Engineering Report

Wastewater Treatment Facility Capacity Evaluation

Prepared For

SHOREWOOD FOREST UTILITIES, INC.

PORTER COUNTY | INDIANA

MAY 9, 2014

McM. No. S0560-540120.00

McMAHON ENGINEERS ARCHITECTS

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Table Of Contents

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I. INTRODUCTION

The Shorewood Forest Utilities Wastewater Treatment Facility has a permitted average design flow of 0.45 mgd. Facility Planning was completed in 2011, recommending 'phased' improvements to the Treatment Facility, which could potentially raise the design capacity to 0.5 mgd, if required. The average flow from the existing service area is projected at 0.442 mgd at build-out, as presented in the McMAHON report.

The initial phases of proposed Facility improvements included dissolved oxygen control of existing aeration blower (completed in 2013), and new primary treatment facilities, which are slated for construction in the summer of 2014. The proposed primary treatment facilities include a new influent Lift Station and two wastewater microscreens used to reduce influent loadings to the existing aeration basins. Subsequent proposed phased improvements include replacing the fine bubble aeration system in Aeration Basin #3, construction of a new Return Activated Waste (RAW) / Waste Activated Sludge (WAS) Pump Station, replacement of the tertiary filters, demolition of Aeration Basins #1 and #2, and construction of a redundant aeration basin and clarifier matching Aeration Basin #3 and its secondary clarifier.

The Wastewater Treatment Facility currently operates only its newer aeration basin (Aeration Basin #3) and secondary clarifier. Aeration Basins #1 and #2 could be used in an emergency, but would need to be replaced for continuous service. Aeration Basin #4 is currently out of service, but could be used on a continuous basis if needed.

The purpose of this Engineering Report is to summarize influent flows and loadings, and take inventory of Wastewater Treatment Facility capacity following construction of the new influent Lift Station and microscreening facilities to determine if there is available capacity that can be sold to future development. Wastewater Treatment Facility capacity was evaluated based on Ten State Standards and Indiana Department Of Environmental Management (IDEM) design requirements, and compared to current Wastewater Treatment Facility influent flows and loadings data on an Equivalent Dwelling Unit (EDU) basis.

II. DESIGN FLOWS & LOADING PROJECTIONS

Article 3 of the Indiana Administrative Code (327 IAC 3-6-11) establishes design flow rate requirements for collection systems and water pollution treatment/control facilities. It states that the calculated average and peak flow rates shall be at least equal to the average and peak daily flow rate of existing influent plus the flow from proposed additional service connections calculated as follows:

The flow rate requirements for the average daily flow rate for residential service connections may be determined by using a general average daily flow rate value. The following method shall be used to calculate average and peak flow rate values:

ADF = (General Avg.) x PRSC
PDF = ADF x PF

Where:

ADF =	Average daily flow rate expressed as gallons per residential service connection per day.
PDF =	Peak daily flow rate expressed as gallons per residential service connection per day.
General Avg. =	General average daily flow rate value in accordance with the following: 200 gpd/unit for 1 bedroom apartment 300 gpd/unit for 2 bedroom apartment 310 gpd/ unit for single-family homes
PRSC =	Proposed number of residential service connections
PF =	Peak daily factor of 4

The average daily flow can also be determined using flow calculation factors provided in Table 11-1 in subsection b., which establishes design flows for commercial establishments. Design loadings are not addressed in Article 3 of the IAC.

The Recommended Standards for Wastewater Facilities (Ten State Standards) requires wastewater facilities receiving flows from new wastewater collection systems to be based on an average daily flow of 100-gallons per capita plus wastewater flow from industrial plants and major institutional and commercial facilities, unless water use data or other justification, upon which to better estimate flow, is provided. In addition, the 100 gal/cap/day figure shall be used in conjunction with a peaking factor from a graph provided in the document. Ten State Standards also suggests that at least 0.17 pounds of BOD_5 per capita per day and 0.20-pounds of suspended solids per capita per day be used to predict loadings unless information is submitted to justify alternate designs. These

suggested values increase to 0.22-pounds of BOD_5 per capita per day and 0.25-pounds of suspended solids per capita per day where garbage grinders are commonly used.

