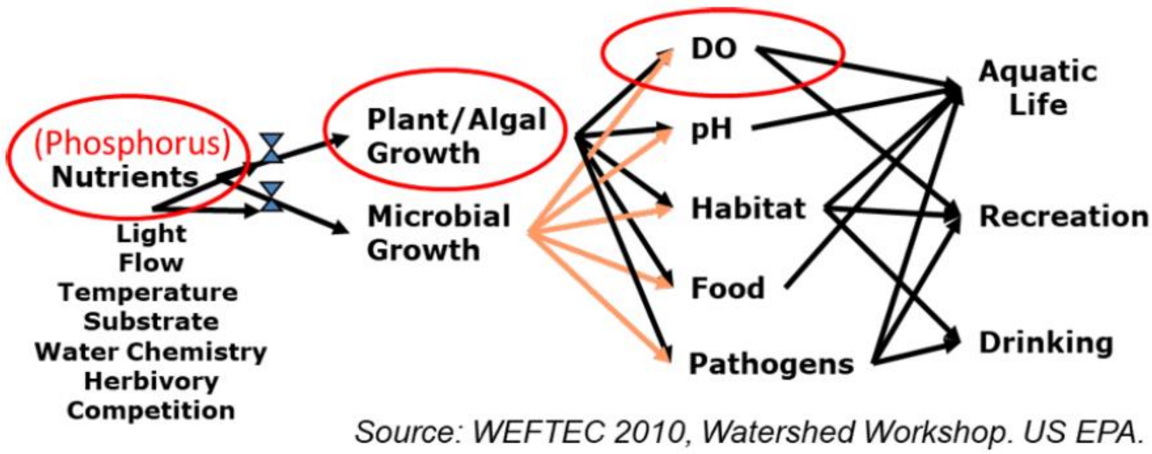
TABLE OF CONTENTS

APPENDICES

1. BACKGROUND

1.1 US EPA and Illinois Nutrient Strategy

The efforts to reduce nutrient-related pollution are ongoing in many states. The US EPA pushes for states to develop numeric criteria (NNC). NNC must protect designated use, but the relationship is not linear.



Illinois nutrient strategy set the goal to reduce total phosphorus (TP and nitrogen (TN) loads by 45% by 2045. Illinois Nutrient Science Advisory Committee developed the instream NNC. However, the Standards were not adopted by Illinois Pollution Control Board. The Environmental groups wanted 0.1 mg/L TP in POTW permits.

In 2018, an Agreement were reached between Illinois Association of Wastewater Agencies, Illinois EPA, and environmental groups, and set the goal for major WWTPs to reach 0.5mg/L TP by 2030. Special conditions were developed in NPDES permits to address of phosphorus related impairments, such as dissolved oxygen (DO) and nuisance algae. The Agreement also allows some flexibility to develop water-shed-specific targets. The Nutrient Assessment and Reduction Plan (NARP) was born.

Based on instream sampling by IEPA, phosphorus related impairment is listed on 303(d) list for DO and offensive condition (algae and/or aquatic plant growth).

1.2 IDOC-Dixon Correctional Center WWTP

Dixon Correctional Center WWTP was designed to treat the wastewater generated solely from the entire operations of the correctional center. The major design Influent parameters are as follows (See Appendix A. Basis of Design for details):

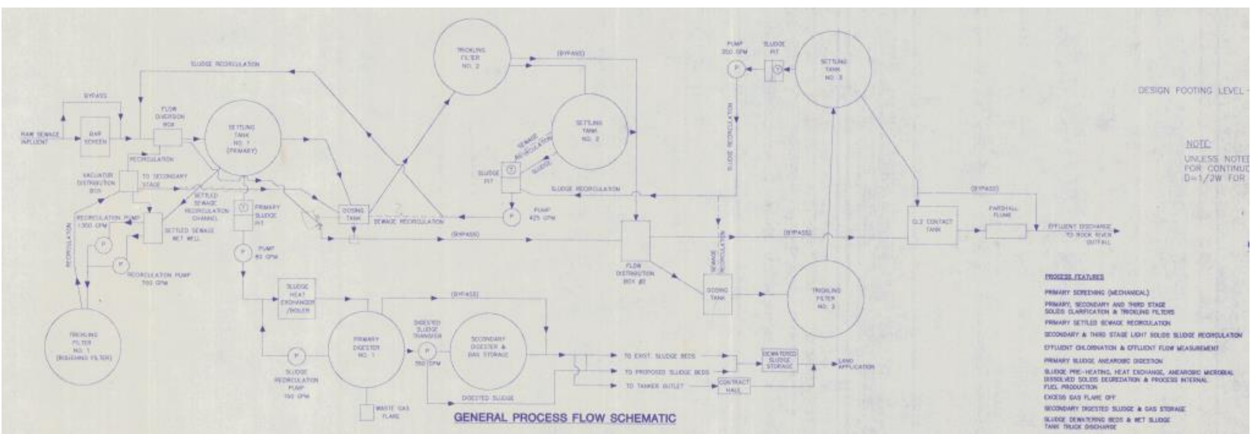
- Average Daily Water Flow (ADWF) 1.0 mgd (694 gpm)
- Maximum Daily Waste Flow (MDWF) 3.0 mgd (2,082 gpm)
- CBOD (Influent) 400 mg/l (3.340 lbs/d)
- Suspended Solid (Influent) 350 mg/l (2,920 lbs/d)

The effluence is discharged to Rock River through a 24" sewer pipe system.

The treatment plant adopts multi-staged Trickling Filter Biological treatment processes with headwater, primary and secondary settling tanks, chlorine contact tank, etc. for wastewater treatment.

Sludge treatment unit uses anaerobic digestion biological process, with primary digester, secondary digester, sludge dewatering beds, and dewatered sludge pad. The treatment sludge is used for land application. See Figure 1: GENERAL PROCESS FLOW SCHEMATIC for details (Enlarged Schematic is also attached in Appendix B).

Figure 1



The WWTP is operating under NPDES Permit No. IL0024724 (Bureau ID: W103020000) issued on December 27, 2019, expiration date is December 31, 2024. The permitted total Phosphorus (as P) effluent limitation is "monitor only, 1 day/month".

The NPDES Permit No. IL0024724 includes 17 special conditions. In order to renew the NPDES Permit, the Permittee – IDOC Correctional Center is required to address Special Conditions 16 & 17. See Appendix C.1 Special Condition 16 and Appendix C.2 Special Condition 17 for details.

In terms of Special Condition 16, the limit of 0.5 mg/L Total Phosphorus is 12 month rolling geometric mean (calculated monthly) basis is not technologically feasible through the use of biological phosphorus removal (BPR) processes(se) at IDOC – Dixon Correctional Center facility.

Therefore, the current facility won't be able to meet the effluent limit by January 1, 2030 without upgrade the treatment plant, such as adding chemical/physical processes.

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(se) of the treatment facility, the Limit shall be met by December 31, 2035.

In terms of Special Condition 17, the Permittee submits a NARP to the Agency by December 31, 2023. The plan is to meet the 0.5 mg/L limit by December 31, 3035.

1.3 Nutrient Assessment Reduction Plan (NARP)

IDOC – Dixon Correctional Center facility developed its own NARP to meet the effluent limit of 0.5 mg/L total Phosphorus by December 31, 2035. The overall strategies are to:

- Join/establish a watershed group
- Develop NARP objective
- Determine P-reduction or other measures to address impairments
- Establish schedule

1.4 Join/Establish a Watershed Group

Dixon Correctional Center WWTP was categorized as NARP – Risk. Figure 3. GIS Map of Illinois NARP for all concerned facilities and Watershed Group, see Figure 2: The treatment plant is in Lower Rock River Watershed (HUC 07090005).

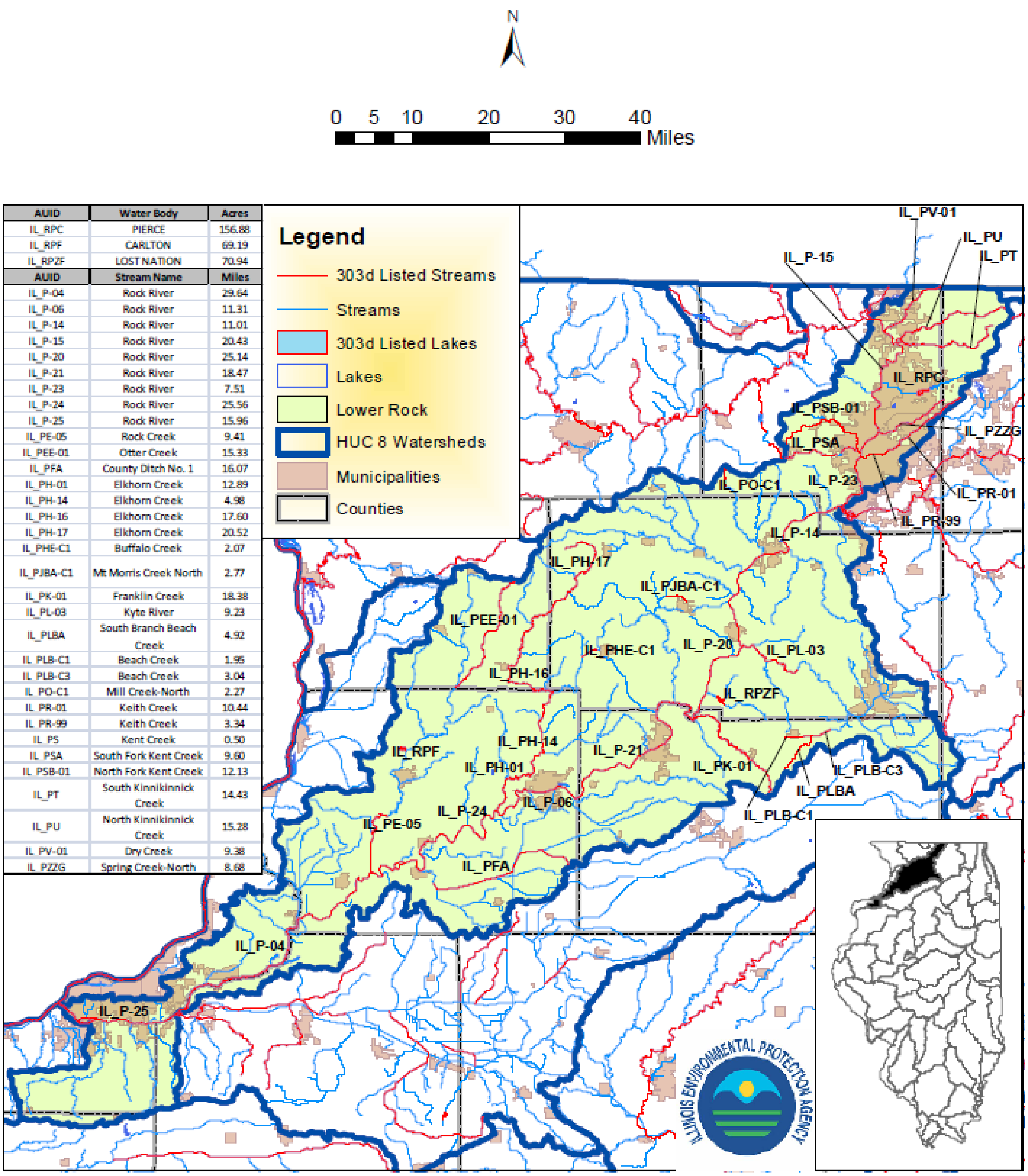
See Figure 3: The Watershed Group, includes the following entities:

1. Rock River Water Reclamation District (W2010300010)
2. IDOC Dixon Correctional Center (W1030200009)
3. Dixon WWTP (W1030200001)
4. City of Sterling WWTP (W1950500003)
5. Rock Falls New STP (W1958090002)
6. Moline South ST (W1610450003)
7. Village of Poplar Grove South STP (W0070150006)
8. Belvidere WWTP (W0070050001)
9. City of South Beloit STW (W2010450005)
10. City of Marengo STW (W1110650003)

IDOC – Dixon Correctional Center reached out to Rock River Watershed Group, but was told that the Group no longer accepted any new group members. See Table 1 Rock River Watershed Group Board Contact List,

IDOC - Dixon Correctional Center WWTP will develop its own Nutrient Assessment Reduction Plan (NARP) that will meet the requirements.

Lower Rock Watershed (HUC 07090005)



AUID	Water Body	Acres
IL_RPC	PIERCE	156.88
IL_RPF	CARLTON	69.19
IL_RPZF	LOST NATION	70.94
AUID	**Stream Name**	**Miles**
IL_P-04	Rock River	29.64
IL_P-06	Rock River	11.31
IL_P-14	Rock River	11.01
IL_P-15	Rock River	20.43
IL_P-20	Rock River	25.14
IL_P-21	Rock River	18.47
IL_P-23	Rock River	7.51
IL_P-24	Rock River	25.56
IL_P-25	Rock River	15.96
IL_PE-05	Rock Creek	9.41
IL_PEE-01	Otter Creek	15.33
IL_PFA	County Ditch No. 1	16.07
IL_PH-01	Elkhorn Creek	12.89
IL_PH-14	Elkhorn Creek	4.98
IL_PH-16	Elkhorn Creek	17.60
IL_PH-17	Elkhorn Creek	20.52
IL_PHE-C1	Buffalo Creek	2.07
IL_PJBA-C1	Mt Morris Creek North	2.77
IL_PK-01	Franklin Creek	18.38
IL_PL-03	Kyte River	9.23
IL_PLBA	South Branch Beach Creek	4.92
IL_PLB-C1	Beach Creek	1.95
IL_PLB-C3	Beach Creek	3.04
IL_PO-C1	Mill Creek-North	2.27
IL_PR-01	Keith Creek	10.44
IL_PR-99	Keith Creek	3.34
IL_PS	Kent Creek	0.50
IL_PSA	South Fork Kent Creek	9.60
IL_PSB-01	North Fork Kent Creek	12.13
IL_PT	South Kinnikinnick Creek	14.43
IL_PU	North Kinnikinnick Creek	15.28
IL_PV-01	Dry Creek	9.38
IL_PZZG	Spring Creek-North	8.68

Figure 2 Lower Rock River Watershed (HUC 07090005)

