer may not assign or permit any other transfer of the Agreement without Seller's prior written consent. The Agreement shall be governed by the laws of the State of North Carolina without regard to its conflict of laws provisions.

Item	*Predicted Life* (months)*	*Replacement Cost*	*Replacement Cost per year*
Pre-Coagulation Tank Mixer			
Oil Change	6	$125.00	$250.00
Grease Bearing	3	$20.00	$80.00
Seal/Bearing Replacement	60	$1,500.00	$300.00
			$630.00
Coagulation Tank Mixer			
Oil Change	6	$125.00	$250.00
Grease Bearing	3	$20.00	$80.00
Seal/Bearing Replacement	60	$1,500.00	$300.00
			$630.00
Maturation Tank Mixer			
Oil Change	6	$125.00	$250.00
Grease Bearing	3	$20.00	$80.00
Seal/Bearing Replacement	60	$1,500.00	$300.00
			$630.00
Scraper			
Oil Change-Gear Housing	6	$85.00	$170.00
			$170.00
Sand Pumps			
Grease Bearing	6	$28.00	$56.00
Belt Replacement	12	$100.00	$100.00
Gland Replacement	30	$600.00	$240.00
			$396.00
Hydrocyclone			
Apex Tips	12	$225.00	$225.00
Vortex Finder	36	$325.00	$108.33
			$333.33
Yearly Totals			**$2,789.33**

* The predicted life is not a warranty.

*The predicted life also assumes 24/7 use. Actual Life depends on actual service conditions and maintenance.

Assumptions are based on a single train operating

Veolia Water Technologies, Inc. dba Kruger
4001 Weston Parkway, Cary, NC 27513

Preliminary Operating Cost Estimate
2 X 4.6 MGD ACTIFLO ACP2 System
Deerfield IL AFS

Mechanical Equipment Summary

Equipment	2 X 4.6 MGD	
Rapid Mixer	TBD	HP
Pre-Coagulation Tank Mixer	2	HP
Coagulation Tank Mixer	2	HP
Maturation Tank Mixer	5	HP
Scraper Motor	0.75	HP
Sand Recirculation Pump	10	HP
Total Power Requirements:	**19.75**	**HP**

Each train has 1 duty + 1 standby sand pumps each with a 10 HP motor.

Total operating HP to be used in table below assumes power draw of 90% of total nameplate HP and does not include standby equipment. Only includes single train equipment.

