Onondaga County Department of
WATER
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PROTECTION

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August 29, 2014

Mr. Joseph M. Zalewski, P.E
Regional Water Engineer
NYS Department of Environmental Conservation
Division of Water, Region 7
615 Erie Boulevard, West
Syracuse, New York 13204-2400

Re: Oak Orchard Wastewater Treatment Plant
Comprehensive Performance Evaluation – August 2014
Request to Re-Rate Organic Loading Capacity

Dear Mr. Zalewski:

Please find attached the above referenced Comprehensive Performance Evaluation (CPE) for the Oak Orchard Wastewater Treatment Plant prepared by our consultant, GHD. As you recall, on August 1, 2013 this department submitted a plan for future growth requesting NYSDEC to consider a re-rating of this facility based on contemporary performance and design criteria. As suggested in your December 23, 2013 letter response, this report presents a review of the design and performance criteria utilizing the suggested standard references. In addition, the consultant used the BioWin® process model to evaluate and compare the relative treatment capacity improvement of selected alternatives. The conclusion of this evaluation indicates that the Oak Orchard facility could be re-rated for an increased organic loading capacity of 17,100 lbs/day of BOD or 13,900 lbs/day of CBOD with no detrimental impact to the environment. Therefore, this department urges the NYSDEC to take prompt action on our request to re-rate the organic loading capacity for this treatment plant.

I suggest that we convene a meeting in about a month to discuss this report and the process forward. In the meantime, if you should have any questions regarding the attached document or our request, please feel free to call me directly.

Sincerely,

ONONDAGA COUNTY DEPARTMENT OF
WATER ENVIRONMENT PROTECTION

Michael J. Lannon

Tom Rhoads, P.E. Commissioner for Tom Rhoads

JCP/ts

Enc.

cc: w/ enc. Ken Lynch, NYSDEC
Valarie Ellis, P.E., NYSDEC
cc: ltr only Mary Beth Primo
Jeanne Powers,
Michael Lannon, P.E.
Daniel Jean
Dave Snyder, P.E.
File: Oak Orchard SPDES Permit

Onondaga County, NY

Oak Orchard Wastewater Treatment Plant
Comprehensive Performance Evaluation

August 2014

OAK ORCHARD WASTEWATER TREATMENT PLANT

COMPREHENSIVE PERFORMANCE EVALUATION

ONONDAGA COUNTY, NY

Prepared for

ONONDAGA COUNTY
DEPARTMENT OF WATER ENVIRONMENT PROTECTION

STATE OF NEW YORK
BRUCE G. MUNN
No. 61769-1
LICENSED PROFESSIONAL ENGINEER

Prepared by

GHD CONSULTING SERVICES INC.
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Cazenovia, NY 13035

August 2014

Project No. 8616538

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1. Introduction

The Oak Orchard Wastewater Treatment Plant (WWTP) is owned and operated by the Onondaga County Department of Water Environment Protection (OCDWEP). The plant service area consists of the Village of North Syracuse and portions of the Towns of Clay and Cicero. The majority of wastewater from the service area is from residential sources, with some from commercial and industrial sources.

The New York State Department of Environmental Conservation (NYSDEC) requires that an Annual Certification Form be completed for the treatment facility as part of the State Pollutant Discharge Elimination System (SPDES) discharge permit administration process. The Annual Certification Form is completed by the treatment facility SPDES discharge permit holder (OCDWEP). The intent of the Certification Form is to identify treatment facilities that are nearing or exceeding their design capacity for flow, influent BOD, or influent TSS loadings.

The 2012 Annual Certification Form for the Oak Orchard WWTP identified that the facility was exceeding the design capacity for influent BOD for 10 of the 12 months in 2012 but has not exceeded the influent flow or TSS capacity. Any facility exceeding design capacity loads in eight or more months of a year is required to prepare a Plan for Future Growth in accordance with 6 NYCRR Part 750-2.9(c)(2) (Appendix A). This plan was prepared and submitted to the NYSDEC Regional Water Engineer on August 1, 2013, indicating that although the influent BOD loadings to the Oak Orchard WWTP had been exceeded, the plant has demonstrated through past performance that it is more than capable of accommodating these higher BOD loadings while maintaining effluent compliance. The County requested a re-rating of the plant as part of their submitted plan, based on the plant’s historical performance.

The NYSDEC responded to the County’s Plan for Future Growth in a letter dated December 23, 2013, in which NYSDEC indicated that a Comprehensive Performance Evaluation (CPE) for the Oak Orchard WWTP would be required prior to re-rating of the plant.

In response, OCDWEP retained the services of GHD Consulting Services Inc. to perform the CPE for the Oak Orchard WWTP, in an effort to evaluate the available treatment capacity at the facility, and to determine if it is feasible to re-rate the plant to handle additional wastewater loads (increase permitted capacity). The focus of the CPE is to determine what, if any, additional wastewater loads can be accommodated at the Oak Orchard WWTP utilizing the existing infrastructure at the facility.

In support of the case for re-rating the treatment plant, and as requested by NYSDEC, the following information is presented in this report:

1. Historical plant loadings and treatment performance.
2. Unit process treatment capacity evaluation.
3. Biological process modeling.

2. Existing Facilities

The Oak Orchard WWTP is located on Oak Orchard Road in Clay, NY. The original facilities at this site consisted of two wastewater treatment lagoons and a chlorine disinfection system. In the late 1970s, the facilities were upgraded to provide primary and secondary treatment. The treatment facility currently performs screenings and grit removal, primary clarification, high purity oxygen (HPO) activated sludge aerobic treatment followed by secondary clarification, tertiary lagoons, and effluent disinfection.

A site plan of the existing treatment plant is included as Figure 2-1 and the existing plant process flow diagram is shown in Figure 2-2.

2.1 Preliminary and Primary Treatment

Raw wastewater entering the WWTP passes through a manually-cleaned coarse bar screen that removes the larger debris. Downstream of this screen, wastewater flows into two aerated grit chambers where sand, gravel, and other heavy particles are removed. After the grit chambers, two mechanically cleaned climber-type bar screens with more closely spaced bars provide additional screenings removal. Another manually-cleaned bar screen is located between the two mechanical screens to provide bypass screening in the event the mechanical screens are out of service.

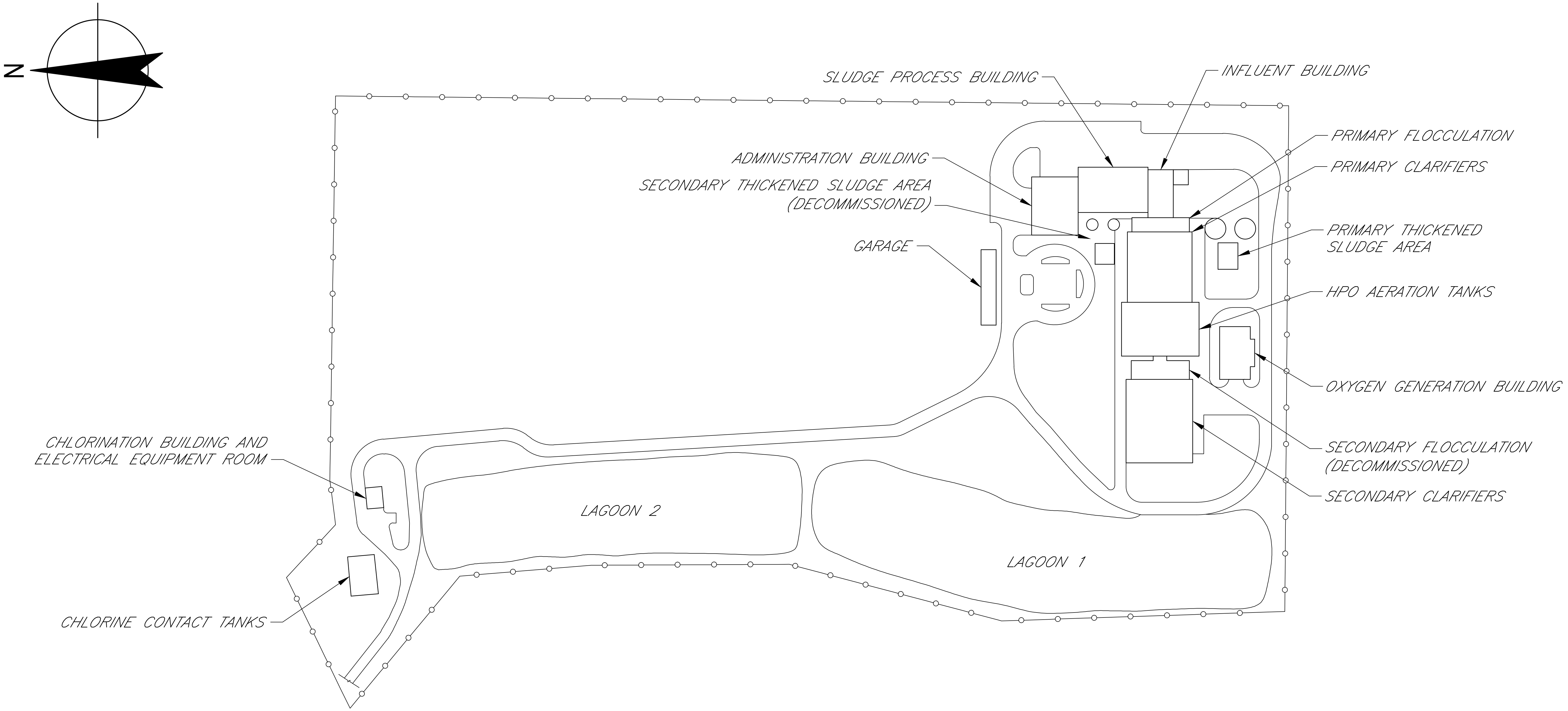
Screened and degritted wastewater flows to two primary clarifiers in the primary treatment system. Each clarifier is separated into three troughs for sludge collection with one common sludge hopper at the influent end of each clarifier. Ahead of the preliminary clarifiers are primary flocculation tanks, which are currently not in use and scheduled for removal. Aluminum sulfate (alum) is added prior to the primary clarifiers to aid in the removal of phosphorus and provide enhanced settling. Tables 2-1, 2-2, and 2-3 summarize the existing preliminary and primary treatment units.

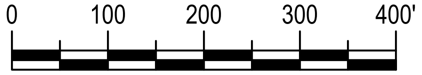
Table 2-1 Grit Removal

Parameter	Value
Type	Aerated grit channels
Number of channels	2
Dimensions (each)	34 feet L x 16 feet W x 12 feet side water depth (SWD)
Total volume	98,000 gallons
Number of grit blowers	2
Capacity (each)	200 cfm

Table 2-2 Influent Mechanical Screening

Parameter	Value
Type	Mechanical climber
Number of units	2
Width	4 feet





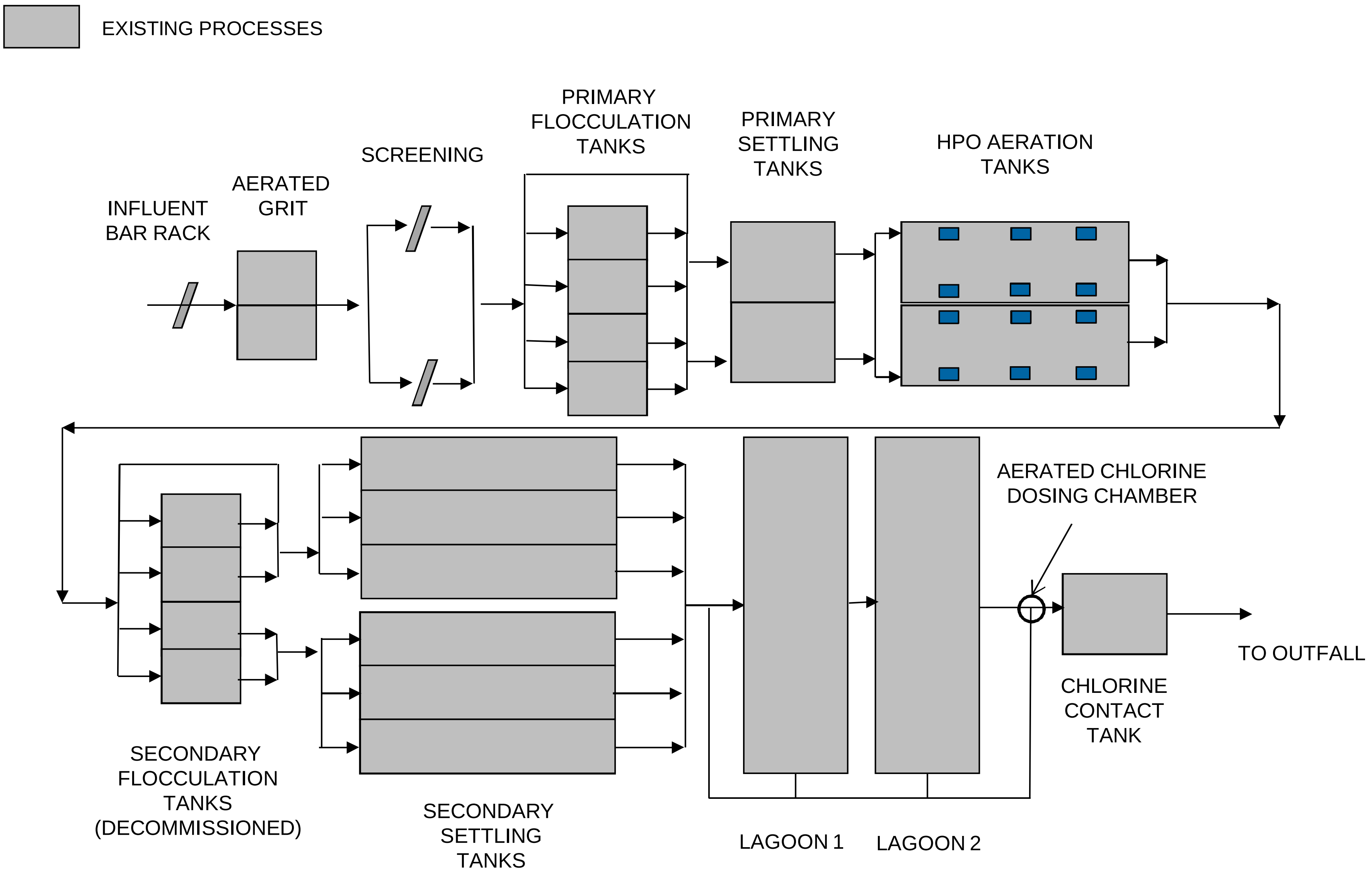
SCALE 1"=200' AT ORIGINAL SIZE

OAK ORCHARD WWTP
COMPREHENSIVE
PERFORMANCE EVALUATION
EXISTING SITE PLAN

Job Number	86-16538
Revision	A
Date	08/2014

Figure 2-1

Plot Date: 22 August 2014 - 5:16 PM Cad File No: G:\86\16538\CADD\Drawings\Figures\Oak Orchard\8615142-FIG 2-1.dwg



CAZENOVIA, NEW YORK

DATE: August 2014 JOB No.: 8616538

Oak Orchard WWTP

Figure 2-2
Existing Process Flow Diagram

Table 2-3 Primary Clarification

Parameter	Value
Type	Rectangular
Collector type	Traveling bridge
Number of units	2
Dimensions (each)	120 feet L x 60 feet W x 11 feet SWD
Total surface settling area	14,400 ft^2
Total weir length	648 feet

2.2 Secondary Treatment

The Oak Orchard WWTP utilizes an HPO aeration treatment process for biological treatment. There are two HPO trains (north and south). Each train is partitioned into three stages configured in series, and each stage is separated by a concrete dividing wall. Each stage contains two mechanical aerators for imparting HPO to the mixed liquor. The Oxygen Generation Building, located adjacent to the aeration tanks to the south, contains a pressure swing adsorption system for generating the HPO used for the biological treatment process.

Downstream of the biological treatment process, the mixed liquor flows through channels to the secondary clarifiers, bypassing the four secondary flocculation tanks which are no longer in service. A polymer solution is added to the mixed liquor upstream of the secondary clarifiers to aid in settling and provide enhanced performance. Currently, limited mixing is provided to mix the polymer with mixed liquor prior to settling. There are six rectangular secondary clarifiers at the plant, each with chain-and-flight-type mechanisms for sludge and scum collection. The six clarifiers are separated into two sets of three units each. Flow distribution to the six units is achieved through the use of channels and adjustable slide gates located at the inlet of each clarifier. In addition, there are intermediate baffles installed in each clarifier to provide improved performance through mitigation of density currents. Use of polymer and the intermediate baffles demonstrated improved total suspended solids removal performance.

There are two treatment lagoons at the Oak Orchard WWTP which were modified as part of the major plant upgrade in the 1970s to provide nitrification of the secondary effluent. The lagoons, which are configured in series, each contain aeration equipment for this purpose. The lagoons have been inadequate in providing the desired nitrification and are therefore not in use for that purpose. The aeration equipment is operated seasonally to provide the necessary effluent dissolved oxygen concentration to meet the requirements of the SPDES permit.

A summary of the secondary treatment process units is provided in Tables 2-4 and 2-5.

Table 2-4 Biological Treatment Process

Parameter	Value
Type	HPO activated sludge
Number of tanks	2
Stages per tank	3
Stage dimensions (each)	72 feet L x 36 feet W x 9 feet SWD
Total volume	1,050,000 gallons
Number of HPO aeration compressors	3
Total oxygen generation capacity (2 duty, 1 standby)	20,000 lbs/day O_2

Table 2-5 Secondary Clarification

Parameter	Value
Type	Rectangular
Collector type	Chain-and-flight
Number of units	6
Dimensions (each)	140 feet L x 20 feet W x 10 feet SWD
Total surface settling area	16,800 ft^2
Total weir length	648 feet

2.3 Effluent Disinfection

Effluent from the secondary treatment process or the lagoon system flows to the disinfection system at the northern end of the treatment plant prior to being discharged from the facility. The flow passes through a lagoon diversion structure where post-lagoon aeration and chlorine addition are provided. The disinfection system consists of two chlorine contact tanks and an adjacent Chlorination Building which houses the liquid sodium hypochlorite and associated chemical feed systems. The original chlorine addition point to the chlorine contact tanks was relocated by the County to the lagoon diversion structure located upstream. Table 2-6 provides a summary of the disinfection system characteristics.

Table 2-6 Disinfection System

Parameter	Value
Type	Chlorine contact tanks
Chemical type	Liquid sodium hypochlorite
Number of units	2
Dimensions (each)	83’ L x 25’ W x 10’ SWD
Total volume	300,000 gallons

2.4 Solids Handling

The solids handling system was originally designed to treat raw sludge using a sludge oxidation process for volatile solids destruction. However this system is not utilized. Currently, the waste activated sludge (WAS) and primary sludge are co-settled in two raw sludge gravity thickeners. The thickened sludge is pumped from the gravity thickeners into trucks and hauled to the Syracuse Metropolitan WWTP or another County-owned treatment plant for disposal.

Table 2-7 Gravity Sludge Thickening

Parameter	Value
Type	Circular
Collector type	Circular scraper
Number of units	2
Dimensions (each)	40 feet diameter x 8 feet SWD
Total surface settling area	2,510 ft^2
Total volume	150,000 gallons

3. Historical Plant Loadings and Treatment Performance

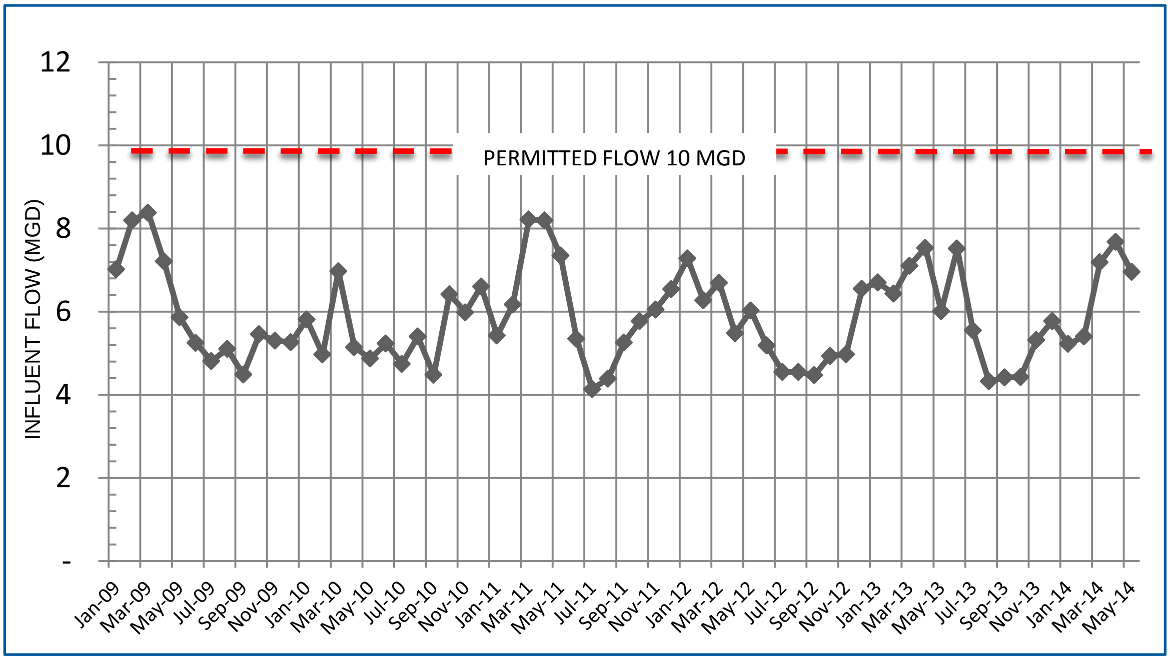
Current wastewater flows and loadings to the Oak Orchard WWTP are presented in this section, along with the corresponding effluent treatment performance achieved by the facility. In support of the County's request to receive a formal treatment capacity re-rate for the Oak Orchard WWTP, this information will illustrate how the WWTP has performed under the high loading conditions.

3.1 Influent Plant Flows and Loads

Current influent flows and loads to the Oak Orchard WWTP were reviewed based on data provided by OCDWEP for a 65-month period from January 2009 through May 2014. During this period, the facility treated wastewater from both the Oak Orchard service area and the Gaskin Road Pump Station. The Gaskin Road Pump Station has the ability to pump to either the Oak Orchard or Wetzel Road WWTPs. Based on a previous report prepared by GHD in 2009, the Gaskin Road Pump Station contributes approximately 0.8 million gallons per day (mgd) of average daily flow to the Oak Orchard WWTP when configured to discharge to this facility.

The average influent flow to the treatment facility over the 65-month period has been 5.9 mgd. The facility has been operating well within the permitted flow of 10 mgd. Figure 3-1 is a graph of the influent flow for this period.