Table 1

Rock River Watershed Group Board Contact List

Rochelle		
Adam Lanning	alanning@rmu.net	815-564-7174
Adriana Milan	amilan@rochelleil.us	
Jessica Mueller	jmueller@rmu.net	
Woodstock		
Anne George	ageorge@woodstockil.gov	815-338-6118 ext. 23101
City of Rockford		
Brad Holcomb	brad.holcomb@rockfordil.gov	
Belvidere		
Brent Anderson	banderson@ci.belvidere.il.us	815-378-9244
Rockton		
Dan Barber	barber@rocktonvillage.com	815-985-5673
South Beloit		
Jeff Reininger	j.reininger@southbeloit.org	815-703-5702
Harvard		
Jim Grant	grant@cityofharvard.org	815-560-2046
Marengo		
Jim Mangum	jmangum@cityofmarengo.com	815-703-8079; 815-353-5839
Dixon		
Josh McNitt	josh.mcnitt@discoverdixon.org	815-622-8510
Rock Falls		
Matt Trotter	mtrotter@rockfalls61071.com	815-632-8288
Winnebago County		
Sean Von Bergen	svonbergen@wincoil.us	815-319-4034
Sterling/Strand		
Scott Howard	showard@sterling-il.gov	
Troy Stinson	troy.stinson@strand.com	608-251-4843
Cory Bradshaw	cbradshaw@sterling-il.gov	
Four Rivers Sanitation Authority		
Greg Cassaro	gcassaro@fourrivers.illinois.gov	815-354-9586
Mike Christensen	mchristensen@fourrivers.illinois.gov	815-262-5858
Fehr-Graham		
Pat Kelsey	Pkelsey@fehrgraham.com	630-423-0482
Leonard Dane	Ldane@fehrgraham.com	
Mark Halm	MHalm@fehrgraham.com	
Black & Veatch		
Dave Koch	KochDS@bv.com	
Anthony Giovannone	GiovannoneA@bv.com	
Leon Downing	DowningL@bv.com	
Geosyntec		
Adrienne Nemura	Anemura@geosyntec.com	
Brian Valleskey	Bvalleskey@geosyntec.com	
Rishab Mahajan	Rmahajan@geosyntec.com	

Updated 4/18/22 by MO

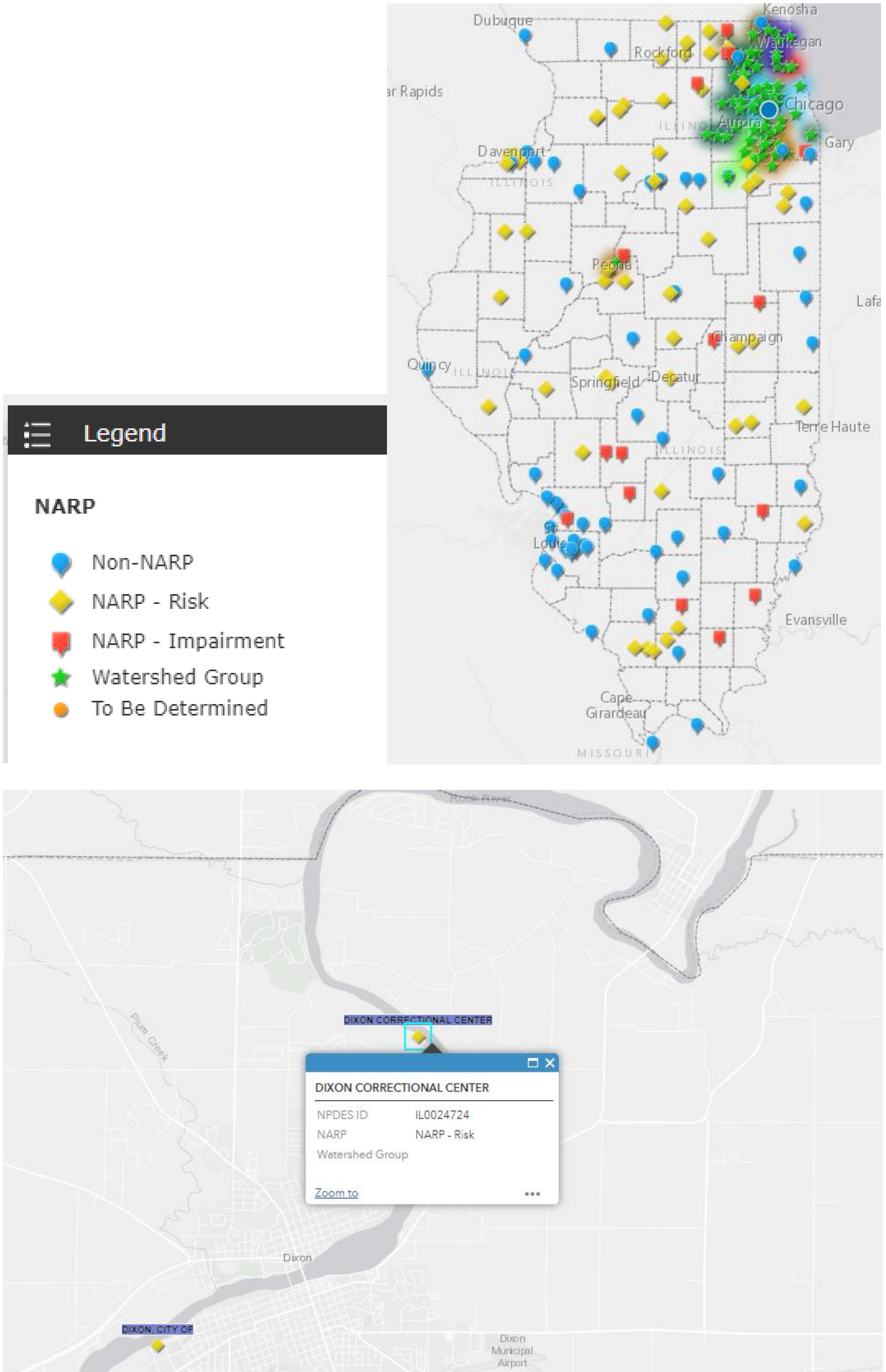


Figure 3. GIS Map of Illinois NARP for all concerned facilities and Watershed Group

2. NARP OBJECTIVES

The NARP developed by IDOC – Dixon Correctional Center facility is to meet the effluent limit of 0.5 mg/L total Phosphorus by December 31, 2035. The Permittee will develop written plan, preliminary engineering report or facility plan no later than January 1, 2025, to rebuild or replace the secondary treatment process(se) of the treatment facility, the Limit shall be met by December 31, 2035.

2.1 Determine P-Reductions or Other Measures

2.1.1 Dixon Facility monthly monitoring

IDOC Dixon Facility compiled 12-month rolling total Phosphorus effluent concentrations between April 2022 and March 2023. The 12-month rolling geometric mean (calculated monthly) is 2.13 mg/L. See Appendix D 12-Month Rolling TP Monitored in Effluent Flow.

The Permittee also investigated the influent sources of Phosphorus. A sample was collected on June 8th, 2023 from influent flow, and analyzed on June 19th, 2023. The total Phosphorus was 6.57 mg/L. See Appendix E Analytical Report of TP in Influent Flow.

2.1.2 Phosphorus Source Investigation

In addition to normal sources of phosphorus from sanitary sewerage generated by the institutional facility, IDOC Dixon facility uses CARUS™ 8600 water treatment chemical to inhibits corrosion of lead and copper plumbing for the public water supplying systems. The chemical residues eventually enter the wastewater treatment plant.

The boiler house also uses a phosphate/polymer blend in the boiler for corrosion control, however very little of this product is discharged to the treatment facility.

The Engineer of the Permittee investigated the non-phosphorus based chemicals for inhabitance of corrosion purposes, such as FlexPro© CL and other chemicals, but failed to find any suitable substitutions.

2.1.3 Total Phosphorus Removal Processes – Scientific Supports

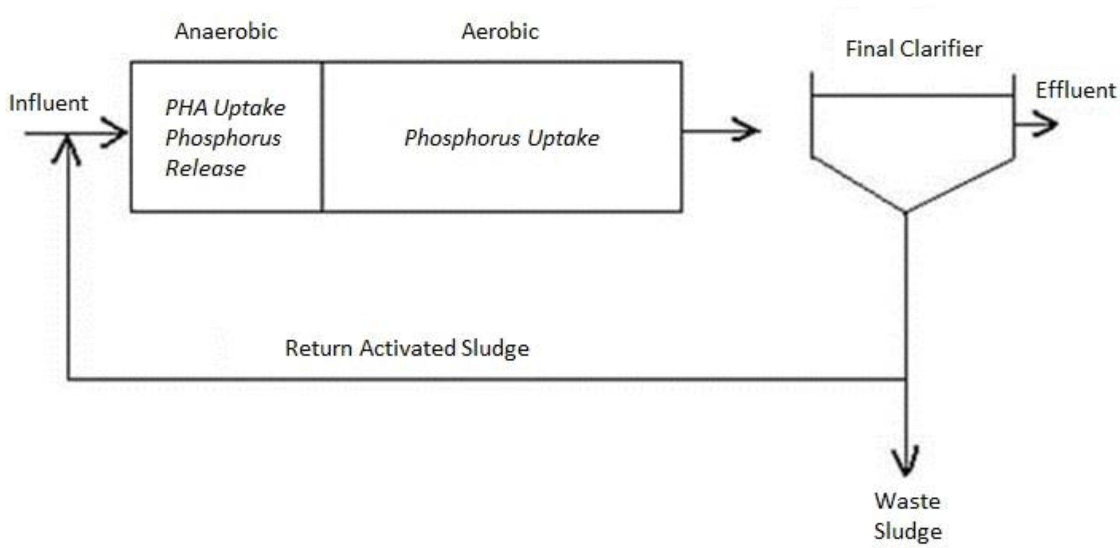
The treatment plant adopts multi-staged Trickling Filter Biological treatment processes with headwater, primary and secondary settling tanks, chlorine contact tank, etc. for wastewater treatment. Because the trickling filter biological treatment processes do not have flexibility of aeration re-arrangement to modify, the enhanced biological treatment processes may not apply to IDOC Dixon facility. Instead, most likely chemical/physical treatment processes will be investigated and implemented to meet the goal of effluent limit of 0.5 mg/J TP.

There are two major total phosphorus removal processes. They are Biological Removal Process and Chemical Process. The Permittee will look into both removal processes and select the best available solutions.

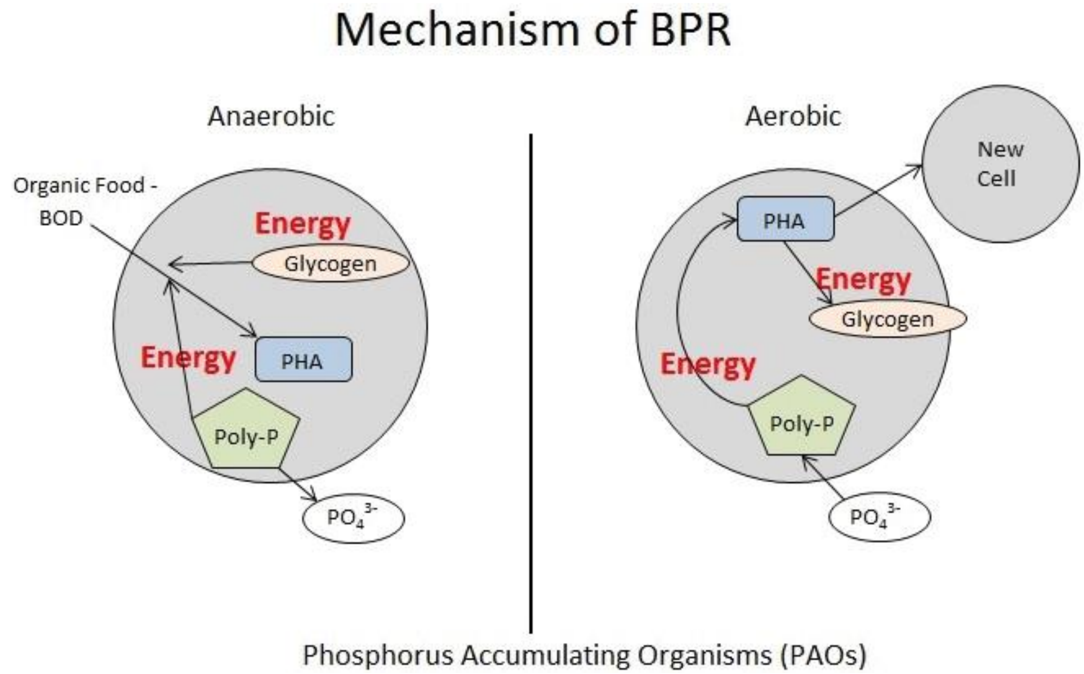
Biological Removal – Enhanced Biological Phosphorus Removal (EBPR)

EBPR relies on the selection and proliferation of a microbial population capable of uptaking orthophosphate in greater amounts than their normal biological growth requirements. EBPR is a process that uses alternating anaerobic and aerobic zones to provide an environment that encourages the growth of phosphorus-accumulating organisms (PAO). PAOs store excess polyphosphate in their cell mass and phosphorus is removed with the waste sludge (see figure). Graphic source: Jeremy Cramer, Stevens Point

A typical EBPR reactor configuration



The unique feature of EBPR is the anaerobic selector used in the treatment process (See figure)

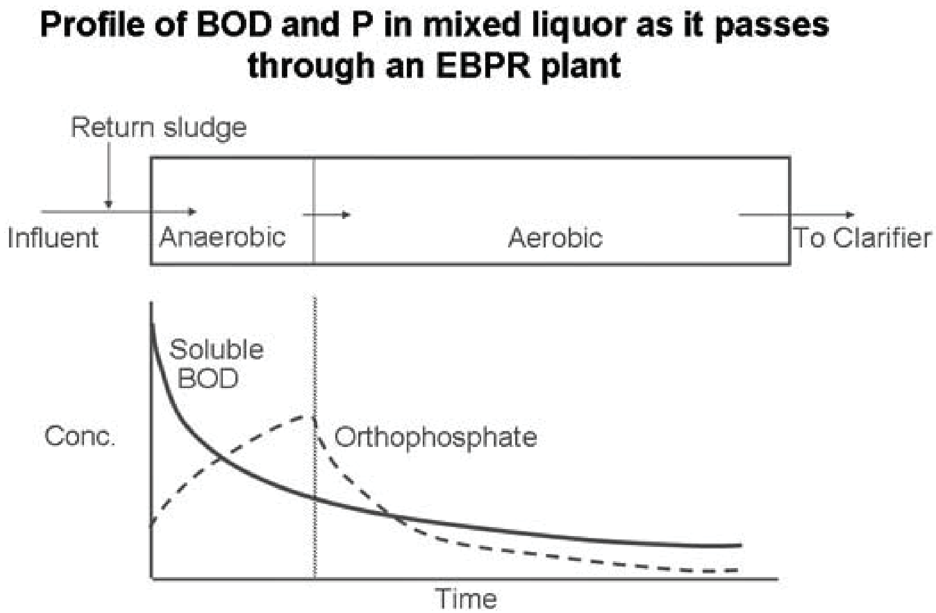


PAOs use polyphosphate (poly-P) and glycogen stored in their cells as energy sources to enable them to uptake volatile fatty acids (VFA). VFAs are converted to polyhydroxyalkanoates (PHA) and stored in the cells of PAOs. As they take up VFA, the PAOs release orthophosphate into the mixed liquor. PAOs do not grow in the anaerobic zone but their ability to uptake food in the form of VFAs gives them a competitive advantage over other bacteria.

