Chapter 3 – Existing Wastewater System Facilities

Purpose

The purpose of this chapter is to:

- Describe the existing collection system.
- Locate and describe significant non-sewered regions within the planning area.
- Provide background information regarding the existing Springfield wastewater treatment plant (WWTP) and other smaller plants in the planning area.
- Identify the number, qualifications, and training of operating personnel.
- Evaluate the performance capabilities of the existing WWTP processes.
- Evaluate the physical condition and mechanical reliability of the existing WWTP process equipment.
- Identify existing industrial users within the planning area and the extent of industrial pretreatment.
- Identify ongoing studies/reports regarding the sanitary sewer collection system and discuss problems associated with infiltration and inflow (I/I).
- Discuss the need for the project.

Collection System/Pump Stations

The Springfield Water & Sewer Commission (SWSC) sewered area is served by a conventional gravity sanitary sewer collection system. Figure 3-1 is a map which illustrates the existing sewered area within Springfield's city limits. SWSC maintains approximately 123,970 linear feet of sanitary sewer lines varying in size from 8-inch to 18-inch, 6 pump stations having 20,500 linear feet of force main ranging in size from 4-inch to 8-inch. The majority of the existing snaitary sewer system was installed in the 1950s/1960s. Manholes and collector lines are in good condition and should last, with normal maintenance, throughout their useful life. No major repairs are identified in the planning period. A map of the Springfield's collection system and pump stations is presented in Appendix H. The most prevalent pipe material in the system is PVC. Table 3-1 list the linear footage of sanitary sewer lines in the city by size.

Figure 3-1

Table 3-1
Existing Sanitary Sewers By Size of Pipe
Springfield Facilities Plan Update

Size of Pipe	*Linear Footage in System (feet)*[1]
8-inch gravity main	117,660
12-inch gravity main	4,000
15-inch gravity main	1,600
16-inch gravity main	900
18-inch gravity main	750
4-inch force main	8,400
6-inch force main	8,500
8-inch force main	3,600
Total Footage	**145,410**[2]

Notes: [1] Springfield Water & Sewer Commission
[2] Combined length of force mains and gravity sewers

The majority of customers are on the older gravity system located within the Road Run Creek drainage basin. Flows from these areas flow by gravity through town directly to the Springfield WWTP.

Interceptor capacities for various size lines are listed in Table 3-2. Figure 3-2 illustrates the capacity of the major interceptor system to the WWTP based on minimum line slope. All pump stations are located out on the edge of Springfield's service area.

Bloomfield Road Pump Station is located on KY 55 on the northwest side of Springfield below the WWTP on Road Run Creek. This pump station serves several industries along KY 55 and a residential area along old KY 150. This pump station was replaced and upgraded in 2001.

City Barn Pump Station is located on KY 555 on the north side of Springfield along Poorhouse Branch. The pump station services a commercial area at the intersection of KY 555 and KY 528, and a residential area along KY 528.

Walnut Street Pump Station is located along Walnut Street (KY 1584) on the north side of Springfield along Poorhouse Branch. The pump station services a small residential area.

Rizer Pump Station is located along KY 55 on the south side of Springfield along a tributary Booker Branch. The pump station services a small residential and commercial area.

St. Catharine's Pump Station is located along US 150 approximately one mile west of Springfield behind St. Catharine's College. The pump station services St. Catharine's College, Mother house, and St. Catharine's Infirmary. This pump station was constructed in 2000.

Figure 3-2.

Clearview Commerce Park Pump Station is located off KY 555 in the new industrial park. The pump station serves only the industrial park area.

Table 3-2
Interceptor Capacity
Springfield, Facilities Plan Update

Interceptor Diameter Inches	*Minimum Slope (feet per 100 feet)*	*Full Pipe Capacity[1] (MGD)[2]*	*Allowable Interceptor Capacity at Peak Flow (percent)*	*Ratio of Full Pipe to Allowable Interceptor Capacity[3]*	*Maximum Allowable Interceptor Capacity (MGD)*
8	0.400	0.49	50	50	0.25
10	0.28	0.75	50	50	0.37
12	0.220	1.08	50	50	0.54
15	0.150	1.62	60	63	1.02
16	0.14	1.85	60	60	1.17
18	0.120	2.35	60	63	1.48
21	0.100	3.24	60	63	2.04
24	0.080	4.13	70	75	3.10
27	0.067	5.18	70	75	3.89
30	0.058	6.38	70	75	4.79
36	0.046	9.24	80	86	7.95

Notes: [1] Full pipe capacity based on Manning Formula
$Q=(0.463 \div n) \times (D\ 8/3) \times (S^{1/2})$
Q=Flow, cubic feet per second (CFS)
CFS=0.646317 MGD
N=0.013
D=Diameter, feet
S=Slope, feet per foot
[2] MGD - Million gallons per day
[3] Ratio of full pipe capacity to maximum interceptor capacity based on Design & Construction of Sanitary & Storm Sewers (WPCF Manual of Practice No. 9 & ASCE Manual of Practice on Engineer Practice No. 39) 5th printing 1982, page 130, Design of Flow, and page 87, Figure 24, based on independent n and f coefficients.

