Chapter 5 – Analysis of Alternatives

Purpose

The purpose of this chapter is to:

- Develop interceptor system within the planning area.
- Define future effluent requirements.
- Discuss the "No Action Alternative."
- Identify alternatives for providing wastewater treatment.
- Analysis of principal alternatives.
- Present the selected alternative.

Interceptor System Alternatives

No Action Alternative

This action involves no initial construction and no action other than maintaining and operating existing facilities. Existing facilities will serve existing customers and a limited number of new customers along existing sewage main routes only and, therefore, expected expansion and growth within the planning area cannot be accommodated. The Springfield Water & Sewer Commission has established goals to accommodate growth and serve developed areas not presently on a sanitary sewer system. Therefore, this alternative is not feasible for the sewer collection system, and no further evaluation will be given to this alternative.

The existing sanitary sewer interceptor and collection system includes gravity sewers, pump stations, and force mains which transport wastewater throughout the service area to the WWTP located in the northwest part of Springfield, adjacent to Road Run Creek. As residential, commercial and industrial development in the planning area increases or shifts, it will be necessary to extend or modify the existing interceptor and collection system to provide sewer service along with miscellaneous rehabilitation work developed through a infiltration/inflow reduction program. Therefore, the purpose of this subsection is to identify interceptor improvements required to provide sanitary sewer service to non-sewered development areas.

Development of the interceptor system for the 20-year planning period is based on drainage area basins and the minimization of pumping of wastewater. Flow projections for each major drainage area is listed in Table 5-1. Figure 5-1 illustrates schematically the flow pattern between drainage areas.

Table 5-1
2020 Wastewater Flow Projections (New Service Areas)
Springfield Facilities Plan Update

Major Drainage Area Basins	Average Flow (GPD)[1]	Peak Flow (MGD)[2]
No. 2	37,100	0.15
No. 5	208,200	0.75
No. 6	115,200	0.44
No. 7	223,500	0.80
No. 10	101,200	0.38
No. 13	124,700	0.46
No. 16	104,700	0.40

Notes: [1]GPD - Gallons per day
[2]MGD - Million gallons per day

Figures 5-2 through 5-6 illustrates an interceptor system layout serving all major drainage area based on future needs and flow projections.

Future Interceptor System Service

Other than the "No Action" alternative, there are two interceptor system alternatives:

- Expanding by the use of conventional interceptor gravity sewers.
- Expanding by the use of a small diameter gravity sewers.

Conventional Interceptor Gravity Sewer

Conventional interceptor gravity sewers are a system of 8-inch and larger lines with manholes located at every vertical/horizontal change or a maximum of 400-foot intervals. This type of system also incorporates pump stations and force mains to transport wastewater.

Opinions of probable construction and total costs were calculated based on past discussions with general contractors, construction bids, equipment and material prices, and a general understanding of the project area. A summary of cost for each major drainage area is presented in Table 5-2. This itemized cost for each area is presented in Appendix I, Tables 1 through 8.

Figure 5-1

Figure 5-2

Figure 5-3

Figure 5-4

Figure 5-5

Figure 5-6

Table 5-2
Summary Table
Conventional Interceptor Gravity Sewer System
Opinion of Probable Project Cost[1]
Springfield Facilities Plan Update

Drainage Areas	*Construction Cost*	*Project Development Cost[2]*	*Total Opinion of Probable Project Cost*
2	$314,500	$78,500	$393,000
3	240,000	60,000	300,000
5	1,505,500	376,500	1,882,000
6	981,000	245,000	1,226,000
7	1,690,000	423,000	2,113,000
10	1,184,000	296,000	1,480,000
13	1,524,000	381,000	1,905,000
16	1,114,750	278,750	1,393,500

Notes: [1]All costs in 2000 dollars
[2]Development costs include administrative, engineering, legal, interest during construction, and contingencies.

Small Diameter Gravity Sewer

Small diameter gravity sewers are a system of interceptor tanks (approximately 1,000 gallon septic tank) and small diameter (6-inch and less) collection mains. The interceptor tanks, located upstream of each service connection, remove grease and settleable solids from the raw wastewater. The settled wastewater is discharged from each tank into the small diameter collection mains. Maintenance access is allowed by installing manholes or cleanouts typically at 400- to 1,000-foot intervals.

Selected Alternative

For this planning area, all major interceptor systems shall be conventional based on topography and operator familiarity. If small areas exist which small diameter gravity sewers might be appropriate, a cost/benefit analysis will be performed.

Wastewater Treatment Alternatives

Chapters 3 and 4 presented an evaluation of the existing wastewater treatment facilities, and a projection of future wastewater flows and loads in the planning area. The existing facilities were shown to be providing a very high level of treatment, and consistently produce an effluent that exceeds effluent requirements set forth in the plant's discharge permit.

The following sections discuss alternatives for providing additional wastewater treatment capacity for the Springfield planning area. It is the intent that all of the alternatives would provide a regional solution to wastewater treatment by sewering existing, unsewered areas, and new development.