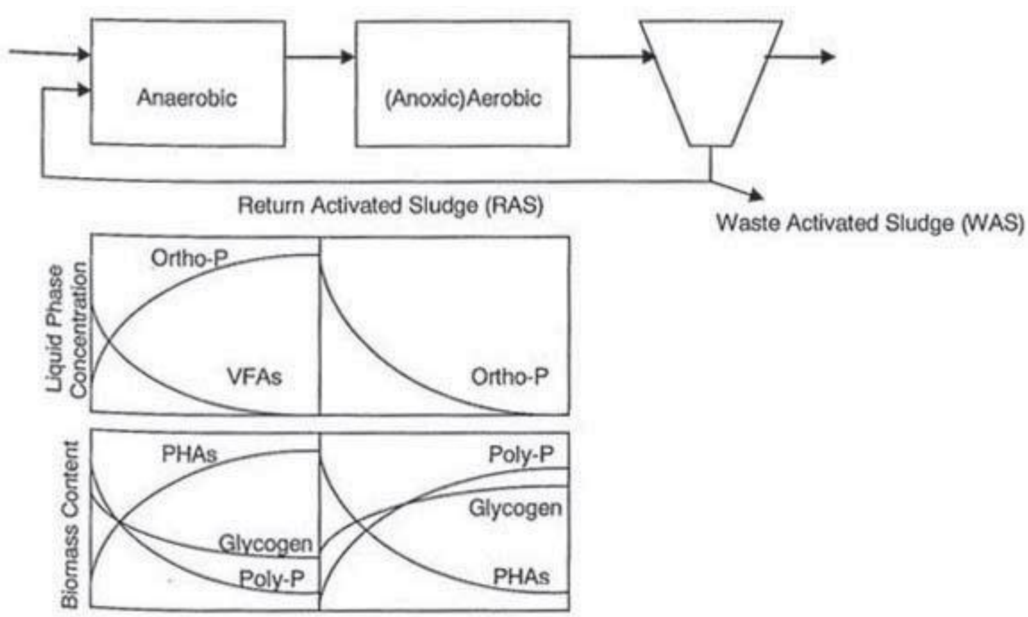
In the aerobic zone, PAOs use PHA as a source of carbon and energy for metabolism and cell growth. PAOs will also restore their supplies of glycogen and polyphosphate in the aerobic zone. To replenish their stored polyphosphate, PAOs will take up excess phosphate from the mixed liquor, the mechanism of EBPR.

In the anaerobic zone, PAOs will rapidly take up BOD (as VFAs) and release orthophosphate into the mixed liquor. As the wastewater passes through the anaerobic zone, VFA will rapidly decrease and orthophosphate will increase. In the aerobic zone, BOD will continue to decrease. As PAOs restore their polyphosphate supplies in the aerobic zone, the concentration of orthophosphate in the mixed liquor will rapidly decrease (see figure).

Graphic source: Jenchie Wang, Symbiont

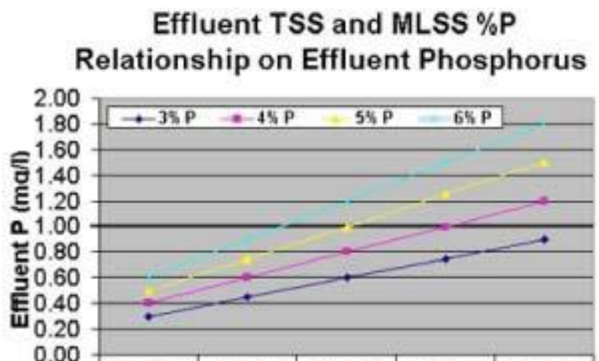


Under anaerobic conditions, PAOs take up VFA from the mixed liquor and store it as PHA within their cells. To do this, PAOs use the glycogen and polyphosphate as energy sources; therefore depleting their stores of these compounds. Under aerobic conditions, PAOs use up their stored PHA for metabolism and growth and to restock their supplies of glycogen and polyphosphate. To build up their supply of polyphosphate, PAOs will take up excess orthophosphate from the mixed liquor in the aerobic zone.



Under anaerobic conditions, PAOs are at a competitive advantage to uptake a readily available food source (VFAs) and therefore are selected for in this environment. Most other bacteria cannot uptake the VFAs under anaerobic conditions.

Sludge phosphorus content is defined as the percentage of phosphorus in cell mass and is expressed as phosphorus/volatile suspended solids (VSS)%. In a conventional activated sludge treatment process, the sludge phosphorus content is approximately 1.5% to 2.5%. In an EBPR system, the sludge phosphorus content is 3.0% to 6.0% or higher. The more efficient the EBPR system is, the higher the sludge phosphorus content will be. Phosphorus is removed from the treatment system by wasting sludge. Because the activated sludge phosphorus content is high in an EBPR plant, effluent TSS should be kept low. A small amount of TSS with high phosphorus content could contribute to a high total phosphorus concentration in the effluent.



	10 mg/l	15 mg/l	20 mg/l	25 mg/l	30 mg/l
3% P	0.30	0.45	0.60	0.75	0.90
4% P	0.40	0.60	0.80	1.00	1.20
5% P	0.50	0.75	1.00	1.25	1.50
6% P	0.60	0.90	1.20	1.50	1.80

Secondary phosphorus release can be defined as phosphorus released from a cell which is not associated with intercellular energy storage. In other words, the secondary phosphorus released is not able to be taken up by the PAOs, which results in a higher phosphorus concentration in the liquid phase, and a reduced phosphorus removal efficiency.

The primary causes of secondary phosphorus release are:

1. The retention time of the anaerobic selector of an EBPR process is too long
2. The retention time of settled sludge in the clarifier is too long
3. The retention time of the aerobic stage of an EBPR process is too long, causing cell lysis and phosphorus release
4. The long storage of waste sludge causing phosphorus to be released back into solution and then returned back into the plant through sidestreams

The idea of EBPR is to create conditions in secondary treatment that result in the microorganisms absorbing excess phosphorus. This phosphorus is removed from the flow when the activated sludge is wasted. If a sidestream is high in phosphorus, the sidestream can be treated. Metal salts can be added to these sidestreams to precipitate the phosphorus to avoid overloading the plant. If only the sidestream is treated chemically, biological phosphorus effluent limits still apply.

Problem	Cause	Corrective Action
Biochemical oxygen demand (BOD)/total phosphorus (TP) ratio has changed	High phosphorus in sidestream recycles from sludge handling	Monitor the BOD, soluble BOD, TP, and orthophosphate in influent to anaerobic zone; control volume of sidestream phosphorus recycles or provide sidestream phosphorus removal
	Increased phosphorus in raw influent from industrial or commercial discharges	Monitor the high TP in raw influent; control industrial or commercial phosphorus discharge to sanitary sewer system
Phosphorus release is poor or not occurring in anaerobic zone	Insufficient volatile fatty acids (VFA)	Monitor VFA/soluble BOD entering anaerobic zone and orthophosphate at end of anaerobic zone; supplement VFA by chemical addition; increase hydraulic retention time (HRT) of anaerobic zone if possible to ferment BOD
Anaerobic zone not truly anaerobic	Excess dissolved oxygen (DO) from recycle flows	Monitor oxidation reduction potential (ORP) above -100 mV in anaerobic zone, DO in recycle; reduce DO in aeration basin; reduce RAS or internal mixed liquor recycle to anaerobic zone
	Excess NO_3 from recycle flows	Monitor ORP above -100 mV in anaerobic zone and nitrate in recycles; reduced RAS or internal mixed liquor recycle to anaerobic zone; increase anoxic zone HRT if possible to promote denitrification
	Air entrainment from excess turbulence in anaerobic zone or upstream processes, i.e. aerated grit tanks	Monitor ORP above -100 mV in anaerobic zone but no nitrates or DO in recycles; reduce turbulence if possible
Insufficient VFA in anaerobic zone	Changes in influent waste strength	Monitor BOD, soluble BOD, TP and orthophosphate in influent to anaerobic zone; supplement VFA with chemical addition; add fermented primary sludge
Rapid phosphorus uptake in aeration basin but effluent TP is higher	Secondary release occurring in aeration basin	Monitor TP profile of aeration basin; reduce solids retention time (SRT) by wasting more sludge
	Secondary release occurring in sludge blanket in final clarifier	Check phosphorus in RAS and sludge blanket in final clarifier; reduce sludge blanket depth
	If phosphorus increases at end of anoxic zone, secondary release occurring with excessive HRT	Monitor phosphorus profile through anoxic zone; reduce anoxic zone HRT if possible
Good phosphorus release in anaerobic zone but poor phosphorus removal	If anaerobic HRT is too long, secondary release could occur after VFAs are used up	Monitor TP profile through selector basins; increase RAS to reduce anaerobic HRT

Chemical Removal Process

The following is the list of the most common chemicals (metal salts) used for phosphorus removal:

A. Ferric chloride

B. Ferrous chloride

C. Ferrous sulfate

D. Aluminum sulfate (alum)

The characteristics of the chemical (metal salts) used for phosphorus removal

A. Ferric chloride ($FeCl_3$)

1. Acidic (may lower pH) and alkalinity
2. Very corrosive
3. Fume producing
4. Supplied as 33% to 36% solution (11% to 13% iron)
5. Several grades available
6. Stains concrete and other materials
7. Can affect ultraviolet (UV) disinfection
8. May affect effluent chloride

B. Ferrous chloride ($FeCl_2$)

1. Acidic (may lower pH) and alkalinity
2. Very corrosive
3. Fume producing
4. Supplied as 18% to 28% solution (8% to 13% iron)
5. Stains concrete and other materials
6. May affect effluent chloride
7. May affect UV disinfection
8. Potential impurities

C. Ferrous sulfate ($FeSO_4$)

1. Acidic (may lower pH) and alkalinity
2. Very corrosive
3. Fume producing
4. Supplied as 23% to 25% solution (5% to 7% iron)
5. Stains concrete and other materials
6. Should be stored in indoor heated space
7. May affect UV disinfection
8. Potential impurities

D. Alum ($Al_2(SO_4)_3$)

1. Acidic (may lower pH) and alkalinity
2. Moderately corrosive
3. 49% aluminum sulfate (8% to 9% aluminum) in liquid form
4. Also available in dry form (powder); must be mixed with water before use
5. Very temperature sensitive in liquid form (must be kept above freezing)
6. Clear, light green, or yellow liquid

When metal ions, iron or aluminum, are added to wastewater two primary precipitates form an insoluble metal phosphate and an insoluble metal hydroxide. For a given metal, the formation of these precipitates is governed by the wastewater alkalinity and soluble orthophosphate concentration in the wastewater, as well as their equilibrium solubility at a given pH.

Polymers can be used as a supplement to enhance phosphorus removal by improving coagulation and settling. Polymers are usually added prior to final clarifiers. The better the settling, the less solids and phosphorus there will be in the final effluent.

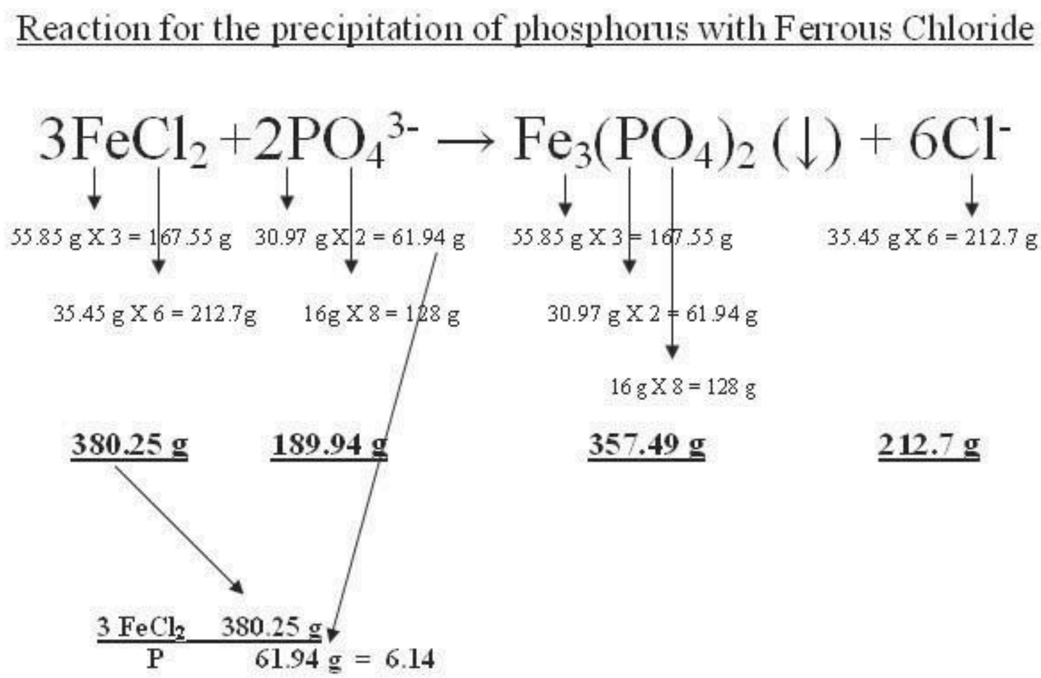
As the percent of product increases, the temperature at which it crystallizes will increase.

- Ferric chloride ($FeCl_3$)
  - 42ºF at 35% solution
  20ºF at 42% solution
- Ferrous chloride ($FeCl_2$)
  28ºF at 25% Solution
  42ºF at 35% Solution
- Ferrous sulfate ($FeSO_4$)
  42ºF at 25% Solution
- Alum ($Al_2(SO_4)_3$)
  32ºF at 8% aluminum sulfate

Crystallization is to be avoided because it is difficult to re-dissolve, plugs pipes and equipment, and forms a solid layer in storage tanks making its removal difficult. Storage room temperatures should be kept warm enough to avoid crystallization.