SWSC's pump stations are listed in Table 3-3 and shown schematically in Figure 3-3. Force main capacity for various size lines are listed in Table 3-4.

Combined Sewers

SWSC's sanitary sewer system is a totally separate system, i.e., there are no known combined sewers. Cross-connections between the sanitary sewer system and the storm sewer system are not known to exist.

Figure 3-3

Table 3-3
Pump Station Inventory of Springfield
Springfield Facilities Plan Update

Pump Station		*Data*					
No.	*Name*	*Pump Rate (GPM[1])*	*TDH[2] (feet)*	*Motor HP*	*No. of Pumps*	*Pump Type*	*Pump Manufacturer*
1	Bloomfield Road	310	61	15	2	Submersible	Meyers
2	City Barn	150	75	7.5	4	Submersible	Davis EMU
3	Walnut Street	125	56	--	2	Wet Pit/Dry Pit	Fairbanks Morse
4	Rizer Avenue	325	75	15	2	Suction Lift	Hydromatic
5	St. Catharines	280	160	40	2	Submersible	Meyers
6	Clearview Commerce Park	245	103	30	2	Submersible	Meyers

Notes: [1] GPM - Gallons per Minute
[2] TDH - Total Dynamic Head

Table 3-4
Force Main Capacity
Springfield, Facilities Plan Update

Force Main Diameter (inches)	*Minimum Flow Capacity (GMP)[1]*	*Friction Losses[2] (ft/1000 ft)[3]*
3	45	8.20
4	80	5.80
6	180	3.60
8	315	2.45
10	485	1.88
12	700	1.55
14	975	1.32
16	1,255	1.09
18	1,600	0.97
20	1,960	0.85

Note: [1] GPM - Gallons per minute
[2] Based on a roughners coefficient of c=120
[3] Friction loss per 1000 feet of force main.

Unsewered Areas

As mentioned above, Figure 3-1 is a map that illustrates the existing sewered areas within Springfield's city limits. All customers within the city have sanitary sewer service.

Most of the designated planning area outside the city limits are without sewer service. In general, this area does not contain much existing development; what does exist is primarily low-density residential development served by on-site disposal systems.

There are approximately 200 homes in the planning area that are on septic tank systems. Those systems that have been installed over the last 5 to 10 years are generally in good condition and operate satisfactorily. The older homes on old septic tank systems are susceptible to failures. It is anticipated that approximately 40 to 50 septic tank systems in the planning area are failing. When a public collection system is available, all homes with septic tank systems will be required to connect to the collection system. No straight pipes are known to exist in the planning area.

Wastewater Treatment Plants

The only permitted wastewater treatment facility in the Planning Area is the Springfield WWTP.

Springfield WWTP

The Springfield WWTP is located adjacent to Road Run Creek in the northeast section of the city.

The WWTP was originally constructed as a trickling filter plant, in the 1950s. The plant was converted to an oxidation ditch activated sludge process with inner-channel clarifies in 1988. In 1997, the plant was converted to a sequencing batch reactor (SBR) plant, by converting the oxidation ditches and inner channel clarifiers to sequencing batch reactors.

The existing process flow schematic is presented as Figure 3-4. The existing treatment facilities were most recently modified in 1997 and started operating in its present configuration in early 1998. The WWTP includes the following process facilities:

- Mechanical Bar Screen
- Vortex Grit Chambers
- Influent Screw Pumps
- Sequencing Batch Reactors
- Post Equalization Basin Pumps
- Post Equalization Basin
- Chlorine Contact Basin
- Post Aeration Ladder
- Aerobic Digester
- Aerated Sludge Holding Basin
- Belt Filter Press
- Backup Sand Drying Beds

Figure 3-4.

In addition to the above facilities, a trickling filter constructed as part of the original WWTP is dedicated to providing pretreatment to waste flows from two industries - Bluegrass Dairy, and GSAFI, Inc. The combined flow from these two sources averaged approximately 75,000 gallons per day in a recent 12-month period. The trickling filter effluent and WWTP side stream flows are combined with the main plant influent following screening and grit removal of the main plant influent.