Future Effluent Requirements

Effluent limits were defined by the Kentucky Department of Environmental Protection, Division of Water (DOW) for the expanded Springfield Wastewater Treatment Plant (WWTP), assuming a capacity of 1.8 MGD and discharge to Road Run Creek either at the current location, or an alternate site approximately 1 mile downstream along Road Run Creek from the existing WWTP site. The 1.8 MGD Springfield WWTP effluent requirements were developed by DOW in consideration of the fact that the lower portion of Road Run Creek only partially supports the aquatic life designated use. The limits are shown in Table 5-3 .

Table 5-3
Springfield WWTP - 1.8 MGD Effluent Requirements
Springfield Facilities Plan Update

Parameter	***May 1- Oct. 31***	***Nov. 1 - April 30***
Average Daily Flow	1.8 MGD	
BOD_5	20 mg/L	
Suspended Solids	30 mg/L	
Ammonia Nitrogen	4 mg/L	10 mg/L
Phosphorus	1 mg/L	2 mg/L
Dissolved Oxygen	7 mg/L	
Reliability Grade	2	

All alternatives evaluated in this section are designed to meet the above limits.

Identification of Potential Alternatives

A "No Action" alternative, plus four expansion alternatives, were identified for the Springfield WWTP. All of the expansion alternatives would have a permitted flow of 1.8 MGD and a 6.0 MGD peak flow; effluent would be discharged to Road Run Creek; and solids would be stored in liquid form, dewatered by a belt filter press, and landfilled. The expansion alternatives are:

- Expand the existing WWTP with new sequencing batch reactors (SBRs).

- Construct a new SBR WWTP at an alternate plant site.

- Construct a new oxidation ditch WWTP at an alternate plant site.
- Construct a deep cell lagoon WWTP at an alternative plant site.

Figure 5-7 illustrates a potential new site for the WWTP which would discharge into Road Run Creek.

Table 5-4 summarizes the above alternatives for the Springfield WWTP. More detailed descriptions of the alternatives are included in the following paragraphs. The descriptions define the facilities on a preliminary basis, for the purpose of this study. Design Flows and Concentration and Unit Process Design Criteria forms are included in Appendix Q for each alternative. All of the preliminary design assumptions should be re-examined and optimized during design development.

Table 5-4
1.8 MGD Process Alternatives
Springfield Facilities Plan Update

Alternative		*Location*	*Wastewater Treatment Processes*	*Solids Treatment Processes/Disposal Method*
1	Expand Existing SBR WWTP	Existing WWTP Site	Construct new screening, influent pumping, SBR, chemical phosphorus removal, and post equalization aeration facilities. Modify chlorine contact basin to add ultraviolet disinfection. Use existing grit removal, post equalization, chlorine contact basin, and post aeration ladder facilities.	Convert one existing SBR basin to aerated sludge holding basins; use existing belt filter press facility, and sand drying beds (as backup); continue to landfill dewatered sludge. Decommission existing aerobic digester and holding basin.
2	Construct New SBR WWTP	Alternate WWTP Site	Construct new transfer pump station/force main; screening, grit removal, SBR treatment, chemical phosphorus removal, post equalization, UV disinfection, and post aeration facilities.	Construct new aerated liquid sludge holding and belt filter press dewatering facilities; dispose of dewatered sludge at landfill.
3	Construct New Oxidation Ditch WWTP	Alternate WWTP Site	Construct new transfer pump station/force main; screening, grit removal, oxidation ditch, chemical phosphorus removal, secondary clarification, UV disinfection, and post aeration facilities.	Construct new aerated liquid sludge holding and belt filter press dewatering facilities; dispose of dewatered sludge at landfill.
4	Construct New Deep Cell Lagoon WWTP	Alternate WWTP Site	Construct new transfer pump station/force main; screening, deep cell lagoon, packed tower, chemical phosphorus removal, secondary clarification, UV disinfection, and post aeration facilities.	Construct new sludge lagoon and use deep cell lagoon system, dewater sludge and dispose at landfill.

No Action Alternative

This alternative involves no initial construction, and no action other than maintaining and operating existing facilities. The objective of this option is to incur no additional capital cost associated with the WWTP.

Figure 5-7

As noted in Chapter 3, Existing Wastewater Facilities, the WWTP is reliably meeting its Kentucky Pollutant Discharge Elimination System (KPDES) permit discharge limits. However, flows to the WWTP have exceeded 90 percent of the permitted flow on a monthly basis. Further, peak flow treatment capacity at the WWTP is constrained, and during certain wet weather conditions, significant flows do not receive full treatment. This alternative does not provide adequate capacity for population and economic growth in the planning area. Eventually, as flows increase to permitted capacity, a ban on any type of development, as well as other penalties, could be imposed.

In consideration of the above, the "No Action" alternative is determined to be impractical, and is not evaluated further.

Regionalization

Due to the absence of any other nearby major wastewater treatment facilites, regionalization is not practical and is not discussed further.