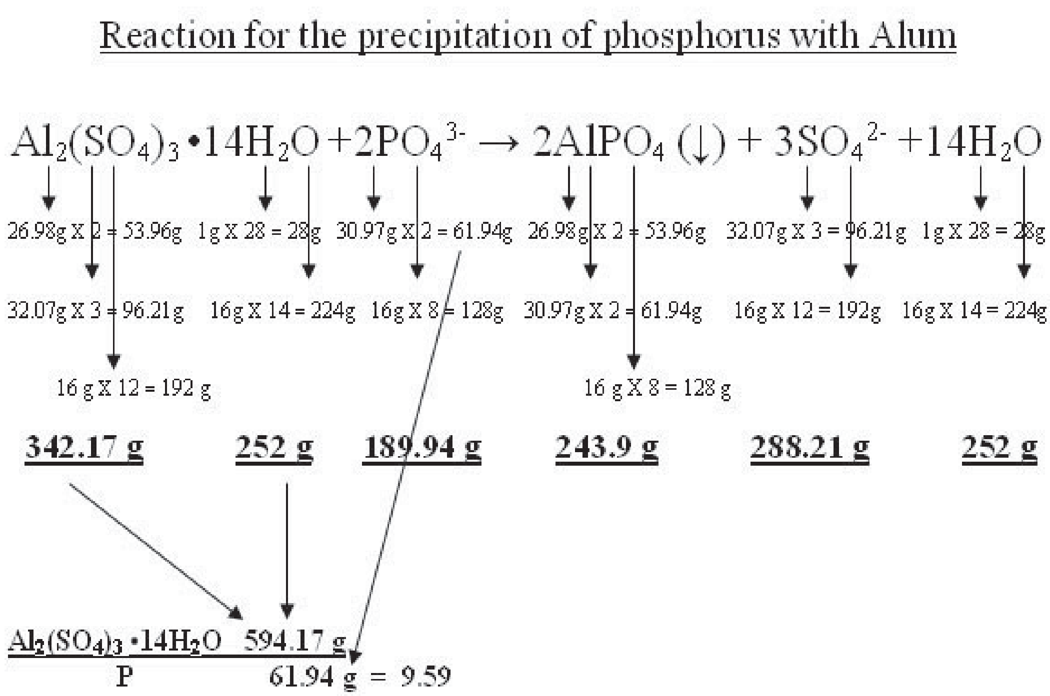
The chemical reaction of the ferrous chloride with phosphorus:

Graphic source: Jeremy Cramer, Stevens Point



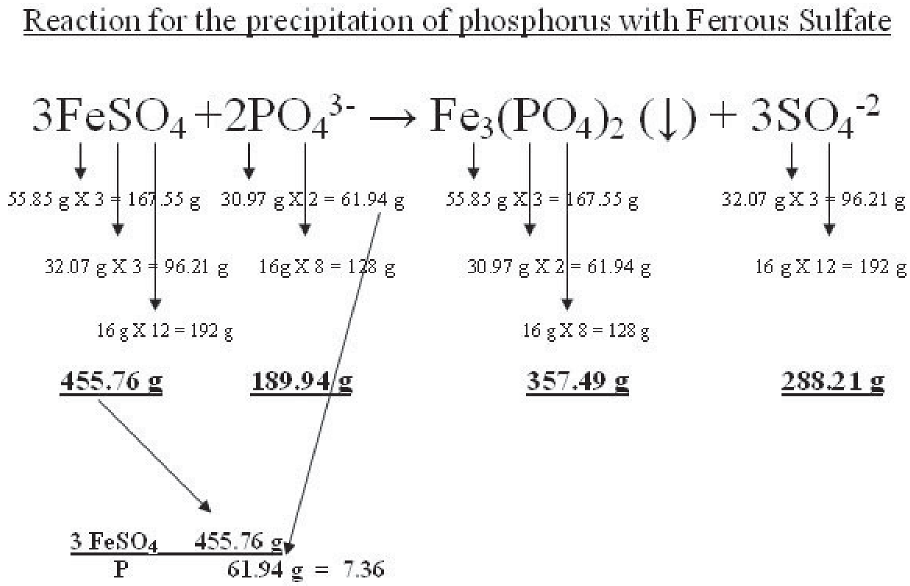
The chemical reaction of the alum with phosphorus:

Graphic source: Jeremy Cramer, Stevens Point



The chemical reaction of ferrous sulfate with phosphorus:

Graphic source: Jeremy Cramer, Stevens Point



Summarize the information of the chemical (metal salts) used of phosphorus removal:

Graphic source: Jenchie Wang, Symbiont

Chemical Compound	Ferric Chloride	Aluminum Sulfate (Alum)
A. Formula	$FeCl_3$	$Al_2(SO_4)_3 \cdot 14H_2O$
B. Molecular Weight (g/mole)	162.5	594
C. Typical Reaction With Phosphorus	$FeCl_3 + PO_4^{-3} \rightarrow FePO_4 \downarrow + 3Cl^-$	$Al_2(SO)_3 \cdot 14H_2O + 2PO_4^{-3} \rightarrow 2AlPO_4 \downarrow + 3SO_4^{-2} + 14H_2O$
D: Mole Ratio (Metal : P)	1:1	1:1
E. Weight Ratio (Metal: P)	1.8 : 1	0.87 : 1
F. Mole Ratio (Metal Compound : P)	1:1	1:2
G. Weight Ratio (Metal Compound : P)	5.2:1	9.6:1
H. Commercial Strength in Solution	33 - 36%	48 – 50%
I. Percent of Active Ingredient (Metal)	11 - 13%	8 – 9%
J. Specific Gravity	1.37 @ 35%	1.335 @ 48.5%
K. Amount (Gallons) of Commercial Strength Chemical Solution Required to Remove 1 Pound of Phosphorus Based on 1x Stoichiometric Reaction	1.26 ~ 1.38	1.73 ~ 1.80

Chemical Compound	Ferrous Chloride	Ferrous Sulfate
A. Formula	$FeCl_2$	$Fe\ SO_4 \cdot 7H_2O$
B. Molecular Weight (g/mole)	127	278
C. Typical Reaction With Phosphorus	$3FeCl_2 + 2PO_4^{-3} \rightarrow Fe_3\ (PO_4)_2 \downarrow + 6Cl^-$	$3FeSO_4\ 7H_2O + 2PO_4^{-3} \rightarrow Fe_3\ (PO_4)_2 \downarrow + 3SO_4^{-2}$
D: Mole Ratio (Metal : P)	3:2	3:2
E. Weight Ratio (Metal: P)	2.7 : 1	2.7 : 1
F. Mole Ratio (Metal Compound : P)	3:2	3:2
G. Weight Ratio (Metal Compound : P)	6.1:1	13.5 :1
H. Commercial Strength in Solution	**18 - 28%**	**23 - 25%**
I. Percent of Active Ingredient (Metal)	**8 - 13%**	**5 - 7%**
J. Specific Gravity	1.40 @ 25%	**1.140 @ 25%**
K. Amount (Gallons) of Commercial Strength Chemical Solution Required to Remove 1 Pound of Phosphorus Based on 1x Stoichiometric Reaction	**1.86 ~ 2.90**	5.68 ~ 6.17

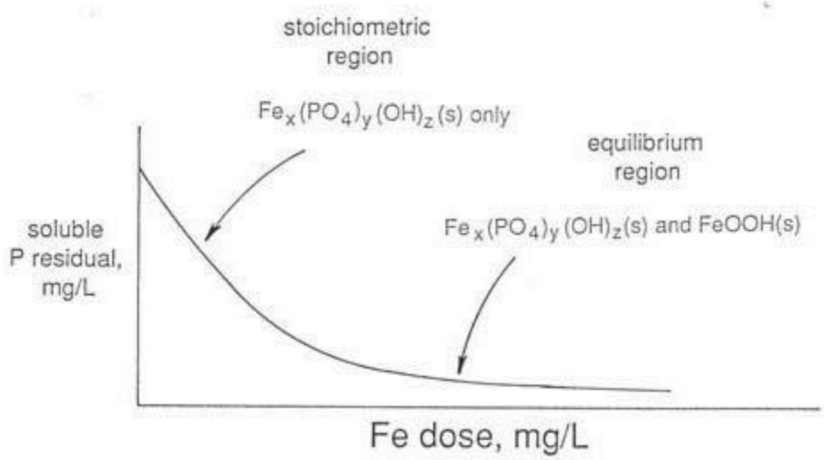
Each phosphorus removal chemical (metal salt) has an optimum pH range for precipitating out the phosphorus as a metal phosphate. Iron phosphate [FePO4] and alum [AlPO4] are least soluble at a pH of 6.8 to 7.0, thus precipitate out best at this pH range. Wastewater pH levels outside of this optimum range will require more chemical to achieve the same removal efficiency. While not all wastewaters are at a pH of 6.8 to 7.0, metal phosphates still precipitate out well in the pH range of most wastewaters of 6.0 to 8.5.

Sulfide will react with iron forming a black precipitate. High sulfide wastewater will require higher dosages of iron salts. Sources of sulfides include hauled and certain industrial wastes and collection systems with long detention times.

Reaching very low effluent phosphorus concentrations requires increasing amounts of metal salt because of the competition between phosphate and hydroxide precipitation.
Using either aluminum or iron salts, a graph of metal dose versus residual dissolved phosphorus can be drawn that illustrates this relationship (see figure 6.3.12.1).

At a given pH and alkalinity, the dissolved orthophosphate concentration in the wastewater will determine whether metal phosphates or metal hydroxides are formed. As the dissolved phosphorus concentration (effluent phosphorus) decreases, more metal hydroxides will be formed.

To achieve low effluent phosphorus limits, increasingly larger doses of metal salts are required to remove additional phosphorus. Eventually, chemical equilibrium will be reached with no further reduction in phosphorus.



Typical Fe dose versus soluble P residual curve.

Actual chemical usage depends on the competing reactions and wastewater characteristics such as pH, alkalinity, and very fine particulate materials (colloids). Wastewater characteristics and competing chemical reactions in the wastewater between the metal salt and phosphorus will result in the need for increased metal salt addition above what was calculated. Biological removal of phosphorus in upstream processes could result in a decreased amount of metal salt addition than calculated. Sampling phosphorus concentrations just upstream of the chemical dose point will help in fine tuning chemical
feed rates.

Good mixing ensures uniform dispersion of metal salts and efficient chemical use. Overdosing with the metal salt can partially compensate for poor mixing.

Ideally, high intensity mixing at the dose point would be followed by a mixed flocculation zone. However, few treatment plants are designed with rapid mix basins. More typically, metal salts are added at locations where turbulence occurs such as at pump suction lines, mechanical or aerated grit basins, flow-splitting structures, aerated flow-distribution channels, or at hydraulic jumps in Parshall flumes.

A flocculation zone should provide sufficient detention time (15 to 20 minutes) to complete the reaction. Gentle mixing promotes flocculation. The enlarged center feed well on a flocculating clarifier provides such a flocculation zone. Where a flocculation zone is not provided, metal salts should be added far enough upstream of a clarifier to provide adequate reaction time.

Metal salt additives require good mixing to provide effective chemical contact with phosphorus. The dose point may depend on facility design and mixing capability.

A. Prior to primary clarification

1. Advantages
    a. Metal salt addition upstream of primary clarifiers enhances suspended solids and
    b. Biochemical oxygen demand (BOD) removal. This reduces loading to the aeration basin
    c. Odor control (especially iron salts)
    d. Convenience and mixing capability
    e. Iron compounds may help balance nutrients in anaerobic digester
    f. May reduce struvite (phosphate mineral crystal) formation

2. Disadvantages
    a. Greater chemical usage
    b. May require additional chemical addition downstream
    c. May result in higher biosolids production
    d. Could affect nutrient ratio and pH for biological treatment
    e. Target dosages can be variable due to competing reactions in the primary clarifier and secondary release in the biological treatment system

B. Addition to secondary treatment (aeration basins)

1. Advantages
    a. Good mixing in aerated basins or lagoons
    b. $Fe+^2$ is oxidized to $Fe+^3$ thus improving reaction with phosphate ($PO4^{-3}$)
    c. Orthophosphates are readily available
    d. Convenience

2. Disadvantages
    a. Not recommended for attached growth systems
    b. Could affect pH, alkalinity, and nutrient ratio
    c. Not recommended for unmixed ponds and lagoons
    d. Iron discoloration of structures and equipment

C. Prior to final clarification

1. Advantages
    a. Efficient and high level of removal because most phosphorus is the orthophosphate form
    b. Enhances final settling
    c. Less interfering or competing reactions
    d. Cost effectiveness

2. Disadvantages
    a. Inadequate mixing

3. IMPLEMENTATION SCHEDULE

The overall schedule is to develop and submit the NARP to IEPA by December 31, 2023, to develop a written plan, preliminary engineering report of the facility plan no later than January 1, 2030, to modify or upgrade the treatment facility, the limit shall be met by December 31, 2035.

- NARP by December 31, 2023

- Written Plan, Preliminary Engineering Report – January 1, 2030
  (Detailed tasks, budget, and timeframes to be added)
  1. Establish the scope of work and budget for the surveying the best available solutions and costs
  2. Written plan
  3. Survey the costs of the treatment processes
  4. Preliminary Engineering Report
  5. Establish the total budget commitment to the compliance

- Compliance with 0.5 mg/L Total Phosphorus effluent limit – December 31, 2035
  (Detailed tasks, budget, and timeframes to be added)
  1. Engineering Design
  2. Construction Plans and Specifications
  3. Permit Applications
  4. Bid Processes and Contract Award
  5. Construction Period
  6. Final Inspections
  7. Commissioning
  8. Operating

APPENDIX A
BASIS OF DESIGN

APPENDIX B
GENERAL PROCESS FLOW SCHEMATIC

APPENDIX C.1
SPECIAL CONDITION 16

APPENDIX C.2
SPECIAL CONDITION 17

APPENDIX D
12-MONTH ROLLING TP MONITORED IN EFFLUENT FLOW

APPENDIX E
ANALYTICAL REPORT OF TP IN INFLUENT FLOW

DIXON CORRECTIONAL FACILITY
WASTEWATER TREATMENT PLANT UPGRADE
Dixon, Illinois
BASIS OF DESIGN

I. DESIGN LOADING SUMMARY:

From Discharge Monitoring Reports 10/89 - 5/93 (See attached summary table):

Average Flow	=	.347 mgd
Average Maximum Flow	=	.466 mgd
Maximum Flow in Record	=	.805 mgd (2/93)
Avg. CBOD	=	379.7 mg/l (1084.3 lbs/d)
Avg. Suspended Solids	=	324.8 mg/l (946.8 lbs/d)

Proposed Design:

Average Daily Waste Flow (ADWF)	1.0 mgd	(694 gpm) (1.547 cfs)
Maximum Daily Waste Flow (MDWF)	3.0 mgd	(2082 gpm) (4.64 cfs)
CBOD (Influent)	400 mg/l (3340 lbs/d)	
Suspended Solids (Influent)	350 mg/l (2920 lbs/d)	

Existing Plant Influent Sewer (24") at .10% (from as-built drawings)