The Springfield WWTP has a current permitted design capacity of 0.88 MGD, a peak flow capacity of 1.7 MGD through the SBR's, and a peak flow capacity of 4.0 MGD through the remainder of the plant. It was designed to treat a moderate strength wastewater. The plant is operating efficiently and effectively, and achieves very high degrees of both BOD and TSS removals.

Major WWTP process equipment at the Springfield WWTP is summarized in Table 3-5 and in the following paragraphs:

Liquid Treatment Facilities

Raw influent wastewater passes through a mechanical bar screen with ½-inch openings. There is also a 2-ft.-wide manually-cleaned aluminum bar rack, with 1-inch spacing, in the bypass channel. After screening, the influent flows by gravity through two 7-foot diameter vortex -type grit removal basins. The screened and degritted influent then combines with the industrial trickling filter effluent and various WWTP side streams in the influent pump station (PS). Two (2) open screw pumps, rated 1.7 MGD each, lift the screened and degritted influent and sidestreams to the old splitter structure, where the flow is directed to one of the two SBR basins. Flows that exceed 1.7 MGD are diverted by gravity at the influent PS wetwell to the post equalization PS, where it is pumped to the post equalization basin.

There are two sequencing batch reactors, in which biochemical oxygen demand (BOD_5) is removed and ammonia is nitrified. Each basin has a working volume of approximately 0.457 MG, with 5 racks of fine bubble diffusers. The SBR reactors are designed to treat an average daily influent flow of 0.88 MGD, and a peak flow of 1.7 MGD. Design BOD_5, total suspended solids (TSS), and total kjeldahl nitrogen (TKN) loadings are 255 mg/L, 350 mg/L, and 45 mg/L, respectively. The basins are designed to operate within a range of 10.7 to 17 feet water level. Each basin has two 7.5-horsepower (hp) mechanical floating mixers and one mechanical floating decanter rated at 2,656 GPM. Oxygen is supplied to the SBR basins by four 40-hp rotary positive displacement blowers, each rated 1,530 standard cubic feet per minute (SCFM).

The SBR effluent flows by gravity to a post equalization basin PS, which pumps the flow to the post equalization basin. The post equalization basin serves as a "wide spot" in the process, i.e. shaves the flow peaks from the SBR reactors, allowing the biologically treated wastewater to be fed at average rates to the

disinfection and dechlorination facilities. The stored SBR effluent flows by gravity from the post equalization basin to the chlorine contact basins, where it is disinfected with chlorine and dechlorinated with sulfur dioxide. The first chlorine contact basin is unbaffled and serves as a settling basin for any solids that have not settled in the upstream processes. The disinfected and dechlorinated effluent flows by gravity to the cascade step ladder for post aeration, and is then discharged to Road Run Creek.

Table 3-5
Springfield WWTP Processes and Equipment
Springfield Facilities Plan Update

Process	*Criteria*
1. **Mechanical Screen**	
- Number	1
-Channel Width	2 ft
-Screen Openings	0.5 inch
2. **Grit Removal**	
-Type	Vortex
- Number	2
-Diameter	7 ft
-Peak flow capacity	2.5 MGD (each)
3. **Influent Pumps**	
-Type	Screw
-Number	2
-Capacity, Each	1,180 GPM (1.7 MGD)
4. **Sequencing Batch Reactors**	
- Number	2
- Average/Peak Flow	0.880/1.700 MGD
- BOD Removal	1,870 lbs/day
- TSS Removal	2,570 lbs/day
- F/M Ratio	0.086 lb BOD_5/lb MLSS
- MLSS (Low Water Level)	4,500 mg/L
5. **Aeration Blowers**	
- Type	Rotary Positive Displacement
- Number	40
- Horsepower, HP	4 @ 1,530 SCFM
- Capacity, Each	
6. **Post Equalization Basin Pumps**	
- Type	Submersible
- Number	3
- Capacity, Each	2,700 GPM
7. **Post Equalization Basin**	
-Number	1
-Volume (Maximum Water Level)	135,700 gallons
8. **Chlorine Contact Basins**	
-Number	2
-Volume, Total	101,451 gallons
-Detention Time @ 4.0 MGD	36.5 minutes
9. **Post Aerator**	
- Type	Cascade
-Vertical Drop	6.0 ft
10. **Aerobic Digester**	
- Diameter	30 ft
- Maximum Water Level	19 ft
- Volume	100,000 gallons

11. **Sludge Holding Tank** - Diameter - Maximum Water Level - Volume	 70 ft 4 ft 115,000 gallons
12. **Belt Filter Press** - Size	 1.5 Meters
13. **Sludge Drying Beds** - Number - Total Area	 7 8,250 square feet

Sludge Handling and Treatment Facilities

Waste sludge from the SBR basins is pumped to an aerobic digester (converted anaerobic digester) where it is mixed and gravity-thickened by decanting. Two positive displacement blowers supply air to coarse bubble diffusers in the tank for mixing. Thickened sludge flows to a sludge holding tank (converted trickling filter). Stored liquid sludge is pumped to a single, 1.5-meter belt filter press for dewatering. Sand drying beds serve as backup dewatering and storage. Dewatered sludge is hauled to the Nelson County landfill for final disposal. The city also owns a ten-acre tract for land farming (Landfarm Permit No. 115-00002), although sludge has not been applied to the site for approximately 5 years.

Process Evaluation

A process evaluation of each major facility was conducted on an individual basis, based on the WWTP permitted capacity of 0.88 MGD; 1.7 MGD peak day flow through the SBRs; and a peak flow of 4.0MGD through the remainder of the plant; manufacturer's criteria; and, criteria contained in Recommended Standards for Wastewater Facilities, Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, 1997.

Findings

The findings of the evaluation of all of the facilities are summarized in Table 3-6. In general, all critical process facilities, with the exception of the aeration ladder, are adequately sized to meet current needs.

The aeration ladder has usually provided the dissolved oxygen needed in the effluent, with the exception of one day in 2000 when the measured dissolved oxygen was 6.9 mg/L (versus a requirement of 7.0 mg/L). The ladder is not conservatively designed for warm temperature wastewater. However, the plant, under normal operation, has consistently produced an effluent of excellent quality and has met all other permit limits since it began operation in its present configuration.

Physical Evaluation

An inspection of the Springfield WWTP indicates that the facility is well maintained, and generally in very good operating condition. Other than minor electrical problems associated with the grit removal equipment, all other maintenance appears to be routine and expected, given the service conditions under which the equipment operates. It is noted, however, that the equipment installed in the 1988 WWTP upgrade is nearing 15 years of age, and instances of unplanned maintenance will increase as the equipment ages.

Table 3-6
Springfield WWTP Major Unit Process Capacities
Springfield Facilities Plan Update

Unit Process	*Facility*	*Evaluation Criteria*	*Capacity*	*Comment*
Screening	1 mechanical screen, 1 by-pass screen	Peak flow with either unit out of service	4.0 MGD	Peak design flow from engineering drawings
Grit Removal	Two 7'-0" diameter vortex units	Peak flow	5.0 MGD	
Influent Pumping	Two screw pumps, 1.7 MGD each	Peak flow with largest unit out of service	1.7 MGD	Cannot pump peak flow of 4.0 MGD.
Biological Treatment	Two sequencing batch reactors	1,870 lb/d BOD; 2,350lb/d TSS, 330 lb/d NH3-N removed	0.88 MGD	
Disinfection	Two chambers, total volume = 101,000 gallons	15 minutes detention @ peak flow rate	9.7 MGD	
Post Aeration	One ladder aerator, 6'-0" drop	7.0-mg/l effluent dissolved oxygen	0.88 MGD	Performance is marginal at high effluent wastewater temperatures
Aerobic Digester/ Sludge Holding	One 30-ft. diameter aerobic digester One 70-ft. diameter sludge holding basin	14 days at annual average sludge production	20 days	
Sludge Dewatering	1.5-M Belt Filter Press	120 GPM feed rate, operation 6 hours/day, 5 days/week	1.80 MGD	Average day flow rating

Operations and Maintenance Staff

Wastewater system operation and maintenance (O&M) for the SWSC is performed by a staff of three full time employees. Table 3-7 provides a list of the wastewater system O&M personnel.

Table 3-7
Springfield Wastewater System Operations and Maintenance Staff
Springfield Facilities Plan Update

Title/Classification	*Number*	*Operator Classification*
WWTP Superintendent	1	III
Operator	1	III
Operator	1	Unclassified
Total Wastewater System	3	

Wastewater Characteristics

The Springfield WWTP has a mixed customer base consisting of domestic, commercial and industrial customers. Two industries, Bluegrass Dairy and GSAFI, Inc., discharge wastes with very high BOD_5 and TSS strengths. However, the wastes are pretreated on-site at the Springfield WWTP and therefore the impact of these wastes on the overall influent is mitigated.