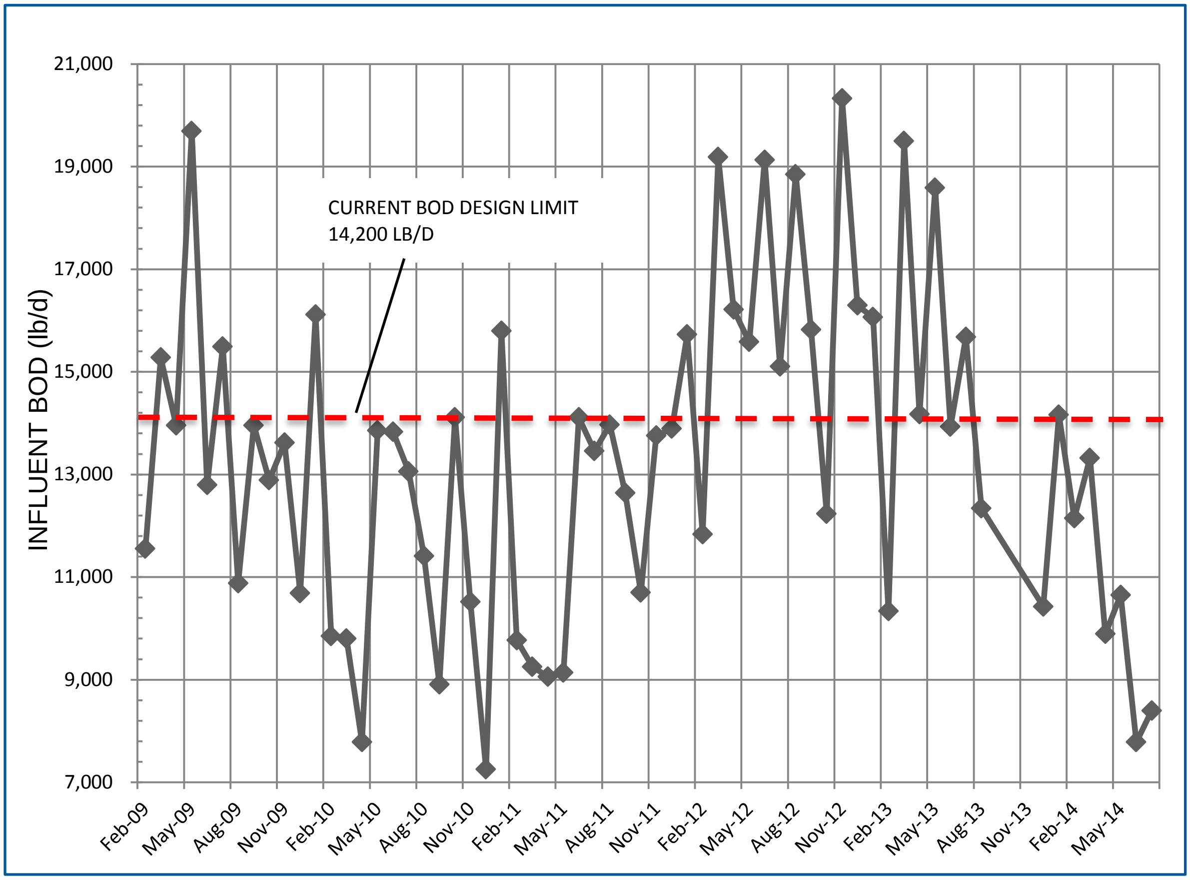
Figure 3-1 Monthly Influent Flows



The organic load of concern from the 2012 Annual Certification was the influent BOD. The treatment facility has a stated design capacity of 14,200 lbs/day of BOD. The available sampling data available for influent BOD is limited since the SPDES permit for Oak Orchard is written around limits based on CBOD. The available individual day sampling for BOD is used in conjunction with the daily flow to determine the average influent BOD on a lbs/day basis. For the year 2012, only one BOD sample per month was taken, so this result was used to represent the monthly average. Beginning in 2013, multiple BOD samples were taken and then averaged to determine the monthly influent BOD.

The influent BOD for the period of January 2012 through May 2013 is shown in Figure 3-2. During this 17-month period, there were 14 occurrences when BOD exceeded the design capacity of 14,200 lbs/day. The average influent BOD during this period was approximately 16,000 lbs/day.

Figure 3-2 Influent BOD Monthly Average

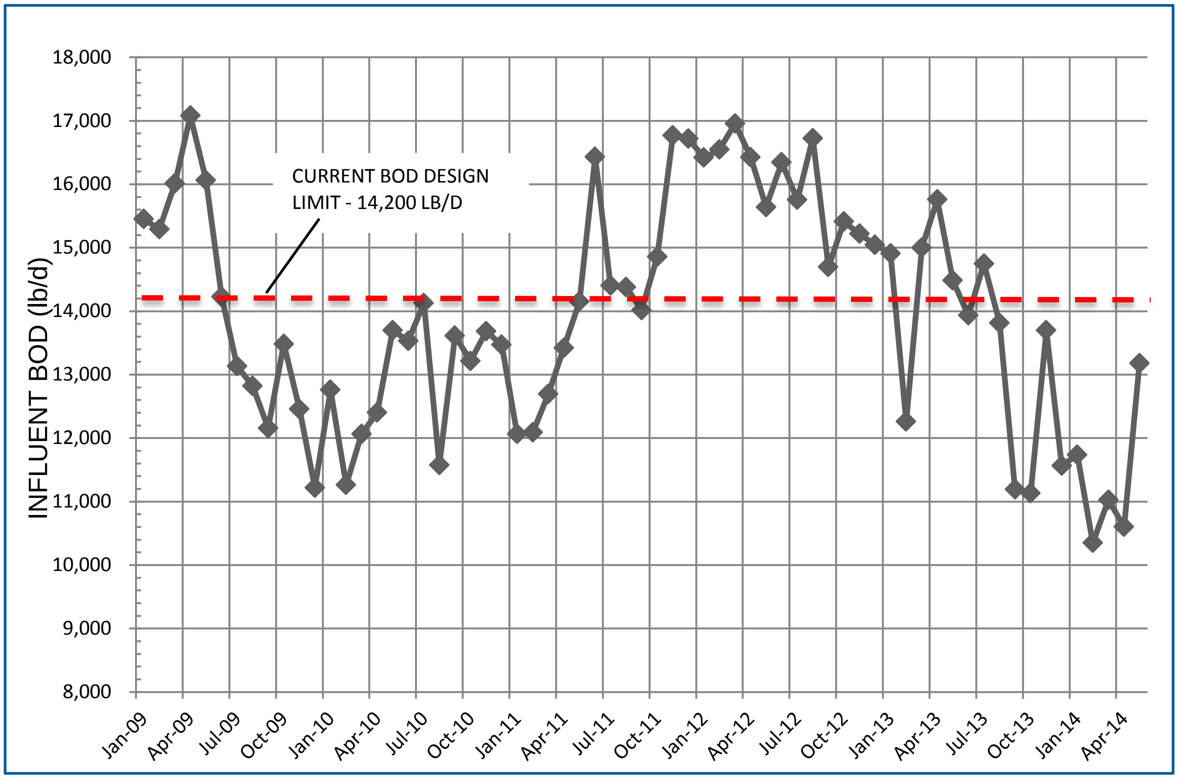


Note: Increased sampling frequency from monthly to biweekly in March 2013.

Based on historical data, the average ratio of CBOD to BOD at the Oak Orchard WWTP is 0.81. Since the County possesses a far greater quantity of data for CBOD than for BOD, estimated BOD values were calculated using the CBOD data along with the historical CBOD-to-BOD ratio. This more robust data set allows for a comparison of the current design capacity for the plant to the historical influent loading. Figure 3-3 represents the historical BOD loading to the plant over the past

65 months based on the conversion of available CBOD data to BOD using the average historical ratio.

Figure 3-3 Influent BOD with CBOD Basis (0.81 CBOD-to-BOD Ratio)



As depicted in the figure above, utilizing the historical CBOD-to-BOD ratio estimates the BOD loading to the Oak Orchard WWTP was in excess of the influent BOD design capacity for all 12 months of the year, and was in excess of this value for several other months over the past several years.

The Annual Certification Form also addresses the influent TSS to a facility. The stated capacity for influent TSS is 16,700 lbs/day. The average TSS for over the stated 65-month period was 7,252 lbs/day, which is less than half of this value and therefore not of concern.

3.2 Current Plant Performance

The Oak Orchard WWTP has a two-season SPDES discharge permit. It requires nitrification in the summer period from June 16 through October 31 with limits for lbs. of ammonia and UOD discharged. The treatment facility has a good history of meeting its discharge limits. There were two effluent violations recorded for effluent ammonia and UOD in June 2013, but these appear to be from an isolated incident. The discharge permit limits are summarized in Table 3-1.

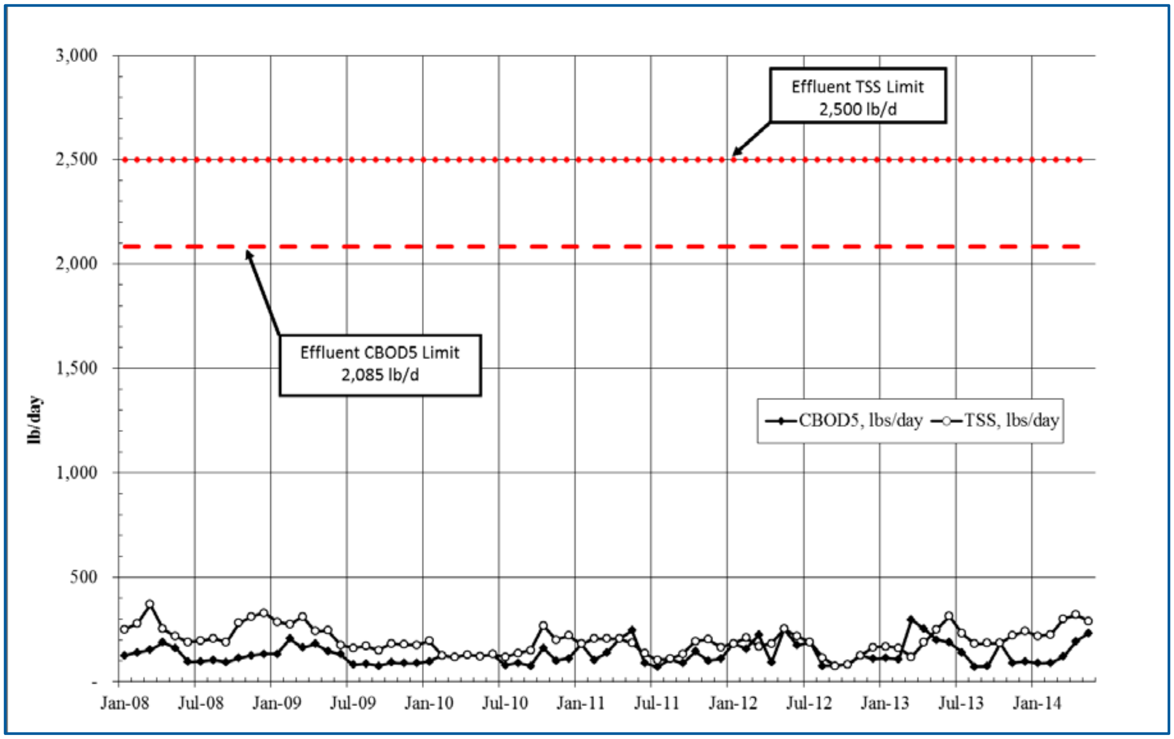
The effluent CBOD and TSS discharges are shown on Figure 3-4. The treatment facility is performing well at removing CBOD and TSS to well below the discharge limits. The high level of CBOD removal efficiency at the facility supports the County's request for increasing the BOD load rating for the treatment facility, as the plant has maintained very low levels of BOD discharge while regularly receiving influent loads well in excess of the plant's current rated capacity. The removal of TSS is aided by the lagoons, which help to settle any TSS that is able to pass through the secondary clarifiers.

Table 3-1 Discharge Permit Limits

Parameter	Averaging Period	Current Permit			
		June 16 - October 31		November 1-June 15	
Flow	30-day average	10 mgd		10 mgd	
CBOD$_5$	30-day average	25 mg/L	2,085 lbs/day	25 mg/L	2,085 lbs/day
CBOD$_5$	7-day average	40 mg/L	3336 lbs/day	40 mg/L	3,336 lbs/day
TSS	30-day average	30 mg/L	2,500 lbs/day	30 mg/L	2,500 lbs/day
TSS	7-day average	45 mg/L	3,750 lbs/day	45 mg/L	3,750 lbs/day
UOD	Daily maximum		4,289 lbs/day		
Ammonia (as NH$_3$)	30-day average		307 lbs/day		2,026 lbs/day
Dissolved oxygen	Daily minimum	2.0 mg/L			
Total phosphorus	30-day average	1.0 mg/L		1.0 mg/L	
Settleable solids	Daily maximum	0.3 ml/L		0.3 ml/L	
pH	Range	6.0 - 9.0 S.U.		6.0 - 9.0 S.U.	
Fecal coliform(1)	30-day geometric mean	200/100 ml		200/100 ml	
Fecal coliform(1)	7-day geometric mean	400/100 ml		400/100 ml	
Chlorine residual	Daily maximum	0.35 mg/L		0.35 mg/L	

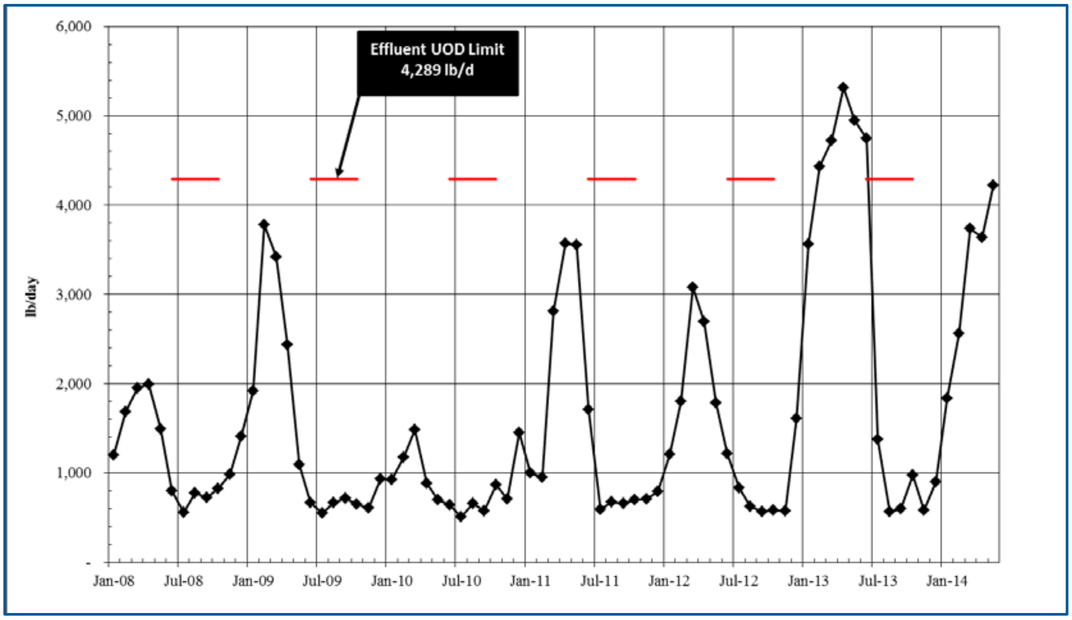
(1) Fecal coliform limits are in effect from May 15 to October 15.

Figure 3-4 Effluent CBOD and TSS Discharge



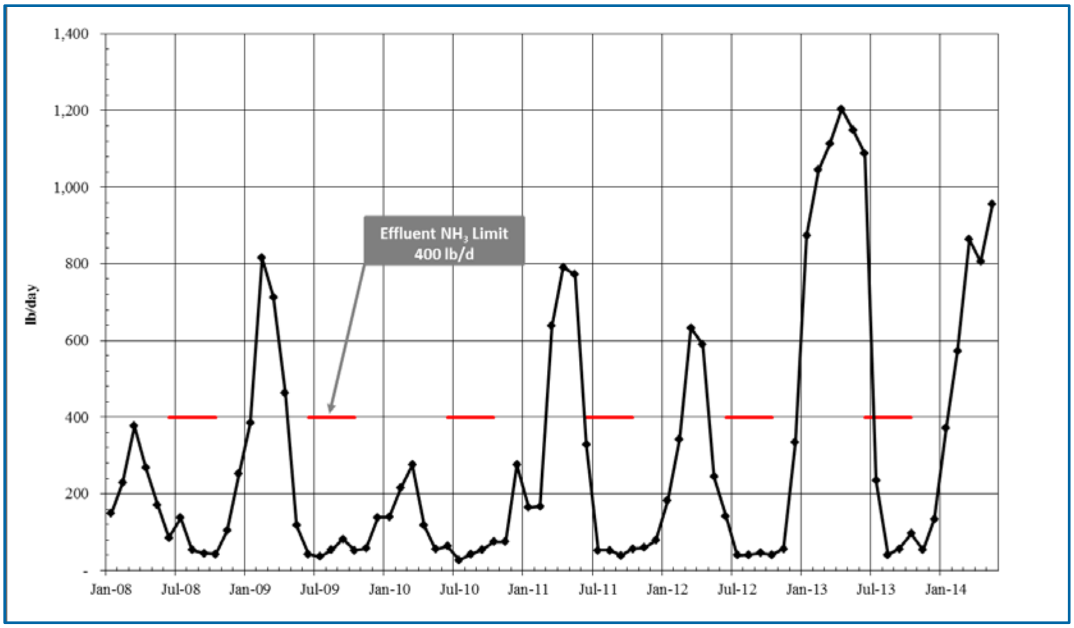
The limit of 4,289 lbs/day for UOD is in effect during the June 16 through October 31 time period. The UOD is calculated from the discharge of CBOD and TKN. The treatment facility is typically able to meet the UOD limit during these periods, but had one exceedance of the limit in June 2013. During that month, the plant experienced abnormally high influent flows which averaged almost 2 mgd more than the long-term average for the facility. The UOD effluent discharge performance is shown in Figure 3-5.

Figure 3-5 Effluent UOD Performance



The effluent ammonia (NH_3) performance is shown in Figure 3-6. The treatment facility sometimes has difficulty establishing nitrification in the spring to meet the June 16 period when the 400 lbs/day limit becomes active. In general, the Oak Orchard WWTP has maintained compliance with this limit; however, there was one exceedance in June 2013.

Figure 3-6 Effluent Ammonia Performance



The treatment facility has been able to successfully meet the other discharge parameters, including settable solids, pH, dissolved oxygen, and total phosphorus.

3.3 Case for Re-Rating BOD Treatment Capacity

Although the Oak Orchard WWTP has had recent permit excursions associated with ammonia and UOD, these are isolated incidents. In addition, as previously stated, in terms of CBOD treatment, the facility is performing exceptionally and has consistently outperformed the permitted limits by a large margin. The Oak Orchard WWTP averages 98.8 percent removal for CBOD. This has occurred with BOD loadings of up to 17,000 lbs/day as compared to the current 14,200 lbs/day permitted design loading. These facts support the proposed re-rating of the Oak Orchard WWTP for BOD treatment capacity.

4. Unit Process Treatment Capacity Evaluation

In accordance with the NYSDEC requirements stipulated in their letter to the County, a comprehensive performance evaluation of the individual unit processes at the Oak Orchard WWTP was performed. The initial component of this process was to evaluate the unit processes utilizing the following design standards as recognized by the industry:

- NEIWPCC TR-16 *Guides for the Design of Wastewater Treatment Works*
- Water Environment Federation Manuals of Practice, *Wastewater Engineering: Treatment and Reuse*
- *Design of Municipal Wastewater Treatment Plants MOP 8*, Fifth Edition (Metcalf & Eddy)
- *Recommended Standards for Wastewater Facilities* (Ten-States Standards)

The second component of the CPE was to utilize the USEPA's *Retrofitting POTWs* document to conduct their version of a CPE.

4.1 Unit Process Loadings

The current loadings at the Oak Orchard WWTP were utilized to evaluate the individual unit processes. This evaluation was performed to determine which unit processes may be capable of handling additional flows and loadings, which are currently at capacity, and which may have insufficient capacity based on current loadings.

Flows and loadings from 2012 were used as the basis for evaluating current unit process loadings, as these are recent plant loadings and were also the cause for the influent BOD loading exceedances discussed in Section 1. The flows and loads for 2012 are summarized in Table 4-1.

Table 4-1 2012 Influent Flows and Loads

Parameter	Flow (mgd)	BOD(1) (lbs/day)	BOD(2) (lbs/day)	CBOD (lbs/day)	TSS (lbs/day)	TKN (lbs/day)
Average	5.58	16,300	15,932	12,905	7,999	1,584
Maximum month	7.28	20,352	16,957	13,735	9,335	1,711
Maximum day	11.41	--	--	--	--	--
Peak(3)	17.72	--	--	--	--	--

(1) Based on limited process sampling for BOD.
(2) BOD value based on historical CBOD data converted using historical 0.81 CBOD-to-BOD ratio.
(3) Peak flow based on instantaneous peak on January 27, 2012.

Table 4-2 Summary of Unit Process Standards Compliance

Process	Metcalf & Eddy	MOP8	Ten-States Standards	TR-16	Summary Notes
Aerated grit	Complies(1)	N/A	Complies	Complies(1)	Complies with all process standards.
Screening	Complies	Complies	Complies	Complies	Satisfies all standards.
Primary settling tanks	Complies	N/A	Complies	Complies	Exceeds surface overflow rate design hourly flow (maximum month) standard.
HPO aeration tanks (BOD only)	No	Complies	N/A	N/A	Low F:M ratio for Metcalf & Eddy standard.
HPO aeration tanks (single-stage nitrification)	N/A	N/A	N/A	N/A	No textbook standards for single-stage nitrification with HPO
Final settling tanks	Complies	N/A	No	No	Exceeds surface overflow rate at PHF for Ten-States and TR-16.
Lagoons (nitrification)					Not evaluated; standards unavailable.
Chlorine contact tank (CCT)	Complies	N/A	Complies	Complies	Exceeds TR-16 standard for contact time, but historical disinfection performance at shorter contact time qualifies for "grandfathering" under TR-16.

(1) Recommended tank geometries do not match best practices.

🟩 = Unit process satisfies this standard.

🟥 = Unit process does not satisfy this standard.

Table 4-3 Summary of Unit Process Treatment Capacity Evaluation

	Peak Hourly Flow Capacity (mgd)[1]				Maximum Month Flow Capacity (mgd)[2]				Load[3]				
Process	MOP8	Metcalf & Eddy	Ten-States Stds	TR-16	MOP8	Metcalf & Eddy	Ten-States Stds	TR-16	MOP8	Metcalf & Eddy	Ten-States Stds	TR-16	Units
Aerated grit	46.8	70.3	46.8	46.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-
Screening	23.2	23.2	N/A	31.0	N/A	N/A	23.2	N/A	N/A	N/A	N/A	N/A	-
Primary settling tanks	N/A	37.8	19.4	45.4	N/A	18.1	15.1	18.1	N/A	N/A	N/A	N/A	-
HPO aeration tanks (high-rate BOD)	N/A	N/A	N/A	N/A	11.9	11.9	N/A	N/A	27,995	27,995	N/A	N/A	lbs BOD/day
HPO aeration tanks (single-stage nitrification)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-
Final settling tanks	N/A	25.9	15.1	10.5	N/A	11.8	N/A	N/A	N/A	725,760	588,000	N/A	lbs/day/SF
Tertiary lagoons	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-
Chlorine contact tank	N/A	29.8	29.8	14.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-

🟩 = Unit process satisfies this standard.

🟥 = Unit process does not satisfy this standard.

(1) Design peak hourly flow = 24 mgd.

(2) Design maximum month flow = 10 mgd,

(3) 2012 maximum month raw BOD load = 20,352 lbs BOD/day.
2012 maximum month HPO aeration tank BOD loading = 13,432 lbs BOD/day.
Based on historical average primary BOD removal of 34 percent.

4.2 Unit Process Evaluation Using Conventional Design Standards

Each unit process at the Oak Orchard WWTP was evaluated against the available design standards from a range of technical resources, as identified above. For this portion of the CPE, the following unit processes were assessed:

1. Aerated grit.
2. Screening.
3. Primary settling tanks.
4. HPO aeration tanks.
    - BOD only
    - Single-stage nitrification
5. Final settling tanks.
6. Lagoons (nitrification).
7. Chlorine contact tank.

Each unit process was first compared to the various design criteria from each technical resource to determine whether it satisfied the standard. Based on this approach, two unit processes at the WWTP were found unable to satisfy all of the standards: (1) HPO aeration tanks (BOD only); and (2) final settling tanks;. Table 4-2 provides a summary of these results.