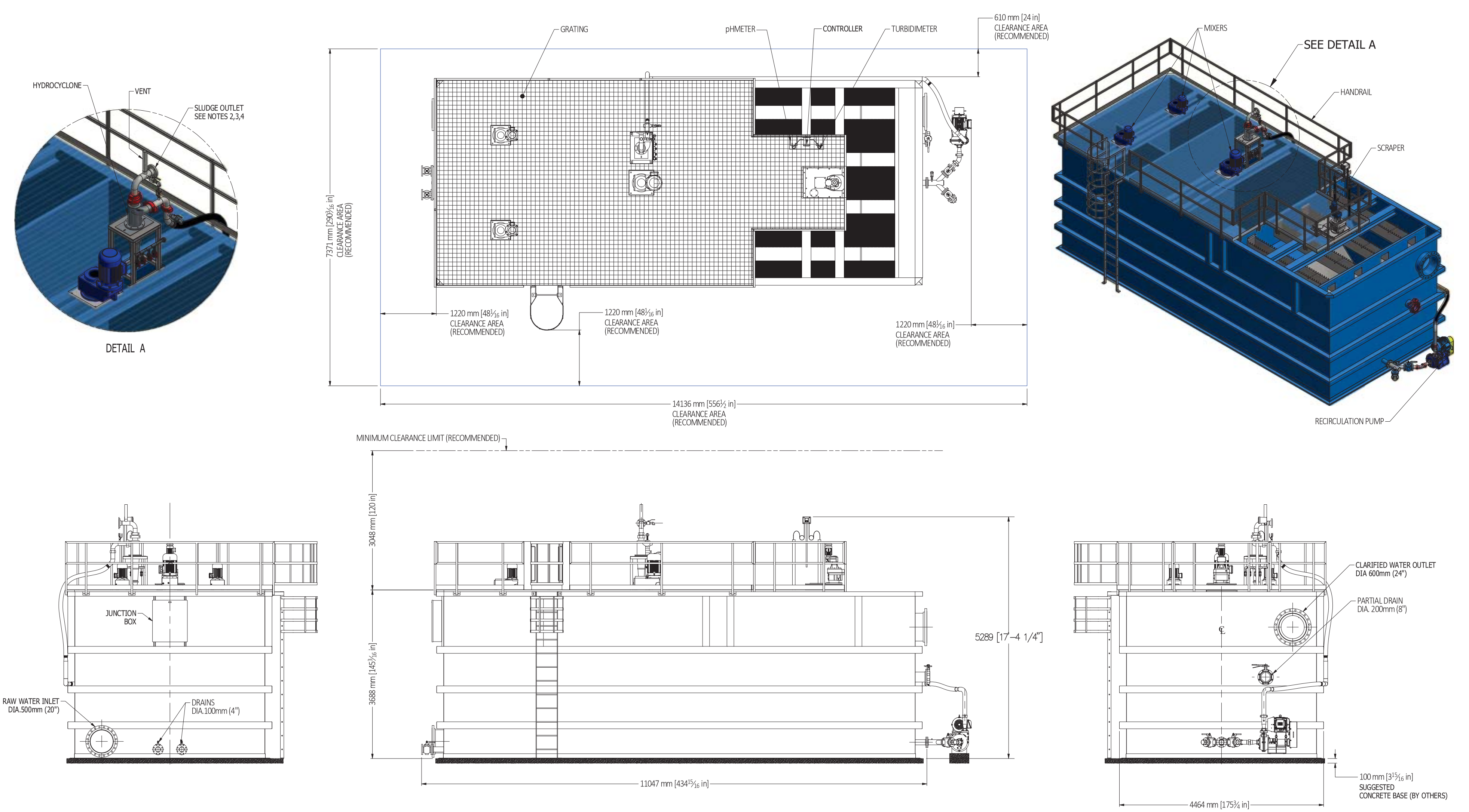
Estimated Operating Costs

ACTIFLO ACP2 System:			4.6 MGD
Item	Estimated Average Dose	Estimated Unit Cost	Estimated Daily Operating Cost
Polymer	0.50 mg/L	$ 5000 / ton	$47.96
Sand Loss	2.0 mg/L	$ 250 / ton	$9.59
Coagulant (Ferric Chloride)	65.0 mg/L	$ 650 / ton	$810.44
Power Consumption	See table above.	$ 0.08 / KWhr	$25.45
Total Estimated Daily Operating Cost			**$893.43**
Operating Cost per 1,000 Gallons			**$0.194**

Assumed Average Influent P = 2.18 mg/L and Target Effluent P = 0.1 mg/L; Actual coagulant dose to be determined via bench-scale and/or pilot testing.

Estimated chemical and power costs may vary. It is recommended that the engineer utilize regional contract pricing to afford the end user the most economical operating costs available.

For nominal capacity operating 24 hours per day.



TOUTES LES DIMENSIONS SONT EN / ALL DIMENSIONS ARE IN: mm

NOTES:

1- FOR COMPLETE EQUIPMENT LIST, PLEASE REFER TO THE TECHNICAL SPECIFICATIONS.

2- HYDROCYCLONE OUTLET ELEVATION MUST BE CONFIRMED BASED ON SUPPLIED RECIRCULATION FLOW (UPON AVAILABLE SELECTIONS).

3- IT IS IMPORTANT TO DROP 3 FEET AT EACH HYDROCYCLONE OULET TO AVOID BACKFLOW. SUBMERGED SLUDGE DISCHARGE PIPE IT NOT ACCEPTED.

4- HYDROCYCLONE DIMENSIONS TO BE CONFIRMED BASED ON RECIRCULATION FLOWRATE.

5- TANK SHALL NOT BE USED AS SUPPORT FOR ANY OTHER EQUIPMENT. EQUIPMENT THAT NEEDS TO BE CONNECTED TO TANK SHALL BE SELF-SUPPORTED.

6- WEIGHT FOR (1) ACTIFLO:
TOTAL WEIGHT: 21 000 kg (46297 LBS) (WITHOUT WATER)
TOTAL WEIGHT IN SERVICE:
173 000 kg (381 400 LBS) (WITH WATER)

PRELIMINARY

RÉV. / REV.	DESCRIPTION	DATE	RÉVISÉ / REVISED	VÉRIFIÉ / CHECKED	APPROUVÉ / APPROVED	ECN
A	PRELIMINARY	2020-11-16	M.M.	G.J.	G.P.	N/A