Alternative No. 1 - Expand Existing SBR WWTP

The existing screening facility would be replaced with a new facility consisting of two mechanical bar screen with 1/4-inch openings, each rated to pass 6 MGD; and a new influent parshall flume. The screened wastewater would then flow to upgraded existing grit removal units. The degritted wastewater would then flow to a new 6 MGD influent pump station (PS), consisting of four variable speed submersible pumps. Three pumps would be used to deliver 6 MGD.

The screened, degritted wastewater would be pumped to three new 105-ft. long x 55-ft. wide by 23-ft. deep sequencing batch reactor basins for biological BOD_5 removal, nitrification, phosphorus removal, and clarification. Air would be provided by four constant speed, 150-horsepower rotary positive displacement blowers, housed in a new blower building.

Backup phosphorus removal would be provided by a new polymer and ferric chloride storage/feed system, housed in a chemical building. Polymer would be delivered, stored in, and pumped directly from 55-gallon drums. Two polymer blend units, similar to the existing unit in service for the belt filter press polymer system, would be provided - one installed, the other serving as a spare for either dewatering or phosphorus removal service. Ferric chloride would be stored in two 4,000-gallon tanks in the in the chemical building, and pumped to the SBR tanks at the end of each react phase with two variable speed diaphragm metering pumps.

The biologically treated SBR effluent would be pumped into the post equalization (PE) basin by the existing PE pump station, upgraded with variable speed drives and a spare pump to handle the higher decant flow variations, and provide the needed capacity. The variable speed drives would prevent the pumps from cycling too frequently, thereby eliminating the need to expand the pump station wet well. The existing 135,000 gallon PE basin is adequately sized to maintain a maximum peak flow to downstream processes of 6 MGD. A new floating mechanical surface aerator would be added to the PE basin, to partially re-aerate the SBR effluent.

The stored, partially re-aerated effluent from the PE basin would flow to the existing chlorine contact basin. The first half of the basin would remain in service in its current capacity, as a settling basin. The second half of the basin would be retrofitted with a new effluent parshall flume, and an ultraviolet (UV) disinfection system. The UV system would replace the existing chlorine disinfection and sulfur dioxide dechlorination systems. The disinfected and partially aerated effluent would flow down the existing aeration ladder for final re-aeration, prior to discharge to Road Run Creek.

One of the existing SBR basins would be converted to serve as two aerobic digesters. With the exception of some re-piping, the only modification that would be needed for this change in service is replacement of the existing fine bubble diffusers with coarse bubble diffusers, which are suitable for sludge service and installation of a dividing wall to facilitate two independent digesters. The existing SBR blowers and building would remain in service to provide air to the converted aerobic digesters. Liquid sludge would be pumped from the new SBR basins to the converted aerobic digesters by submersible waste activated sludge pumps, located in each new SBR basin. Concentrated sludge in the converted aerobic digesters would be pumped to the existing belt filter press by the existing belt filter press feed pumps located in the headhouse pump room. The existing 1.5-meter belt filter press and polymer feed equipment would remain in service to dewater the sludge. The only change in the polymer feed is that polymer would be delivered and fed directly from 230-gallon polymer tote bins instead of 55-gallon drums (which are currently used), to minimize having to change drums. The dewatered sludge would be hauled to the existing landfill for final disposal.

A process flow schematic of this alternative is presented as Figure 5-8.

The advantages of this alternative include reuse of many facilities at the existing WWTP site; the familiarity of WWTP staff with the SBR process; relatively simple biological phosphorus removal; the ideal settling and clarification environment afforded by SBR reactors; and the availability of a large amount of sludge storage volume afforded by the converted SBR basin. The remaining basin can be converted in the future, to achieve higher degrees of sludge stabilization if needed for other sludge disposal options.
Figure 5-8

The primary disadvantage of this alternative is use of the existing plant site, which is crowded and would preclude any additional expansion beyond the proposed 1.8-MGD capacity.

Alternative No. 2 - Construct New SBR WWTP

This alternative would have similar processes to Alternative No. 1. However it would be a totally new facility constructed on a site not currently owned by the City. This site is located approximately one mile north of the existing WWTP, on Highway 55.

Flows currently entering the existing WWTP would be pumped to the new WWTP by a new raw sewage transfer PS and an 16-inch force main. This pump station would be a variable speed submersible pump PS similar to the influent PS in Alternative No. 1, except that it would pump at higher pressure to the new WWTP site.

The headworks would be constructed at an elevation high enough to allow gravity flow of the liquid process stream, through the rest of the WWTP. The headworks would include a screening facility similar to that in Alternative No. 1; vortex grit removal tanks and equipment similar to those at the existing WWTP, sized slightly larger for a 6 MGD peak flow rating; and an influent parshall flume.

The screened and degritted wastewater would flow by gravity to one of 3 sequencing batch reactor basins for biological BOD_5 removal, nitrification, phosphorus removal, and clarification. Air would be provided by four constant speed, 150 horsepower rotary positive displacement blowers housed in a blower building. Backup phosphorus removal would be provided by a polymer and ferric chloride storage/feed system, housed in a chemical building. The blowers, blower building, chemical building and chemical storage/feed equipment are identical to that of Alternative No. 1.