Future Wastewater Treatment Facility design flows and loadings projections are commonly calculated based on historical data, when available, to justify use of alternative per capita or per customer criteria. Current Shorewood Forest Utilities customer and wastewater flows and loadings data over the past 3-years are summarized below and can be used to form the basis for determining available capacity for future customers at the Wastewater Treatment Facility.

III. CURRENT WASTEWATER TREATMENT FACILITY INFLUENT FLOWS & LOADINGS

The following is a summary of influent flows and loadings based on Wastewater Treatment Facility data for the years 2011 through 2013.

Parameter	2011	2012	2013	3-year Summary
Influent Flow, mgd				
▪ Average	0.169	0.156	0.170	0.165
▪ Maximum Month	0.192	0.173	0.220	0.220
▪ Maximum Day	0.451	0.295	0.413	0.451
BOD, mg/L (Average)	249	351	182	261
BOD, lbs./day				
▪ Average	343	437	245	342
▪ Maximum Month	528	529	470	529
▪ Maximum Day	2,138	1,179	718	2,138
TSS, mg/L (Average)	255	386	331	324
TSS, lbs./day				
▪ Average	351	479	454	428
▪ Maximum Month	616	562	550	616
▪ Maximum Day	3,247	1,228	1,136	3,247
NH3-N, mg/L (Average)	34	32	35	34
Total Phosphorus, mg/L (Average)	4	5	6	5

Influent flow averaged 0.165 mgd over the 3-year period. Influent Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) loadings varied significantly year to year over the 3-year period. Peaking factors for maximum month and maximum day loadings were very high compared to conventional peaking factors, which range from about 2:1 to 4:1 for maximum day to average ratios. Average influent BOD and TSS concentrations were generally higher than 2009 and 2010 data (218 mg/L BOD and 213 mg/L TSS). Ammonia and Phosphorus concentrations are in line with conventional parameters and previous Wastewater Treatment Facility data.

The Shorewood Forest Utilities Wastewater Treatment Facility currently serves a total service area divided into eight individual areas, which includes the Shelbourne Conference Center, the Shorewood Forest Clubhouse, and residential developments. A summary of existing wastewater customers or Equivalent Dwelling Units (EDU's) by area is as follows:

Serviced Area	2011 EDU's	2012 EDU's	2013 EDU's
Shelbourne*	20	20	20
Shorewood	853	851	855
Edgewood	21	25	27
Sagamore	14	19	29
Deer Creek	14	14	14
Arbor Lakes	9	13	17
Shorewood Forest Clubhouse	1	1	1
Section 29*	3	3	3
Total	**935**	**946**	**965**

*Assumed Values

Wastewater Treatment Facility influent flows and loadings on a per EDU basis can be summarized as follows:

Parameter	2011	2012	2013	3-Year Average
Avg. Flow, gal/EDU/day	180	165	177	174
Avg. BOD, lb./EDU/day	0.37	0.46	0.25	0.36
Avg. TSS, lb./EDU/day	0.38	0.51	0.47	0.45

It should be noted that 350-gallons per EDU per day has been used in past flow projections for the Service Area.

By comparing the 'per EDU' Wastewater Treatment Facility flows and loadings with recommended standards per capita flows and loadings, it can be estimated that there are an average of 1.7 persons/EDU.

IV. WASTEWATER TREATMENT FACILITY CAPACITY EVALUATION

The following is a summary of the Wastewater Treatment Facility's rated treatment capacity based on Ten State Standards and equipment design.

A. Influent Lift Station

The new influent Lift Station will be provided with three 15-HP submersible chopper pumps, each rated for 470 gpm (0.68 mgd) at 56-feet Total Dynamic Head (TDH). The pumps will be operated on Variable Frequency Drives (VFD's) to match influent flow. The Lift Station is expected to have an ultimate capacity exceeding 938 gpm (1.35 mgd) with two pumps running.

B. Microscreens

The two new microscreens will have rated peak capacity of 468 gpm, each (1.35 mgd total) at 300 mg/L of influent TSS. However, the microscreen Manufacturer has stated that the screens being provided will be able to handle up to 521 gpm, each. The screens are

designed to remove 20% to 30% of the influent BOD load and 40% to 60% of the influent TSS.

C. Aeration Basins

The Recommended Standards for wastewater facilities (Ten State Standards) requires single stage nitrification activated sludge treatment systems be designed based on the following criteria.