Capacity = 4.6 mgd

Velocity at ADWF = ± 2 fps

Dixon WWTP Upgrade Discharge Monitoring Report Summary Tabulation

Date	Average Flow mgd	Maximum Flow mgd	CBOD Influent mg/l	CBOD Influent lb/d	SS Influent mg/l	SS Influent lb/d	CBOD Effluent lb/d	CBOD Effluent mg/l	SS Effluent lb/d	SS Effluent mg/l	pH	FC	Chlorine Residual
10/89	0.331	0.386	505.0	1395.7	443.8	1225.1	54.9	19.9	27.6	10.0	7.4	<100	0.09
11/89	0.316	0.378	407.8	1074.7	302.6	707.5	52.4	19.9	39.8	15.1	7.6	340	0.08
12/89	0.286	0.400	388.3	926.2	268.5	640.4	42.7	17.9	37.4	15.7	7.6	225	0.08
1/90	0.321	0.406	379.0	1014.6	263.0	704.1	53.0	19.8	36.9	13.8	7.6	140	0.08
2/90	0.326	0.389	365.0	992.4	335.0	910.8	31.5	11.6	20.7	7.6	7.7	130	0.07
3/90	0.364	0.496	497.5	1510.3	403.2	1224.0	33.7	11.1	27.6	9.1	7.6	<100	0.11
4/90	0.375	0.483	445.0	1391.7	307.6	962.0	50.4	16.1	40.3	12.9	7.7	<100	0.10
5/90	0.408	0.486	548.0	1864.7	395.7	1346.0	54.4	16.0	50.0	14.7	7.7	<100	0.09
6/90	0.426	0.687	650.6	2311.5	592.9	2106.5	52.2	14.7	40.5	11.4	7.6	<100	0.07
7/90	0.390	0.515	345.0	1122.1	258.7	841.4	40.0	12.3	42.6	13.1	7.6	<100	0.08
8/90	0.404	0.578	493.3	1662.1	507.2	1708.9	33.0	9.8	39.8	11.8	7.7	<100	0.07
9/90	0.390	0.518	386.3	1256.5	281.1	914.3	37.1	11.4	27.3	8.4	7.8	174	0.07
10/90	0.347	0.424	367.5	1063.5	312.7	904.9	29.8	10.3	29.2	10.1	7.9	<100	0.10
11/90	0.334	0.387	395.6	1102.0	243.4	678.0	32.9	11.8	25.6	9.2	7.9	132	0.08
12/90	0.283	0.436	543.8	1283.5	414.1	977.4	29.3	12.4	25.5	10.8	8	<100	0.10
1/91	0.275	0.337	477.0	1094.0	462.3	1060.3	33.3	14.5	30.7	13.4	8	<100	0.08
2/91	0.318	0.564	375.0	994.5	239.0	633.9	25.5	9.6	26.5	10.0	8	<100	0.12
3/91	0.323	0.521	345.0	929.4	240.4	647.6	23.2	8.6	31.8	11.8	8	<100	0.12
4/91	0.342	0.414	322.0	918.4	268.1	764.7	25.1	8.8	47.6	16.7	7.8	<100	0.08
5/91	0.373	0.482	390.0	1213.2	300.1	933.6	21.5	6.9	45.1	14.5	7.8	<100	0.09
6/91	0.403	0.474	385.7	1296.3	375.1	1260.7	19.8	5.9	29.2	8.7	7.8	<100	0.07
7/91	0.401	0.485	298.5	998.3	274.0	916.3	17.7	5.3	27.4	8.2	7.8	<100	0.08
8/91	0.404	0.540	290.6	979.1	265.1	893.2	16.8	5.0	22.9	6.8	7.9	<100	0.09
9/91	0.357	0.432	307.5	915.5	250.0	744.3	19.4	6.5	28.3	9.5	7.9	<100	0.07
10/91	0.322	0.523	351.0	942.6	251.5	675.4	23.6	8.8	22.0	8.2	7.8	<100	0.09
11/91	0.283	0.407	324.0		276.0	764.7	26.7	11.3	17.5	7.4	7.8	<100	0.09
12/91	0.313	0.372	433.0	1130.0	226.0	590.0	30.5	11.7	23.5	9.0	7.7	<100	0.08
1/92	0.304	0.373	283.0	717.5	217.0	550.0	32.2	12.7	21.6	8.5	7.7	<100	0.09
2/92	0.306	0.367	384.0	980.0	282.0	720.0	41.1	16.1	18.9	7.4	7.7	<100	0.08
3/92	0.313	0.365	286.0	747.0	295.0	775.0	32.1	12.3	21.4	8.2	7.7	<100	0.07
4/92	0.320	0.422	435.0	1161.0	418.0	1116.0	20.3	7.6	14.4	5.4	7.8	<100	0.10
5/92	0.300	0.354	324.0	811.0	379.0	948.0	15.4	6.2	11.8	4.7	7.8	<100	0.07
6/92	0.264	0.351	267.0	587.0	267.0	587.0	16.9	7.7	17.1	7.8	7.8	<100	0.09
7/92	0.326	0.425	363.0	986.9	331.0	899.9	21.2	7.8	35.8	13.2	7.6	<100	0.07
8/92	0.334	0.427	422.0	1175.5	262.2	730.3	24.2	8.7	24.5	8.8	7.6	<100	0.09
9/92	0.397	0.532	378.0	1251.0	253.0	837.0	44.1	13.4	32.4	9.8	7.7	<100	0.06
10/92	0.390	0.440	330.0	1073.0	292.0	949.7	54.6	16.8	24.0	7.4	7.6	<100	0.06
11/92	0.357	0.475	352.0	1048.0	340.0	1012.0	35.4	11.9	27.9	9.4	7.6	<100	0.06
12/92	0.358	0.547	350.0	1045.0	462.0	1379.0	39.4	13.2	30.4	10.2	7.6	<100	0.08

Dixon WWTP Upgrade Discharge Monitoring Report Summary Tabulation

Date	Average Flow mgd	Maximum Flow mgd	CBOD Influent mg/l	CBOD Influent lb/d	SS Influent mg/l	SS Influent lb/d	CBOD Effluent lb/d	CBOD Effluent mg/l	SS Effluent lb/d	SS Effluent mg/l	pH	FC	Chlorine Residual
1/93	0.370	0.501	451.0	1391.0	752.0	2320.0	38.8	12.6	21.8	7.1	7.5	<100	0.10
2/93	0.387	0.805	249.5	805.2	187.0	603.5	30.5	9.5	23.3	7.3	7.7	<100	0.08
3/93	0.389	0.691	278.0	901.0	303.0	983.0	40.5	12.5	26.9	8.3	7.4	<100	0.16
4/93	0.362	0.489	256.0	772.8	256.0	772.8	43.1	14.3	30.7	10.2	7.6	<100	0.09
5/93	0.372	0.404	282.0	874.0	238.0	738.0	27.3	8.8	36.2	11.7	7.5	<100	0.07
Total	15.264	20.488	16707.5	47709.7	14291.3	41657.2	1467.5	510	1282.4	443.3	339.6	1141	3.75
Avg.	0.347	0.466	379.7	1084.3	324.8	946.8	33.4	11.6	29.1	10.1	7.7	25.9	0.1

II. PLANT WASTEWATER TREATMENT PROCESS UNITS:

A. Preliminary Treatment

(1) Mechanical Bar Screen (Bar Screen Building)

In-channel type, stainless steel, front cleaning
Bar rack width = 2 ft
Total channel height = 5.0 ft
Maximum flow depth at MDWF = 2 ft
Bar thickness = 1/4" s.s
Bar depth = 1 1/2"
Clear spacing = 3/4"
Clear opening efficiency = .75
Velocity through bar rack
ADWF = .52 ft/s
MDWF = 1.55 ft/s

(2) Bar Rack (Emergency Bypass Channel)

In-channel, manually cleaned
Width of bar rack = 2 ft
Depth at MDWF = 2 ft
Bar thickness = ½"
Bar depth = 2"
Clear spacing between bars = 1.0"

Clear opening efficiency $\frac{1.0}{.5+1.0} = .67\%$

Velocity = Q/A = 4.64 cfs/(2x2x.67) = 1.73 ft/-S at MDWF
= 1.55 cfs/(2x2x.67) = .58 ft/s at ADWF

B. Primary Settling Tank (Existing)

Configuration:

Diameter	45 ft
SWD	9.0 ft
Area	1590 sf
Volume	14,310 cf (107,031 gal)
Weir length	141.4 ft

Hydraulic Parameters:

Flow	Overflow Rate	Estimated Removal (BOD)	(SS)	Weir Loading Rate	Detention Time
MDWF	1887 gpd/sf	23%	40%	21,220 gpd/ft	0.94 hrs
ADWF	629 gpd/sf	36%	65%	7,070 gpd/ft	2.6 hrs

Removals:

Flow	Load	Raw	Removal	Effluent
MDWF	CBOD	3340 lbs/d	768 lb/d	2572 lb/d
	SS	2920 lbs/d	1168 lb/d	1752 lb/d
ADWF	CBOD	3340 lbs/d	1202 lb/d	2138 lb/d
	SS	2920 lbs/d	1898 lb/d	1022 lb/d

Primary Effluent Recirculation:

Pump 1 Characteristics:	Capacity	700 gpm
	TDH	24.5 ft
	Motor	7½ Hp, 1150 rpm
Pump 2 Characteristics:	Capacity	1300 gpm
	TDH	25 ft
	Motor	15 Hp, 1150 rpm

Recirculation Ratio $R = Q_R/Q$ ADWF 700 gpm/700 gpm = 100%
MDWF (700 + 1300) gpm/2083 = 96%

C. First Stage Trickling Filter (Existing)

Configuration:	Diameter	55 ft
	Stone Media Depth	4 ft
	Area	2375 sf (.054 ac)
	Rock Volume	9500 cf (.218 ac ft)

Hydraulic Parameters & Removals:

	BOD Influent	Loading	Hydraulic Loading	Estimated Removal NRC	Removal	Effluent
MDWF	2572 lb/d	271 lbs/d/1000 cf	1263 gpd/sf	60%	1543lb/d	1029 lb/d
ADWF	2138 lb/d	225 lbs/d/1000 cf	421 gpd/sf	63%	1347lb/d	791 lb/d

NRC Removal Efficiency (%): $= 100/(1+.0085(W/VF)^{.5})$

W = Influent BOD (lbs/d)
V = Ac. ft Rock Volume
F = 1 + R = 2
R = Recirculation Ratio (100%)

D. Second Stage Trickling Filter (Existing)

Configuration:		
	Diameter	108 ft
	Stone Media Depth	6.5 ft
	Area	9160 sf (.21 ac)
	Rock Volume	59,540 cf (1.37 ac. ft)

Hydraulic Parameters & Removals:

	BOD Influent	Loading	Hydraulic Loading	Estimate Removal (NRC Formation)	Removal	Effluent
MDWF	1029 lb/d	17 lb/d/1000 cf	328 gpd/sf	68%	700 lb/d	329 lb/d
ADWF	791 lb/d	13 lb/d/1000 cf	109 gpd/sf	69%	546 lb/d	245 lb/d

NRC: Removal Efficiency (%) = $100/(1+(.0085/1\text{-}E_1)(W_2/VF)^{.5})$

W = Influent BOD (lbs/d)
V = Ac. ft Rock Volume
F = 1 + R = 1.5
R = Recirculation Ratio = Qr/Q = 50% of ADWF
E_1 = Removal Efficiency through First Stage Filter

E. Second Stage Setting Tank (Existing)

Configuration:		
	Diameter	34 ft
	SWD	7 ft
	Area	908 sf
	Volume	6355 sf (47,532 gal)
	Weir Length	107 ft

Hydraulic Parameters:

Flow	Overflow Rate	Estimated Removal (BOD)	(SS)	Weir Loading Rate	Detention Time
MDWF	3304 gpd/sf	(NRC)	33%	28,037 gpd/ft	.38 hr
ADWF	1101 gpd/sf	(NRC)	55%	9,346 gpd/ft	1.1 hr

Removals:

Flow	Load	Raw	Removal	Effluent
MDWF	CBOD	329 lb/d	(NRC)	329 lb/d
	SS	1752 lb/d	(578)	1174 lb/d
ADWF	CBOD	245 lb/d	(NRC)	245 lb/d
	SS	1022 lb/d	560 lb/d	462 lb/d

F. Third Stage Trickling Filter (Existing)

Configuration:		
	Diameter	55 ft
	Stone Media Depth	4 ft
	Area	2376 sf (.054 ac)
	Rock Volume	9504 cf (.218 ac. ft)

Hydraulic Parameters & Removals:

	BOD Influent	Loading	Hydraulic Loading	Estimate Removal (NRC Formation)	Removal	Effluent
MDWF	329 lb/d	70 lb/d/1000 cf	1263 gpd/sf	49%	161 lb/d	168 lb/d
ADWF	245 lb/d	56 lb/d/1000 cf	421 gpd/sf	52%	127 lb/d	118 lb/d

NRC: Removal Efficiency (%) = $100/(1 + (.0085/1\text{-}E_1)\ (W_2/VF)^{.5})$

W = Influent BOD (lbs/d)
V = Ac.ft Rock Volume
F = 1 + R = 1.0
R = No Recirculation

G. New Final Settling Tank

Configuration:		
	Diameter	65 ft
	SWD	10.2 ft
	Area	3318 sf
	Volume	33,847 cf (253,154 gal)
	Weir Length	204 ft

Hydraulic Parameters:

Flow	Overflow Rate	Estimated (BOD)	Removal (SS)	Weir Loading Rate	Detention
MDWF	904 gpd/sf	(NRC)	57%	14,706 gpd/ft	2 hrs
ADWF	301 gpd/sf	(NRC)	75%	4,902 gpd/ft	6 hrs

Removals:

Flow	Load	Raw	Removal	Plant Effluent		NPDES Requirements	
				lbs/d	mg/l	lbs/day	mg/l
MDWF	CBOD	168 lb/d	(NRC)	168	6.7	*	*
	SS	1174 lb/d	669 lb/d	505	20.2	*	*
ADWF	CBOD	118 lb/d	(NRC)	118	14.1	166.8	20
	SS	462 lb/d	347 lb/d	115	13.8	208.5	25

*Maximum limits not known at this time

H. Chlorine Contact Tank (Existing)

Configuration:	Tank Area		420 sf
	Water Depth		8.5 ft
	Tank Volume		3570 cf (26,702 gal)
	Detention Time	MDWF	*13.8 min
		ADWF	*41.4 min

Equipment Type	Vacuum Solution Feed By Gas
Gas Storage	2 Ea 150 lb Cylinders in Heated Storage Building
Storage Room Temperature	65°F +
Gas Delivery Capacity**	83 - 130 lb/d
Effluent Dosage Required	10 mg/l at ADWF
Required Cl_2 Feed Capacity	83.4 lb/d

*Includes volume in outlet structure and parshall flume only. Contact time in the effluent main to the Rock River outfall is not included in the detention time calculation

**IEPA Standard = 41.5 lb/d per 150 lb cylinder at 65° F
Manufacturer = 65 lb/d at 1 lb/day/°F

I. Parshall Flume

Type	Precast Fiberglass Flume & Inlet/Exit Channel Set in Cast in Place Monolithic Concrete
Flume Width	9"
Flow Measurement	0-5.7 MGD

III. SLUDGE TREATMENT PROCESS UNITS (ANAEROBIC DIGESTION)

A. Sludge Production

Design Assumptions:

(1) All BOD removed converted to waste solids (No allowance for process destruction)

(2) Effluent BOD = 20 mg/l; influent BOD = 400 mg/l

(3) Volatile Suspended Solids (VSS) = 70% Total Solids (TS)

(4) All waste sludge from primary treatment at 4% Avg. TSS
Secondary & final stage sludges will be recirculated through the primary stage

BOD Removal Required = 1.0 mgd x 8.34 x (400-20)		=	3170 lb/d
TS Removal Required = BOD Removal Required		=	3170 lb/d
VSS Loading to Digester = .7(3170)		=	2220 lb/d
Sludge Volume at 4% TS	3170/(.04x8.34)	=	9500 gpd
at 2% TS	3170/(.02x8.34)	=	19,000 gpd

B. Primary Digester

Configuration:	Diameter	50 ft
	SWD	19.4 ft
	Area	1963 sf
	Volume	38,023 cf (284,393 gal)
	Floating Steel	
	Duo Deck Cover Area	1925 sf

Total Deck Weight 125,125 lbs
Floating Cover Operating Pressure 10.5" W.C.
Gas System Operating Pressure 9.5" W.C.
Floating Cover Static Pressure 12.5" W.C.