The biologically treated SBR effluent would flow by gravity into a divided post equalization (PE) basin. The PE basin would provide a working storage volume of 135,000 gallons, and measure 60 - ft. long x 33-ft. wide x 12.6-ft. deep. The total PE volume is sized to maintain a maximum peak flow to downstream processes of 6 MGD. A new floating mechanical surface aerator would be provided for each section of the PE basin, to re-aerate the SBR effluent.

The stored, re-aerated effluent from the PE basin would flow by gravity to an effluent parshall flume, and then to a UV contact basin for disinfection. The final effluent would be discharged to Road Run Creek.

Liquid sludge would be pumped from the SBR basins to two aerated sludge holding basins by submersible waste activated sludge pumps located in each SBR basin. The sludge holding basins are sized to provide 20 days of storage, total. A floating surface mechanical aerator located in each basin would keep the sludge mixed and aerated. The sludge would be gravity thickened in the basins by decanting, and pumped to a new dewatering building by a thickened waste activated sludge PS consisting of two variable speed progressing cavity pumps rated 150 GPM, each. The pumps would be housed in a separate part of the chemical building. The dewatering building would house the 1.5-meter belt filter press and polymer feed equipment relocated from the existing WWTP. The dewatered sludge would be hauled to the existing landfill for disposal.

A new Operations/Laboratory/Maintenance building would be constructed at the new plant site.

A process flow schematic of this alternative is presented as Figure 5-9.

The advantages of this alternative include operationally simple biological phosphorus removal, plus chemical removal backup; the ideal settling and clarification environment afforded by SBR reactors, which results in a very high quality effluent; and the use of a new WWTP site, which would provide the area that may be required in the future for expansion beyond 1.8-MGD capacity.

The disadvantages of this alternative include the need to acquire a new plant site, with potential objections from neighboring development; abandonment of the existing facilities, which have recently been upgraded; and the maintenance associated with a force main between the new and existing plants.

Alternative No. 3 - Construct New Oxidation Ditch WWTP

This alternative would be a totally new facility constructed on the same new site as Alternative No. 2.

The features of this project, from the raw sewage transfer PS at the existing WWTP site, through the headworks at the new plant, would be similar to Alternative No. 2.

The screened and degritted wastewater would flow by gravity to a flow splitter structure. The flow splitter would divide the flow evenly to three concrete oxidation ditches, for biological BOD_5 removal and nitrification of the wastewater. Each basin would be 200 feet long x 45 feet wide, and would have a working volume of 0.675 MG. Mixing and aeration would be provided by two 75-hp mechanical aerators in each basin.

Figure 5-9 Alternative 2 - Construct New SBR WWTP

Ferric chloride and polymer would be added to the oxidation ditch effluent for chemical phosphorus removal upstream of the clarifier flow splitter structure. The ferric chloride and polymer storage/feed system would be housed in a chemical building and is similar to that in Alternatives No. 1 and No. 2. The oxidation ditch effluent with the chemicals added for phosphorus removal would flow by gravity to a clarifier splitter structure which would divide the flow evenly to three circular 65-ft. diameter, 14-ft. deep clarifiers. The clarified effluent would then flow to a UV contact basin for disinfection, and an aerated channel for re-aeration. The final effluent would be discharged to Road Run Creek.

The solids facilities would include a return activated sludge (RAS) PS; a waste activated sludge (WAS) PS, aerated holding/thickening basins; a thickened waste activated sludge (TWAS) PS; and a belt filter press dewatering facility.

The RAS PS would have a capacity of 3 MGD with four variable speed submersible sewage pumps. Two pumps would be rated 0.75 MGD each; and the remaining two pumps would be rated 1.5 MGD each.

The sludge would be gravity thickened in the aerated sludge holding basins by decanting, and would be pumped to a new dewatering building by a TWAS PS. The TWAS PS would consist of two variable speed progressing cavity pumps rated 150 GPM, each. The pumps would be housed in a separate part of the chemical building. The dewatering building would house the 1.5-meter belt filter press relocated from the existing WWTP; the dewatered sludge would be hauled to the existing landfill for disposal.

A new Operations/Laboratory/Maintenance building would be constructed on the new plant site.

A process flow schematic of this alternative is presented as Figure 5-10.

The advantages of this alternative include the use of a new WWTP site, which would provide the area that may be required in the future for expansion beyond 1.8 MGD capacity; and no need for post equalization, as is required of the SBR alternatives.

The disadvantages are the same as those of Alternative No. 2, plus: the need for separate oxidation ditch and clarifier splitter structures; an RAS PS; separate clarifiers; and, a separate re-aeration facility.

Alternative No. 4 - Construct Deep Cell Lagoon WWTP

This alternative would be a totally new facility constructed on an expanded new site adjacent to Alternatives No. 2 and No. 3.