BOD Loading:	15 lbs./day/1,000 ft^3
F/M Ratio:	0.05 to 0.1 lbs. BOD/lb. MLVSS
MLSS Concentration:	3,000 to 5,000 mg/L

In addition, the design HRT should be in the range of 6 to 15-hours for single stage nitrification activated sludge treatment systems.

Aeration Basins #1 and #2 each have a volume of 8,289 cubic feet or a total of 16,578 cubic feet. Therefore, the basins theoretically have a combined BOD loading capacity of 249 lbs./day. The average design flow should be approximately 0.198 mgd to maintain a reasonable HRT in the aeration basin. Due to their condition, Aeration Basins #1 and #2 should not be counted in the true or 'real' flow and loading capacity of the Wastewater Treatment Facility.

Aeration Basin #3 has a volume of 27,000 cubic feet (201,960-gallons) and a corresponding average BOD loading capacity of 405 lbs./day. The design Mixed Liquor Suspended Solids (MLSS) concentration at 405 lbs./day of BOD is 3,000 to 4,809 mg/L at an F/M ratio of 0.05 to 0.09. Average design flow should be approximately 0.323 mgd to maintain a reasonable HRT in the aeration basin.

Aeration Basin #4 has a volume of 16,491 cubic feet (123,353-gallons) and a corresponding average BOD loading capacity of 247 lbs./day. The design MLSS concentration at 247 lbs./day of BOD is 3,000 to 4,802 mg/L at an F/M ratio of 0.05 to 0.08. Average design flow should be approximately 0.197 mgd to maintain a reasonable HRT in the aeration basin.

D. Aeration Blowers

Ten State Standards requires aeration equipment be capable of maintaining a minimum of 2.0 mg/L of dissolved oxygen in the mixed liquor at all times, and provide thorough mixing of the mixed liquor. In the absence of experimentally determined values, the design oxygen requirements for the extended aeration process should be 1.5 lbs. O_2/lb. BOD to include endogenous respiration requirements. In addition, the nitrogenous oxygen demand shall be taken as 4.6 lbs. O_2/lb. TKN.

Ten State Standards requires multiple aeration blowers be provided with capacities

meeting the maximum air demand with the single largest unit out of service. In addition, diffuser systems should be capable of providing 200% of the designed average day oxygen demand.

The existing Wastewater Treatment Facility has four aeration blowers in operation. Blowers #3 and #4 are used to supply air to Aeration Basins #3 and #4. Blower #2 is dedicated to the aerobic digesters, while Blower #1 is a spare blower for both the aeration basins and digesters.

Based on available records, it is estimated that two blowers can supply approximately 1,600 cfm of air to the aeration basins and air lift Return Activated Sludge (RAS) pumps. However, it is estimated that based on the design average BOD loadings to Aeration Basins #3 and #4, the blowers would need to produce in excess of 1,800 cfm, plus the air demand for the air lift RAS pumps, in order to satisfy Ten State Standards. In addition, IDEM will require the blower capacity be able to satisfy the oxygen demand with one microscreen out of service.

E. Secondary Clarifiers

Ten State Standards Requires that secondary clarifiers be designed based on the following criteria.

Average Design Flow:	1,000 gpm/ft^2
Peak Solids Loading:	35 lbs./day/ft^2
Weir Peak Overflow Rate:	20,000 gpd/ft.

It is also stated that average design flow should be reduced to 900 gpm/square foot for system using chemical addition to the MLSS for Phosphorus removal.

The 30-foot diameter clarifier with Aeration Basin #3 has a design peak flow capacity of 0.636 mgd based on 900 gpm/square foot or 0.707 mgd based on 1,000 gpm/square foot. The peak design solids loading rate is 24,740 lbs./day with a corresponding total flow (Max Day + RAS) of 0.989 mgd at a MLSS concentration of 3,000 mg/L. Assuming a RAS rate of 1.5 x average design, the corresponding maximum day flow capacity of the clarifier would be 0.505 mgd. The weir length is 82.7-feet with a corresponding peak overflow rate of 1.65 mgd.