The unit processes were then assigned a treatment capacity based on applicable standards from each technical resource. This approach provides a better comparison of the relative differences between the various design standards, as some unit processes exhibited a wide range of potential treatment capacities. Table 4-3 summarizes the treatment capacity evaluation.

One major limitation to the approach in evaluating the unit processes' treatment capacity is that the traditional design standards used for this exercise do not specifically address the treatment technology and process operations at the Oak Orchard WWTP, where the HPO activated sludge process is used to provide both carbonaceous and nitrification treatment.

4.3 USEPA Comprehensive Performance Evaluation

As indicated in the December 23, 2013 correspondence from the NYSDEC, the USEPA's *Retrofitting POTWs* was utilized to perform a CPE of the Oak Orchard WWTP. It must be noted that the USEPA's CPE process is primarily intended to evaluate wastewater treatment facilities that are experiencing performance issues. This is not the case for the Oak Orchard WWTP, where effluent performance and permit compliance have been good. Instead, the CPE process is being conducted to assess how the Oak Orchard facility scores against standards set forth in the USEPA document.

The major unit processes at the plant were evaluated for their capacity to adequately treat current loadings. Hydraulic and organic loadings were based on historical data records as discussed earlier in this section. The treatment plant's ability to handle current loads was assessed using a numerical point system, which resulted in the plant being categorized as a Type 1, 2, or 3 for each unit process system, and for the entire treatment plant, as described below:

1. Type 1 - Type 1 plants are those publicly owned treatment works (POTWs) where a CPE reveals that current performance difficulties are not caused by limitations in the size or capabilities of the existing major unit processes. In these cases, major problems are related to plant operation, maintenance, or administration, or can be corrected with only minor facility modifications. POTWs in this category are more likely to achieve desired performance through the implementation of a non-construction-oriented Composite Correction Program (CCP).
2. Type 2 - Represent a situation where the marginal capacity of major unit processes will potentially prohibit the ability to achieve the desired performance level. For Type 2 facilities, implementation of a CCP will lead to improved performance levels with no modifications to the major treatment units.
3. Type 3 - Plants have inadequate existing major unit processes. Although other limiting factors may exist (i.e., operators' process control capability or the administration's unfamiliarity with plant needs), performance cannot be expected to improve significantly until the physical limitations of major unit processes are eliminated. In this case, implementation of a non-construction-oriented CCP may only be of limited value and is not recommended. Owners with a Type 3 plant could meet their performance requirements by pursing modifications of existing facilities. However, depending on future waste loads, more detailed study of treatment alternatives and financing mechanisms may be warranted.

   CPEs that identify Type 3 facilities are still of benefit to POTW administrators in that the need for construction is clearly defined for facility owners. Additionally, the CPE provides an understanding of the capabilities and weaknesses of existing operation and maintenance practices and administrative policies. POTW owners can use this information to evaluate use of their existing facilities as part of any plant modification and as a guideline for optimizing operational, maintenance, and administrative practices.

4.3.1 Facility CPE Scoring

There are three major unit processes identified in the USEPA's *Retrofitting POTWs* that were applicable or partially applicable to Oak Orchard. For an activated sludge-based biological treatment plant such as Oak Orchard, these unit processes include aeration basins, secondary clarification, and sludge handling capabilities.

A "Suspended Growth Major Unit Process Evaluation Worksheet" was completed for the Oak Orchard WWTP. This was the most applicable worksheet for the Oak Orchard WWTP, but it did not accurately assess the aeration basin system, as the system at Oak Orchard is designed to utilize high purity oxygen in a specialized form of suspended growth (activated sludge) process. As a result, the plant could not be scored for the aeration basins, as the worksheet is not applicable to this type of treatment system.

The worksheet evaluations for the aeration basins were focused on the hydraulic and organic loading rates to the tanks, along with the oxygen availability of the aeration system to provide adequate aeration. Because the worksheet lacked any specific components to address HPO treatment systems, the aeration basins scored very low in terms of hydraulic and organic loading rates. However, the facility did score well for oxygen availability. The final score assessed for the aeration basins was N/A (not applicable) for the reasons discussed above.

For the other two unit processes, the facility scored well. For the secondary clarification component, the plant scored 7, which is in the middle of the range, as a Type 2. For sludge handling capabilities, the facility scored 28, which is categorized as a Type 1, at the high end of the range.

The secondary clarifier evaluation consisted of a number of different assessment criteria, ranging from tank configuration to loading rates and return activated sludge capabilities. A list of these criteria and Oak Orchard's corresponding scores is provided below:

Clarifier configuration	Score: -10 points
Clarifier surface overflow rate	Score: 12 points
Depth at weirs	Score: 0 points
RAS removal type	Score: 0 points
RAS control capability	Score: 5 points
Total Score	7 points

The plant scored well on surface overflow rates based on the current actual maximum monthly average daily flows and the available surface settling area, but was hindered by low scores that resulted from the rectangular configuration of the clarifier units and their relatively shallow depth. In particular, a score of -10 points was assessed due to the effluent weirs/launders being located at the end of the clarifiers.

For the sludge handling capabilities, sludge controllability and the capabilities of each sludge handling unit process at the facility were assessed. The least capable sludge handling unit process was then used to determine a score for the facility based on the percent capability (available capacity). For Oak Orchard, the only applicable sludge handling system was the gravity sludge thickeners, which scored very well based on the sludge loading rates to the unit process. In terms of sludge controllability, the ability of a facility to measure its sludge quantities and sample the sludge was assessed. The sludge handling capabilities scores for Oak Orchard are as follows:

Sludge controllability	Score: 3 points
Sludge handling unit process capability	Score: 25 points
Total Score	28 points

Once each major unit process was evaluated and scored within the worksheet, two final values were assessed for the treatment plant. A total score consisting of the sum of scores from the evaluation of each unit process was tallied, and Oak Orchard was scored as a Type 2 facility.

In addition, the "Overall Type" of the facility was determined. This was based solely upon the lowest scoring result from each of the major unit processes, such that the unit process determined to be the weakest link for the facility would then decide the facility's Overall Type rating. The Oak Orchard WWTP was assessed as a Type 2 facility by this criteria as well, since the lowest scoring major unit process was the secondary clarifiers (Type 2).

A summary of the results from the USEPA's CPE, including the major unit process evaluations, is provided in Table 4-4.

Table 4-4 Comprehensive Performance Evaluation Summary

Process	Oak Orchard WWTP		Point System for CPE		
	Score	Type	Type 1	Type 2	Type 3
Aeration basins	N/A(1)	N/A(1)	13 - 30	0 - 12	<0
Secondary clarification	7	2	25 - 55	0 - 24	<0
Sludge handling capabilities	28	1	10 - 30	0 - 9	<0
Total	**35**	**2**	60 - 115	20 - 59	<20
Overall Type (must be worst case from categories)		**2**			

(1) N/A = Not applicable.

Based on the evaluation criteria available in the USEPA's CPE, only two of the three major unit processes could be evaluated for the Oak Orchard WWTP. A higher total score may have been possible if there had been an applicable worksheet for the HPO aeration basin. However, this major unit process provided no points to the total score, and only the secondary clarifiers and sludge handling capabilities categories could be utilized. The completed worksheets associated with these evaluation results have been included in Appendix B.

4.3.2 Performance Limiting Factors

The process at the Oak Orchard WWTP shown to have some limitations was secondary clarification. Its rating is primarily due to the rectangular construction of the tanks and the relatively shallow tank depths, which are less desirable based on the USEPA CPE method. The operators at the Oak Orchard WWTP mitigate these factors through the active application of liquid polymer as a settling aid to the process, as well as close attention to the secondary clarification process. The impact of this regimen is clearly indicated by the very low concentrations of effluent TSS historically recorded from the secondary clarifiers. In addition, these clarifiers were previously upgraded with baffles to improve performance, further mitigating these process limitations. The combination of these physical and operational modifications has yielded significant performance optimization for the functionality of the secondary clarification process, and has resulted in excellent effluent quality for the facility.

The aeration basins could not be assessed properly utilizing the USEPA CPE method due to the specialized nature of the process. However, this unit process is a critical component of the Oak Orchard facility and plays a major role in the County's efforts to re-rate the BOD treatment capacity of the plant. To better assess the treatment capacity of the biological treatment process at the Oak Orchard WWTP, process simulation modeling was performed and is presented in Section 5.

4.3.3 Pending WWTP Improvements

In addition to the items discussed above in this section, the County is currently in the process of implementing improvements to the Oak Orchard WWTP that will further enhance the facility's performance. The additional improvements are as follows:

1. Influent Screening – The existing 1-inch spaced mechanical screening equipment is scheduled for replacement with new 3/8-inch spaced screening units. This upgrade will provide improved screenings removal.
2. Primary Clarification – The two existing primary clarifiers are being modified and partitioned to provide four primary clarifier units. This will provide greater operational flexibility and will improve the primary clarification capacity when units are taken offline for service.

5. Biological Treatment Process Simulation Modeling

5.1 BioWin Modeling – Treatment Capacity Evaluation

A computer-based wastewater process simulation software package was utilized to further evaluate biological treatment process at the Oak Orchard WWTP.

Process modeling of the Oak Orchard WWTP was performed using BioWin® Version 3.1 (Envirosims) to evaluate and compare the relative treatment capacity improvement of the selected treatment alternatives, The model is a well-established and respected kinetic model based on International Water Association (IWA) activated sludge models, utilizing the IWA format for activated sludge models. It is capable of modeling the processes responsible for biological carbon, phosphorus, and nitrogen removal, including both activated sludge and fixed-film processes. It also has the ability to simulate the chemical reactions associated with phosphorus removal by precipitation with aluminum or iron salts.

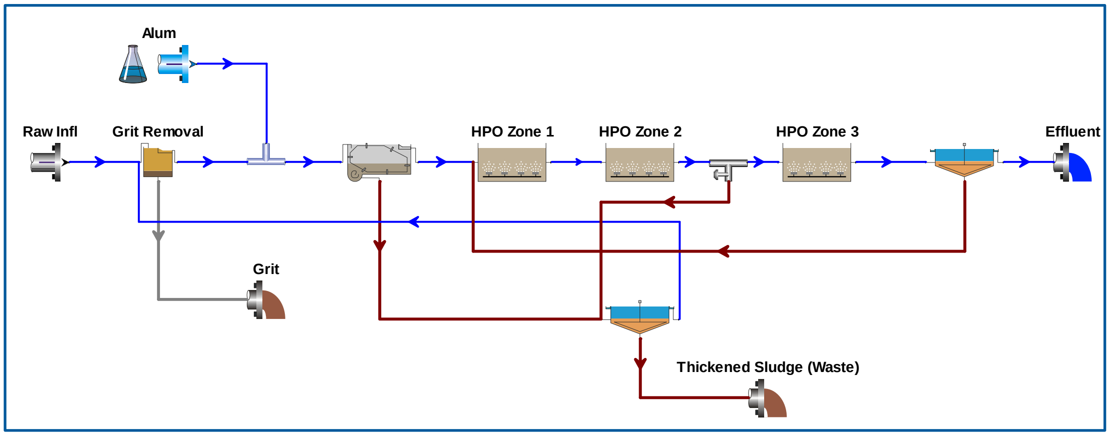
Developing a process-specific model requires an understanding of the various carbon, nitrogen, and phosphorus fractions in the influent wastewater.. Historical plant data was used in conjunction with a computer-based influent specification worksheet (provided by the modeling software development company) and information provided by the plant operations staff.

For the purposes of this report, all modeling was performed using steady-state conditions. No dynamic modeling was performed.

5.1.1 Calibration Modeling

Prior to performing any modeling of the selected treatment alternatives, a calibration model was developed and run to confirm that the BioWin model would be capable of achieving a reasonably accurate fit with the historic data. The calibration model was developed based on data from the Oak Orchard WWTP for March 2012. This period was selected based on its high loadings and cold wastewater temperatures. The model results indicated the calibration was successful in predicting the performance and output values of the actual treatment plant as compared to historical data. Figure 5-1 illustrates the configuration of the BioWin process model that was utilized for the project.

Figure 5-1 BioWin Process Model Configuration



5.1.2 Treatment Process Modeling

Upon completion of the calibration modeling process, the model was used to simulate plant operations under a number of increased loading conditions at various temperatures corresponding with seasonal variations. Modeling was conducted under multiple influent loading conditions to assess treatment performance and potential limitations under various operating conditions. The initial loading conditions modeled were based on the monthly average influent flows and loads to the plant from March 2012, which was a high loading month at the facility, with the highest UOD mass loading for the period of record. This period was selected due to the high influent organic loading to the plant. In addition, the data from this period was generally representative of the typical influent characteristics for Oak Orchard.

The following is a list of conditions used to perform all of the treatment scenario modeling:

1. A maximum MLSS concentration of 5,500 mg/L was utilized based on historical operations and performance.
2. The return activated sludge (RAS) flow was maintained at 5.6 mgd based on historical operations and discussion with the plant operators (no flow pacing of RAS). This RAS flow rate represents an approximate return rate of 60 to 85 percent based upon the raw influent wastewater flow rates modeled as part of this evaluation.
3. A primary clarifier solids removal rate of 50 percent was utilized based on historic plant data and projected flow and loading increases being modeled.
4. An influent alkalinity of 4.0 mmol/L was used based on data collected from the Oak Orchard WWTP influent wastewater.
5. Based on calibration modeling results, the alum-to-phosphorus ratio was modified to more accurately simulate the historical performance of phosphorus removal through the primary clarifiers.
6. Additional Seasonal Criteria
    - Winter
        - Minimum 30-day average aeration tank wastewater temperature (9.45°C).
        - Failure Indication: Total loss of nitrification, maintain sufficient solids retention time (SRT) safety factor.
    - Spring
        - Minimum 30-day average aeration tank temperature for late May (11.8°C)
            - Lowest average influent temperature in the month of May for the period of record (2010 – 2014).
            - May temperature selected to allow plant nitrification to fully develop preceding the mid-June SPDES permit period commencement for effluent ammonia and UOD.
        - Failure Indication: Compliance with ammonia and UOD limits, maintain sufficient SRT safety factor.
    - Summer
        - Typical summer wastewater temperature (20°C).

- — Failure Indication: Compliance with ammonia and UOD limits, exceed available oxygen supply for aeration.

To assess the potential treatment capacity increase opportunities for the Oak Orchard WWTP, the initial loading conditions from March 2012 (base model) were scaled up linearly by increasing the plant flow and maintaining the same constituent concentrations, such as CBOD, TSS, TKN, etc. The modeling results for each loading condition were then evaluated individually for adequate aerobic SRT, mixed liquor suspended solids (MLSS) concentrations, and effluent performance in relation to the plant's historic performance. In this manner, the model was used to assess plant performance at increased loadings for each of the three seasonal scenarios modeled (winter, spring, summer).

Modeling Results

As presented above, three seasonal scenarios were modeled. For each scenario, specific failure indicators were used to assess the upper treatment limits of the Oak Orchard WWTP under those conditions. Based on the modeling results under all three seasonal conditions, the Oak Orchard WWTP was able to successfully accommodate additional BOD loadings above the currently established design capacity of 14,200 lbs/day BOD for the plant. This determination was achieved by utilizing the modeling results in conjunction with several other critical operating conditions for the treatment plant, such as SRT, effluent ammonia and UOD levels, etc.

The outcomes of the seasonal modeling are shown graphically in Table 5-1. In this table, the incrementally increasing BOD and corresponding CBOD loadings are shown at the top. The seasonal models run are shown for winter, spring and summer. Areas of acceptable performance are indicated in green, and areas where limitations where encountered are shown in red.

Table 5-1 Modeling Performance Results

	Current BOD Rating	BOD Rating Increase					
		20%(1)	26%	32%	38%	44%	50%
BOD loading (lb/d)	14,200	17,100	17,900	18,800	19,700	20,500	21,400
CBOD loading (lb/d)	11,500	13,900	14,500	15,200	15,900	16,600	17,300
Winter condition	🟩	🟩	🟥 Limited nitrification	🟥	🟥	🟥	🟥
Spring condition	🟩	🟩	🟥 Ammonia violation	🟥	🟥	🟥	🟥
Summer condition	🟩	🟩	🟩	🟩	🟩	🟥 Oxygen limitation	🟥

(1) Process modeling indicates an aerobic nitrification SRT safety factor of 1.6 under the spring condition, which was identified as the most limiting condition for the plant.

🟩 = Acceptable.
🟥 = Failure.

Winter Conditions

Under the winter modeling conditions, the cold wastewater temperatures slow down the rate of biological growth for the nitrifying bacteria in the system, which can cause a loss of nitrification.

Failure to maintain some partial nitrification in the plant through the winter months has occurred on occasion, resulting in difficulties in re-establishing the nitrifying biomass. This has also made it difficult to achieve compliance with the plant's ammonia and UOD limits in the spring.

Therefore, when modeling winter conditions at the Oak Orchard WWTP, the primary failure indicator used in the model was the total loss of nitrification. In addition, the SRT in the biological system was monitored and compared with the minimum SRT (SRT_{MIN}) for nitrification. This yields an SRT safety factor by dividing the actual SRT by the SRT_{MIN} for nitrification.

Spring Conditions

The spring modeling condition is likely the most critical operating condition for the Oak Orchard WWTP. With cold wastewater temperatures associated with spring snow melt, rain, and cool air temperatures, the plant is required to ramp up nitrification performance in order to achieve the ammonia and UOD treatment required by the SPDES permit.

Therefore, for this modeling scenario, the primary failure indicator was a failure to achieve compliance with the effluent ammonia and UOD limits for the plant. Similar to the winter conditions, the system SRT was also monitored to maintain a minimum SRT safety factor. A minimum safety factor of approximately 1.6 was used under the spring operating conditions.

Summer Conditions

During summer operating conditions, the wastewater temperatures are no longer a limiting condition and thorough nitrification is achieved. Based on the modeling results generated from the summer modeling, the biological system was able to maintain full nitrification at significant levels of increased plant loadings (over 50 percent increased loadings possible). In addition, maintaining a minimum SRT safety factor for nitrification was also easily accomplished. However, with the increased loadings and full nitrification occurring in the plant under these conditions, the primary limiting factor became the available oxygen for the biological aeration process. At the higher loadings (approaching 50 percent increase), the oxygen uptake rate begins to surpass the oxygen generation capacity of the HPO generation system, limiting the plant's capacity.

A full compilation of the modeling results is provided in Appendix C.

5.1.3 Other Modeling Observations

Based on historical data and the plant configuration (HPO activated sludge process) for the Oak Orchard WWTP, the following observations were made while performing the modeling and should be noted:

1. pH in Aeration Tanks – Due to the HPO process and its inherent low pH, the model runs indicate some level of nitrification inhibition, primarily during the late spring through fall period when significant nitrification is occurring. However, this condition is somewhat mitigated by the elevated nitrification rates associated with the high DO concentrations maintained within the HPO treatment process.
2. Phosphorus Limitations – Based on the historical data used for the modeling and Oak Orchard's current alum coagulant feed set-up preceding the primary clarifiers, there appears to be a shortage of phosphorus in the biological treatment process, which can potentially impact cell growth and proper treatment. This indicates that the biological treatment process

may benefit from a modification to the current chemically enhanced primary treatment regimen. A slight reduction in coagulant addition to the primary clarifiers should alleviate this low phosphorus condition without adversely affecting process performance.

6. Summary/Conclusions

The Oak Orchard WWTP has been evaluated based on the facility's historic treatment performance, industry standard unit process design criteria, USEPA Comprehensive Performance Evaluation guidelines, and biological treatment process simulation models. These evaluations have provided insight into the strengths and weakness of the facility and have helped estimate the upper treatment capacity limits of the current facility.

Review of the historic performance reveals the high level of treatment being achieved by the Oak Orchard WWTP. The facility is able to remove BOD and TSS to well below the discharge limits for these parameters. In the summer months, the facility is able to easily meet the seasonal discharge limits for ammonia and UOD. However, graphs of the effluent ammonia reveal that the facility is loaded to a point where nitrification is periodically reduced during the winter months. Subsequently, the plant can struggle to regain sufficient nitrification in the cold spring months in order to meet the onset of the June 15 permit limits for ammonia. Process modeling was undertaken to better estimate the effects increased loading will have on meeting this springtime ammonia limit.

The unit processes at the facility were evaluated based on industry standard design guidelines. This evaluation process was limited due to the lack of published design standards for a HPO process that has single-stage carbonaceous and nitrification treatment. The final settling tanks appear to be undersized according to current standards and were likely not designed for nitrification upstream in the HPO tanks. However, the historic performance of the final settling tanks shows excellent removal for TSS and BOD even during high loading periods. This exceptional secondary clarification performance is due to the addition of tank baffling, chemically enhanced settling through polymer use, and diligent operator attention to the process.

The CPE evaluation also did not reveal any significant insight into the capabilities of the plant. The CPE guidelines are very general regarding activated sludge and do not account for the specifics of an HPO process.

In light of these limitations, process modeling of the facility was conducted to determine how the facility will perform under incremental higher loadings. This modeling effort confirmed that the limiting factor is the ability to meet the June ammonia limits. The model runs were conservatively conducted using the coldest historically observed spring temperatures and incrementally increased organic loadings to the facility. The results indicate that the BOD loading can be increased approximately 20 percent from the current limit of 14,200 to 17,100 and meet SPDES effluent limits.

In addition, it is recommended that the organic capacity be expressed in CBOD since this data is readily available from discharge sampling and is the basis for the facility's SPDES permit.

Table 6-1 provides a summary of the proposed modifications to the existing design capacity/criteria established for the Oak Orchard WWTP, based on modeling results and other findings of this report.

Table 6-1 Proposed Design Criteria Modifications

Criteria	Original Design Criteria	Proposed Design Criteria
Flow (mgd)		
Maximum month	10	10
Peak hour	24	24
Organic loading (lbs/day)	14,200 BOD 11,500 CBOD	17,100 BOD 13,900 CBOD
TSS loading (lbs/day)	16,700	16,700

Appendix A – 6 NYCRR Part 750-2.9(c)(2)

§750-2.9 Additional Conditions Applicable to a Publicly Owned Treatment Works(POTWs)

(a) GENERAL

(1) In addition to the requirements set forth in this subpart, all POTWs must provide adequate notice to the department of the following:

(i) As set forth in department guidance on what is a substantial change in volume or character of pollutants introduced into a POTW, any such change.

(ii) For purposes of this paragraph, adequate notice shall include information on:

(a) the quality and quantity of effluent introduced into the POTW; and

(b) any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

(2) If the department determines, on the basis of a notice provided pursuant to paragraph (1) of this subdivision and any related investigation, inspection or sampling, that a modification of a permit is necessary to assure maintenance of water quality standards and guidance values or compliance with other provisions of ECL Article 17, this Part, or the Act, then the department may propose such a modification. Unless the department determines that such permit modification is unnecessary, the noticed Act is prohibited until the permit has been modified pursuant to Part 621 of this title.

(3) The permittee shall identify all inflow to the tributary system and remove excessive infiltration/inflow to an extent that is economically feasible.

(4) The permittee shall enact, maintain and enforce or cause to be enacted, maintained and enforced up-to-date and effective sewer use law in all parts of the POTW service area. Such enactment and enforcement shall include intermunicipal agreements and/or other enforceable legal instruments that allow the permittee to control discharges, either directly or through jurisdictions contributing flows to the POTW, flow and loads to the POTW as well as discharges to the POTW.

(5) New connections to a publicly owned sewer system or a privatized municipal sewer system are prohibited when the permittee is notified by the department:

(i) that the discharge(s) regulated by a SPDES permit create(s) or is likely to create a public health or potential public health hazard, a contravention of water quality standards or guidance values or the impairment of the best use of waters, as determined by the commissioner; or

(ii) that the permittee has failed or is likely to fail to carry out, meet or comply with any limit or requirement of the permit, compliance schedule, order of the department, judicial order, or consent decree.