Figure 5-10

The features of this project, from the raw sewage transfer PS at the existing WWTP site, through the headworks at the new plant, would be similar to Alternatives No. 2 and No. 3.

The screened and degritted wastewater would flow by gravity to a flow splitter structure. The flow splitter would divide the flow evenly to two deep cell lagoons for biological BODs removal, each with 45 day detention of design flow, of wastewater. Each deep cell lagoon would have approximately 16 acres of surface area, and be 18 feet deep with a volume of 81 MG.

Packed towers would follow the deep cell lagoon's to strip ammonia nitrogen. Ferric chloride and polymer would be added to the packed tower effluent for chemical phosphorus removal upstream of the clarifier flow splitter structure. The ferric chloride and polymer storage/feed system would be housed in a chemical building and is similar to that in Alternative No. 1, No. 2, and No. 3. The packed tower effluent with the chemicals added for phosphorus removal would flow by gravity to a clarifier splitter structure which would divide the flow evenly to three circular 60-ft. diameter, 14-ft. depth clarifiers. The clarified effluent would then flow to a UV contact basin for disinfection, and an aerated channel for re-aeration. The final effluent would be discharged to Road Run Creek.

The solids facilities would include biological sludge storage in the deep cell lagoons and chemical sludge storage in sludge lagoons. Waste sludge (WS) PS would transport chemical sludge from the clarifiers to sludge lagoons.

Sludge from the sludge lagoons would be pumped to a new dewatering building by the belt filter press (BFP) PS. The BFP PS would consist of two variable speed progressing cavity pumps rated at 150 GPM, each. The pumps would be housed in a separate part of the chemical building. The dewatering building would house the 1.5-meter BFP relocated from the existing WWTP; dewatered sludge would be land applied or hauled to the existing landfill for disposal.

A new Operations/Laboratory/Maintenance Building would be constructed on the new plant site.

A process flow schematic of this alternative is presented as Figure 5-11.

The advantages of this alternatives include the use of a new WWTP site, which would provide some area for future expansion beyond 1.8 MGD capacity, limited sludge dewatering, and less mechanical equipment.

Figure 5-11

The disadvantages of this alternative include the requirement of a new and large plant site, potential objections from neighboring development; abandonment of the existing facilities, which have recently been upgraded; and the maintenance associated with a force main between new and existing plants.

Analyses of Principal Alternatives

Present Worth Analysis

Present worth analyses, which represent the total life-cycle expenditure in terms of current dollar amounts, provide an equitable method of comparing the cost of various alternatives. This section includes present worth cost analyses for the treatment systems.

The present worth analysis includes capital costs; annual operations, maintenance and replacement (O,M&R) costs; and salvage values. Capital cost estimates, which include construction of improvements, miscellaneous construction items, and contractor's overhead and profit, were developed based on equipment prices from suppliers and bid tabulations from similar, recent construction projects.

Annual O,M&R cost includes manpower, utilities, maintenance, equipment repairs and replacement, consumables, and administration. Salvage values are calculated on a straight-line depreciation over the 20-year planning period. Tables 5-5 through 5-8 provide opinions of probable construction costs and project costs for the alternatives. Table 5-9 summarizes estimated operation, maintenance and replacement costs for all of the alternatives. Present worth analysis summaries for the wastewater treatment alternatives, based on a 20-year planning period and an EPA stipulated interest rate of 6-7/8 percent, are provided in Table 5-10.

Non-Economic Analysis

The present worth comparison is limited when used to evaluate alternatives because only the construction costs, O,M&R costs, and salvage values are considered. Other factors not directly related to these costs are included in the evaluation to determine the true effectiveness of an alternative. Evaluation criteria, both economic and non-economic, used to rank the wastewater treatment alternatives are as follows:

- Environmental Impact-short-and long-term impacts on the environment.
- Public Acceptance - a measure of public acceptance of the project.
- Flexibility - ability to adapt to changing conditions.
- Reliability - a measure of performance dependability.

- Expandability - ability of the site to expand beyond the planned 20-year capacity
- Operability - ease of operation.
- Energy Use - energy conservation.
- Constructability - ease with which the alternative can be constructed and phased into operation.

Table 5-5
Opinion of Probable Project Cost[1]
Alternative 1 - Expand Existing SBR WWTP
Springfield Facilities Plan Update

Item	***Capital Cost***	***Service Life (years)***	***20-Year Salvage Value***
Site/Civil Improvements	$ 50,000	40	$25,000
Headworks - Mechanical Screen/Grit Removal/Flow Measurement	320,000	20	-
Grit Removal/Influent Pump Station	225,000	20	-
SBR Tanks/Equipment/Blowers/Building	1,733,000	30	578,000
Ferric Chloride, Polymer Equipment/Chemical Building	150,000	20	-
Post Equalization Basin/Modification	30,000	30	10,000
Post Equalization PS Modifications	40,000	20	-
UV Disinfection Equipment/Basin Modifications	180,000	20	-
Existing SBR Modifications	22,000	30	7,000
Site Piping	400,000	40	200,000
Miscellaneous Metals	100,000	20	-
Electrical/Instrumentation	325,000	20	-
Mobilization/Demobilization	130,000	20	-
Miscellaneous	260,000	20	-
Contractor's Overhead and Profit	585,000	20	-
Subtotal Construction Cost	**$4,550,000**		
Project Development Cost[2]@ 25%	1,138,000		
Total Opinion of Probable Project Cost/Salvage Value	**$5,688,000**		**$820,000**

Notes: [1]All costs in 2001 dollars
[2]Project development cost includes administrative, engineering, legal, interest during construction, and contingencies.