Springfield WWTP influent and effluent wastewater characteristics for the 18-month period, January 2001 to June 2002, are summarized in Table 3-8. Table 3-9 summarizes the influent and effluent data for the same period, on a monthly basis.

Table 3-8
18-Month Wastewater Characteristics Summary [1]
Springfield Facilities Plan Update

	January 2001 - June 2002		*KPDES*[2]
Parameter	*Influent*	*Effluent*	*Effluent Limits*[3]
Flow (MGD)[4]	--	0.57	0.88
BOD_5[5] (mg/L)[6]	160	3.5	30
TSS[7] (mg/L)	231	4.0	30
NH_3-N[8] (mg/L)	15	0.5	4 summer / 10 winter

Notes:
[1]Developed from Discharge Monitoring Reports submitted to Kentucky Division of Water
[2]KPDES - Kentucky Pollutant Discharge Elimination System
[3]Monthly average
[4]MGD - Million gallons per day
[5]BOD_5 - Five-day biochemical oxygen demand
[6]mg/L - Milligrams per liter
[7]TSS - Total suspended solids
[8]NH_3-N - Ammonia nitrogen

Table 3-9

Eighteen-Month Influent/Effluent Wastewater Characteristics

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Month	Flow MGD[1]		BOD_5[2], mg/L[3]		Monthly Average TSS[4], mg/L		Monthly Average NH_3-N[5], mg/L		Monthly Average Phosphorus, mg/L	
	Monthly Average	Maximum Day	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
Jan. 2001	0.634	1.316	176	3	195	2	15.7	0.76	--	--
Feb. 2001	0.87	2.369	160	4.7	206	4.5	12.9	0.5	--	--
Mar. 2001	0.691	1.984	165	5	324	7	11	0.75	--	--
Apr. 2001	0.52	1.12	202	3	386	9	14	0.5	--	--
May 2001	0.486	1.35	167	3.2	234	3.2	15.1	0.4	--	--
Jun. 2001	0.38	0.96	141	3	263	3	14	0.4	--	--
Jul. 2001	0.41	0.972	159	1	236	2	17	0.5	--	--
Aug. 2001	0.443	0.77	140	3.2	292	2.6	16	0.5	--	--
Sep. 2001	0.311	0.412	220	2.5	343	1.5	21.2	0.5	--	--
Oct. 2001	0.44	1.12	187	1.7	183	3.4	21.9	0.43	--	--
Nov. 2001	0.50	1.97	166	3.5	274	4.3	--	0.6	--	--
Dec. 2001	0.71	1.31	120	3.5	190	2	--	0.4	--	--
2001 Average	**0.53**	**1.30**	**166.92**	**3.11**	**260.5**	**3.71**	**15.88**	**0.52**	**--**	**--**
Jan. 2002	0.634	1.977	176	3	195	2	15.7	0.76	7.36	1.4
Feb. 2002	0.523	1.154	115	3.5	142	1.7	12.8	0.4	4.5	0.9
Mar. 2002	0.85	2.41	101	7	133	12	10	0.8	3.87	1.4
Apr. 2002	0.60	1.454	128	4	166	4	12	0.4	5	1.4
May 2002	0.886	1.94	210	7	144	4.6	10.5	0.5	5.1	1.45
Jun. 2002	0.425	0.999	146	1.7	249.9	3.3	16.7	0.6	7.83	0.93
2002 Average	**0.653**	**1.656**	**146**	**4.37**	**171.65**	**4.6**	**12.95**	**0.58**	**5.61**	**1.25**

Notes: [1]MGD - Million gallons per day

[2]BOD_5 - Five-day biochemical oxygen demand

[3]mg/L - Milligrams per liter

[4]TSS - Total suspended solids

[5] HN_3-N - Ammonia Nitrogen

Industrial Pretreatment

The City has an industrial pretreatment program monitors industrial discharge compliance through its Enforcement Response Plan. This plan was developed to ensure that all industrial discharges meet applicable state and federal requirements. The plan is modified periodically, as necessary, to ensure compliance with changing regulations.

Infiltration/Inflow Study

SWSC is not currently performing an I/I study. Additional information regarding infiltration and inflow in the SWSC sewer system is provided in Chapter 4.

Need for the Project

The Springfield WWTP is performing well and consistently produces a higher quality effluent than required by its permit.

However, the permitted capacity of the WWTP is 0.88 MGD. In May 2002, the average flow to the plant was 0.886 MGD, which is 101 percent of the rated plant capacity. The average eighteen-month flow from January 2001 through June 2002 was 0.57 MGD, which is 65 percent of the rated plant capacity. The impetus for this project is to provide additional future capacity for residential and economic growth.