AVIS DE CONFIDENTIALITÉ ET DE PROPRIÉTÉ INTELLECTUELLE

CONFIDENTIALITY AND INTELLECTUAL PROPERTY NOTICE

DESSINÉ PAR / DRAWN BY	DATE
D.M.	2019-04-08
VÉRIFIÉ PAR / CHECKED BY	DATE
P.S.	2019-04-08
INGÉNIERIE PAR / ENGINEERING BY	DATE
ÉCHELLE: / SCALE: 1:25	

TITRE / TITLE: ACTIFLO PACKAGE PLANT
MK III / MODEL ACP2-70
GENERAL ARRANGEMENT

CLIENT

VEOLIA

VEOLIA WATER TECHNOLOGIES CANADA INC. 4105 Sartelon, Saint-Laurent, Qc, Canada. Tel: (514) 334-7230

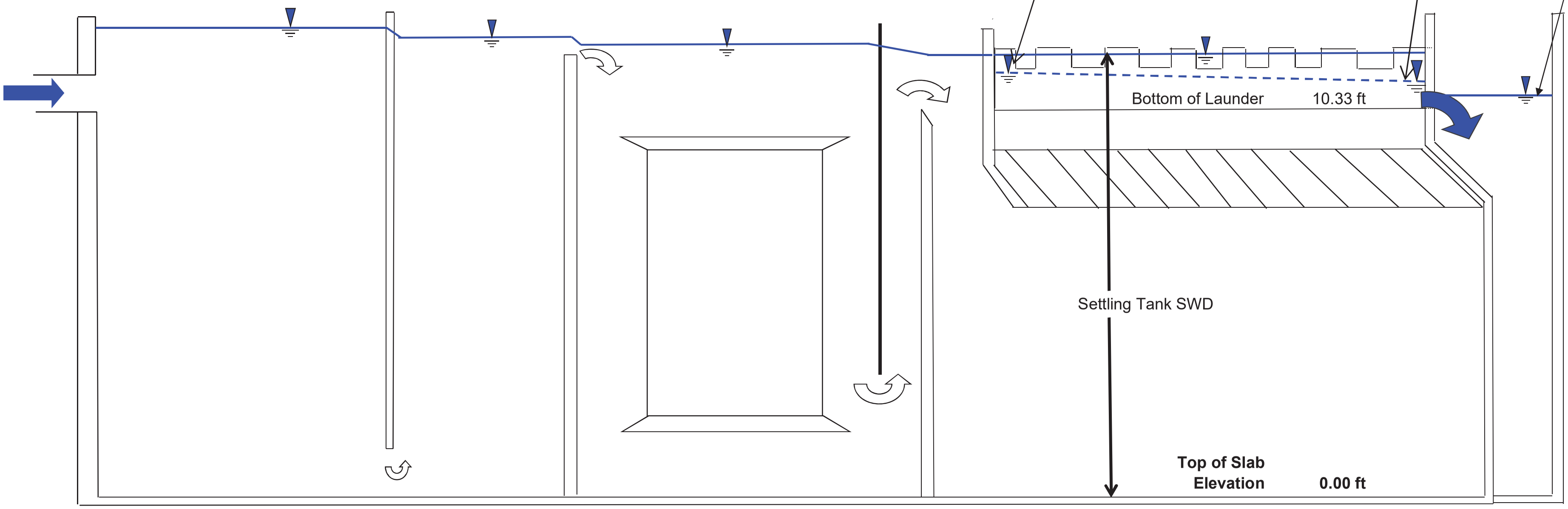
PROJET / PROJECT	DESSIN / DRAWING	NUMÉRO INTERNE / INTERNAL NUMBER	FEUILLETS / PAGES	RÉV. / REV.
-	EQ270		1 / 1	A

STD: "D" 22 X 34 REF:

BARRE = 1" À L'ÉCHELLE D'IMPRESSION
BAR = 1" AT PLOT SCALE

Actiflo® ACP2-70 Preliminary Hydraulic Profile

Flow per Train (MGD)		Pre-Coag Tank	Coagulation Tank	Maturation Tank	Start of Launder	Settling Tank	Launder Discharge	Collection Channel (See Note 1)
Peak	**4.6**	11.75 ft	11.74 ft	11.74 ft	11.04 ft	11.73 ft	10.74 ft	10.62 ft
ADF	**2.18**	11.69 ft	11.69 ft	11.69 ft	10.76 ft	11.69 ft	10.58 ft	10.51 ft



Note 1: Downstream Hydraulic conditions must be designed in a manner such that the water level in the effluent collection channel does not exceed levels indicated at each respective flow rate.