Table 5-6
Opinion of Probable Project Cost[1]
Alternative 2 - Construct New SBR WWTP
Springfield Facilities Plan Update

Item	*Capital Cost*	*Service Life (years)*	*20-Year Salvage Value*
Site/Civil Improvements	$ 150,000	40	$75,000
Raw Sewage Transfer PS	225,000	20	-
Raw Sewage Force Main	158,000	60	105,000
Plant Sewer PS	50,000	20	-
Headworks - Mechanical Screen, Grit Removal, Flow Measurement	450,000	20	-
SBR Tanks/Equipment/Blowers/Building	1,925,000	30	642,000
Ferric Chloride-Polymer Equipment/Chemical Building	150,000	20	-
Post Equalization Basins/Diffusers/Blowers/Transfer Pumps	224,000	30	80,000
Effluent Parshall Flume/UV Contact Basin/UV Equip't.	200,000	20	-
Aerated Sludge Holding Basins/Aerators	348,000	30	116,000
Thickened Sludge Pump Station	55,000	20	-
Dewatering Building	130,000	30	43,000
Operations/Laboratory/Maintenance Bldg.	200,000	30	67,000
Site Piping	300,000	40	150,000
Miscellaneous Metals	100,000	20	-
Electrical and Instrumentation	467,000	20	-
Mobilization/Demobilization	187,000	20	-
Miscellaneous	373,000	20	-
Contractor's Overhead and Profit	840,000	20	-
Subtotal Construction Cost	**$6,532,000**		
Project Development Cost[2] @ 27%	1,764,000		
Total Opinion of Probable Project Cost/Salvage Value	**$8,296,000**		**$1,273,000**

Notes: [1]All costs in 2001 dollars
[2]Project development cost includes administrative, engineering, legal, interest during construction, land acquisition and contingencies.

Table 5-7
Opinion of Probable Project Cost[1]
Alternative 3 - Construct New Oxidation Ditch WWTP
Springfield Facilities Plan Update

Item	*Capital Cost*	*Service Life (years)*	*20-Year Salvage Value*
Site/Civil Improvements	$150,000	40	$75,000
Raw Sewage Transfer PS	225,000	20	-
Raw Sewage Force Main	158,000	60	-
Plant Sewer PS	50,000	20	-
Headworks - Mechanical Screen, Grit Removal, Flow Measurement	450,000	20	-
Oxidation Ditch Splitter Structure	55,000	30	18,000
Oxidations Ditches/Equipment	1,288,000	30	429,000
Ferric Chloride-Polymer Equipment/Chemical Building	150,000	20	-
Clarifier Splitter Structure	55,000	30	18,000
Clarifiers/Scum PS	740,000	30	193,000
Effluent Parshall Flume/UV Contact Basin/UV Equip't	200,000	20	-
Reaeration Channel & Equipment	35,000	30	-
RAS/WAS Pump Station	225,000	20	-
Aerated Sludge Holding Basins/Aerators	348,000	30	116,000
Thickened Sludge Pumps	55,000	20	-
Dewatering Building	130,000	20	-
Operations/Laboratory/Maintenance Building	200,000	30	67,000
Site Piping	400,000	40	200,000
Miscellaneous Metals	100,000	20	-
Electrical and Instrumentation	501,000	20	-
Mobilization/Demobilization	201,000	20	-
Miscellaneous	401,000	20	-
Contractor's Overhead and Profit	903,000	20	-
Subtotal Construction Cost	**$7,020,000**		
Project Development Cost @ 27%	1,895,000		
Total Opinion of Probable Project Cost/Salvage Value	**$8,915,000**		**$1,170,000**

Notes: [1]All costs in 2001 Dollars
[2]Project development cost includes administrative, engineering, legal, interest during construction, land acquisition and contingencies.