The clarifier attached to Aeration Basin #4 has an area of 288 square feet with a corresponding design peak flow capacity of 0.259 to 0.288 based on 900 to 1,000 gpm/square foot. The peak design solids loading rate is 10,080 lbs./day with a corresponding total flow of 0.403 mgd at a MLSS concentration of 3,000. Assuming a RAS rate of 1.5 x average design, the corresponding average and maximum day flow capacities of the clarifier would be approximately 0.127 mgd and 0.213 mgd, respectively. The weir length is estimated at 32-feet with a corresponding peak overflow rate of 0.640 mgd. The peak solids loading rate is limiting for the existing 12-foot by 24-foot clarifier.

F. Tertiary Filters

The existing tertiary filters were originally designed as traveling bridge filters with a total surface area of 143 square feet. Ten State Standards allows loading up to 5 gpm/square foot at peak hour flows with one unit out of service. Therefore, the peak design loading rate is 358 gpm or 0.515 mgd. The filter media and mechanisms have been removed, and the filters were retrofitted with static mesh screens. It appears the filters currently function during normal Wastewater Treatment Facility flows, but do not appear to be loaded uniformly nor do they have automatic backwashing. Therefore, it is not possible to predict their ultimate capacity or performance at higher flows and solids loadings. Regardless, the filter system is undersized compared to the other treatment processes with a peak design flow of 0.515 mgd. It should be noted that the filters can be bypassed if the secondary clarifier effluent meets effluent TSS discharge limits.

G. UV Disinfection

According to available records, the existing Ultraviolet (UV) disinfection system has a peak flow capacity of 1.04 mgd. Water quality and flow rate through the unit affect disinfection efficiency. Ten State Standards requires UV disinfection processes be limited to a high quality effluent having at least 65% UV radiation transmittance at 254 nanometers wave length, and BOD and Suspended Solids (SS) concentrations no greater than 30 mg/L at any time. In addition, the UV radiation dosage shall be based on the design peak hourly flow. Therefore, this system is undersized compared to the proposed influent Lift Station and microscreens.

H. Summary

Existing Wastewater Treatment Facility rated capacities are summarized as follows:

Process	**Avg. Flow Capacity** (mgd)	**Peak Flow Capacity** (mgd)	**Avg. BOD Load Capacity** (ppd)
Influent Lift Station	0.450	1.35+	N/A
Microscreens	0.450	1.35+	20-30% Removal
Aeration Basins			
▪ Aeration Basins 1/2 and Clarifiers	0.128	0.289*	249
▪ Aeration Basin 3 and Clarifier	0.323	0.707	405
▪ Aeration Basin 4 and Clarifier	0.127	0.288	247
Total Aeration Basin Capacity	*0.578*	*1.284*	*901*
Real Aeration Basin Capacity	***0.450***	***0.995***	***652***
Tertiary Filters	--	0.515	--
UV Disinfection	--	1.040	--

*Assumed

1. The new influent Lift Station and Headworks are designed for a future peak flow capacity of 1.35 mgd (PF = 3 x 0.45 mgd).

2. Aeration Basins #1 and #2 should be not included in the real Wastewater Treatment Facility flow and loading capacity.

3. Based on Ten State Standards, Aeration Basin #3 has a design average loading capacity of 405 lbs./day at 15 lbs./kcf, with an average flow up to 0.323 mgd at an HRT of 15-hours.

4. The 30-foot diameter clarifier has a peak flow capacity of 0.707 mgd, assuming a peak surface overflow rate of 1,000 gpd/sf.

5. Based on Ten State Standards, Aeration Basin #4 has a design average loading capacity of 247 lbs./day at 15 lbs./kcf, with an average flow up to 0.127 mgd based on the solids loading rate to the clarifier.

6. The clarifier attached to Aeration Basin #4 diameter clarifier has a peak flow capacity of 0.288 mgd, assuming a peak surface overflow rate of 1,000 gpd/sf.

7. The existing tertiary filters have a rated peak flow capacity of 0.515 mgd based on Ten State Standards, but it is not possible to determine their actual peak capacity based on available information.

8. The existing UV disinfection system has a peak flow capacity of 1.04 mgd.

V. CONCLUSIONS

A. Existing & Proposed Future Capacity

A summary of current and committed EDU's is as follows:

Serviced Area	Current EDU's	Committed EDU's	Undeveloped / Unrealized
Shelbourne	20	43	23
Shorewood	864	913	49
Edgewood	37	50	13
Sagamore	62	189	127
Deer Creek	14	14	0
Arbor Lakes	33	88	55
S.F. Clubhouse	1	1	0
Section 29	3	10	7
Total	1,034	1,308	274

It should be noted that the Total Committed EDU's used in the 2011 Facility Planning was 1,264, resulting in an average design flow capacity of 0.442 mgd based on 350-gallons/EDU/day.

Current average influent flow is estimated at 0.180 mgd based on current EDU's and average influent flow data from 2011 through 2013. The current 'reserve capacity' is approximately 0.270 mgd, assuming a real Wastewater Treatment Facility capacity of 0.450 mgd. The following is a summary of committed flow capacity based on the current EDU's, reserve capacity assuming the Wastewater Treatment Facility's rated influent average flow capacity of 0.450 mgd, and the corresponding additional EDU's that could be added to the service area.

Basis	WWTF Capacity	Committed Capacity	Reserve Capacity
WWTF Data (174 gal/EDU/day)	0.450 mgd	0.228 mgd	0.222 mgd

Assuming a reserve capacity of 0.222 mgd, using 174-gallons/EDU/day based on current Wastewater Treatment Facility data for undeveloped/unrealized committed capacity, and using 310-gallons/EDU/day for new development based on Indiana Administrative Code requirements, the total number of additional EDU's that can be added under the existing Wastewater Treatment Facility capacity is 716.

Current average influent BOD loading is estimated at 372 ppd, based on current EDU's and average influent loading data. Assuming the microscreens will remove at least 20% of influent BOD, the aeration basins will be loaded at an average of 298 ppd, compared to their 'real' capacity of 652 ppd. The corresponding reserve loading capacity in the aeration basins is approximately 472 ppd. Therefore, reserve capacity after installation of the microscreens is approximately 590 ppd. Using the current average per EDU BOD loading of

0.36 lbs./EDU/day, the Wastewater Treatment Facility would have capacity to add 1,638 additional EDU's. Therefore, the existing treatment facility is limited by its flow capacity, not by BOD loading.

Construction of a new aeration basin and clarifier to match existing Aeration Basin #3 and its 30-foot diameter clarifier and abandonment of Aeration Basin #4 is planned under Phase 2 of the proposed Wastewater Treatment Facility improvements. Doing so could increase the average design flow to approximately 0.6 mgd based on maintaining a minimum design hydraulic residence time in the basins. However, the capacity would still be limited by the peak surface overflow rate of the clarifiers. Theoretical Design Criteria for the Wastewater Treatment Facility following Phase 2 improvements could be as follows:

- **Influent Flows & Loadings:**

  Average Design Flow = 0.60 mgd
  Peak Design Flow = 1.35 mgd
  Average Influent BOD = 1,013 lbs./day
  (Assuming 20%, min., BOD Removal by Microscreens)

- **Aeration Basins & Clarifiers:**

  Average BOD to Aeration = 810 lbs./day
  MLSS = 2,900 to 3,000 mg/L
  F/M = 0.08 mg/L
  HRT = 16-hrs
  Max. RAS Flow = 0.90 mgd (1.5 x Avg. Design Flow)
  Clarifier Peak Solids Loading = 35 lbs./day/sq.ft.

B. Additional Conclusions

1. Existing total 'stated' average flow capacity is 0.58 mgd using the rated capacity Aeration Basins #1 and #2; however, peak flow is limited to 1.04 mgd when bypassing the existing filters. Overall, total average BOD loading capacity to the aeration basins is 901 lbs./day.

2. The 'real' average flow and BOD loading capacities of Aeration Basins #3 and #4 are 0.45 mgd, and 652 lbs./day of BOD, respectively, to maintain a minimum HRT of 15-hours and maximum BOD loading of 15 lbs./kcf.

3. The microscreens are designed to remove 20% to 30% of the influent BOD; therefore, 'real' Wastewater Treatment Facility influent average design BOD loading will be 815 to 979 lbs./day after construction of the new Headworks (Phase 1B Improvements) is completed.

4. The existing aeration blowers cannot satisfy resulting maximum oxygen demand based on allowable design BOD and ammonia loadings to Aeration Basins #3 and #4. Installation of additional aeration capacity is recommended, if capacity re-rating or expansion of the facility is considered.

5. The existing tertiary filters and UV disinfection system will need to be replaced to increase the Facility's design peak flow capacity.

6. Due to the variability in the influent loading data over the past 3-years, verification of influent loading parameters is needed.

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