(6) The provisions provided for in paragraph (5) of this subdivision shall remain in effect until the permittee can demonstrate to the department's satisfaction and approval that adequate available capacity exists in the plant and that the facility is in full compliance with all of the effluent limitations required by the permit.

(b) NATIONAL PRETREATMENT STANDARDS

(1) All POTWs shall comply with the provisions contained in 40 CFR 403.5(a), (b), (c) and (d) (see 750-1.24 of this Part).

(2) EPA and State Enforcement Actions. If, within 30 days after notice of an interference or pass-through violation has been sent by EPA or the department to the POTW, and to persons or groups who have requested such notice, the POTW fails to commence appropriate enforcement action to correct the violation, EPA and the department may take appropriate enforcement action.

(3) POTWs required by the department to develop a pretreatment program in accordance with 40 CFR 403.8 shall submit an approvable program application in accordance with 40 CFR 403.8 (see section 750 -1.24 of this Part).

(4) The approval authority, as defined by 40 CFR 403.3 (see section 750-1.24 of this Part), shall review, require changes to, approve and/or disapprove such a program in accordance with 40 CFR 403.9 and 403.11(see section 750-1.24 of this Part).

(5) POTWs and industrial users shall submit reports as required in accordance with 40 CFR 403.12 (see section 750 - 1.24 of this Part).

(6) Industrial users may obtain intake credits in accordance with 40 CFR 403.15 (see section 750 - 1.24 of this Part).

(7) Modifications to pretreatment programs shall be made in accordance with 40 CFR 403.18 (see section 750 - 1.24 of this Part).

(c) POTW DESIGN, PLANNING AND FLOW MANAGEMENT

(1) Flow Management Plan

(i) Within 120 days of when the permittee determines in accordance with paragraph 4 of this subdivision that the annual average flow value for a calendar year to a POTW has reached or exceeded 95 percent of that POTW's design flow, the permittee shall submit to the regional water engineer a flow management plan to identify and implement reductions in hydraulic loading to the POTW treatment plant or failing that, approvable engineering reports, plans and specifications and/or capital improvements as necessary to stabilize annual average flows below the POTW treatment plant design flow. This plan shall be certified by a professional engineer licensed to practice in the State of New York and endorsed by the chief fiscal officer of the municipality. The provisions of the plan may reflect new efforts or may refer to existing, ongoing efforts. The flow management plan shall, at a minimum, include provisions for:

(a) A statement to the effect that the permittee has the authority in all parts of the POTW service area to implement or cause to be implemented the provisions of this subdivision or, if the permittee does not have such authority, a proposed schedule, not to exceed three years, to obtain such authority or a statement from the permittee's designated legal representative that existing law precludes the permittee from obtaining such authority;

(b) An inventory of all known facilities/projects that have applied to connect to the sewer system and a determination if there is capacity for connection;

(c) A schedule of implementation for all flow reduction measures identified herein;

(d) A map delineating the service area as defined; and

(e) A description of information that will be reported during implementation of the plan to the regional water engineer and a schedule for such reporting.

(ii) The flow management plan required by subparagraph (i) of this paragraph shall also include provisions for implementation of any or all of the following that are necessary to stabilize influent flows below design flows:

(a) Water conservation measures to reduce customer usage by measures including but not limited to customer metering, meter calibration, retrofitting existing plumbing fixtures with water conservation fixtures and revision of water rate structures;

(b) Reduction of infiltration and inflow through continuous measures including but not limited to sewer system metering, evaluation and rehabilitation, removal of roof leaders and footing drains from separate sanitary sewers and installation of separate storm sewers;

(c) Prevention of future sources of infiltration and inflow where feasible through measures including but not limited to implementation of standards for sewer installation and requirements to provide for adequate drainage from roof leaders and footing drains in new construction;

(d) Measures to maximize sewer system and sewage treatment works capacity at a minimum cost; and/or

(e) Approvable engineering reports and/or plans and specifications to assure annual average flows do not exceed 95 percent of the POTW treatment plant design flow.

(f) Capital improvements necessary to assure annual average flows do not exceed 95 percent of the POTW treatment plant design flow.

(iii) Within 90 days of submittal to the regional water engineer of the plan required under subparagraphs (i) and (ii) of this paragraph, the permittee shall begin to implement the provisions of said program in accordance with the proposed schedule or cause the provisions of said program to be implemented by another party.

(iv) The regional water engineer may object to the plan, or implementation of the plan, submitted in accordance with subparagraph (i) and (ii) of this paragraph if the plan does not provide for substantive and effective measures to reduce hydraulic loading to the POTW. Within 90 days of receipt of written notification from the regional water engineer documenting the aspects of the plan that must be revised, the permittee shall submit a revised plan that addresses the department's objection(s).

(2) Planning

(i) Within 120 days of when the permittee determines that the actual influent mass loading of Biochemical Oxygen Demand or Total Suspended Solids to a POTW has reached or exceeded the design influent loading for those parameters for any eight calendar months during a calendar year, the permittee shall submit a plan for future growth at the POTW. The plan shall include:

(a) Provisions for obtaining any necessary funding; and

(b) Provisions for preparation and submission to the regional water engineer of approvable engineering reports and/or plans and specifications to provide for growth of discharges in the POTW service area.

(c) A demonstration of the permittee's ability to impose a connection moratorium in any and all parts of the service area or, if the permittee does not have such authority, a proposed schedule, not to exceed three years, to obtain such authority or a statement from the permittee's designated legal representative that existing law precludes the permittee from obtaining such authority.

(ii) The regional water engineer may object to the plan, or implementation of the plan, submitted in accordance with subparagraph (i) of this paragraph if the plan does not provide for substantive and effective measures to accommodate future growth of discharges from the POTW service area. Within 90 days of receipt of written notification from the regional water engineer documenting the aspects of the plan that must be revised, the permittee shall submit an approvable, revised plan that addresses the department's objection(s).

(iii) Within 90 days of submittal to the regional water engineer of the plan required under subparagraph (i) of this paragraph, the permittee shall begin to implement the plan to obtain the authority required under clause '(c)' of subparagraph (i) of this paragraph.

(3) Plan Implementation and Sewer Connection Moratorium. For POTWs that have exceeded the design influent loading criteria set forth in paragraph (2) of this subdivision, within 90 days of when the permittee determines that, in accordance with the annual review required by paragraph (4) of this subdivision, that the effluent discharge from a publicly owned treatment works has exceeded a SPDES permit limit for Biochemical Oxygen Demand or Ultimate Oxygen Demand for any four or more months during two consecutive calendar quarters, or a SPDES permit limit for Total Suspended Solids for any four or more months during two consecutive calendar quarters , the permittee shall:

(i) Begin to implement the plan developed in accordance with paragraph (2) of this subdivision or in accordance with subparagraph (i) of this paragraph; and

(ii) Cease the further approval of sewer connections to the POTW;

(4) Annual Certification. The chief fiscal officer of any municipality subject to this subdivision shall certify in writing to the department as an attachment to its February discharge monitoring report that the municipality is complying with the provisions of this subdivision and, if applicable, is complying with the implementation schedule in the program adopted in accordance with paragraphs 1, 2 and 3 of this subdivision or if such compliance certification cannot be provided to the department, satisfactory explanation for deviation from the provisions of this subdivision must be provided.

(5) Rescission of Plan Requirements or Moratoria. The regional water engineer may rescind or hold in abeyance any or all of the conditions imposed under this subdivision provided the permittee can demonstrate to the satisfaction of the department that:

(i) The conditions were implemented on the basis of erroneous data; or

(ii) The situation that gave rise to the imposition of the conditions has been adequately addressed; or

(iii) There is an existing or potential public health nuisance or hazard as determined by the state Department of Health, that is best remediated by rescinding or holding in abeyance the conditions; or

(iv) All compliance conditions in a SPDES permit or a judicially or administratively imposed order have been or will be met;

(6) Violations of Permit Limits. Compliance with this section does not, in any way, shield the permittee from enforcement actions for violations of SPDES permit limits.

(7) The regional water engineer may, by written approval, upon adequate demonstration of compelling need, allow for relaxation of schedules contained in this subdivision.

Appendix B - USEPA Retrofitting POTWs Suspended Growth Major Unit Process Evaluation Worksheets

Appendix L

Suspended Growth Major Unit Process Evaluation Worksheet

This worksheet is used to evaluate the capability of existing major unit processes, i.e., aerator, secondary clarifier, and sludge handling system. Key loading and process parameters are compared with standard values and point scores are assigned. These points are subsequently compared with expected point scores for Type 1, Type 2, and Type 3 facilities, and a determination of the plant Type is made.

Instructions for use:

- Proceed through the steps contained in this worksheet *in order*.
- Use actual values in lieu of calculations if such data are available and appear reliable, e.g., waste sludge volume.
- When assigning points, interpolate and use the nearest whole number.
- Minimum and maximum point values are indicated - do not exceed the range illustrated.

Aeration Basin

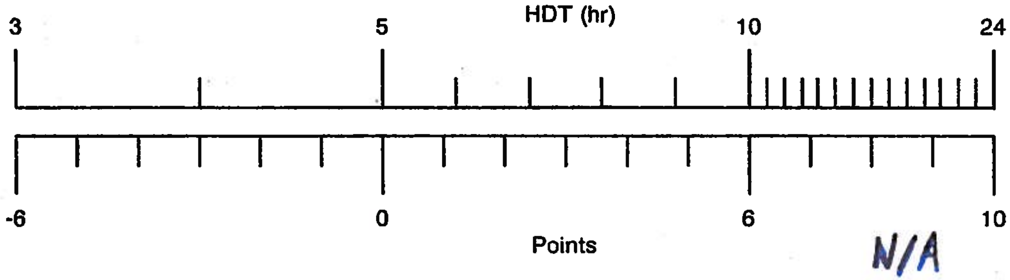
HPO Aeration

Calculate Hydraulic Detention Time (HDT):

$$\text{HDT} = \frac{\text{Aeration Basin Volume}}{\text{Peak Month Average Daily Flow}}$$

$$\text{HDT} = \frac{(\ 145{,}800\ \text{cu ft})}{(\ 7{,}280{,}000\ \text{gpd})} \times 180 = \underline{\ 3.61\ }\ \text{hr}$$

Determine HDT Point Score:



N/A

HDT Point Score = -4.5 ①

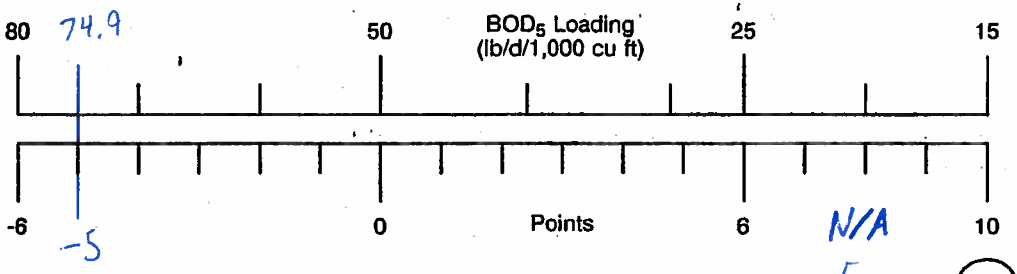
this scale is not indicative of HPO aeration tanks

Calculate BOD_5 Loading:

$$BOD_5\ \text{Loading} = \frac{\text{Average Daily } BOD_5 \text{ Loading}}{\text{Aeration Basin Volume}}$$

$$BOD_5\ \text{Loading} = \frac{(\ 10{,}921\ \text{lb/d})}{(\ 145{,}800\ \text{cu ft})} \times 1000 = \underline{\ 74.9\ }\ \text{lb } BOD_5\text{/d/1000 cu ft}$$

Determine BOD_5 Loading Point Score:



BOD_5 Loading Point Score = -5 ②

Calculate Oxygen Availability: this is not indicative of HPO aeration

Mechanical Aeration Systems

If data are not available on oxygen transfer capacity, calculate it as Wire Horsepower (Appendix F) times Actual Oxygen Transfer Rate (Appendix E).

(__________hp) x (__________lb/hp-hr) x 24 = 20,000 lb O_2/d

Diffused Air Aeration Systems

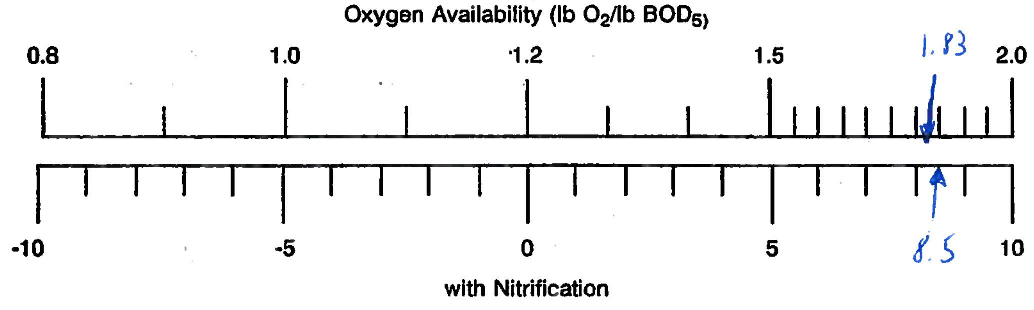
If data are not available on oxygen transfer capacity, calculate an actual oxygenation rate (Section 2.3.3.1).

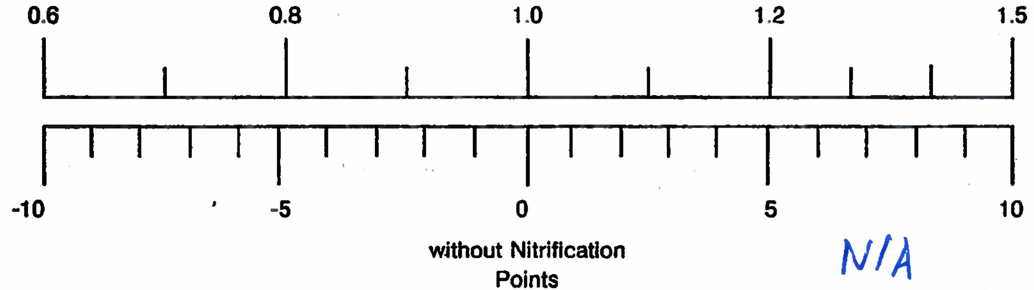
20,000 lb O_2/d

$$\text{Oxygen Availability} = \frac{\text{Oxygen Transfer Capacity}}{BOD_5 \text{ Loading to Aerator}}$$

$$\text{Oxygen Availability} = \frac{(\ 20{,}000\ \text{lb/d})}{(\ 10{,}921\ \text{lb/d})} = 1.83\ \text{lb } O_2/\text{lb } BOD_5$$

Determine Oxygen Availability Point Score:





Oxygen Availability Point Score = 8.5 ③

this scale is not indicative of HPO aeration

Add Scores 1, 2, and 3 to Obtain Subtotal for Aeration Basin: N/A

***Aeration Basin Subtotal* = -10** ④

this is not indicative OF HPO aeration

Secondary Clarifier

Determine Clarifier Configuration Point Score:

Configuration	Points
Circular with "donut" or interior launders	10
Circular with weirs on walls	5
Rectangular with 33% covered with launders	5
Rectangular with 20% covered with launders	0
Rectangular with launder at or near end	-10

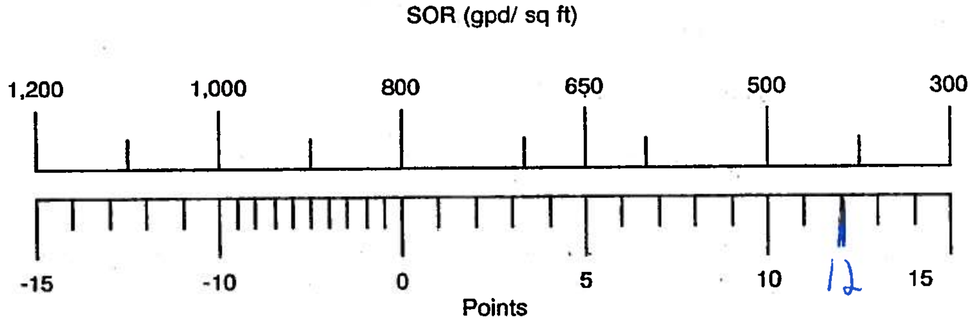
***Clarifier Configuration Point Score* = -10** ⑤

Calculate Clarifier Surface Overflow Rate (SOR):

$$\text{SOR} = \frac{\text{Peak Month Average Daily Flow}}{\text{Clarifier Surface Area}}$$

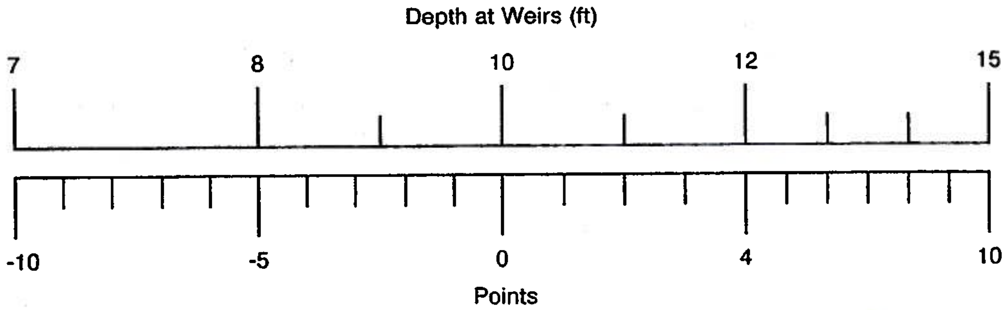
$$\text{SOR} = \frac{(\ 7,280,000\ \text{gpd})}{(\ 16,800\ \text{sq ft})} = 433.3\ \text{gpd/sq ft}$$

Determine SOR Point Score:



***SOR Point Score* = 12** ⑥

Determine Depth at Weirs Point Score:



***Depth at Weirs Point Score* = 0** ⑦

Determine Return Activated Sludge Point Score:

RAS Removal	Points
Circular, rapid withdrawal	10
Circular, scraper to hopper	8
Rectangular, co-current scraper	2
Rectangular, counter-current scraper	0
No mechanical removal	-5

***RAS Removal Point Score* =** 0 ⑧

Determine Typical RAS Rate from Following:

Process Type	RAS Rate, % of Average Daily Wastewater Flow	
	Minimum	Maximum
Conventional (plug flow or complete mix)	25	100
Extended Aeration (including oxidation ditches)	50	100
Contact Stabilization	50	125

Minimum Typical RAS Rate = 25 percent

MaximumTypical RAS Rate = 50 percent

Calculate Typical RAS Flow Range:

Min. Typical RAS Rate x Min. Month POTW Flow = Min. Recommended RAS Flow

(25 %) x (4,470,000 god) x (0.01) = 11,175 gpd or MGD

Max. Typical RAS Rate x Max. Month POTW Flow = Max. Recommended RAS Flow

(50 %) x (7,280,000 god) x (0.01) = 36,400 gpd or MGD

Determine Possible RAS Flow Range for Existing Facilities:

Minimum Possible RAS Flow = ____________gpd

Maximum Possible RAS Flow = ____________gpd

Determine RAS Control Point Score:

RAS Control	Points
The possible RAS flow range is completely within the typical RAS flow range and the capability to measure RAS flow exists	10
The possible RAS flow range is completely within the typical RAS flow range but the capability to measure RAS flow does not exist	7
50% of the typical RAS flow range is covered by the possible RAS flow range and the capability to measure RAS flow exists	[✓ 5]
50% of the typical RAS flow range is covered by the possible RAS flow range but the capability to measure RAS flow does not exist	0
The possible RAS flow range is completely outside the typical RAS flow range	-5

RAS Control Point Score = 5 ⑨

Add Scores 5, 6, 7, 8, and 9 to Obtain Subtotal for Secondary Clarifier:

Secondary Clarifier Subtotal = 7 ⑩

Sludge Handling Capability

Determine Sludge Controllability Point Score:

Controllability	Points
Automated sampling and volume control	5
[✓ Metered volume and hand sampling]	[✓ 3]
Hand measured volume and hand sampling	2
Sampling or volume measurement by hand not practical	0

Sludge Controllability Point Score = 3 ⑪

Calculate Expected BOD_5 Mass to be Removed (in the following calculations, 1.25 is a variability factor, described in Chapter 2):

<u>POTW w/Primary Clarification:</u>

Primary BOD_{5in} - Primary BOD_{5out} = Primary BOD_5 Concentration Removed

(352 mg/L) - (82 mg/L) = 270 mg/L

Primary BOD_{5out} - POTW Effluent BOD_5 = Secondary BOD_5 Concentration Removed

(270 mg/L) - (92.8 mg/L) = 177 mg/L

Prim. BOD_5 Conc. Rem. x Avg. Annual POTW Flow x 1.25 = Prim. BOD_5 Mass Removed

(270 mg/L) x (5,540,000 gpd) x (8.34 x 10^{-6}) x 1.25 = 15,593 lb/d

Sec. BOD_5 Conc. Rem. x Avg. Annual POTW Flow x 1.25 = Sec. BOD_5 Mass Removed

(177 mg/L) x (5,540,000 gpd) x (8.34 x 10^{-6}) x 1.25 = 10,222 lb/d

POTW w/o Primary Clarification:

BOD$_{5in}$ - POTW Effluent BOD$_5$ = Total BOD$_5$ Concentration Removed

(__________mg/L) - (__________mg/L) = __________mg/L

Total BOD$_5$ Conc. Rem. x Avg. Annual POTW Flow x 1.25 = Total BOD$_5$ Mass Removed

(__________mg/L) x (__________gpd) x (8.34 x 10^{-6}) x 1.25 = __________lb/d

Determine Typical Unit Sludge Production From Following:

Process Type	lb TSS (sludge)/lb BOD$_5$ Removed
Primary Clarification	1.7 *
Activated Sludge w/Primary Clarification	0.7 *
Activated Sludge w/o Primary Clarification	
Conventional[1]	0.85
Extended Aeration[2]	0.65
Contact Stabilization	1.0

[1] Includes tapered aeration, step feed, plug flow, and complete mix with wastewater times <10 hr.

[2] Includes oxidation ditch.

If plant records include actual sludge production data, the actual unit sludge production value should be compared to the typical value. If a discrepancy of more than 15 percent exists between the two values, further evaluation is needed. If not, use the actual unit sludge production value.

Calculate Expected Sludge Mass:

POTW w/Primary Clarification:

Unit Sludge Production x Primary BOD$_5$ Mass Removed = Primary Sludge Mass

(1.7 lb/lb) - (6,988 lb/d) = 11,880 lb/d 2011 Actual: 4,472

Unit Sludge Production x Secondary BOD$_5$ Mass Removed = Secondary Sludge Mass

(0.7 lb/lb) - (9,167 lb/d) = 6,417 lb/d

Total Sludge Mass = 18,297 lb/d

POTW w/o Primary Clarification:

Unit Sludge Production x Total BOD$_5$ Mass Removed = Total Sludge Mass

(__________lb/lb) - (__________lb/d) = __________lb/d

Determine Typical Unit Sludge Production From Following:

Sludge Type	Waste Concentration, mg/l
Primary	50,000
Activated	
Return Sludge/Conventional	6,000
Return Sludge/Extended Aeration	7,500
Return Sludge/Contact Stabilization	8,000
Return Sludge/small plant with low SOR[1]	10,000
Separate waste hopper in secondary clarifier	12,000

[1] Returns can often be shut off for short periods to thicken waste sludge in clarifiers with surface overflow rates <500 gpd/sq ft.