Digester Solids Loading = 2220/38.023 = 58 say 60 lb VSS/day/cf

17,0.96

Hydraulic Detention:

Input Solids Concentration	Input Volume (gal/day)	Detention Time (Days)
2%	19,000	15
2.5%	15,204	18.7
3%	12,700	22.4
3.5%	10,860	26.2
4%	9500	30(Design)

C. **Digester Primary Sludge Feed Pump**

Pump Characteristics:

11" Plunger
5 Hp/230/460V/3ph
Max. Capacity = 80 gpm
TDH 75 ft

Sludge Loading	% Solids	Sludge Volume	Sludge Transfer Time 80 gpm
3170 lb/d	4%	9500 gpd	2 hr
3170 lb/d	2%	19,000 gpd	4 hr

D. **Digester Heating Requirement**

Sludge Heating Requirement:

$$Qs = 19{,}000 \text{ gal sludge/day} \times 8.34 \text{ lb/gal} \times (95\text{-}55)\ {}^\circ\text{F} \times \frac{1 \text{ day}}{24 \text{ hr}} \times \frac{1 \text{ Btu}}{\text{lb } {}^\circ\text{F}} = 264{,}100 \frac{\text{Btu}}{\text{hr}}$$

Qs = 264,100 Btu/hr (at 2% TSS)

Q_S = 9500 (8.34) (40) (1/24) (1) = 132,050 Btu/hr (at 4% TSS)

Assumptions:

- All walls buried to SWD
- Cover area = 1925 sf
- Bottom area = 1963 sf
- Wall area = π(50) x 21 (full tank depth) = 3300 sf
- Digester operating temp = 95° F

- U-Factors

Floating cover w/3" perlite insulation	U = .17
Walls on dry soil (due to sharply sloped raised berm)	U = .06
Bottom on wet soil (high water table condition)	U = .105

- Soil Temperature = 40° F

- Air Temperature = 0° F (cold climate winter conditions)

Heat flow equation through compound structures

$Q = U \times A\ (T_2 - T_1)$

Q = Heat loss (Btu/hr)
A = Metered area normal to direction of flow (ft^2)
T_1 = Outside temp (°F)
T_2 = Digester Op. temp (°F)

V = Heat transfer coeff. (Btu/sf.hr)

Heat Losses:

Cover Q_c =	$.17 \frac{Btu}{sf.°F\ hr} \times 1925\ sf\ (95-0)°F$	= 31,089 Btu/hr
Walls Q_w =	.06 x 3300 sf (95-40)	= 10,890 Btu/hr
Floor Q_f =	.105 x 1963 sf (95-40)	= 11,336 Btu/hr
	Q_t = Total Heat Losses	= 53,315 Btu/hr

Total Heat Requirement = Digester Sludge Heating Requirement (Q_s) + Total Heat Losses (Q_t)
= 264,100 + 53,315 = *317,415 Btu/hr
*For worst conditions imposed on system (conservative)

E. Sludge Heater

Heat Requirement	317,415 Btu/hr
Heater Capacity	375,000 Btu/hr
Reserve Capacity	57,585 Btu/hr
Sludge Recirculation Rate	150 gpm
Boiler Output Rating	380,000 Btu/hr
Fired Surface	88 sf
Exhaust Fan Capacity	550 cfm

F. Fuel Requirements

Furnace Efficiency	Fuel Energy Input Required (Btu/hr)	
60%	529,025	At winter conditions & including cover & floor losses & Sludge at 2% TS
65%	488,331	
70%	453,450	
75%	423,220 (Design)	
80%	396,769	

Check Heat Requirements For Anticiapted Actual Ambient Conditions:

	Summer	Winter
Raw Sludge From Primary	65°F	55°F
Air Temp	70°F	0°F
Soil Temp	55°F	40°F

Sludge at 4% TS; V sludge = 9500 gal/d

Summer Heat Requirements:

Sludge	9500 (8.34) (95-65) x 1/24 x 1 Btu/lb °F	=	99,038
Cover	.17 x 1925 (95-70)	=	8,181
Walls	.06 x 330 (95-55)	=	7,920
Bottom	.105 x 1963 (95-55)	=	8,245

Total Actual Summer Heat Requirement = 123,384 Btu/hr

Fuel Required at 75% Efficiency = 164,512 Btu/hr

Winter Heat Requirements:

Sludge	9500 (8.34) (95-55) x 1/24 x 1	=	132,050
Cover	.17 x 1925 (95-0)	=	31,089
Walls	.06 x 3300 (95-40)	=	10,890
Bottom	.105 x 1963 (95-40)	=	11,336

Total Actual Winter Heat Requirement = 185,365 Btu/hr

Fuel Required at 75% Efficiency = 247,153 Btu/hr

Summary, Heat & Fuel Requirements:

	Total Heat Requirement (Btu/hr)	Fuel Energy Requirement At 75% Efficiency (Btu/hr)
Worst Case Condition	317,415	423,220 (Design)
Anticipated Summer	123,384	164,512
Anticipated Winter	185,365	247,153

G. Gas Production Anaerobic Digestion

Assumptions:
40% Volatile Suspended Solids Destruction in digester (conservative)
15 cf of Gas Production/lb VSS destroyed
640 Btu/cf Heat Valve (methane gas)
VSS P 70% of total solids

Gas Volume = (3170 lb TS/d x .70 VSS/TS) x 40% Destruction x 15 $\frac{\text{cf}}{\text{lb VS}}$ Meth = 13,314 cf/day

Heat Value = 13,314 cf/d x 640 Btu/cf x $\frac{\text{1d}}{\text{24 hr}}$ = 355,040 Btu/hr

H. Fuel Budget Balance (Btu/hr)

	Total Heat Requirement	Fuel Energy Requirement/75% Eff	Available Gas Energy	Excess (Flare Off)	Natural Gas Backup
Worst Case Condition	317,415	423,220	355,040	---	68,180
Anticipated Summer	123,384	164,512	355,040	190,528	---
Anticipated Winter	185,365	247,153	355,040	107,887	---

* Under anticipated operating conditions, the digesters will generate required heating fuel. However, under worst case design conditions a natural gas backup will be required.

Natural Gas Backup Required Under Worst Case:

68,180 Btu/hr x 1 cf/1000 Btu Nat. Gas x 24 hr/day = 1640 cf Natural Gas/day

Digester Gas Flare Off Under Anticipated Conditions:

Summer 190,528 Btu/hr x 1cf/650 Btu x 24 hr/d = 7035 cf Dig. Gas/day Flare-off

Winter 125,340 (1/650) (24 hr/d) = 4628 cf Dig. Gas/day Flare-off

I. Digester Gas Flare

Diameter	12¾"		
Capacity	2000 cf/hr		
Flame Burn Duration:		Summer	3.5 hrs
		Winter	2 hrs

J. Digested Sludge Production

Raw Total Solids = 3170 lb/d (sludge input)

VS = 70% TS; 40% VSS Destruction

Total Sludge = 3170 lb/d
70% VSS 3170 (.7) = 2219 lb VSS/d
40% VSS Destruction
Remaining VSS = (1-.4) 2219 = 1331.4 lb/day

Sludge Output = Total sludge - VSS Destruction
= 3170 - (2219 - 1331.4)

Sludge Output From
Primary Digester to
Secondary Digester = 2282 lb/d

Sludge Balance (Assume Digesters Concentrate Influent Sludge to 4% TS):

Input Sludge Concentration	Input Volume at 3170 lb/d (gal/day)	Output Volume at 2282 lb/d to Secondary (4% TS) (gal/day)	Supernatant Recycle to Head of Plant* (gal/day)
2%	19,005	6,841	12,164
2.5%	15,204	6,841	8,363
3%	12,700	6,841	5,859
3.5%	10,860	6,841	4,019
4.0%	9,503	6,841	2,662

* Decant Draw Off By Gravity Flow to Head of Plant

K. Primary Sludge Recirculation (Pre-Heating)

Pump Characteristics:	Capacity	150 gpm
	TDH	43 ft
	Motor	5 HP/1750 rpm

L. Secondary Digester

Configuration:	Diameter	37 ft
	SWD	18.5 ft
	Area	1075 sf
	Volume	19,891 cf (148776 gal)
	Floating Steel	1032 sf
	Duo Deck Cover Area	
	Operating Weight	49,100 lbs
	Gas Storage	7,575 cf
	Operating Pressure	9.5" W.C.
	Static Maximum Pressure	11" W.C.

Average Daily Gas Volume Production at ADWF & 3170 lb/d TS
(3170 lb TS/d x 70 VSS/TS) x 40% Destruction x 15 cf Meth/lbVSS = 13,314 cf/d

Hourly Gas Production = 555 ft^3/hr

Storage Duration	13.7 hrs
	57% of daily gas production

Sludge Transfer From Primary	2282 lb/d
Sludge Volume at 4% TS	6841 gal/d
Detention Time at	21.7 days

M. Secondary & Third Stage Sludge Recirculation

Secondary Recirculation:

Recirculation Ratio $R = Q_R/Q$ = 50% of ADWF = 350 gpm (.5 mgd)

Pump Characteristics:	Capacity	425 gpm
	TDH	32.5 ft
	Motor	5 HP/1750 rpm

Third Stage Recirculation:

Recirculation Ratio $R = Q_R/Q$ = 50% of ADWF = 350 gpm (.5 mgd)

Pump Characteristics:	Capacity	350 gpm
	TDH	24 ft
	Motor	5 HP/1750 rpm

N. Sludge Transfer

Primary to Secondary Digester or
Secondary Digester to Dewatering Beds

Pump Characteristics:	Capacity	350 gpm
	TDH	53 ft
	Motor	15 HP/1750 rpm

O. Sludge Dewatering Beds

(1) Existing Beds (to be rehabilitated):

Area	5 ea at (26 x 100)	= 13,000 sf
Volume	(1 ft depth)	= 13,000 cf (97,233 gal)

Type: Sand filter drain with concrete access pad
Underdrain decant collection and recycle to 3rd
Stage trickling filter influent

(2) Proposed Additional Beds:

Area	6 ea at (29.2 x 90)	= 15,768 sf
Volume	(1 ft depth)	= 15,768 cf (117,936 gal)

Type: Sand filter drain with concrete access driveway "strips". Underdrain decant collection and recycle to Bar screen influent channel.

(3) Annual Sludge Production:

2280 lb/d x 365 d/yr = 832,200 lb/yr (dry solids)

Volume at 4% solids = 2,494,604 gal/yr (liquid volume)

(4) Dewatering Capacity:

Total Bed Capacity = 97,233 + 117,936 = 215,170 gal

Desired Bed Turnover Level = 7 Turnovers/yr (52 days/turnover cycle)

Sludge Handling Required:

2,494,605 gal x 1/7 = 356,370 gal/bed turnover

% of required capacity available for de-watering = $\frac{215,170}{356,370}$ = 60%

(5) Wet Haul Requirement (Tanker Truck):

40% of Annual Capacity = 997,840 gal/yr

Tanker Truck Discharge Outlet (gravity feed) to be provided at existing sludge beds

(6) Plant Sludge Storage Capacity:

Primary Digester	284,393 gal
Secondary Digester	148,776 gal
Existing Sludge Beds	97,233 gal
New Sludge Beds	117,936 gal
Primary Sludge Pit	4,220 gal
*Total	652,558 gal

* Pipe System Storage Not Included

Plant Design BOD Loading = 400 mg/l x 1 mdg x 8.34 = 3336 lb/d (conservative)

IEPA Design Criteria .17 lb/day/capita
Per Capita Equivalent = 3336/.17 = 19,623 at proposed design plant loading

IEPA Design Criteria .09 lb/day/capita Sludge Production
Plant BOD Loading = .09 x 19,623 = 1766 lb/day (by strict criteria)

Sludge Volume at 4% TS 1766 x (1/.04 x 8.34) x 365 d/yr = 1,932,324 gal/yr
(5294 gpd)

Interim Sludge Storage Time:

652,558 gal/5294 gpd = 123 days

P. Dewatered Sludge Storage Pad

Daily Sludge Production 2282 lb/d

Assume Sludge Dewatered to 40% Solids
Dewatered Sludge Density 45 lb/cf

Annual Dewatered Sludge Production = 2282 lb/d x 1/.4 x 1 cf/45 lb x 365 d/yr =
46,274 cf (1714 cy)

Concrete Storage Pad Area	5200 sf
Push Wall Height	5 ft

Runoff Collection and Decant to 3rd Stage Trickling Filter Influent

Q. Recommended Dewatered Sludge Land Application Equipment

(1) 4WD Tractor with Heavy Duty Front Loader, 22-25 cf Bucket Capacity
(2) Push Cylinder Driven 220-340 cf Capacity Spreader, Tractor Pulled
(3) Medium Capacity Dump Truck (tandem axle)

60% of Annual Sludge Production Land Applied on Prison (State Owned) Cropland.

40% of Annual Sludge Production Contract Wet Hauled from Tanker Outlet

GENERAL

G-1. PLAN DIMENSIONS AND DETAILS RELATIVE TO EXISTING STRUCTURES HAVE BEEN TAKEN FROM MINIMAL FIELD MEASUREMENTS AND FROM EXISTING PLANS AND ARE SUBJECT TO VARIATIONS. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO VERIFY SUCH DIMENSIONS AND DETAILS IN THE FIELD AND MAKE NECESSARY APPROVED ADJUSTMENTS PRIOR TO CONSTRUCTION OR ORDERING OF MATERIALS. SUCH VARIATIONS SHALL NOT BE CAUSE FOR ADDITIONAL COMPENSATION FOR A CHANGE IN THE SCOPE OF THE WORK.

G-2. IF DAMAGE IS DONE TO EXISTING OR NEW STRUCTURES DURING CONSTRUCTION, THEY SHALL BE REPLACED OR REPAIRED IN A SATISFACTORY MANNER BY THE CONTRACTOR AT HIS OWN EXPENSE.

G-3. STRUCTURAL SHEETS SHALL BE COORDINATED WITH ALL OTHER SHEETS FOR PIPE SIZES AND LOCATIONS, ELECTRICAL REQUIREMENTS, AND ANCHOR BOLTED ATTACHMENTS.

G-4. LOCATIONS AND ELEVATIONS OF EXISTING UNDERGROUND PIPING, CONDUITS, STRUCTURES, ETC., SHALL BE FIELD VERIFIED BY EXCAVATION (AS NECESSARY) BEFORE STARTING CONSTRUCTION OF NEW FACILITIES.