Table 5-8
Opinion of Probable Project Cost[1]
Alternative 4 - Construct New Deep Cell Lagoon WWTP
Springfield Facilities Plan Update

Item	*Capital Cost*	*Service Life (years)*	*20-Year Salvage Value*
Site/Civil Improvements	$250,000	40	$125,000
Raw Sewage Transfer PS	225,000	20	-
Raw Sewage Force Main	158,000	20	-
Plant Sewer PS	50,000	20	-
Headworks - Mechanical Screen, Grit Removal, Flow Measurement	450,000	20	-
Deep Cell Lagoon			
- Excavation/Embankment	1,915,000	30	632,000
- Liner	590,000	20	-
- Mechanical Aerators	110,000	40	55,000
Packed Tower	315,000	30	104,000
Clarifiers/Scum PS	740,000	30	244,000
Ferric Chloride, Polymer Equipment/Chemical Building	150,000	20	-
Clarifier Splitter Structure	55,000	20	-
Effluent Parshall Flume/UV Contact Basin/Equipment	200,000	20	-
Reaeration Channel and Equipment	35,000	20	-
Recirculation PS	110,000	20	-
Sludge Lagoon	95,000	20	-
Site Piping	150,000	40	75,000
Miscellaneous Metals	50,000	20	-
Operations/Laboratory/Maintenance Building	200,000	30	67,000
Electrical and Instrumentation	292,000	20	-
Mobiliziation/Demobilization	234,000	20	-
Miscellaneous	585,000	20	-
Contractor's Overhead and Profit	1,253,000	20	-
Subtotal Construction Cost	**$8,212,000**		
Project Development Cost @ 32%	$2,628,000		
Total Opinion of Probable Project Cost/Salvage Value	**$10,840,000**		**$1,302,000**

Notes: [1] All costs in 2001 Dollars.
[2] Project development cost includes administration, engineering, legal, interest during construction, land acquisition, and contingencies.

Table 5-9
Average Annual Wastewater Treatment O,M&R[1] Costs[2]
Springfield Facilities Plan Update

	Alternative	Power	Chemical	Equipment/ Materials Replacement	Staffing	Sludge Disposal	Total O,M&R
1	Expand Existing SBR WWTP	$ 40,000	$ 75,000	$99,000	$207,000	$44,000	$465,000
2	Construct New SBR WWTP	37,000	75,000	131,000	207,000	44,000	494,000
3	Construct New Oxidation Ditch WWTP	74,000	75,000	140,000	207,000	44,000	540,000
4	Construct New Deep Cell Lagoon WWTP	25,000	75,000	95,000	207,000	10,000	412,000

Notes: [1]O,M&R - Operation, maintenance and replacement
[2]All costs based on average flow of 0.96 MGD over 20-year period

Table 5-10
Wastewater Treatment Alternatives Opinions of Probable Costs and Present Worth[1]
Springfield Facilities Plan Update

	Alternative	Construction Cost	Project Cost	Annual O,M&R[3]	Salvage Value	Total Present Worth
1	Expand Existing SBR WWTP	$4,550,000	$5,688,000	$465,000	$820,000	$10,445,525
2	Construct New SBR WWTP	6,532,000	8,296,000	494,000	1,273,000	$13,243,926
3	Construct New Oxidation Ditch WWTP	7,020,000	8,915,000	540,000	1,170,000	$14,382,268
4	Construct New Deep Cell Lagoon WWTP	8,212,000	10,840,000	412,000	1,302,000	$14,903,042

Notes: [1]All costs in 2001 dollars
[2]Prices include mobilization, demobilization, general conditions and contractor's overhead and profit
[3]O,M&R = Operation, maintenance, repair and replacement
[4]Present worth = [project cost + (10.6977 x O,M&R cost)] - (0.2645 x salvage value). Factors correspond to 20 year recovery and 6.875% interest.

These evaluation criteria were used to provide a quantitative score for each of the alternatives. The score for any particular alternative is determined by using an analysis matrix. Anticipated performance of a particular alternative and the relative importance of specific evaluation criteria is considered by assigning a numerical value to each alternative. A ranking of one to five was selected based on anticipated success of the alternative relative to the specific evaluation criteria. One represents the least favorable ranking, and five represents the most favorable ranking. The eight evaluation criteria were assigned a weight factor based on relative importance. A total of 110 points was distributed among the eight criteria. A score for each wastewater treatment alternative was calculated by multiplying the weight factor by the ranking.

Table 5-11 presents the non-economic effectiveness analysis for the wastewater treatment alternatives. This analysis provides a numerical comparison of different alternatives including both economic and non-economic performance factors. As indicated in Table 5-11, Alternative No. 2, Construct New SBR WWTP, scored highest in the non-economic analysis. The second highest scoring alternative was Alternative No. 1, followed by Alternative No. 3.

Table 5-12 presents a comparison of the present worth and the non-economic effectiveness of each alternative. This comparison is derived by dividing the present worth by the non-economic effectiveness total for each alternative.

Table 5-11
Non-Economic Effectiveness Analysis for Treatment Alternatives
Springfield Facilities Plan Update

Evaluation Criteria	*Weight Factor*	*Alternative No. 1 Expand Existing SBR WWTP*		*Alternative No. 2 Construct New SBR WWTP*		*Alternative No. 3 Construct New Oxidation Ditch WWTP*		*Alternative No. 4 Construct New Deep Cell Lagoon WWTP*	
		Raw Score	*Wt. Score*	*Raw Score*	*Wt. Score*	*Raw Score*	*Wt. Score*	*Raw Score*	*Wt. Score*
Environmental Impact	15	4	60	3	45	3	45	2	30
Public Acceptance	20	4	80	2	40	2	40	2	40
Flexibility	15	4	60	4	60	4	60	4	60
Reliability	15	5	75	5	75	5	75	5	75
Expandability	10	1	10	5	50	5	50	5	50
Operability	10	4	40	4	40	4	40	4	40
Energy Use	10	5	50	5	50	3	30	5	50
Constructability	15	2	30	4	60	4	60	3	45
Total Wt. Score	**110**	**405**		**420**		**400**		**390**	

Note: [1]Raw score based on a range from one to five with five being superior and one being poor.

Table 5-12
Wastewater Treatment Economic/Non-Economic Effectiveness Comparison
Springfield Facilities Plan Update

	Alternative	*Construction Cost*	*Total Project Cost[1]*	*Present Worth*	*Non-Economic Effectiveness*	*PW/NE Ratio*
1	**Expand Existing SBR WWTP**	**$4,550,000**	**$5,688,000**	**$10,445,525**	**405**	**25,791**
2	Construct New SBR WWTP	$6,532,000	$8,296,000	$13,243,926	420	31,533
3	Construct New Oxidation Ditch WWTP	$7,020,000	$8,915,000	$14,382,268	400	35,956
4	Construct New Deep Cell Lagoon WWTP	$8,212,000	$10,840,000	$14,903,042	390	38,213

Notes: [1]Total project cost equals construction cost plus project development cost
[2]Recommended alternative is shaded

From this table, the selected alternative is recommended.

Selected Alternative

Alternative No. 1, expanding the SBR plant at the existing WWTP site with chemical phosphorus removal, has the lowest present worth cost and achieved the second highest non-economic effectiveness score of the alternatives. These factors combine to give it the highest score in the overall economic/non-economic evaluation. Alternative No. 1 is, therefore, the recommended alternative.

Process reliability for each process will be addressed during the preliminary design stage. As stated in Table 5-3, the reliability classification is a grade 2 as per 401 KAR5:005, Section 13. The proposed alternate power source to provide continuous use of preliminary, primary, secondary, and disinfection treatment process will be a standby power generator. Based on design flow and loading, the necessary unit processes will have redundancy.

Table 5-13 provides design data for the major components of the proposed Springfield WWTP.

Table 5-13
Selected WWTP Alternative Design Criteria
Alternative No. 1 - Expand Existing SBR WWTP
Springfield Facilities Plan Update

Process	***Design Criteria***
1. Design flow, MGD	1.8
- Peak flow rate, MGD	6.0
- Five-day biochemical oxygen demand, mg/L and lbs/day	220 and 3,303
- Total suspended solids, mg/L and lbs/day	220 and 3,303
- Total kjeldahl nitrogen, mg/L ad lbs/day	25 and 375
- Total phosphorus, mg/L and lbs/day	6 and 90
2. Influent Pumps	
- Number of units	4
- Capacity, each, GPM	2 @ 4.0 MGD 2 @ 1.0 MGD
- Type	Variable speed submersible
3. Screens	
- Number of units	2 mechanical bar screen
- Capacity, MGD each	6.0
- Size opening, inches	1/4
4. Grit Removal/Influent Flow Measurement	
- Grit Removal Type	Vortex
- Number of unit	3 (2 existing and1 new)
- Capacity, MGD (each)	2.5
- Influent Flow Measurement Type	Parshall flume
- Peak Flow Capacity	6 MGD

Process	Design Criteria
5. Sequencing Batch Reactors	
- Number of tanks	3
- Maximum water depth, feet	21
- Length x width, feet (each)	105 x 55
- Total volume, gallons	2,721,000
- Aeration type	Fine bubble diffusion
- F:M ratio, lb. BOD_5/lb. MLSS-Day	0.061
- Number, type of blowers	4 rotary positive displacement (variable speed)
- Blower horsepower, each	150
- MLSS, mg/L	4,500 @ minimum water depth
6. Post Equalization Basin Pumps	
- Type	Variable speed submersible
- Number	4 (3 installed,1 spare)
- Capacity, Each	2,700 GPM
7. Post Equalization Basin	
- Number	1, existing
- Volume (at maximum water level)	135,700 gallons
- Re-aeration aerator type	Floating mechanical surface aerator
- Number	2 (1 installed, 1 spare)
- Horsepower	7.5
8. Disinfection	
- Type	Ultraviolet
- Number of lamp modules	6
- Number of lamps per module, total number of lamps	40, 240
9. Final post aeration	
- Type	Ladder (existing)
- Vertical drop	6.0 ft
10. Aerobic Digesters (Sludge Holding)	
- No. of tanks	2 (convert exist SBR)
- Volume, gallons	457,000
- Storage at design condition, days	40
- Aeration type	Coarse bubble diffusion
- Number, type of blowers	3 rotary positive displacement (existing)
- Capacity, each	1,530 scfm
11. Belt Filter Press	
- Number, size	1, 1.5 meters (existing)

Note: All design criteria and equipment/facility sizings to be verified during design.