Calculate Expected Sludge Volume:

POTW w/Primary Clarification:

$$\text{Sludge Volume} = \frac{\text{Primary Sludge Mass}}{\text{Primary Sludge Concentration}}$$

$$\text{Sludge Volume} = \frac{(\qquad\qquad\qquad \text{lb/d})}{(\qquad 50{,}000 \qquad \text{mg/l})} \text{ x } (120{,}000) = \underline{\qquad\qquad\qquad} \text{ gpd}$$

$$\text{Sludge Volume} = \frac{\text{Secondary Sludge Mass}}{\text{Secondary Sludge Concentration}}$$

$$\text{Sludge Volume} = \frac{(\qquad\qquad\qquad \text{lb/d})}{(\qquad\qquad\qquad \text{mg/l})} \text{ x } (120{,}000) = \underline{\qquad\qquad\qquad} \text{ gpd}$$

$$\text{Total Sludge Volume} = \underline{\qquad\qquad\qquad} \text{ gpd}$$

POTW w/o Primary Clarification:

$$\text{Total Sludge Volume} = \frac{\text{Total Sludge Mass}}{\text{Waste Sludge Concentration}}$$

$$\text{Total Sludge Volume} = \frac{(\qquad\qquad\qquad \text{lb/d})}{(\qquad\qquad\qquad \text{mg/l})} \text{ x } (120{,}000) = \underline{\qquad\qquad\qquad} \text{ gpd}$$

Calculate Capability of Sludge Handling Unit Processes:

1. Establish capability of *each* existing sludge handling process (treatment and disposal). The most common unit processes for which this calculation will have to be performed are:

   - Aerobic digestion
   - Anaerobic digestion
   - Gravity thickening
   - Mechanical dewatering
   - Drying beds
   - Liquid haul

For example, the capability of a gravity thickener is based on the maximum sludge loading it must handle:

$$\text{Thickener Loading} = \frac{\text{Total Sludge Mass}}{\text{Thickener Surface Area}}$$

$$\text{Avg Thickener Loading} = \frac{(\;9{,}265 \quad \text{lb/d})}{(\;2{,}513 \quad \text{sq ft})} = \underline{\;3.686\;} \text{ lb/d/sq ft}$$

$$\text{Peak Day Thickener Loading} \quad \frac{13{,}726 \text{ lb/d}}{2{,}513 \text{ sq ft}} = 5.461$$

2. Determine percentage of the expected sludge production that each process can handle.

Assume the sludge being thickened by the gravity thickener above is mixed primary and activated. From Table 2-9, 10 lb/d/sq ft is considered typical loading for the thickener. Its capability would therefore be calculated as:

$$\frac{(\quad 10 \quad \text{lb/d/sq ft})}{(\quad \text{Actual Loading} \quad \text{lb/d/sq ft})} \times 100 = \underline{\;271\;} \text{ percent}$$

3.686

$$\frac{10}{5.461} = 183\%$$

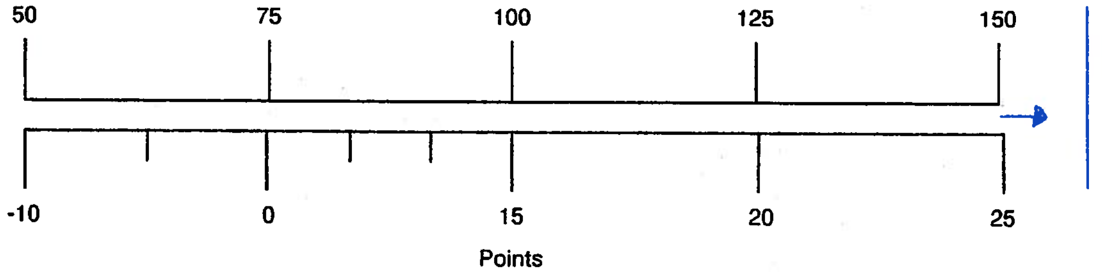
List Each Process and its Associated Sludge Handling Capability and Identify the Lowest Percentage Capability:

Process	Percentage
Gravity Thickening	271 %

Lowest Capability = 271 %

Determine Sludge Handling Capability Point Score:

183% to 271%



Sludge Handling Capability Point Score = 25 ⑫

Add Scores 11 and 12 to Obtain Subtotal for Sludge Handling Capability:

Sludge Handling Capability Subtotal = 28 ⑬

Compare Subtotals and Total Score with Following to Determine Whether POTW is Type 1, Type 2, or Type 3:

		Points Required		
	Score	Type 1	Type 2	Type 3
Aeration Basin	N/A (4)	13-30	0-12	<0
Secondary Clarifier	7 (10)	25-55	[✓ 0-24]	<0
Sludge Handling Capability	28 (13)	[✓ 10-30]	0-9	<0
Total	35	60-115	[✓ 20-59]	<20

	Type
Aeration Basin	N/A
Secondary Clarifier	2
Sludge Handling Capability	1
Total	

Select the Worst Case: POTW is Type 2

Appendix C - BioWin Process Model Results

Oak Orchard WWTP - Capacity Evaluation
Raw Influent Loadings

Treatment Configuration / Parameter	20% BOD Capacity Increase	26% BOD Capacity Increase	32% BOD Capacity Increase	38% BOD Capacity Increase	44% BOD Capacity Increase	50% BOD Capacity Increase	56% BOD Capacity Increase	62% BOD Capacity Increase	68% BOD Capacity Increase
Model Flow (MGD) (3)	3.34	3.51	3.68	3.85	4.01	4.18	4.35	4.52	4.68
Modeled Plant Flow (MGD)	6.69	7.02	7.36	7.69	8.03	8.36	8.70	9.03	9.37
CBOD									
- Concentration (mg/L)	248	248	248	248	248	248	248	248	248
- Load (lbs/day)	13,858	14,551	15,244	15,936	16,629	17,323	18,015	18,709	19,401
BOD (1)									
- Concentration (mg/L)	307	307	307	307	307	307	307	307	307
- Load (lbs/day)	17,109	17,964	18,819	19,675	20,530	21,387	22,240	23,097	23,952
% Increase over Design (2)	20.5%	26.5%	32.5%	38.6%	44.6%	50.6%	56.6%	62.7%	68.7%
TKN									
- Concentration (mg/L)	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
- Load (lbs/day)	1,674	1,758	1,841	1,925	2,009	2,092	2,176	2,260	2,343
Ammonia									
- Concentration (mg/L)	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
- Load (lbs/day)	1,339	1,406	1,473	1,540	1,607	1,674	1,741	1,808	1,875
Total Phosphorus									
- Concentration (mg/L)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
- Load (lbs/day)	223	234	245	257	268	279	290	301	312

Modeling Notes:

1. BOD values based on historic CBOD to BOD ratio of 0.81
2. Percent increase based on current design capacity of: 14,200 lbs/day BOD.
3. 1/2 of theoretical plant flow, as model is set up for 1/2 of the Oak Orch WWTP.

Oak Orchard WWTP - Capacity Evaluation
Modeling Results

Winter Model Conditions

Parameter	20% BOD Capacity Increase	26% BOD Capacity Increase	32% BOD Capacity Increase	38% BOD Capacity Increase	44% BOD Capacity Increase	50% BOD Capacity Increase	56% BOD Capacity Increase	62% BOD Capacity Increase
Total Plant Flow (MGD)	6.69	7.02	7.36	7.69	8.03	8.36	8.70	9.03
Model Flow (MGD)	3.34	3.51	3.68	3.85	4.01	4.18	4.35	4.52
- Effl. Ammonia (mg/L)	8.03		10.82	11.62	12.22	12.84	13.44	14.10
- Effl. Nitrate (mg/L)	5.55		2.67	2.09	1.73	1.41	1.13	0.82
- Effl. Nitrite (mg/L)	3.40		3.20	2.84	2.49	2.08	1.65	1.14
- Effl. Filtered TKN (mg/L)	9.11		11.89	12.69	13.30	13.91	14.51	15.18
- Effl. TSS (mg/L)	4.10		3.90	3.80	3.80	3.70	3.70	3.60
- Model SRT (days)	6.64		5.84	5.53	5.30	5.07	4.83	4.54
- Temperature (°C)	9.45		9.45	9.45	9.45	9.45	9.45	9.45
- Aerobic SRT Safety Factor at 9.45 °C	1.77		1.56	1.48	1.42	1.35	1.29	1.21
- 2nd Bio-Stage MLSS (mg/L)	5,541		5,505	5,506	5,548	5,573	5,581	5,511
- Tot. Sludge Production (lbs/day)	12,380		13,821	14,535	15,235	15,946	16,667	17,434
- WAS Solids Rate (lbs/day)	7,062		7,991	8,449	8,893	9,348	9,814	10,327
Alarms								

Spring Model Conditions

Parameter	20% BOD Capacity Increase	26% BOD Capacity Increase	32% BOD Capacity Increase	38% BOD Capacity Increase	44% BOD Capacity Increase	50% BOD Capacity Increase	56% BOD Capacity Increase	62% BOD Capacity Increase
Total Plant Flow (MGD)	6.69	7.02	7.36	7.69	8.03	8.36	8.70	9.03
Current (HPOAS)	3.34	3.51	3.68	3.85	4.01	4.18	4.35	4.52
- Effl. Ammonia (mg/L)	4.66	5.29	5.98	6.81	8.47			
- Effl. Nitrate (mg/L)	9.62	8.49	7.34	6.04	4.02			
- Effl. Nitrite (mg/L)	2.88	3.22	3.56	3.88	4.11			
- Effl. Filtered TKN (mg/L)	5.73	6.37	7.05	7.89	9.54			
- Effl. TSS (mg/L)	4.00	4.00	3.90	3.80	3.70			
- Model SRT (days)	6.71	6.34	6.00	5.67	5.34			
- Temperature (°C)	11.80	11.80	11.80	11.80	11.80			
- Aerobic SRT Safety Factor at 11.8 °C	2.20	?	1.97	1.86	1.75			
- 2nd Bio-Stage MLSS (mg/L)	5,506	5,526	5,547	5,545	5,508			
- Tot. Sludge Production (lbs/day)	12,263	12,964	13,668	14,388	15,116			
- WAS Solids Rate (lbs/day)	6,940	7,385	7,833	8,298	8,768			
Alarms								

Summer Model Conditions

Parameter	20% BOD Capacity Increase	26% BOD Capacity Increase	32% BOD Capacity Increase	38% BOD Capacity Increase	44% BOD Capacity Increase	50% BOD Capacity Increase	56% BOD Capacity Increase	62% BOD Capacity Increase	68% BOD Capacity Increase
Total Plant Flow (MGD)	6.69	7.02	7.36	7.69	8.03	8.36	8.70	9.03	9.03
Current (HPOAS)	3.34	3.51	3.68	3.85	4.01	4.18	4.35	4.52	4.52
- Effl. Ammonia (mg/L)	0.24		0.26		0.30		0.36		0.48
- Effl. Nitrate (mg/L)	17.56		17.26		16.89		16.45		15.85
- Effl. Nitrite (mg/L)	0.09		0.11		0.15		0.22		0.39
- Effl. Filtered TKN (mg/L)	1.31		1.34		1.38		1.45		1.56
- Effl. TSS (mg/L)	4.00		3.90		3.80		3.60		3.50
- Model SRT (days)	7.17		6.51		5.84		5.21		4.63
- Temperature (°C)	20.00		20.00		20.00		20.00		20.00
- Aerobic SRT Safety Factor at 20 °C	4.66		4.23		3.79		3.38		3.01
- 2nd Bio-Stage MLSS (mg/L)	5,442		5,553		5,581		5,551		5,466
- Tot. Sludge Production (lbs/day)	11,752		13,078		14,071		15,924		17,440
- WAS Solids Rate (lbs/day)	6,406		7,219		8,100		9,041		10,048
Alarms									

Modeling Notes:

- RAS fixed at 2.8 MGD for model per historic data (5.6 MGD for the total plant).
- Influent alkalinity assumed to be 5.0 mmol/L based upon data provided for the BSK WWTP (4.4 - 6.2 mmol/L), which is located nearby, and has the same municipal water supply source.

OCDWEP - Oak Orchard WWTP	5/20/2014	8616538
Client	Date	Job No.
Nitrification SRT Calculations	JDG	
Subject	Comp. By	Checked By

Nitrification

$$SRT_{min} = \frac{1}{\mu_N}$$

Where:

μ_m = Maximum Bacterial Growth Rate (gVSS/VSS/day)

k_d = Endogenous decay coefficient (gVSS/gVSS/day)

Θ_μ =

Θ_{kn} =

K_n =

K_{do} =

$$\mu_N = \frac{\mu max \times N}{Kn + N} \quad \frac{DO}{Ko + DO} \quad (-kd)\,(\Theta\ mu)^{T-20}$$

$$SF = \frac{SRT_{des}}{SRT_{min}}$$

🟨 Input Values

	Winter		Spring		Summer	
μ_{max} =	0.76	d^{-1}	0.76	d^{-1}	0.76	d^{-1}
Θ_μ =	1.07		1.07		1.07	
Θ_{kn} =	1.053		1.053		1.053	
k_d =	0.17		0.17		0.17	
K_n =	0.7		0.7		0.7	
Ammonia N (mg/L) =	6	mg/L	3.7	mg/L	2	mg/L
K_{do} =	0.5		0.5		0.5	
Aerobic DO (mg/L) =	10	mg/L	10	mg/L	10	mg/L
Min Design Temp (^{o}C) =	9.45	C	11.8	C	20	C
μ_N =	0.234		0.252		0.366	
SRT_{MIN} =	**4.27**	**days**	**3.97**	**days**	**2.73**	**days**

Winter Modeling Results

Winter Modeling (March 2012 Flow & Load Basis)

Temp 9.45 ^{o}C

20% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 6.64 Days

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD		
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH
Raw Infl	**30**	**837**	**24**	**670**	**0.00**	**0.00**	**4.0**	**112**	**3.00**	**84**	**186**	**5,204**	**216**	**6,043**	**248**	**6,934**	**7.01**
Primary Clar	28	788	24	674	0.08	2.25	3.4	96	2.83	80	98	2,793	110	3,112	191	5,424	6.87
HPO Zone 1	425	22,005	12	614	3.60	186	142	7,355	12.61	652.74	4,706	243,528	5,555	287,483	2,326	120,349	6.06
HPO Zone 2	424	21,920	9.7	499	4.60	238	142	7,355	12.39	641.32	4,691	242,745	5,541	286,772	2,309	119,470	5.94
HPO Zone 3	422	21,574	8.0	411	5.55	284	142	7,264	12.33	630.33	4,675	238,964	5,526	282,476	2,293	117,198	5.84
Effluent	**9.41**	**261**	**8.0**	**223**	**5.55**	**154**	**0.21**	**5.9**	**0.12**	**3.24**	**3.44**	**96**	**4.07**	**113**	**2.59**	**72**	**5.84**
Grit	30	0.08	24	0.06	0.08	0.00	**4.1**	**0.01**	2.96	0.01	189	0.47	169,941	425	247	0.62	6.92
Primary Clar (U)	787	66	24	1.98	0.08	0.01	**225**	**19**	47	3.94	30,891	2,578	34,163	2,851	19,289	1,610	6.87
Secondary Clar (U)	912	21,313	8.0	188	5.55	130	311	7,259	26.84	627.09	10,222	238,869	12,084	282,363	5,012	117,126	5.84
Thickener	30	17	11	6.25	4.07	2.26	6.4	3.6	1.13	0.63	302	167	346	191	182	101	6.01
Thickened Sludge (Waste)	1,911	319	11	1.88	4.07	0.68	634	106	67	11.21	32,354	5,400	37,089	6,190	17,854	2,980	6.01

32% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 5.84 Days

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD		
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH
Raw Infl	**30**	**921**	**24**	**737**	**0.00**	**0.00**	**4.0**	**123**	**3.00**	**92**	**186**	**5,725**	**216**	**6,647**	**248**	**7,627**	**7.01**
Primary Clar	28	869	24	743	0.04	1.25	3.4	106	2.84	89	98	3,074	109	3,414	191	5,969	6.89
HPO Zone 1	427	23,331	14	761	1.67	91	140	7,675	11.10	606.34	4,696	256,542	5,520	301,544	2,397	130,928	6.14
HPO Zone 2	426	23,269	12.1	663	2.17	119	140	7,675	10.85	592.54	4,681	255,720	5,505	300,724	2,379	129,993	6.04
HPO Zone 3	425	22,901	10.8	583	2.67	144	140	7,573	10.75	579.57	4,665	251,482	5,489	295,896	2,364	127,415	5.95
Effluent	**12.18**	**372**	**10.8**	**330**	**2.67**	**81**	**0.15**	**4.4**	**0.05**	**1.64**	**3.29**	**101**	**3.88**	**118**	**2.62**	**80**	**5.95**
Grit	30	0.08	24	0.06	0.04	0.00	**4.0**	**0.01**	2.95	0.01	189	0.47	186,918	468	247	0.62	6.92
Primary Clar (U)	865	72	24	1.98	0.04	0.00	**241**	**20**	45	3.77	33,999	2,837	37,485	3,128	21,224	1,771	6.89
Secondary Clar (U)	964	22,529	10.8	253	2.67	62	324	7,569	24.73	577.93	10,758	251,382	12,658	295,776	5,449	127,335	5.95
Thickener	32	20	13	8.56	1.95	1.25	5.7	3.7	0.58	0.37	291	187	333	214	177	114	6.09
Thickened Sludge (Waste)	2,163	361	13	2.23	1.95	0.33	709	118	68	11.27	36,234	6,048	41,403	6,911	20,277	3,384	6.09

38% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 5.53 Days

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD		
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH
Raw Infl	**30**	**963**	**24**	**770**	**0.00**	**0.00**	**4.0**	**128**	**3.00**	**96**	**186**	**5,985**	**216**	**6,949**	**248**	**7,974**	**7.01**
Primary Clar	28	910	24	778	0.03	1.04	3.4	111	2.84	93	98	3,214	109	3,565	191	6,241	6.89
HPO Zone 1	429	24,063	15	815	1.29	72	139	7,821	9.63	539.89	4,710	264,101	5,521	309,565	2,436	136,569	6.17
HPO Zone 2	428	24,008	12.8	720	1.69	95	139	7,821	9.36	524.93	4,695	263,259	5,506	308,725	2,419	135,607	6.07
HPO Zone 3	427	23,627	11.6	642	2.09	116	139	7,714	9.25	511.62	4,680	258,792	5,491	303,644	2,403	132,877	5.98
Effluent	**12.98**	**414**	**11.6**	**371**	**2.09**	**67**	**0.14**	**4.5**	**0.05**	**1.57**	**3.24**	**104**	**3.81**	**122**	**2.64**	**84**	**5.98**
Grit	30	0.08	24	0.06	0.03	0.00	**4.0**	**0.01**	2.95	0.01	189	0.47	195,409	489	247	0.62	6.92
Primary Clar (U)	904	75	24	1.99	0.03	0.00	**249**	**21**	44	3.69	35,554	2,967	39,148	3,267	22,192	1,852	6.89
Secondary Clar (U)	993	23,213	11.6	271	2.09	49	330	7,710	21.83	510.05	11,071	258,689	12,989	303,521	5,683	132,792	5.98
Thickener	32	22	14	9.51	1.53	1.05	5.6	3.9	0.51	0.35	288	197	329	225	176	120	6.11
Thickened Sludge (Waste)	2,289	382	14	2.32	1.53	0.26	743	124	63	10.52	38,180	6,373	43,543	7,268	21,494	3,587	6.11

44% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 5.30 Days

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD		
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH
Raw Infl	**30**	**1,005**	**24**	**804**	**0.00**	**0.00**	**4.0**	**134**	**3.00**	**100**	**186**	**6,245**	**216**	**7,251**	**248**	**8,320**	**7.01**
Primary Clar	28	950	24	812	0.03	0.91	3.4	117	2.85	97	98	3,355	109	3,716	191	6,513	6.89
HPO Zone 1	434	24,947	15	861	1.05	61	140	8,037	8.58	493.38	4,757	273,502	5,563	319,848	2,485	142,853	6.19
HPO Zone 2	433	24,897	13.4	769	1.39	80	140	8,037	8.30	477.33	4,742	272,637	5,548	318,985	2,467	141,862	6.09
HPO Zone 3	432	24,503	12.2	693	1.73	98	140	7,925	8.18	463.61	4,726	267,946	5,532	313,657	2,451	138,983	6.01
Effluent	**13.58**	**453**	**12.2**	**407**	**1.73**	**58**	**0.14**	**4.5**	**0.05**	**1.53**	**3.22**	**107**	**3.78**	**126**	**2.66**	**89**	**6.01**
Grit	30	0.08	24	0.06	0.03	0.00	**4.0**	**0.01**	2.95	0.01	189	0.47	203,892	510	247	0.62	6.92
Primary Clar (U)	943	79	24	1.99	0.03	0.00	**257**	**21**	43	3.61	37,106	3,097	40,808	3,406	23,158	1,933	6.89
Secondary Clar (U)	1,029	24,050	12.2	286	1.73	40	339	7,920	19.77	462.08	11,462	267,839	13,418	313,530	5,944	138,894	6.01
Thickener	33	23	14	10.31	1.26	0.91	5.6	4.0	0.46	0.33	288	207	328	236	176	126	6.13
Thickened Sludge	2,410	402	14	2.40	1.26	0.21	776	129	60	9.94	40,083	6,690	45,637	7,617	22,669	3,784	6.13

Winter Modeling (March 2012 Flow & Load Basis)

Temp 9.45 °C

50% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 5.07 Days

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD		
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH
Raw Infl	30	1,047	24	837	0.00	0.00	4.0	140	3.00	105	186	6,506	216	7,554	248	8,667	7.01
Primary Clar	28	990	24	847	0.02	0.78	3.4	122	2.85	101	98	3,495	109	3,868	191	6,786	6.90
HPO Zone 1	437	25,773	15	909	0.85	50	140	8,224	7.43	437.89	4,789	282,234	5,588	329,315	2,527	148,910	6.21
HPO Zone 2	437	25,730	13.9	820	1.13	67	140	8,224	7.14	420.69	4,774	281,349	5,573	328,432	2,510	147,892	6.11
HPO Zone 3	436	25,322	12.8	746	1.41	82	140	8,107	7.00	406.63	4,758	276,430	5,557	322,851	2,494	144,860	6.03
Effluent	14.20	493	12.8	446	1.41	49	0.13	4.6	0.04	1.49	3.18	111	3.73	130	2.68	93	6.03
Grit	30	0.08	24	0.06	0.02	0.00	4.0	0.01	2.95	0.01	189	0.47	212,393	532	247	0.62	6.92
Primary Clar (U)	982	82	24	1.99	0.02	0.00	265	22	42	3.53	38,662	3,227	42,473	3,545	24,127	2,013	6.90
Secondary Clar (U)	1,063	24,829	12.8	300	1.41	33	347	8,103	17.34	405.14	11,825	276,319	13,811	322,721	6,195	144,767	6.03
Thickener	33	25	15	11.19	1.03	0.78	5.6	4.2	0.41	0.31	287	217	327	247	176	133	6.15
Thickened Sludge	2,535	423	15	2.47	1.03	0.17	809	135	55	9.21	42,022	7,014	47,768	7,973	23,878	3,985	6.15

56% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 4.83 Days

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD		
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH
Raw Infl	30	1,089	24	871	0.00	0.00	4.0	145	3.00	109	186	6,765	216	7,855	248	9,013	7.01
Primary Clar	28	1,030	24	881	0.02	0.65	3.4	127	2.86	106	98	3,636	109	4,019	191	7,058	6.90
HPO Zone 1	439	26,525	16	957	0.67	40	139	8,380	6.18	373.33	4,806	290,135	5,596	337,780	2,562	154,648	6.23
HPO Zone 2	439	26,488	14.4	872	0.90	54	139	8,380	5.88	354.92	4,791	289,232	5,581	336,880	2,545	153,604	6.13
HPO Zone 3	438	26,067	13.4	799	1.13	67	139	8,258	5.73	340.59	4,776	284,080	5,565	331,043	2,529	150,417	6.06
Effluent	14.79	534	13.4	485	1.13	41	0.13	4.6	0.04	1.44	3.15	114	3.68	133	2.70	97	6.06
Grit	30	0.08	24	0.06	0.02	0.00	4.0	0.01	2.94	0.01	189	0.47	220,867	553	247	0.62	6.92
Primary Clar (U)	1,021	85	24	1.99	0.02	0.00	274	23	41	3.46	40,215	3,356	44,134	3,683	25,093	2,094	6.90
Secondary Clar (U)	1,093	25,533	13.4	314	1.13	26	353	8,253	14.51	339.15	12,152	283,966	14,161	330,909	6,433	150,320	6.06
Thickener	34	27	15	12.14	0.82	0.65	5.5	4.4	0.35	0.28	285	227	324	258	175	139	6.17
Thickened Sludge	2,662	444	15	2.55	0.82	0.14	842	141	50	8.35	43,989	7,342	49,928	8,333	25,117	4,192	6.17

62% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 4.54 Days

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD		
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH
Raw Infl	30	1,131	24	904	0.00	0.00	4.0	151	3.00	113	186	7,026	216	8,158	248	9,360	7.01
Primary Clar	28	1,071	24	916	0.01	0.51	3.4	132	2.86	110	98	3,777	108	4,171	191	7,331	6.90
HPO Zone 1	436	26,942	16	1,009	0.48	29	136	8,391	4.38	270.54	4,759	294,209	5,526	341,619	2,570	158,903	6.25
HPO Zone 2	435	26,914	15.0	928	0.65	40	136	8,391	4.06	250.70	4,744	293,296	5,511	340,709	2,553	157,840	6.16
HPO Zone 3	435	26,479	14.1	858	0.82	50	136	8,264	3.88	236.39	4,729	287,896	5,496	334,599	2,537	154,481	6.08
Effluent	15.45	580	14.1	529	0.82	31	0.12	4.6	0.04	1.37	3.07	115	3.59	135	2.70	101	6.08
Grit	30	0.08	24	0.06	0.01	0.00	4.0	0.01	2.94	0.01	188	0.47	229,366	574	247	0.62	6.92
Primary Clar (U)	1,060	88	24	1.99	0.01	0.00	282	24	40	3.38	41,776	3,486	45,803	3,822	26,067	2,175	6.90
Secondary Clar (U)	1,108	25,900	14.1	329	0.82	19	353	8,259	10.06	235.02	12,316	287,780	14,313	334,464	6,607	154,379	6.08
Thickener	34	29	16	13.42	0.59	0.51	5.3	4.5	0.28	0.24	279	238	316	270	172	147	6.19
Thickened Sludge	2,802	468	16	2.63	0.59	0.10	876	146	42	6.94	46,093	7,693	52,227	8,717	26,486	4,421	6.19

Winter Modeling (March 2012 Flow & Load Basis)

Temp 9.45 °C

20% BOD Capacity Increase w/ 4 mg/L Infl TP 0.75 PO4:TP & 48% PC removal rate

SRT = 6.64 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	6.2	4,706	**5,555**	6,923	10.08	425.22	12.94	11.87	3.6	142.12	0.44	2,326	2.6	0.17	9.45
HPO Zone 2	6.2	4,691	**5,541**	6,895	7.84	423.57	10.7	9.65	4.6	142.12	0.18	2,309	1.02	0.17	9.45
HPO Zone 3	6.12	4,675	**5,526**	6,869	7.67	422.08	9.11	8.03	5.55	142.12	0.11	2,293	0.9	0.17	9.45
Raw Infl	**3.34**	**186**	**216**	**492**	**193.76**	**30**	**25.61**	**24**	**0**	**4**	**3**	**248**	**132.34**	**0**	**9.45**
Effluent	**3.32**	**3.4**	**4.1**	**13**	**7.67**	**9.41**	**9.11**	**8.03**	**5.55**	**0.21**	**0.11**	**2.59**	**0.9**	**0**	**9.45**
Grit Removal	3.41	189	204	492	190.56	30	25.35	23.75	0.08	4.05	2.96	247	130.08	0.04	9.45
Secondary Clar	3.32	3.4	4.1	13	7.67	9.41	9.11	8.03	5.55	0.21	0.11	2.59	0.9	0.63	9.45
Thickener	0.07	302	346	490	28.99	30.09	12.39	11.28	4.07	6.41	0.51	182	15.96	0.07	9.45
Primary Clar	3.4	98	110	348	190.55	27.77	25.35	23.75	0.08	3.4	2.65	191	130.07	0.59	9.45
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	9.45
Pri Clar Coag Feed Pt	3.41	189	209	492	190.55	30	25.35	23.75	0.08	4.05	2.65	247	130.07	0	9.45
Grit	0.00	189	169,941	492	190.56	30	25.35	23.75	0.08	4.05	2.96	247	130.08	0	9.45
Thickened Sludge (Waste)	0.02	32,354	37,089	49,470	28.99	1910.89	12.39	11.28	4.07	633.64	0.51	17,854	15.96	0	9.45
WAS Splitter	6.12	4,691	5,541	6,895	7.84	423.57	10.7	9.65	4.6	142.12	0.18	2,309	1.02	0	9.45

32% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 5.84 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	6.55	4,696	**5,520**	6,905	10.47	427.07	15.01	13.94	1.67	140.49	0.02	2,397	2.88	0.17	9.45
HPO Zone 2	6.55	4,681	**5,505**	6,877	7.94	425.92	13.18	12.13	2.17	140.49	0.03	2,379	1.09	0.17	9.45
HPO Zone 3	6.46	4,665	**5,489**	6,851	7.75	424.84	11.89	10.82	2.67	140.49	0.04	2,364	0.96	0.17	9.45
Raw Infl	**3.68**	**186**	**216**	**492**	**193.76**	**30**	**25.61**	**24**	**0**	**4**	**3**	**248**	**132.34**	**0**	**9.45**
Effluent	**3.66**	**3.3**	**3.9**	**13**	**7.75**	**12.18**	**11.89**	**10.82**	**2.67**	**0.15**	**0.05**	**2.62**	**0.96**	**0**	**9.45**
Grit Removal	3.76	189	204	492	190.34	30.03	25.38	23.78	0.04	4.04	2.95	247	129.93	0.04	9.45
Secondary Clar	3.66	3.3	3.9	13	7.75	12.18	11.89	10.82	2.67	0.15	0.05	2.62	0.96	0.63	9.45
Thickener	0.08	291	333	471	26.75	31.7	14.44	13.33	1.95	5.73	0.03	177	14.38	0.07	9.45
Primary Clar	3.75	98	109	347	190.34	27.81	25.38	23.78	0.04	3.4	2.67	191	129.92	0.59	9.45
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	3.76	189	209	492	190.34	30.03	25.38	23.78	0.04	4.04	2.67	247	129.92	0	9.45
Grit	0.00	189	186,918	492	190.34	30.03	25.38	23.78	0.04	4.04	2.95	247	129.93	0	9.45
Thickened Sludge (Waste)	0.02	36,234	41,403	55,342	26.75	2162.61	14.44	13.33	1.95	709.26	0.03	20,277	14.38	0	9.45
WAS Splitter	6.46	4,681	5,505	6,877	7.94	425.92	13.18	12.13	2.17	140.49	0.03	2,379	1.09	0	9.45

Winter Modeling (March 2012 Flow & Load Basis)

Temp 9.45 °C

38% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 5.53 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	6.72	4,710	**5,521**	6,925	10.59	429.18	15.61	14.53	1.29	139.49	0.02	2,436	2.96	0.17	9.45
HPO Zone 2	6.72	4,695	**5,506**	6,897	7.97	428.19	13.89	12.84	1.69	139.49	0.03	2,419	1.11	0.17	9.45
HPO Zone 3	6.63	4,680	**5,491**	6,871	7.78	427.25	12.69	11.62	2.09	139.49	0.03	2,403	0.98	0.17	9.45
Raw Infl	**3.85**	**186**	**216**	**492**	**193.76**	**30**	**25.61**	**24**	**0**	**4**	**3**	**248**	**132.34**	**0**	**9.45**
Effluent	**3.83**	**3.2**	**3.8**	**13**	**7.78**	**12.98**	**12.69**	**11.62**	**2.09**	**0.14**	**0.04**	**2.64**	**0.98**	**0**	**9.45**
Grit Removal	3.93	189	204	491	190.26	30.05	25.39	23.79	0.03	4.03	2.95	247	129.87	0.04	9.45
Secondary Clar	3.83	3.2	3.8	13	7.78	12.98	12.69	11.62	2.09	0.14	0.04	2.64	0.98	0.63	9.45
Thickener	0.08	288	329	466	25.86	32.18	15.02	13.91	1.53	5.64	0.03	176	13.74	0.07	9.45
Primary Clar	3.92	98	109	347	190.26	27.81	25.39	23.79	0.03	3.41	2.68	191	129.86	0.59	9.45
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	3.93	189	208	491	190.26	30.04	25.39	23.79	0.03	4.03	2.68	247	129.86	0	9.45
Grit	0.00	189	195,409	491	190.26	30.05	25.39	23.79	0.03	4.03	2.95	247	129.87	0	9.45
Thickened Sludge (Waste)	0.02	38,180	43,543	58,288	25.86	2288.5	15.02	13.91	1.53	742.62	0.03	21,494	13.74	0	9.45
WAS Splitter	6.63	4,695	5,506	6,897	7.97	428.19	13.89	12.84	1.69	139.49	0.03	2,419	1.11	0	9.45

44% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 5.30 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	6.72	4,710	**5,521**	6,925	10.59	429.18	15.61	14.53	1.29	139.49	0.02	2,436	2.96	0.17	9.45
HPO Zone 2	6.72	4,695	**5,506**	6,897	7.97	428.19	13.89	12.84	1.69	139.49	0.03	2,419	1.11	0.17	9.45
HPO Zone 3	6.63	4,680	**5,491**	6,871	7.78	427.25	12.69	11.62	2.09	139.49	0.03	2,403	0.98	0.17	9.45
Raw Infl	**3.85**	**186**	**216**	**492**	**193.76**	**30**	**25.61**	**24**	**0**	**4**	**3**	**248**	**132.34**	**0**	**9.45**
Effluent	**3.83**	**3.2**	**3.8**	**13**	**7.78**	**12.98**	**12.69**	**11.62**	**2.09**	**0.14**	**0.04**	**2.64**	**0.98**	**0**	**9.45**
Grit Removal	3.93	189	204	491	190.26	30.05	25.39	23.79	0.03	4.03	2.95	247	129.87	0.04	9.45
Secondary Clar	3.83	3.2	3.8	13	7.78	12.98	12.69	11.62	2.09	0.14	0.04	2.64	0.98	0.63	9.45
Thickener	0.08	288	329	466	25.86	32.18	15.02	13.91	1.53	5.64	0.03	176	13.74	0.07	9.45
Primary Clar	3.92	98	109	347	190.26	27.81	25.39	23.79	0.03	3.41	2.68	191	129.86	0.59	9.45
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	3.93	189	208	491	190.26	30.04	25.39	23.79	0.03	4.03	2.68	247	129.86	0	9.45
Grit	0.00	189	195,409	491	190.26	30.05	25.39	23.79	0.03	4.03	2.95	247	129.87	0	9.45
Thickened Sludge (Waste)	0.02	38,180	43,543	58,288	25.86	2288.5	15.02	13.91	1.53	742.62	0.03	21,494	13.74	0	9.45
WAS Splitter	6.63	4,695	5,506	6,897	7.97	428.19	13.89	12.84	1.69	139.49	0.03	2,419	1.11	0	9.45

Winter Modeling (March 2012 Flow & Load Basis)

Temp 9.45 °C

50% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 5.07 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	7.06	4,789	**5,588**	7,039	10.81	437.33	16.51	15.43	0.85	139.56	0.02	2,527	3.12	0.17	9.45
HPO Zone 2	7.06	4,774	**5,573**	7,010	8.03	436.6	14.97	13.92	1.13	139.56	0.03	2,510	1.15	0.17	9.45
HPO Zone 3	6.96	4,758	**5,557**	6,984	7.83	435.88	13.91	12.84	1.41	139.56	0.03	2,494	1.01	0.17	9.45
Raw Infl	**4.18**	**186**	**216**	**492**	**193.76**	**30**	**25.61**	**24**	**0**	**4**	**3**	**248**	**132.34**	**0**	**9.45**
Effluent	**4.16**	**3.2**	**3.7**	**13**	**7.83**	**14.2**	**13.91**	**12.84**	**1.41**	**0.13**	**0.04**	**2.68**	**1.01**	**0**	**9.45**
Grit Removal	4.27	189	204	491	190.18	30.07	25.4	23.81	0.02	4.03	2.95	247	129.81	0.04	9.45
Secondary Clar	4.16	3.2	3.7	13	7.83	14.2	13.91	12.84	1.41	0.13	0.04	2.68	1.01	0.63	9.45
Thickener	0.09	287	327	463	24.51	33.13	15.91	14.81	1.03	5.56	0.02	176	12.79	0.07	9.45
Primary Clar	4.26	98	109	347	190.17	27.83	25.4	23.8	0.02	3.42	2.71	191	129.81	0.59	9.45
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	4.27	189	208	491	190.17	30.07	25.4	23.8	0.02	4.03	2.71	247	129.81	0	9.45
Grit	0.00	189	212,393	491	190.18	30.07	25.4	23.81	0.02	4.03	2.95	247	129.81	0	9.45
Thickened Sludge (Waste)	0.02	42,022	47,768	64,107	24.51	2534.9	15.91	14.81	1.03	808.83	0.02	23,878	12.79	0	9.45
WAS Splitter	6.96	4,774	5,573	7,010	8.03	436.6	14.97	13.92	1.13	139.56	0.03	2,510	1.15	0	9.45

56% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 4.83 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	7.23	4,806	**5,596**	7,063	10.93	439.39	16.94	15.86	0.67	138.82	0.02	2,562	3.2	0.17	9.45
HPO Zone 2	7.23	4,791	**5,581**	7,034	8.06	438.79	15.49	14.44	0.9	138.82	0.02	2,545	1.17	0.17	9.45
HPO Zone 3	7.13	4,776	**5,565**	7,008	7.86	438.2	14.51	13.44	1.13	138.82	0.03	2,529	1.03	0.17	9.45
Raw Infl	**4.35**	**186**	**216**	**492**	**193.76**	**30**	**25.61**	**24**	**0**	**4**	**3**	**248**	**132.34**	**0**	**9.45**
Effluent	**4.33**	**3.2**	**3.7**	**12**	**7.86**	**14.79**	**14.51**	**13.44**	**1.13**	**0.13**	**0.03**	**2.70**	**1.03**	**0**	**9.45**
Grit Removal	4.44	189	204	491	190.12	30.08	25.41	23.81	0.02	4.03	2.94	247	129.77	0.04	9.45
Secondary Clar	4.33	3.2	3.7	12	7.86	14.79	14.51	13.44	1.13	0.13	0.03	2.70	1.03	0.63	9.45
Thickener	0.1	285	324	459	23.84	33.51	16.35	15.25	0.82	5.49	0.02	175	12.32	0.07	9.45
Primary Clar	4.43	98	109	347	190.11	27.84	25.41	23.81	0.02	3.42	2.72	191	129.76	0.59	9.45
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	4.44	189	208	491	190.11	30.07	25.41	23.81	0.02	4.03	2.72	247	129.76	0	9.45
Grit	0.00	189	220,867	491	190.12	30.08	25.41	23.81	0.02	4.03	2.94	247	129.77	0	9.45
Thickened Sludge (Waste)	0.02	43,989	49,928	67,084	23.84	2662.31	16.35	15.25	0.82	841.98	0.02	25,117	12.32	0	9.45
WAS Splitter	7.13	4,791	5,581	7,034	8.06	438.79	15.49	14.44	0.9	138.82	0.02	2,545	1.17	0	9.45

Winter Modeling (March 2012 Flow & Load Basis)

Temp 9.45 °C

62% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 4.54 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	7.41	4,759	**5,526**	6,993	11.11	435.8	17.4	16.31	0.48	135.73	0.02	2,570	3.33	0.17	9.45
HPO Zone 2	7.41	4,744	**5,511**	6,964	8.1	435.36	16.06	15.01	0.65	135.73	0.02	2,553	1.21	0.17	9.45
HPO Zone 3	7.3	4,729	**5,496**	6,938	7.9	434.92	15.18	14.1	0.82	135.73	0.03	2,537	1.06	0.17	9.45
Raw Infl	**4.52**	**186**	**216**	**492**	**193.76**	**30**	**25.61**	**24**	**0**	**4**	**3**	**248**	**132.34**	**0**	**9.45**
Effluent	**4.5**	**3.1**	**3.6**	**12**	**7.9**	**15.45**	**15.18**	**14.1**	**0.82**	**0.12**	**0.03**	**2.70**	**1.06**	**0**	**9.45**
Grit Removal	4.62	188	204	491	189.98	30.08	25.41	23.82	0.01	4.03	2.94	247	129.67	0.04	9.45
Secondary Clar	4.5	3.1	3.6	12	7.9	15.45	15.18	14.1	0.82	0.12	0.03	2.70	1.06	0.63	9.45
Thickener	0.1	279	316	448	22.98	33.67	16.82	15.73	0.59	5.32	0.02	172	11.71	0.07	9.45
Primary Clar	4.61	98	108	347	189.98	27.84	25.41	23.82	0.01	3.43	2.73	191	129.67	0.59	9.45
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	4.62	188	207	491	189.98	30.08	25.41	23.82	0.01	4.03	2.73	247	129.67	0	9.45
Grit	0.00	188	229,366	491	189.98	30.08	25.41	23.82	0.01	4.03	2.94	247	129.67	0	9.45
Thickened Sludge (Waste)	0.02	46,093	52,227	70,261	22.98	2801.76	16.82	15.73	0.59	875.63	0.02	26,486	11.71	0	9.45
WAS Splitter	7.3	4,744	5,511	6,964	8.1	435.36	16.06	15.01	0.65	135.73	0.02	2,553	1.21	0	9.45

Winter Modeling (March 2012 Flow & Load Basis)

Temp 9.45 ^{o}C

56% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC remov SRT = 4.83 Days

Elements	Total solids mass [lb]	PolyP heterotrophs [lb COD/d]	Non-polyP heterotrophs [lb COD/d]	Ammonia oxidizing biomass [lb COD/d]	Nitrite oxidizing biomass [lb COD/d]	Endogenous products [lb COD/d]	**Total Biomass (lb COD/d)**	Carbonaceous OUR [lb/d]	Nitrogenous OUR [lb/d]	Total oxygen uptake rate [lb/d]
HPO Zone 1	8,149	46	256,563	732	208	46,047	**257,549**	2,894	141	3,035
HPO Zone 2	8,127	46	257,172	735	209	46,275	**258,162**	1,726	136	1,862
HPO Zone 3	8,104	45	253,753	728	206	45,828	**254,732**	1,586	131	1,717
	% Comp	**0.018%**	**99.616%**	**0.285%**	**0.081%**	**--**	**--**	**93.8%**	**6.2%**	**6,613**

62% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC remov SRT = 4.54 Days

Elements	Total solids mass [lb]	PolyP heterotrophs [lb COD/d]	Non-polyP heterotrophs [lb COD/d]	Ammonia oxidizing biomass [lb COD/d]	Nitrite oxidizing biomass [lb COD/d]	Endogenous products [lb COD/d]	**Total Biomass (lb COD/d)**	Carbonaceous OUR [lb/d]	Nitrogenous OUR [lb/d]	Total oxygen uptake rate [lb/d]
HPO Zone 1	8,047	47	263,258	557	168	44,381	**264,030**	2,963	106	3,069
HPO Zone 2	8,026	47	263,930	559	169	44,609	**264,705**	1,760	103	1,863
HPO Zone 3	8,003	46	260,318	553	167	44,161	**261,084**	1,620	100	1,720
	% Comp	**0.018%**	**99.707%**	**0.211%**	**0.064%**	**--**	**--**	**95.4%**	**4.6%**	**6,652**

Spring Modeling Results

Spring Modeling (March 2012 Flow & Load Basis)

Temp 11.8 °C Spring 2014 Temp (30-Day Rolling Avg from 5-20-2014)

20% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 6.71 Days

Total WWTP Compliance

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD			Total NH3	Total UOD
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH	lb/d	lb/d
Raw Infl	30	837	24	670	0.00	0.00	4.0	112	3.00	84	186	5,204	216	6,043	248	6,934	7.01		
Primary Clar	28	787	24	673	0.14	3.87	3.4	96	2.83	80	98	2,792	109	3,107	191	5,423	6.87		
HPO Zone 1	420	21,731	9	489	6.29	326	141	7,285	12.15	628.47	4,678	242,081	5,520	285,629	2,267	117,281	5.96		
HPO Zone 2	418	21,613	6.6	343	8.02	415	141	7,285	11.94	617.68	4,663	241,279	5,506	284,895	2,249	116,385	5.81		
HPO Zone 3	416	21,252	4.7	238	9.62	491	141	7,196	11.90	608.17	4,647	237,536	5,491	280,641	2,233	114,152	5.69		
Effluent	6.04	167	4.7	129	9.62	267	0.27	7.6	0.18	4.99	3.42	95	4.05	112	2.53	70	5.69	258.5	1,718
Grit	30	0.07	24	0.06	0.14	0.00	4.1	0.01	2.96	0.01	189	0.47	169,941	425	247	0.62	6.91		
Primary Clar (U)	786	66	24	1.98	0.14	0.01	225	19	48	4.03	30,882	2,577	34,175	2,852	19,280	1,609	6.87		
Secondary Clar (U)	902	21,085	4.7	109	9.62	225	308	7,188	25.81	603.18	10,161	237,441	12,005	280,529	4,882	114,082	5.69		
Thickener	27	15	9	4.72	7.10	3.88	6.4	3.5	1.16	0.63	303	165	347	190	182	99	5.90		
Thickened Sludge (Waste)	1,880	314	9	1.44	7.10	1.19	623	104	65	10.92	32,056	5,350	36,737	6,132	17,538	2,927	5.90		

26% Flow Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 6.34 Days

Total WWTP Compliance

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD			Total NH3	Total UOD
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH	lb/d	lb/d
Raw Infl	30	879	24	703	0.00	0.00	4.0	117	3.00	88	186	5,464	216	6,345	248	7,280	7.01		
Primary Clar	28	827	24	707	0.12	3.66	3.4	101	2.84	85	98	2,932	109	3,258	191	5,696	6.87		
HPO Zone 1	423	22,511	10	533	5.48	292	141	7,512	11.77	626.09	4,705	250,221	5,540	294,603	2,316	123,161	5.99		
HPO Zone 2	421	22,394	7.3	386	7.04	375	141	7,512	11.55	614.24	4,690	249,394	5,526	293,852	2,299	122,235	5.84		
HPO Zone 3	419	22,015	5.3	278	8.49	446	141	7,418	11.50	603.68	4,674	245,428	5,511	289,354	2,283	119,857	5.72		
Effluent	6.66	194	5.3	154	8.49	247	0.24	7.0	0.15	4.32	3.37	98	3.97	116	2.54	74	5.72	308.34	1,970
Grit	30	0.07	24	0.06	0.12	0.00	4.1	0.01	2.96	0.01	189	0.47	178,430	447	247	0.62	6.91		
Primary Clar (U)	825	69	24	1.98	0.12	0.01	234	20	47	3.96	32,435	2,707	35,836	2,991	20,246	1,690	6.87		
Secondary Clar (U)	934	21,821	5.3	124	8.49	198	317	7,411	25.65	599.37	10,499	245,330	12,378	289,238	5,126	119,783	5.72		
Thickener	28	16	9	5.31	6.28	3.67	6.3	3.7	1.10	0.64	300	175	343	200	180	105	5.92		
Thickened Sludge (Waste)	2,001	334	9	1.52	6.28	1.05	660	110	66	11.03	33,944	5,665	38,836	6,482	18,694	3,120	5.92		

32% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 6.00 Days

Total WWTP Compliance

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD			Total NH3	Total UOD
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH	lb/d	lb/d
Raw Infl	30	921	24	737	0.00	0.00	4.0	123	3.00	92	186	5,725	216	6,647	248	7,627	7.01		
Primary Clar	28	867	24	741	0.11	3.37	3.4	107	2.84	89	98	3,073	109	3,409	191	5,968	6.88		
HPO Zone 1	427	23,299	11	580	4.67	255	142	7,744	11.45	625.38	4,733	258,458	5,562	303,723	2,363	129,046	6.02		
HPO Zone 2	425	23,186	7.9	433	6.05	331	142	7,744	11.22	612.46	4,717	257,608	5,548	302,953	2,346	128,091	5.87		
HPO Zone 3	423	22,789	6.0	322	7.34	396	142	7,644	11.15	600.82	4,701	253,419	5,532	298,210	2,329	125,565	5.76		
Effluent	7.35	224	6.0	183	7.34	224	0.21	6.4	0.12	3.61	3.32	101	3.91	119	2.56	78	5.76	365	2,253
Grit	30	0.08	24	0.06	0.11	0.00	4.1	0.01	2.96	0.01	189	0.47	186,916	468	247	0.62	6.91		
Primary Clar (U)	864	72	24	1.98	0.11	0.01	242	20	47	3.89	33,987	2,836	37,497	3,129	21,212	1,770	6.88		
Secondary Clar (U)	966	22,565	6.0	140	7.34	172	327	7,637	25.56	597.21	10,841	253,317	12,757	298,091	5,370	125,487	5.76		
Thickener	28	18	10	5.97	5.43	3.38	6.3	3.9	1.05	0.65	297	185	340	211	179	112	5.95		
Thickened Sludge (Waste)	2,123	354	10	1.60	5.43	0.91	697	116	67	11.15	35,838	5,982	40,944	6,834	19,859	3,315	5.95		

38% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 5.67 Days

Total WWTP Compliance

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD			Total NH3	Total UOD
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH	lb/d	lb/d
Raw Infl	30	963	24	770	0.00	0.00	4.0	128	3.00	96	186	5,985	216	6,949	248	7,974	7.01		
Primary Clar	28	907	24	775	0.09	2.96	3.4	112	2.85	93	98	3,213	109	3,560	191	6,240	6.88		
HPO Zone 1	428	23,996	11	633	3.80	213	142	7,944	11.14	624.64	4,738	265,577	5,559	311,555	2,400	134,535	6.05		
HPO Zone 2	426	23,887	8.7	488	4.96	278	142	7,944	10.89	610.58	4,723	264,706	5,545	310,771	2,383	133,553	5.91		
HPO Zone 3	424	23,475	6.8	377	6.04	334	142	7,838	10.81	597.73	4,707	260,288	5,529	305,777	2,367	130,876	5.80		
Effluent	8.18	261	6.8	218	6.04	193	0.17	5.6	0.08	2.68	3.26	104	3.83	122	2.57	82	5.80	435.14	2,597
Grit	30	0.08	24	0.06	0.09	0.00	4.0	0.01	2.96	0.01	189	0.47	195,408	489	247	0.62	6.91		
Primary Clar (U)	903	75	24	1.98	0.09	0.01	250	21	46	3.81	35,542	2,966	39,161	3,268	22,180	1,851	6.88		
Secondary Clar (U)	993	23,214	6.8	159	6.04	141	335	7,833	25.46	595.04	11,135	260,184	13,081	305,655	5,597	130,794	5.80		
Thickener	29	19	10	6.79	4.47	2.97	6.2	4.1	0.99	0.66	293	195	335	223	177	118	5.98		
Thickened Sludge (Waste)	2,248	375	10	1.70	4.47	0.75	736	123	68	11.30	37,775	6,305	43,101	7,194	21,065	3,516	5.98		

44% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 5.34 Days

Total WWTP Compliance

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD			Total NH3	Total UOD
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH	lb/d	lb/d
Raw Infl	30	1,005	24	804	0.00	0.00	4.0	134	3.00	100	186	6,245	216	7,251	248	8,320	7.01		
Primary Clar	28	947	24	810	0.06	2.10	3.4	116	2.85	97	98	3,354	109	3,711	191	6,512	6.89		
HPO Zone 1	428	24,592	13	720	2.48	142	140	8,054	10.04	577.08	4,717	271,218	5,524	317,579	2,425	139,391	6.09		
HPO Zone 2	426	24,499	10.2	586	3.26	187	140	8,054	9.77	561.75	4,702	270,330	5,508	316,692	2,407	138,381	5.97		
HPO Zone 3	425	24,076	8.5	480	4.02	228	140	7,943	9.67	548.16	4,686	265,682	5,493	311,410	2,391	135,548	5.87		
Effluent	9.83	327	8.5	282	4.02	134	0.15	5.0	0.06	1.99	3.19	106	3.74	125	2.58	86	5.87	564.34	3,206
Grit	30	0.08	24	0.06	0.06	0.00	4.0	0.01	2.95	0.01	189	0.47	203,895	510	247	0.62	6.91		
Primary Clar (U)	942	79	24	1.98	0.06	0.01	258	22	45	3.73	37,097	3,096	40,822	3,407	23,148	1,932	6.89		
Secondary Clar (U)	1,016	23,749	8.5	198	4.02	94	340	7,938	23.37	546.17	11,365	265,575	13,321	311,284	5,797	135,461	5.87		
Thickener	30	21	11	8.18	2.96	2.11	5.6	4.0	0.52	0.37	288	205	328	234	175	125	6.02		
Thickened Sludge	2,376	397	11	1.92	2.96	0.49	773	129	67	11.13	39,740	6,633	45,282	7,558	22,305	3,723	6.02		

Spring Modeling (March 2012 Flow & Load Basis)

Temp 11.8 ^{o}C

20% BOD Capacity Increase w/ 4 mg/L Infl TP 0.75 PO4:TP & 48% PC removal rate

SRT = 6.71 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (^{o}C)
HPO Zone 1	6.2	4,678	5,520	6,885	9.97	419.98	10.52	9.45	6.29	140.78	0.47	2,267	2.52	0.17	11.8
HPO Zone 2	6.2	4,663	5,506	6,856	7.81	417.7	7.69	6.64	8.02	140.78	0.22	2,249	1	0.17	11.8
HPO Zone 3	6.12	4,647	5,491	6,831	7.65	415.78	5.73	4.66	9.62	140.78	0.17	2,233	0.88	0.17	11.8
Raw Infl	3.34	186	216	492	193.76	30	25.61	24	0	4	3	248	132.34	0	11.8
Effluent	3.32	3.4	4.1	13	7.65	6.04	5.73	4.66	9.62	0.27	0.17	2.53	0.88	0	11.8
Grit Removal	3.41	189	204	492	190.6	29.95	25.3	23.7	0.14	4.05	2.96	247	130.11	0.04	11.8
Secondary Clar	3.32	3.4	4.1	13	7.65	6.04	5.73	4.66	9.62	0.27	0.17	2.53	0.88	0.63	11.8
Thickener	0.07	303	347	492	29.19	27.41	9.75	8.63	7.1	6.43	0.55	182	16.1	0.07	11.8
Primary Clar	3.4	98	109	348	190.6	27.73	25.3	23.7	0.14	3.4	2.65	191	130.1	0.59	11.8
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	3.41	189	209	492	190.6	29.95	25.3	23.7	0.14	4.05	2.65	247	130.1	0	11.8
Grit	0.00	189	169,941	492	190.6	29.95	25.3	23.7	0.14	4.05	2.96	247	130.11	0	11.8
Thickened Sludge (Waste)	0.02	32,056	36,737	49,040	29.19	1880.46	9.75	8.63	7.1	623.25	0.55	17,538	16.1	0	11.8
WAS Splitter	6.12	4,663	5,506	6,856	7.81	417.7	7.69	6.64	8.02	140.78	0.22	2,249	1	0	11.8

26% Flow Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 6.34 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (^{o}C)
HPO Zone 1	6.37	4,612	5,430	6,784	10.1	415.53	11.38	10.31	5.06	138.6	0.46	2,286	2.61	0.17	11.8
HPO Zone 2	6.37	4,596	5,416	6,756	7.84	413.43	8.68	7.63	6.5	138.6	0.19	2,269	1.02	0.17	11.8
HPO Zone 3	6.29	4,581	5,401	6,730	7.68	411.63	6.77	5.7	7.85	138.6	0.11	2,253	0.9	0.17	11.8
Raw Infl	3.51	186	216	492	193.76	30	25.61	24	0	4	3	248	132.34	0	11.8
Effluent	3.49	3.3	3.9	13	7.68	7.07	6.77	5.7	7.85	0.21	0.11	2.53	0.9	0	11.8
Grit Removal	3.58	189	204	492	190.41	29.95	25.3	23.7	0.12	4.04	2.96	247	129.98	0.04	11.8
Secondary Clar	3.49	3.3	3.9	13	7.68	7.07	6.77	5.7	7.85	0.21	0.11	2.53	0.9	0.63	11.8
Thickener	0.07	292	334	473	27.62	27.62	10.48	9.37	5.81	6.18	0.5	176	14.99	0.07	11.8
Primary Clar	3.57	98	109	347	190.41	27.73	25.3	23.7	0.12	3.4	2.67	191	129.97	0.59	11.8
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	3.58	189	209	492	190.41	29.95	25.3	23.7	0.12	4.04	2.67	247	129.97	0	11.8
Grit	0.00	189	178,431	492	190.41	29.95	25.3	23.7	0.12	4.04	2.96	247	129.98	0	11.8
Thickened Sludge (Waste)	0.02	34,081	38,998	52,097	27.62	2014.23	10.48	9.37	5.81	664.91	0.5	18,826	14.99	0	11.8
WAS Splitter	6.29	4,596	5,416	6,756	7.84	413.43	8.68	7.63	6.5	138.6	0.19	2,269	1.02	0	11.8

32% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 6.00 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (^{o}C)
HPO Zone 1	6.54	4,733	5,562	6,961	10.14	426.64	11.69	10.61	4.67	141.8	0.47	2,363	2.64	0.17	11.8
HPO Zone 2	6.54	4,717	5,548	6,932	7.85	424.56	8.97	7.92	6.05	141.8	0.19	2,346	1.03	0.17	11.8
HPO Zone 3	6.46	4,701	5,532	6,906	7.69	422.77	7.05	5.98	7.34	141.8	0.11	2,329	0.91	0.17	11.8
Raw Infl	3.68	186	216	492	193.76	30	25.61	24	0	4	3	248	132.34	0	11.8
Effluent	3.66	3.3	3.9	13	7.69	7.35	7.05	5.98	7.34	0.21	0.11	2.56	0.91	0	11.8
Grit Removal	3.75	189	204	492	190.45	29.96	25.31	23.71	0.11	4.05	2.96	247	130	0.04	11.8
Secondary Clar	3.66	3.3	3.9	13	7.69	7.35	7.05	5.98	7.34	0.21	0.11	2.56	0.91	0.63	11.8
Thickener	0.07	297	340	481	27.16	28.21	10.7	9.59	5.43	6.28	0.5	179	14.66	0.07	11.8
Primary Clar	3.74	98	109	348	190.45	27.74	25.31	23.71	0.11	3.41	2.68	191	130	0.59	11.8
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	3.75	189	209	492	190.45	29.96	25.31	23.71	0.11	4.05	2.68	247	130	0	11.8
Grit	0.00	189	186,916	492	190.45	29.96	25.31	23.71	0.11	4.05	2.96	247	130	0	11.8
Thickened Sludge (Waste)	0.02	35,838	40,944	54,770	27.16	2122.5	10.7	9.59	5.43	697.32	0.5	19,859	14.66	0	11.8
WAS Splitter	6.46	4,717	5,548	6,932	7.85	424.56	8.97	7.92	6.05	141.8	0.19	2,346	1.03	0	11.8

Spring Modeling (March 2012 Flow & Load Basis)

Temp 11.8 °C

38% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 5.67 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	6.72	4,738	5,559	6,968	10.24	428.12	12.36	11.29	3.8	141.74	0.48	2,400	2.71	0.17	11.8
HPO Zone 2	6.72	4,723	5,545	6,939	7.88	426.18	9.75	8.7	4.96	141.74	0.18	2,383	1.04	0.17	11.8
HPO Zone 3	6.63	4,707	5,529	6,912	7.72	424.49	7.89	6.81	6.04	141.74	0.08	2,367	0.93	0.17	11.8
Raw Infl	3.85	186	216	492	193.76	30	25.61	24	0	4	3	248	132.34	0	11.8
Effluent	3.83	3.3	3.8	13	7.72	8.18	7.89	6.81	6.04	0.17	0.08	2.57	0.93	0	11.8
Grit Removal	3.93	189	204	492	190.36	29.97	25.32	23.72	0.09	4.04	2.96	247	129.94	0.04	11.8
Secondary Clar	3.83	3.3	3.8	13	7.72	8.18	7.89	6.81	6.04	0.17	0.08	2.57	0.93	0.63	11.8
Thickener	0.08	293	335	474	26.19	28.68	11.31	10.21	4.47	6.18	0.47	177	13.98	0.07	11.8
Primary Clar	3.92	98	109	347	190.36	27.74	25.32	23.72	0.09	3.42	2.7	191	129.94	0.59	11.8
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	3.93	189	208	492	190.36	29.97	25.32	23.72	0.09	4.04	2.7	247	129.94	0	11.8
Grit	0.00	189	195,408	492	190.36	29.97	25.32	23.72	0.09	4.04	2.96	247	129.94	0	11.8
Thickened Sludge (Waste)	0.02	37,775	43,101	57,702	26.19	2247.76	11.31	10.21	4.47	735.86	0.47	21,065	13.98	0	11.8
WAS Splitter	6.63	4,723	5,545	6,939	7.88	426.18	9.75	8.7	4.96	141.74	0.18	2,383	1.04	0	11.8

44% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 5.34 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	6.89	4,717	5,524	6,936	10.51	427.75	13.59	12.52	2.48	140.09	0.03	2,425	2.9	0.17	11.8
HPO Zone 2	6.89	4,702	5,508	6,907	7.95	426.12	11.24	10.19	3.26	140.09	0.04	2,407	1.09	0.17	11.8
HPO Zone 3	6.79	4,686	5,493	6,880	7.75	424.65	9.54	8.47	4.02	140.09	0.04	2,391	0.96	0.17	11.8
Raw Infl	4.01	186	216	492	193.76	30	25.61	24	0	4	3	248	132.34	0	11.8
Effluent	3.99	3.2	3.7	12	7.75	9.83	9.54	8.47	4.02	0.15	0.05	2.58	0.96	0	11.8
Grit Removal	4.1	189	204	491	190.25	29.99	25.34	23.74	0.06	4.03	2.95	247	129.86	0.04	11.8
Secondary Clar	3.99	3.2	3.7	12	7.75	9.83	9.54	8.47	4.02	0.15	0.05	2.58	0.96	0.63	11.8
Thickener	0.09	288	328	465	25.25	29.7	12.58	11.48	2.96	5.64	0.03	175	13.32	0.07	11.8
Primary Clar	4.09	98	109	347	190.25	27.76	25.33	23.74	0.06	3.41	2.7	191	129.86	0.59	11.8
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	4.1	189	208	491	190.25	29.99	25.33	23.74	0.06	4.03	2.7	247	129.86	0	11.8
Grit	0.00	189	203,895	491	190.25	29.99	25.34	23.74	0.06	4.03	2.95	247	129.86	0	11.8
Thickened Sludge (Waste)	0.02	39,740	45,282	60,675	25.25	2376.07	12.58	11.48	2.96	773.08	0.03	22,305	13.32	0	11.8
WAS Splitter	6.79	4,702	5,508	6,907	7.95	426.12	11.24	10.19	3.26	140.09	0.04	2,407	1.09	0	11.8

Spring Modeling (March 2012 Flow & Load Basis)

Temp 11.8 ^{o}C

20% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC remova SRT = 6.71 Days

Elements	Total solids mass [lb]	PolyP heterotrophs [lb COD/d]	Non-polyP heterotrophs [lb COD/d]	Ammonia oxidizing biomass [lb COD/d]	Nitrite oxidizing biomass [lb COD/d]	Endogenous products [lb COD/d]	Total Biomass (lb COD/d)	Carbonaceous OUR [lb/d]	Nitrogenous OUR [lb/d]	Total oxygen uptake rate [lb/d]
HPO Zone 1	8,039	38	193,949	2,287	1,078	51,848	197,351	2,431	565	2,996
HPO Zone 2	8,018	38	194,232	2,296	1,082	52,063	197,648	1,480	483	1,963
HPO Zone 3	7,996	37	191,876	2,274	1,072	51,644	195,259	1,343	408	1,751
	% Comp	0.019%	98.272%	1.162%	0.548%	--	--	78.3%	21.7%	6,709

26% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC remova SRT = 6.34 Days

Elements	Total solids mass [lb]	PolyP heterotrophs [lb COD/d]	Non-polyP heterotrophs [lb COD/d]	Ammonia oxidizing biomass [lb COD/d]	Nitrite oxidizing biomass [lb COD/d]	Endogenous products [lb COD/d]	Total Biomass (lb COD/d)	Carbonaceous OUR [lb/d]	Nitrogenous OUR [lb/d]	Total oxygen uptake rate [lb/d]
HPO Zone 1	8,068	39	203,714	2,249	1,001	51,394	207,003	2,523	546	3,068
HPO Zone 2	8,047	39	204,038	2,258	1,005	51,614	207,340	1,531	471	2,001
HPO Zone 3	8,025	38	201,521	2,236	996	51,185	204,791	1,391	402	1,793
	% Comp	0.019%	98.407%	1.089%	0.485%	--	--	79.3%	20.7%	6,863

32% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC remov SRT = 6.00 Days

Elements	Total solids mass [lb]	PolyP heterotrophs [lb COD/d]	Non-polyP heterotrophs [lb COD/d]	Ammonia oxidizing biomass [lb COD/d]	Nitrite oxidizing biomass [lb COD/d]	Endogenous products [lb COD/d]	Total Biomass (lb COD/d)	Carbonaceous OUR [lb/d]	Nitrogenous OUR [lb/d]	Total oxygen uptake rate [lb/d]
HPO Zone 1	8,099	41	213,501	2,190	909	51,008	216,640	2,613	521	3,134
HPO Zone 2	8,079	41	213,868	2,199	913	51,232	217,020	1,580	453	2,034
HPO Zone 3	8,056	40	211,188	2,177	904	50,794	214,309	1,439	391	1,830
	% Comp	0.019%	98.547%	1.013%	0.421%	--	--	80.5%	19.5%	6,998

38% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC remov SRT = 5.67 Days

Elements	Total solids mass [lb]	PolyP heterotrophs [lb COD/d]	Non-polyP heterotrophs [lb COD/d]	Ammonia oxidizing biomass [lb COD/d]	Nitrite oxidizing biomass [lb COD/d]	Endogenous products [lb COD/d]	Total Biomass (lb COD/d)	Carbonaceous OUR [lb/d]	Nitrogenous OUR [lb/d]	Total oxygen uptake rate [lb/d]
HPO Zone 1	8,095	42	222,638	2,079	785	50,213	225,544	2,699	484	3,184
HPO Zone 2	8,074	42	223,052	2,088	788	50,441	225,970	1,626	426	2,052
HPO Zone 3	8,052	41	220,202	2,067	781	49,995	223,091	1,484	370	1,853
	% Comp	0.019%	98.708%	0.924%	0.349%	--	--	81.9%	18.1%	7,089

44% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC remov SRT = 5.34 Days

Elements	Total solids mass [lb]	PolyP heterotrophs [lb COD/d]	Non-polyP heterotrophs [lb COD/d]	Ammonia oxidizing biomass [lb COD/d]	Nitrite oxidizing biomass [lb COD/d]	Endogenous products [lb COD/d]	Total Biomass (lb COD/d)	Carbonaceous OUR [lb/d]	Nitrogenous OUR [lb/d]	Total oxygen uptake rate [lb/d]
HPO Zone 1	8,044	43	230,909	1,776	554	48,978	233,282	2,777	391	3,169
HPO Zone 2	8,022	43	231,378	1,784	556	49,208	233,762	1,671	355	2,026
HPO Zone 3	7,999	42	228,352	1,766	551	48,757	230,711	1,525	320	1,844
	% Comp	0.018%	98.980%	0.763%	0.238%	--	--	84.9%	15.1%	7,039

Summer Modeling Results

Summer Modeling (March 2012 Flow & Load Basis)

Temp 20 °C Typical Summer Temp at Oak Orchard

20% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 7.17 Days

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD			Total WWTP Compliance	
																		Total NH3	Total UOD
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH	lb/d	lb/d
Raw Infl	30	837	24	670	0.00	0.00	4.0	112	3.00	84	186	5,204	216	6,043	248	6,934	7.01		
Primary Clar	28	784	24	670	0.25	7.00	3.4	96	2.82	80	98	2,789	109	3,093	191	5,420	6.86		
HPO Zone 1	409	21,148	5	246	12.40	641	137	7,081	10.26	530.25	4,637	239,749	5,458	282,214	2,049	105,955	5.81		
HPO Zone 2	406	20,984	1.2	62	15.84	819	137	7,081	10.10	522.15	4,620	238,869	5,442	281,387	2,031	104,990	5.59		
HPO Zone 3	405	20,685	0.2	12	17.56	897	137	7,001	10.15	518.99	4,603	235,278	5,425	277,304	2,013	102,912	5.51		
Effluent	**1.61**	**45**	**0.2**	**7**	**17.56**	**487**	**0.55**	**15.3**	**0.46**	**12.69**	**3.39**	**94**	**4.00**	**111**	**2.30**	**64**	**5.51**	13.08	594
Grit	30	0.07	24	0.06	0.25	0.00	**4.1**	**0.01**	2.97	0.01	189	0.47	169,938	425	247	0.62	6.91		
Primary Clar (U)	782	65	24	1.97	0.25	0.02	**229**	**19**	53	4.41	30,844	2,574	34,212	2,855	19,241	1,606	6.86		
Secondary Clar (U)	883	20,640	0.2	6	17.56	410	299	6,986	21.67	506.29	10,065	235,184	11,863	277,193	4,401	102,849	5.51		
Thickener	23	12	4	2.01	13.90	7.02	6.6	3.3	1.30	0.66	314	159	360	182	183	92	5.75		
Thickened Sludge (Waste)	1,753	293	4	0.67	13.90	2.32	577	96	58	9.69	30,762	5,134	35,205	5,876	16,229	2,709	5.75		

32% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 6.51 Days

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD			Total WWTP Compliance	
																		Total NH3	Total UOD
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH	lb/d	lb/d
Raw Infl	30	921	24	737	0.00	0.00	4.0	123	3.00	92	186	5,725	216	6,647	248	7,627	7.01		
Primary Clar	28	862	24	737	0.25	7.71	3.4	106	2.84	89	98	3,069	109	3,393	191	5,963	6.87		
HPO Zone 1	420	22,933	5	280	11.86	647	140	7,625	9.62	524.79	4,751	259,198	5,569	303,841	2,170	118,393	5.83		
HPO Zone 2	417	22,753	1.4	75	15.37	838	140	7,625	9.44	514.90	4,734	258,258	5,553	302,964	2,151	117,358	5.61		
HPO Zone 3	416	22,414	0.3	14	17.26	930	140	7,534	9.47	510.36	4,717	254,244	5,536	298,419	2,134	115,013	5.52		
Effluent	**1.63**	**50**	**0.3**	**8**	**17.26**	**527**	**0.50**	**15.2**	**0.41**	**12.40**	**3.33**	**102**	**3.91**	**119**	**2.34**	**72**	**5.52**	15.8	662
Grit	30	0.07	24	0.06	0.25	0.00	**4.1**	**0.01**	2.97	0.01	189	0.47	186,913	468	247	0.62	6.90		
Primary Clar (U)	860	72	24	1.97	0.25	0.02	**245**	**20**	51	4.28	33,943	2,833	37,533	3,132	21,167	1,766	6.87		
Secondary Clar (U)	957	22,364	0.3	6	17.26	403	322	7,519	21.31	497.96	10,876	254,143	12,766	298,300	4,919	114,941	5.52		
Thickener	23	13	4	2.21	13.65	7.73	6.5	3.7	1.20	0.68	313	177	357	202	183	103	5.75		
Thickened Sludge (Waste)	1,976	330	4	0.65	13.65	2.28	645	108	58	9.74	34,344	5,732	39,177	6,539	18,341	3,061	5.75		

44% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 5.84 Days

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD			Total WWTP Compliance	
																		Total NH3	Total UOD
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH	lb/d	lb/d
Raw Infl	30	1,005	24	804	0.00	0.00	4.0	134	3.00	100	186	6,245	216	7,251	248	8,320	7.01		
Primary Clar	28	941	24	804	0.25	8.51	3.4	116	2.85	97	98	3,349	108	3,694	191	6,508	6.88		
HPO Zone 1	425	24,417	6	319	11.28	647	141	8,077	9.14	524.82	4,790	275,050	5,597	321,387	2,264	130,008	5.86		
HPO Zone 2	422	24,221	1.6	93	14.79	849	141	8,077	8.93	512.84	4,773	274,058	5,581	320,472	2,245	128,913	5.63		
HPO Zone 3	420	23,837	0.3	17	16.89	958	141	7,975	8.93	506.37	4,755	269,603	5,564	315,441	2,227	126,280	5.53		
Effluent	**1.66**	**55**	**0.3**	**10**	**16.89**	**563**	**0.42**	**14.1**	**0.33**	**11.15**	**3.24**	**108**	**3.79**	**126**	**2.37**	**79**	**5.53**	19.94	736
Grit	30	0.07	24	0.06	0.25	0.00	**4.0**	**0.01**	2.96	0.01	189	0.47	203,891	510	247	0.62	6.90		
Primary Clar (U)	937	78	24	1.97	0.25	0.02	**262**	**22**	50	4.16	37,048	3,092	40,861	3,410	23,098	1,928	6.88		
Secondary Clar (U)	1,018	23,782	0.3	7	16.89	395	341	7,961	21.19	495.22	11,533	269,495	13,494	315,315	5,401	126,201	5.53		
Thickener	23	15	4	2.49	13.29	8.53	6.4	4.1	1.09	0.70	306	197	348	224	180	116	5.76		
Thickened Sludge	2,215	370	4	0.65	13.29	2.22	718	120	60	9.94	38,096	6,358	43,350	7,235	20,617	3,441	5.76		

56% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 5.21 Days

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD			Total WWTP Compliance	
																		Total NH3	Total UOD
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH	lb/d	lb/d
Raw Infl	30	1,089	24	871	0.00	0.00	4.0	145	3.00	109	186	6,765	216	7,856	248	9,014	7.01		
Primary Clar	28	1,020	24	872	0.25	9.35	3.4	126	2.86	106	98	3,631	108	3,995	191	7,052	6.88		
HPO Zone 1	425	25,653	6	363	10.65	642	140	8,455	8.79	529.97	4,776	288,000	5,566	335,672	2,334	140,736	5.88		
HPO Zone 2	422	25,443	1.9	116	14.11	851	140	8,455	8.55	515.65	4,759	286,966	5,551	334,729	2,315	139,587	5.66		
HPO Zone 3	420	25,009	0.4	22	16.45	979	140	8,341	8.52	506.74	4,741	282,051	5,534	329,193	2,297	136,649	5.55		
Effluent	**1.72**	**62**	**0.4**	**13**	**16.45**	**594**	**0.34**	**12.2**	**0.25**	**9.07**	**3.12**	**113**	**3.65**	**132**	**2.40**	**87**	**5.55**	26.32	819
Grit	30	0.07	24	0.06	0.25	0.00	**4.0**	**0.01**	2.96	0.01	189	0.47	220,870	553	247	0.62	6.90		
Primary Clar (U)	1,015	85	24	1.97	0.25	0.02	**279**	**23**	48	4.03	40,157	3,351	44,192	3,688	25,033	2,089	6.88		
Secondary Clar (U)	1,068	24,947	0.4	9	16.45	384	356	8,329	21.30	497.68	12,066	281,938	14,082	329,061	5,844	136,563	5.55		
Thickener	22	16	4	2.88	12.82	9.37	6.2	4.5	0.98	0.72	297	217	337	246	176	128	5.77		
Thickened Sludge	2,468	412	4	0.66	12.82	2.14	797	133	62	10.27	41,999	7,010	47,702	7,962	23,042	3,846	5.77		

68% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP)

SRT = 4.63 Days

	TKN		Ammonia N		Nitrate N		Total P		PO_4-P (Sol. & Me Complexed)		VSS		TSS		Total CBOD			Total WWTP Compliance	
																		Total NH3	Total UOD
Elements	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgN/L]	[lb N/d]	[mgP/L]	[lb P/d]	[mgP/L]	[lb P/d]	[mgVSS/L]	[lb VSS/d]	[mgTSS/L]	[lb TSS/d]	[mg/L]	[lb /d]	pH	lb/d	lb/d
Raw Infl	30	1,172	24	938	0.00	0.00	4.0	156	3.00	117	186	7,286	216	8,460	248	9,707	7.01		
Primary Clar	28	1,100	24	939	0.26	10.17	3.4	137	2.86	114	98	3,912	108	4,297	191	7,598	6.89		
HPO Zone 1	421	26,616	7	413	9.94	628	138	8,749	8.52	538.76	4,712	297,796	5,481	346,400	2,378	150,281	5.91		
HPO Zone 2	418	26,395	2.3	147	13.28	840	138	8,749	8.26	521.82	4,695	296,730	5,466	345,441	2,359	149,087	5.69		
HPO Zone 3	416	25,905	0.5	30	15.85	987	138	8,622	8.19	509.95	4,678	291,335	5,449	339,377	2,341	145,826	5.56		
Effluent	**1.82**	**71**	**0.5**	**19**	**15.85**	**617**	**0.24**	**9.4**	**0.16**	**6.11**	**2.99**	**117**	**3.49**	**136**	**2.42**	**94**	**5.56**	37.02	921
Grit	30	0.07	24	0.06	0.26	0.00	**4.0**	**0.01**	2.96	0.01	188	0.47	237,854	596	247	0.62	6.90		
Primary Clar (U)	1,094	91	24	1.97	0.26	0.02	**296**	**25**	47	3.89	43,272	3,611	47,529	3,966	26,973	2,251	6.89		
Secondary Clar (U)	1,106	25,834	0.5	11	15.85	370	369	8,612	21.56	503.83	12,463	291,219	14,518	339,241	6,237	145,732	5.56		
Thickener	22	18	4	3.43	12.20	10.19	5.9	4.9	0.87	0.73	285	238	323	270	170	142	5.78		
Thickened Sludge	2,736	457	4	0.68	12.20	2.04	880	147	64	10.75	46,065	7,689	52,243	8,720	25,625	4,277	5.78		

Summer Modeling (March 2012 Flow & Load Basis)

Temp 20 °C Typical Summer Temp at Oak Orchard

20% BOD Capacity Increase w/ 4 mg/L Infl TP 0.75 PO4:TP & 48% PC removal rate

SRT = 7.17 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	6.2	4,637	**5,458**	6,835	9.64	409.04	5.81	4.75	12.4	136.97	0.57	2,049	2.29	0.17	20
HPO Zone 2	6.2	4,620	**5,442**	6,805	7.73	405.86	2.25	1.2	15.84	136.97	0.38	2,031	0.94	0.17	20
HPO Zone 3	6.12	4,603	**5,425**	6,777	7.55	404.68	1.31	0.24	17.56	136.97	0.45	2,013	0.82	0.17	20
Raw Infl	**3.34**	**186**	**216**	**492**	**193.76**	**30**	**25.61**	**24**	**0**	**4**	**3**	**248**	**132.34**	**0**	**20**
Effluent	**3.32**	**3.4**	**4.0**	**13**	**7.55**	**1.61**	**1.31**	**0.24**	**17.56**	**0.55**	**0.45**	**2.30**	**0.82**	**0**	**20**
Grit Removal	3.41	189	204	492	190.86	29.87	25.24	23.64	0.25	4.05	2.97	247	130.29	0.04	20
Secondary Clar	3.32	3.4	4.0	13	7.55	1.61	1.31	0.24	17.56	0.55	0.45	2.30	0.82	0.63	20
Thickener	0.06	314	360	512	30.47	22.97	5.1	3.99	13.9	6.61	0.71	183	17	0.07	20
Primary Clar	3.4	98	109	348	190.85	27.66	25.24	23.64	0.25	3.38	2.66	191	130.29	0.59	20
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	3.41	189	209	492	190.85	29.87	25.24	23.64	0.25	4.05	2.66	247	130.29	0	20
Grit	0.00	189	169,938	492	190.86	29.87	25.24	23.64	0.25	4.05	2.97	247	130.29	0	20
Thickened Sludge (Waste)	0.02	30,762	35,205	47,181	30.47	1752.89	5.1	3.99	13.9	577.36	0.71	16,229	17	0	20
WAS Splitter	6.12	4,620	5,442	6,805	7.73	405.86	2.25	1.2	15.84	136.97	0.38	2,031	0.94	0	20

32% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 6.51 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	6.54	4,751	**5,569**	6,999	9.74	420.37	6.19	5.13	11.86	139.76	0.58	2,170	2.36	0.17	20
HPO Zone 2	6.54	4,734	**5,553**	6,968	7.75	417.06	2.42	1.38	15.37	139.76	0.36	2,151	0.96	0.17	20
HPO Zone 3	6.46	4,717	**5,536**	6,940	7.58	415.8	1.34	0.26	17.26	139.76	0.4	2,134	0.84	0.17	20
Raw Infl	**3.68**	**186**	**216**	**492**	**193.76**	**30**	**25.61**	**24**	**0**	**4**	**3**	**248**	**132.34**	**0**	**20**
Effluent	**3.66**	**3.3**	**3.9**	**12**	**7.58**	**1.63**	**1.34**	**0.26**	**17.26**	**0.5**	**0.4**	**2.34**	**0.84**	**0**	**20**
Grit Removal	3.75	189	204	492	190.77	29.87	25.23	23.64	0.25	4.05	2.97	247	130.23	0.04	20
Secondary Clar	3.66	3.3	3.9	12	7.58	1.63	1.34	0.26	17.26	0.5	0.4	2.34	0.84	0.63	20
Thickener	0.07	313	357	508	28.58	22.98	5.02	3.91	13.65	6.54	0.67	183	15.67	0.07	20
Primary Clar	3.74	98	109	348	190.77	27.65	25.23	23.64	0.25	3.4	2.7	191	130.22	0.59	20
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	3.75	189	209	492	190.77	29.87	25.23	23.64	0.25	4.05	2.7	247	130.22	0	20
Grit	0.00	189	186,913	492	190.77	29.87	25.23	23.64	0.25	4.05	2.97	247	130.23	0	20
Thickened Sludge (Waste)	0.02	34,344	39,177	52,620	28.58	1975.87	5.02	3.91	13.65	644.71	0.67	18,341	15.67	0	20
WAS Splitter	6.46	4,734	5,553	6,968	7.75	417.06	2.42	1.38	15.37	139.76	0.36	2,151	0.96	0	20

44% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 5.84 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	6.88	4,790	**5,597**	7,051	9.87	425.22	6.62	5.56	11.28	140.67	0.58	2,264	2.45	0.17	20
HPO Zone 2	6.88	4,773	**5,581**	7,020	7.79	421.81	2.66	1.61	14.79	140.67	0.33	2,245	0.98	0.17	20
HPO Zone 3	6.79	4,755	**5,564**	6,992	7.61	420.43	1.38	0.3	16.89	140.67	0.33	2,227	0.86	0.17	20
Raw Infl	**4.01**	**186**	**216**	**492**	**193.76**	**30**	**25.61**	**24**	**0**	**4**	**3**	**248**	**132.34**	**0**	**20**
Effluent	**3.99**	**3.2**	**3.8**	**12**	**7.61**	**1.66**	**1.38**	**0.3**	**16.89**	**0.42**	**0.33**	**2.37**	**0.86**	**0**	**20**
Grit Removal	4.09	189	204	492	190.62	29.86	25.22	23.62	0.25	4.04	2.96	247	130.12	0.04	20
Secondary Clar	3.99	3.2	3.8	12	7.61	1.66	1.38	0.3	16.89	0.42	0.33	2.37	0.86	0.63	20
Thickener	0.08	306	348	495	26.64	22.75	4.99	3.88	13.29	6.38	0.62	180	14.3	0.07	20
Primary Clar	4.08	98	108	348	190.61	27.64	25.22	23.62	0.25	3.41	2.72	191	130.12	0.59	20
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	4.09	189	208	492	190.61	29.86	25.22	23.62	0.25	4.04	2.72	247	130.12	0	20
Grit	0.00	189	203,891	492	190.62	29.86	25.22	23.62	0.25	4.04	2.96	247	130.12	0	20
Thickened Sludge (Waste)	0.02	38,096	43,350	58,304	26.64	2214.9	4.99	3.88	13.29	718	0.62	20,617	14.3	0	20
WAS Splitter	6.79	4,773	5,581	7,020	7.79	421.81	2.66	1.61	14.79	140.67	0.33	2,245	0.98	0	20

Summer Modeling (March 2012 Flow & Load Basis)

Temp 20 °C Typical Summer Temp at Oak Orchard

56% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 5.21 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	7.23	4,776	**5,566**	7,026	10.03	425.41	7.09	6.02	10.65	140.21	0.57	2,334	2.56	0.17	20
HPO Zone 2	7.23	4,759	**5,551**	6,995	7.82	421.93	2.98	1.92	14.11	140.21	0.28	2,315	1.01	0.17	20
HPO Zone 3	7.13	4,741	**5,534**	6,966	7.65	420.41	1.45	0.36	16.45	140.21	0.25	2,297	0.89	0.17	20
Raw Infl	**4.35**	**186**	**216**	**492**	**193.76**	**30**	**25.61**	**24**	**0**	**4**	**3**	**248**	**132.34**	**0**	**20**
Effluent	**4.33**	**3.1**	**3.7**	**12**	**7.65**	**1.72**	**1.45**	**0.36**	**16.45**	**0.34**	**0.25**	**2.40**	**0.89**	**0**	**20**
Grit Removal	4.44	189	204	492	190.43	29.85	25.2	23.6	0.25	4.04	2.96	247	129.99	0.04	20
Secondary Clar	4.33	3.1	3.7	12	7.65	1.72	1.45	0.36	16.45	0.34	0.25	2.40	0.89	0.63	20
Thickener	0.09	297	337	478	24.8	22.44	5.04	3.94	12.82	6.17	0.55	176	13	0.07	20
Primary Clar	4.43	98	108	347	190.42	27.62	25.2	23.6	0.25	3.42	2.75	191	129.98	0.59	20
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	4.44	189	208	492	190.42	29.85	25.2	23.6	0.25	4.04	2.75	247	129.98	0	20
Grit	0.00	189	220,870	492	190.43	29.85	25.2	23.6	0.25	4.04	2.96	247	129.99	0	20
Thickened Sludge (Waste)	0.02	41,999	47,702	64,208	24.8	2468.09	5.04	3.94	12.82	796.51	0.55	23,042	13	0	20
WAS Splitter	7.13	4,759	5,551	6,995	7.82	421.93	2.98	1.92	14.11	140.21	0.28	2,315	1.01	0	20

68% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC removal rate

SRT = 4.63 Days

HPO Aer DO = 10.0 mg/L

Element name	Flow (MGD)	VSS (mg/L)	TSS (mg/L)	Total COD (mg/L)	Filtered COD (mg/L)	TKN (mg/L)	Filtered TKN (mg/L)	Ammonia N (mg/L)	Nitrate N (mg/L)	Total P (mg/L)	Soluble PO4-P (mg/L)	Total CBOD (mg/L)	Filtered CBOD (mg/L)	Volume (MG)	Temperature (°C)
HPO Zone 1	7.57	4,712	**5,481**	6,928	10.21	421.14	7.61	6.53	9.94	138.43	0.55	2,378	2.7	0.17	20
HPO Zone 2	7.57	4,695	**5,466**	6,897	7.87	417.64	3.38	2.33	13.28	138.43	0.23	2,359	1.04	0.17	20
HPO Zone 3	7.46	4,678	**5,449**	6,869	7.7	415.94	1.56	0.48	15.85	138.43	0.15	2,341	0.92	0.17	20
Raw Infl	**4.68**	**186**	**216**	**492**	**193.76**	**30**	**25.61**	**24**	**0**	**4**	**3**	**248**	**132.34**	**0**	**20**
Effluent	**4.66**	**3.0**	**3.5**	**12**	**7.7**	**1.82**	**1.56**	**0.48**	**15.85**	**0.24**	**0.15**	**2.42**	**0.92**	**0**	**20**
Grit Removal	4.78	188	204	491	190.19	29.83	25.18	23.58	0.26	4.04	2.96	247	129.82	0.04	20
Secondary Clar	4.66	3.0	3.5	12	7.7	1.82	1.56	0.48	15.85	0.24	0.15	2.42	0.92	0.63	20
Thickener	0.1	285	323	457	23.05	22.07	5.2	4.1	12.2	5.91	0.48	170	11.76	0.07	20
Primary Clar	4.77	98	108	347	190.19	27.6	25.18	23.58	0.26	3.43	2.76	191	129.81	0.59	20
Alum	0.00	0	0	0	0	0	0	0	0	0	0	0.00	0	0	20
Pri Clar Coag Feed Pt	4.78	188	207	491	190.19	29.83	25.18	23.58	0.26	4.04	2.76	247	129.81	0	20
Grit	0.00	188	237,854	491	190.19	29.83	25.18	23.58	0.26	4.04	2.96	247	129.82	0	20
Thickened Sludge (Waste)	0.02	46,065	52,243	70,347	23.05	2736.12	5.2	4.1	12.2	880.49	0.48	25,625	11.76	0	20
WAS Splitter	7.46	4,695	5,466	6,897	7.87	417.64	3.38	2.33	13.28	138.43	0.23	2,359	1.04	0	20

Summer Modeling (March 2012 Flow & Load Basis)

Temp 20 ^{o}C Typical Summer Temp at Oak Orchard

20% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC remov

SRT = 7.17 Days

Elements	Total solids mass [lb]	PolyP heterotrophs [lb COD/d]	Non-polyP heterotrophs [lb COD/d]	Ammonia oxidizing biomass [lb COD/d]	Nitrite oxidizing biomass [lb COD/d]	Endogenous products [lb COD/d]	**Total Biomass (lb COD/d)**	Carbonaceous OUR [lb/d]	Nitrogenous OUR [lb/d]	Total oxygen uptake rate [lb/d]
HPO Zone 1	7,949	39	174,268	2,941	1,771	63,046	**179,018**	2,593	1,142	3,735
HPO Zone 2	7,926	39	174,411	2,951	1,779	63,291	**179,180**	1,592	728	2,320
HPO Zone 3	7,901	38	172,233	2,913	1,758	62,815	**176,942**	1,422	298	1,720
	% Comp	**0.022%**	**97.341%**	**1.645%**	**0.992%**	**--**	**--**	**72.1%**	**27.9%**	**7,775**

32% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC remov

SRT = 6.51 Days

Elements	Total solids mass [lb]	PolyP heterotrophs [lb COD/d]	Non-polyP heterotrophs [lb COD/d]	Ammonia oxidizing biomass [lb COD/d]	Nitrite oxidizing biomass [lb COD/d]	Endogenous products [lb COD/d]	**Total Biomass (lb COD/d)**	Carbonaceous OUR [lb/d]	Nitrogenous OUR [lb/d]	Total oxygen uptake rate [lb/d]
HPO Zone 1	8,111	42	194,618	3,210	1,930	63,852	**199,800**	2,800	1,212	4,012
HPO Zone 2	8,087	42	194,823	3,222	1,939	64,111	**200,027**	1,712	796	2,509
HPO Zone 3	8,062	42	192,357	3,180	1,917	63,606	**197,496**	1,535	337	1,873
	% Comp	**0.021%**	**97.401%**	**1.609%**	**0.969%**	**--**	**--**	**72.1%**	**27.9%**	**8,394**

44% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC remov

SRT = 5.84 Days

Elements	Total solids mass [lb]	PolyP heterotrophs [lb COD/d]	Non-polyP heterotrophs [lb COD/d]	Ammonia oxidizing biomass [lb COD/d]	Nitrite oxidizing biomass [lb COD/d]	Endogenous products [lb COD/d]	**Total Biomass (lb COD/d)**	Carbonaceous OUR [lb/d]	Nitrogenous OUR [lb/d]	Total oxygen uptake rate [lb/d]
HPO Zone 1	8,151	46	213,520	3,428	2,057	62,857	**219,051**	2,991	1,263	4,254
HPO Zone 2	8,127	45	213,803	3,443	2,067	63,127	**219,358**	1,820	858	2,678
HPO Zone 3	8,102	45	211,022	3,396	2,043	62,600	**216,507**	1,638	388	2,025
	% Comp	**0.021%**	**97.470%**	**1.568%**	**0.942%**	**--**	**--**	**72.0%**	**28.0%**	**8,957**

56% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC remov

SRT = 5.21 Days

Elements	Total solids mass [lb]	PolyP heterotrophs [lb COD/d]	Non-polyP heterotrophs [lb COD/d]	Ammonia oxidizing biomass [lb COD/d]	Nitrite oxidizing biomass [lb COD/d]	Endogenous products [lb COD/d]	**Total Biomass (lb COD/d)**	Carbonaceous OUR [lb/d]	Nitrogenous OUR [lb/d]	Total oxygen uptake rate [lb/d]
HPO Zone 1	8,106	48	230,850	3,597	2,149	60,664	**236,644**	3,168	1,295	4,463
HPO Zone 2	8,084	48	231,225	3,613	2,160	60,942	**237,046**	1,916	911	2,827
HPO Zone 3	8,059	47	228,106	3,564	2,135	60,397	**233,852**	1,730	449	2,179
	% Comp	**0.020%**	**97.546%**	**1.523%**	**0.911%**	**--**	**--**	**72.0%**	**28.0%**	**9,468**

68% BOD Capacity Increase w/ 4 mg/L Infl TP (0.75 PO_4:TP) & 48% PC remov

SRT = 4.63 Days

Elements	Total solids mass [lb]	PolyP heterotrophs [lb COD/d]	Non-polyP heterotrophs [lb COD/d]	Ammonia oxidizing biomass [lb COD/d]	Nitrite oxidizing biomass [lb COD/d]	Endogenous products [lb COD/d]	**Total Biomass (lb COD/d)**	Carbonaceous OUR [lb/d]	Nitrogenous OUR [lb/d]	Total oxygen uptake rate [lb/d]
HPO Zone 1	7,982	50	246,101	3,704	2,191	57,412	**252,046**	3,329	1,305	4,634
HPO Zone 2	7,960	50	246,582	3,723	2,202	57,695	**252,557**	1,999	951	2,950
HPO Zone 3	7,936	49	243,101	3,671	2,176	57,139	**248,997**	1,811	522	2,332
	% Comp	**0.020%**	**97.636%**	**1.473%**	**0.872%**	**--**	**--**	**72.0%**	**28.0%**	**9,917**

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