G-5. THE CONTRACTOR SHALL PROVIDE TEMPORARY SHORING AND BRACING FOR EXCAVATIONS AS REQUIRED BY OSHA AND ALL APPLICABLE BUILDING CODES. THE CONTRACTOR IS RESPONSIBLE FOR THE ADEQUACY OF TEMPORARY SHORING AND BRACING FOR BUILDING AND EARTH LOADS.

G-6. NO PIPES OR SLEEVES FOR MECHANICAL TRADES SHALL PASS THROUGH STRUCTURAL MEMBERS WITHOUT APPROVAL OF THE ENGINEER.

G-7. THE CONTRACTOR SHALL HAVE THE RESPONSIBILITY, BEFORE ANY CONSTRUCTION WORK HAS BEGUN, OF OBTAINING FROM ALL UTILITY AGENCIES THE EXACT LOCATION OF ANY UNDERGROUND FACILITIES IN THE AREA OF CONSTRUCTION, WHETHER INDICATED ON THE PLANS OR NOT. ANY FACILITIES DISTURBED BY THE CONTRACTOR SHALL BE RESTORED BY HIM AT HIS OWN EXPENSE. THE CONTRACTOR SHALL COORDINATE, WITH THE PROPER UTILITY AGENCY, THE RELOCATION OF ANY FACILITY DESIGNATED ON THE PLANS OR DEEMED NECESSARY BY THE OWNER TO BE RELOCATED IN ORDER TO COMPLETE CONSTRUCTION OF THE PROJECT. WHENEVER A QUESTION ARISES REGARDING THE EXISTENCE OR LOCATION OF A BURIED UTILITY, THE CONTRACTOR SHALL CALL THE TOLL FREE J.U.L.I.E. TELEPHONE NUMBER, 1-800-892-0123, OR CONSULT WITH THE OWNER AND ENGINEER BEFORE STARTING EXCAVATION HE SHALL ALLOW 48 HOURS FOR OTHER THAN EMERGENCY ASSISTANCE.

G-8. EXISTING PIPING LOCATIONS AS DEPICTED ARE FOR GENERAL REFERENCE ONLY AND BASED ON RECORD INFORMATION FROM PREVIOUS CONSTRUCTION PROVIDED BY THE OWNER. IT IS ALSO PROBABLE THIS PLAN IS NOT COMPREHENSIVE.

G-9. ALL PIPE LOCATIONS ARE TO BE FIELD VERIFIED PRIOR TO EXCAVATION. ALL ASSOCIATED REPAIR COSTS TO EXISTING KNOWN PIPING DAMAGED DURING EXCAVATION WORK ARE THE RESPONSIBILITY OF THE CONTRACTOR. RE-ROUTING OF EXISTING MAINS TO ACCOMODATE NEW CONSTRUCTION ARE TO BE INCLUDED IN THE CONTRACT BID PRICE AND WILL NOT BE SUBJECT TO ADDITIONAL COMPENSATION.

STRUCTURAL STEEL

S-1. ALL STRUCTURAL STEEL SHALL BE ASTM A36 UNLESS NOTED OTHERWISE.

S-2. ALL WELDS SHALL BE MADE WITH E70XX ELECTRODES AND SHALL CONFORM TO THE LATEST EDITION OF AWS SPECIFICATIONS. ALL WELDS SHALL BE PERFORMED BY CERTIFIED WELDERS.

S-3. ALL STEEL BOLTS SHALL BE ASTM A325 UNLESS NOTED OTHERWISE.

S-4. UNLESS SPECIFIED OTHERWISE ON PLANS, STAINLESS STEEL BOLTS SHALL CONFORM TO THE FOLLOWING:

1. BOLTS CONFORM TO ASTM F593 AND SHALL BE SUPPLIED WITH ONE WASHER AND NUT PER BOLT.
2. NUTS SHALL CONFORM TO ASTM 594
3. WASHERS SHALL CONFORM TO ASTM A 240, TYPE 302

FOUNDATIONS

F-1. THE CONTRACTOR SHALL FAMILIARIZE HIMSELF WITH THE SOIL CONDITIONS IN THE PROJECT AREA AND SHALL TAKE THE NECESSARY PRECAUTIONS IN ORDER TO PROTECT EXISTING STRUCTURES FROM DAMAGE DUE TO HIS OPERATIONS.

F-2. THE FOOTING ELEVATIONS ARE SHOWN ON THE PLANS. IF UNSUITABLE BEARING SOILS EXIST AT THE REQUIRED FOOTING DEPTHS, THE FOUNDATION SHALL BE OVER-EXCAVATED UNTIL SOUND MATERIAL IS ENCOUNTERED. THE OVER-EXCAVATION SHALL BE BROUGHT UP TO THE DESIGN FOUNDATION ELEVATION WITH CRUSHED STONE (CA-6 OR CA-10) AND SHALL BE COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D-1557. THE FILL SHALL BE PLACED IN 6" MAXIMUM LOOSE LIFTS AND AT MOISTURE CONTENTS WITHIN 3% OF OPTIMUM. SEE ALSO DETAIL 1, SHEET G3. THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF THE DIFFERING SITE CONDITION. THE CONTRACTOR SHALL NOT PROCEED WITH THE ADDITIONAL WORK WITHOUT WRITTEN APPROVAL OF THE ENGINEER AND CDB.

F-3. ALL FOUNDATION EXCAVATIONS SHALL BE INSPECTED AND APPROVED BY THE ENGINEER PRIOR TO PLACEMENT OF CONCRETE.

F-4. IT IS THE CONTRACTOR'S RESPONSIBILITY TO KEEP ALL STRUCTURAL EXCAVATIONS DEWATERED DURING CONSTRUCTION. THIS INCLUDES DEWATERING WELLS AND/OR WELL POINTS IF NECESSARY.

F-5. A MINIMUM OF FOUR INCHES OF CRUSHED STONE (CA-6 OR CA-10) SHALL BE PLACED IMMEDIATELY BELOW FOOTINGS AND BASE SLABS WITHIN 24 HOURS OF THE TIME THE EXCAVATION IS MADE. THE GRANULAR BASE SHALL BE PLACED IN A STABLE SUBGRADE AND COMPACTED. THE COMPACTION SHALL CONSIST OF AT LEAST 2 PASSES WITH A VIBRATORY PLATE COMPACTOR. IF THE FOOTING OR SLAB IS NOT POURED WITHIN 7 CALENDAR DAYS OF THE TIME THE EXCAVATION IS MADE, THE 4" OF CRUSHED STONE SHALL BE REPLACED BY 4" OF CONCRETE UNLESS THIS IS DETERMINED TO BE UNNECESSARY BY THE ENGINEER. A MINIMUM OF 12 INCHES OF CA-5 OR CA-7 CRUSHED STONE COMPACTED TO 90% OF RELATIVE DENSITY SHALL BE USED BELOW THE BASE SLAB AND FOOTINGS OF THE NEW CLARIFIER.

F-6. BEFORE PLACEMENT OF ANY FILL, ALL VEGETATION, INCLUDING THE ROOT ZONE SHALL BE STRIPPED FROM THE SITE. THE EXACT DEPTHS OF STRIPPING SHALL BE DETERMINED BY THE ENGINEER AT THE TIME OF CONSTRUCTION. AFTER ALL VEGETATION HAS BEEN STRIPPED FROM THE SITE, THE SUBGRADE SHALL BE PROOFROLLED WITH A FULLY LOADED DUMP TRUCK. AREAS OF EXCESSIVE YIELDING, PUMPING, OR RUTTING SHALL BE EXCAVATED, REPLACED AND COMPACTED.

F-7. ALL FILL MATERIAL SHALL BE APPROVED FOR USE IN ADVANCE OF PLACEMENT BY THE ENGINEER. NO FILL SHALL BE PLACED OVER FROZEN, MUDDY OR OTHER DELETERIOUS MATERIAL. NO FILL MAY BE PLACED OVER A PREVIOUS LIFT THAT HAS NOT BEEN ADEQUATELY COMPACTED AND ACCEPTED BY THE ENGINEER.

F-8. FILL MATERIAL USED TO INCREASE THE EARTH ELEVATION UNDER FLOATING SLABS AND PAVEMENTS SHALL BE A NON-EXPANSIVE MATERIAL. CRUSHED STONE (CA-5) IS CONSIDERED SUITABLE FOR USE AS STRUCTURAL FILL OR BACKFILL. THE FILL MATERIAL PLACED BELOW THE SLAB OR PAVEMENTS MUST BE PLACED IN LAYERS OF NOT MORE THAN 6 INCHES IN THICKNESS, AT MOISTURE CONTENTS WITHIN 3 PERCENT OF OPTIMUM, AND COMPACTED TO 98% OF THE STANDARD PROCTOR MAXIMUM DRY DENSITY.

F-9. THE FOUNDATION DESIGNS ARE BASED ON A NET ALLOWABLE SOIL BEARING OF 2000 P.S.F. BEFORE FOUNDATIONS ARE POURED, THE SOIL SHALL BE FIELD TESTED TO DETERMINE IF THE 2000 P.S.F. ALLOWABLE BEARING IS ACHIEVED. IF THE 2000 P.S.F. ALLOWABLE IS NOT MET, THE FOUNDATION SHALL BE OVEREXCAVATED IN ACCORDANCE WITH NOTE F-2. THE CONTRACTOR SHALL NOTIFY THE ENGINEER AND CDB OF THE DIFFERING SITE CONDITION PRIOR TO EXECUTION OF THE ADDITIONAL WORK. THE CONTRACTOR SHALL NOT PROCEED WITH THE ADDITIONAL WORK WITHOUT APPROVAL OF THE ENGINEER AND CDB.

ABBREVIATIONS

ASTM	AMERICAN SOCIETY OF TESTING MATERIALS
AWS	AMERICAN WELDING SOCIETY
E.F.	EACH FACE
SPA.	SPACING

CONCRETE

C-1. ALL CONSTRUCTION JOINTS SHOWN ON THE DRAWINGS SHALL BE INCORPORATED IN THE STRUCTURE UNLESS THEIR ELIMINATION IS APPROVED BY THE OWNER'S REPRESENTATIVE. ADDITIONAL CONSTRUCTION JOINTS REQUIRED TO FACILITATE CONSTRUCTION SHALL BE LOCATED AND DETAILED ON SHOP DRAWINGS. CONSTRUCTION JOINTS SHALL BE CONSTRUCTED AS FOLLOWS:

1. THE REINFORCEMENT SHALL PASS CONTINUOUSLY THROUGH THE JOINT.
2. A KEY SHALL BE PROVIDED FOR ADEQUATE SHEAR TRANSFER AT ALL HORIZONTAL JOINTS. SHEAR KEYS SHALL BE AT LEAST 1 1/2 INCHES DEEP AND BE AT LEAST 1/3 OF THE WALL THICKNESS IN WIDTH.
3. VERTICAL JOINTS SHALL BE INTENTIONALLY ROUGHENED TO A 1/4 INCH MINIMUM AMPLITUDE.
4. WATERSTOPS SHALL BE ADDED TO CONSTRUCTION JOINTS IN WATERTIGHT STRUCTURES. WATERSTOPS SHALL BE OF THE TYPE SHOWN ON DETAIL 3 SHEET S7. ALL WATERSTOPS SHALL BE WIRED TO THE REINFORCEMENT AS SHOWN ON DETAIL 3 SHEET S7. WATERSTOPS IN VERTICAL JOINTS SHALL BE PLACED IN THE MIDDLE OF THE WALL.

C-2. ALL CONCRETE SURFACES RECEIVING A LAYER OF GROUT SHALL BE INTENTIONALLY ROUGHENED TO AN AMPLITUDE OF 1/2 IN.

C-3. WHERE NEW CONCRETE IS TO BE CAST AGAINST EXISTING MASONARY OR CONCRETE, THE EXISTING SURFACE SHALL BE CLEAN, DRY, AND FREE OF LAITANCE. A BONDING AGENT SHALL BE USED AT THE JOINT. THE BONDING AGENT SHALL BE AS DESCRIBED IN THE SPECIFICATIONS. THE BONDING AGENT SHALL BE USED IN STRICT ACCORDANCE WITH THE MANUFACTURERS INSTRUCTIONS WITH REGARDS TO POT LIFE, COMPATIBILITY WITH THE LIQUIDS IN WHICH IT WILL HAVE CONTACT, ETC.

C-4. THE CONCRETE STRENGTH, f'c, SHALL = 4000 PSI AT 28 DAYS

C-5. REINFORCEMENT BARS SHALL CONFORM TO THE REQUIREMENTS OF ASTM A-615. THE CONCRETE COVER OVER REINFORCEMENT SHALL BE 2" CLEAR FOR CONCRETE CAST AGAINST FORMS, AND 3" CLEAR FOR CONCRETE CAST AGAINST EARTH, UNLESS OTHERWISE SHOWN. SPACING OF REINFORCEMENT IS MEASURED FROM CENTERLINE TO CENTERLINE OF BARS. THE YIELD STRENGTH OF THE REINFORCEMENT SHALL BE 60,000 P.S.I.

C-6. UNLESS OTHERWISE SHOWN OR NOTED, PROVIDE TWO #5 BARS IN EACH FACE AROUND UNFRAMED OPENINGS IN CONCRETE WALLS AND SLABS. PLACE BARS ON ALL FOUR SIDES OR CORNERS OF OPENINGS AND EXTEND BARS 28" BEYOND CORNERS OF SQUARE OPENINGS AND THE EDGE OF CIRCULAR OPENINGS. PLACE BARS AT DIAGONALS TO THE MAIN REINFORCEMENT.

C-7. SIZE AND LOCATION OF CONCRETE BASES AND EMBEDDED ANCHORAGES FOR EQUIPMENT SHALL BE COORDINATED WITH THE EQUIPMENT SUPPLIER AND SHALL BE IN ACCORDANCE WITH APPROVED SHOP DRAWINGS.

C-8. ALL DOWELS SHALL BE ANCHORED INTO PLACE BEFORE PLACEMENT OF CONCRETE. DO NOT "FLOAT" ANY "L" SHAPED DOWELS INTO PLACE.

C-9. THE MAXIMUM ALLOWABLE AGGREGATE SIZE FOR THE CONCRETE MIX SHALL BE 1".

C-10. ALL REBAR SHOWN DOWELED INTO THE EXISTING CONCRETE ON THE PLANS SHALL BE INSTALLED IN ACCORDANCE WITH THE HIT C-100 SYSTEM BY HILTI OR AN APPROVED EQUIVALENT. THE EMBEDMENT LENGTH FOR THE REBAR DOWELS INTO THE EXISTING CONCRETE SHALL BE AS FOLLOWS:

REBAR SIZE	MINIMUM EMBEDMENT LENGTH (INCHES)
#3	5
#4	6.5
#5	8

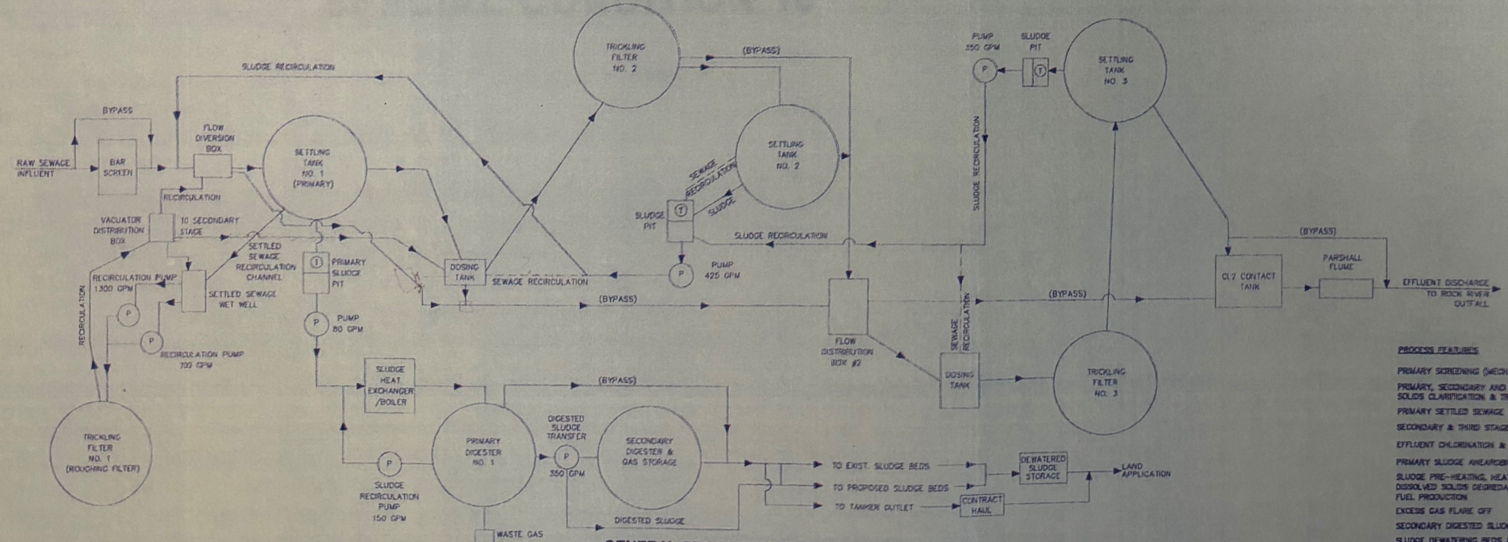
C-11. SAW CUTS THROUGH EXISTING CONCRETE SHALL BE 1" DEEP. EXISTING REINFORCEMENT SHALL NOT BE CUT. EXISTING REINFORCEMENT WHICH IS CALLED OUT FOR REUSE ON THE PLANS SHALL BE CLEANED TO REMOVE OLD CONCRETE.

C-12. CONCRETE EQUIPMENT PADS UP TO 12" IN THICKNESS SHALL HAVE #4@12" REINFORCING PLACED AT THE MID-HEIGHT OF THE CONCRETE PAD.

C-13. ALL SAWCUT JOINTS SHALL BE FILLED IN WITH SIKAFLEX-1A OR AN APPROVED EQUIVALENT.

C-14. EPOXY ADHESIVE ANCHOR BOLTS SHALL BE TYPE 304 STAINLESS STEEL AND SHALL BE INSTALLED IN ACCORDANCE WITH THE HILTI HVA SYSTEM OR APPROVED EQUIVALENT. PROVIDE 2 STAINLESS STEEL WASHERS (ANSI B18.22.1 (1965) TYPE A PLAIN) & 2 STAINLESS STEEL NUTS. EMBEDMENT LENGTHS UNLESS OTHERWISE NOTED 1" DIA.-8 1/4" & 5/8" DIA.- 7 1/2" U.N.O. ON DRAWINGS.

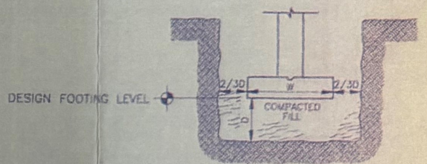
C-15. PUMP EQUIPMENT CONCRETE SUPPORT BASES TO EXTEND BEYOND EQUIPMENT SUPPORT BASE BY A MINIMUM OF 4 INCHES ON ALL SIDES.



PROCESS FEATURES

- PRIMARY SCREENING (MECHANICAL)
- PRIMARY, SECONDARY AND THIRD STAGE SOLIDS CLARIFICATION & TRICKLING FILTERS
- PRIMARY SETTLED SEWAGE RECIRCULATION
- SECONDARY & THIRD STAGE LIGHT SOLIDS SLUDGE RECIRCULATION
- EFFLUENT CHLORINATION & EFFLUENT FLOW MEASUREMENT
- PRIMARY SLUDGE ANAEROBIC DIGESTION
- SLUDGE PRE-HEATING, HEAT EXCHANGE, ANAEROBIC MICROBIAL DISSOLVED SOLIDS DEGREDATION & PROCESS INTERNAL FUEL PRODUCTION
- EXCESS GAS FLARE OFF
- SECONDARY DIGESTED SLUDGE & GAS STORAGE
- SLUDGE DEWATERING BEDS & WET SLUDGE TANK TRUCK DISCHARGE

GENERAL PROCESS FLOW SCHEMATIC



NOTE:
UNLESS NOTED OTHERWISE, THE MINIMUM DEPTH D=W FOR CONTINUOUS FOOTINGS AND MINIMUM DEPTH D=1/2W FOR ISOLATED FOOTINGS

1/G3
OVEREXCAVATION DETAIL
N.T.S.

REVISIONS			DRAWN	PREPARED
NO	DATE	REMARKS	NDH	PJS
			TRACED	APPROVED PJS
			CHECKED PJS	APPROVED GAF

PATRIK J. SHERIDAN 048518 REGISTERED PROFESSIONAL ENGINEER OF ILLINOIS 10/15/94 Exp 11/30/94

FARNSWORTH & WYLIE P.C. 4600 North Brandywine Drive · Suite 105 Peoria, Illinois 61614 Architects · Engineers · Surveyors

CDB STATE OF ILLINOIS CAPITAL DEVELOPMENT BOARD

GENERAL, STRUCTURAL NOTES AND PROCESS SCHEMATIC

WASTEWATER TREATMENT PLANT
DIXON CORRECTIONAL FACILITY
DIXON, ILLINOIS

PROJECT NO 120-075-034
DATE AUGUST 1994
SHEET NO G3 OF 33

Special Condition 16.

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 Permitee 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 EPS-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 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
   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 of the facility plan no later than January 1, 2030, 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, and has a 1.0 mg/L Total Phosphorus monthly average shall be met by December 31, 2035; 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 1.5 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.

OVER →

6. If the Permittee participates in a watershed group that is developing 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.

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, 2035, 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 the 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, s defined herein, do not require use of supplemental treatment processes at the treatment facility before or after the biological system, such as but not limited to chemical addition, carbon supplementation, formation or filtration. The us 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 CONDITION 17. 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 be at risk of eutrophication due to phosphorus levels in the waterbody. This determination was made upon reviewing available information concerning the characteristics of the relevant waterbody/segment and the relevant facility (such as quantity of discharge flow and nutrient load relative to the stream flow

A waterbody or segment is at risk of eutrophication if there is available information that plant, algal or cyanobacterial growth is causing or will cause violation of a water quality standard

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, 2023. This requirement can be accomplished by the Permitee by participation in n existing watershed groups or by creating a new group. The NARP shall be supported by data and sound scientific rationale.
B. The Permittee shall cooperate and work with other stakeholders in the watershed to determine the most cost-effective means to address the risk of eutrophication. 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 risk of eutrophication, 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 from point sources and non-point sources in addition to other measures necessary to remove the risk of eutrophication characteristics that will cause or may cause violation of a water quality standard. The NARP may determine, based on an assessment of relevant data, that the watershed does not have a risk of eutrophication related to phosphorus, in which case phosphorus input reductions or other measures would not be necessary. Alternatively the NARP could determine that phosphorus input reduction from point sources are not necessary, or that phosphorus input reductions from both point and nonpoint source 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 and other measures. 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 risk of eutrophication characteristics 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 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 risk of eutrophication. 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

OVER →

Permittees discharge will not cause or contribute to violations of the dissolved oxygen or narrative offensive condition of water quality standards;

April	2.10
May	2.10
June	1.80
July	2.20
August	2.00
September	2.00
October	2.40
November	2.40
December	2.40
January	2.50
February	1.70
March	2.10
GEOMEAN	2.13

2323 Fourth Street
P.O. Box 483
Peru, Illinois 61354
815-224-1650
800-659-4659
FAX 815-224-1688
www.testinc.com

ANALYTICAL REPORT

June 20, 2023

David Tullerow
Attn: David Tullerow
215 W. Chilppewa St
Dwight, IL 60420

Order Number: 230600301

TEST, Inc. received 1 sample on June 08, 2023 at 10:45 for the analyses presented in the following report.

There were no problems with the analyses and all the data for the associated QC met EPA or laboratory specifications . Exceptions would be described in the Case Narrative, if applicable.

This final Analytical Report consists of this cover letter , case narrative, laboratory results and any accompanying documentation including, but not limited to, chain of custody records.

This report may not be reproduced, except in full, without prior written approval from TEST, Inc.

If you have any questions regarding these test results, please do not hesitate to contact me at (815) 224-1650 or (800) 659-4659.

Sincerely,

Total Environmental Service Technologies, Inc.

Layne Zens
Quality Assurance Officer

CLIENT: David Tullerow

DATE: June 20, 2023

ORDER NUMBER: 230600301

TEST Inc.
2323 Fourth Street
P.O. Box 483
Peru, Illinois 61354
815-224-1650
800-659-4659
FAX 815-224-1688
www.testinc.com

GENERAL COMMENTS:

All results reported in wet weight unless otherwise indicated (mg/kg = Dry Weight).

Sample results relate only to the analytes of interest and to the sample as received by the laboratory.

Accreditation by the State of Illinois is not an endorsement or a guarantee of the validity of data generated. For more information about the laboratories' scope of accredition in regards to Alkalinity/SM2320B; Chloride/SM4500Cl-B; TDS/SM2540C; Fluoride/SM4500F-C; Nitrate/EPA353.2R2; Nitrite/SM4500NO2-B; pH/SM4500H-B; Sulfate/ASTM D516-90; Al, Ba, Cr, Cu, Fe, Mg, Mn, Ni, Ag, Na, Zn/EPA 200.7R4.4; As, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag/EPA200.8R5.4 please contact TEST, Inc. or the Agency.

LIMIT: Method Detection Limit. The minimum concentration of an analyte that can be measured and reported with a 99% confidence that analyte is greater than zero.

Outside laboratories references under analyst on the Final Report include:
PACE: Pace Analytical QCA: QC Analytical, LLC SB: Suburban Laboratories ESI: EnviroScience, Inc. EURO: Eurofins
TEK: Teklab, Inc.
The subcontracted analytical report (if not provided) is available upon request.

DATA QUALIFIERS:

A: Sample was received in lab with improper preservation
B: Analyte detected in the associated Method Blank
J: The analyte was positively identified; the associated numerical value is less than the RL but greater than or equal to the MDL, and the concentration is an approximate value

TNTC: Too Numerous to Count
H: Analysis run past method hold time
I: Invalid
L: Result was over the maximum contaminant level set by the EPA
ND: Non-Detect
T: Sample received outside thermal preservation acceptance criteria

S: Sample sent to subcontracted NELAP Laboratory

Q: Results accepted outside of quality control limits

METHOD REFERENCES:

EPA: USEPA Methods for the Determination of Inorganic Substances in Environmental Samples; Methods for Chemical Analysis of Water and Wastes; Methods for Organic Chemical Analyses of Municipal and Industrial Wastewater; 40CFR136 App A; Methods for Determination of Metals in Environmental Samples; Methods for the Determination of Organic Compounds in Drinking Water

SW: USEPA, Test Methods for Evaluating Solid Waste, SW-846, 3rd Ed, includes Updates I-III

SM: Standard Methods for the Examination of Water and Wastewater, 20th Ed.
D: ASTM, Annual Book of Standards

Reported To:
David Tullerow
David Tullerow
215 W. Chilppewa St
Dwight, IL 60420

Order No.: 230600301
P.O. No.:
Date Received: 06/08/2023
Collected by: David Tullerow
Report Date: 06/20/2023
PWS ID No.:

Laboratory Results

Sample No.: 230600301-001
Date Collected: 06/08/2023
Time Collected: 09:45
Location: WW INF
Type: Grab
Sample Matrix: Waste Water

Laboratory Test	Tested Value	Test Units	Detection Limit	Qualifier	Test Method	Date of Analysis	Analyst
Phosphate,Total	6.57	mg/L	0.614		SM4500PBE	6/19/23 13:00	JN

TEST Inc.
www.testinc.com

CHAIN OF CUSTODY RECORD

TEST, INC. • 2323 4TH STREET • P.O. BOX 483 • PERU, IL 61354 • (815) 224-1650

PAID
Cash

Project #: 23000301

Client Name: DAVID TUTTEROW

Samples Signature: [signature]

Contact phone number:

Print Name: DAVID TUTTEROW

email address:

Samp #	Collection Date	Time	Grab Comp	Preservative	pH	Matrix	Qty	Sampling Location	Phosphate
1	6/18/23	9:45 am	X			WW		WW INF	X
2	/ /	:							
3	/ /	:							
4	/ /	:							
5	/ /	:							
6	/ /	:							
7	/ /	:							
8	/ /	:							
9	/ /	:							
10	/ /	:							

Analysis Required: Phosphate

Specify Regulatory Program:
- ☐ None (info only)
- ☐ NPDES
- ☐ 503 Sludge
- ☐ *Other

* Please specify in sampler remarks section below.

Relinquished By	Date / Time	Received By	Date / Time
[signature]	Date: 6/8/23 Time: 10:45 AM	[signature]	Date: 6/8/23 Time: 10:45
	Date: __/__/__ Time: __:__		Date: __/__/__ Time: __:__
	Date: __/__/__ Time: __:__		Date: __/__/__ Time: __:__
	Date: __/__/__ Time: __:__		Date: __/__/__ Time: __:__

Sampler Remarks:
DAVID TUTTEROW
215 W. CHIPPEWA ST W1
DWIGHT IL. 60420
dwt217@yahoo.com

Lab use only

Samples received on ice ?:	Yes ☒ No ☐	Temperature of samples:	12 °C
Samples in proper container / bottle ?:	Yes ☒ No ☐	Sample containers intact ?:	Yes ☒ No ☐
Samples received within holding time ?:	Yes ☒ No ☐	Sufficient sample volume ?:	Yes ☒ No ☐
Samples have proper preservative ?:	Yes ☒ No ☐	COC properly completed ?:	Yes ☒ No ☐

Lab Remarks: