City of St. Joseph, Missouri

Facilities Plan

Technical Memorandum No. TM-WW-2

Eastside Wastewater Service Assessment

By

Black & Veatch

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Eastside Wastewater Service Assessment

1.0 Executive Summary

The Eastside wastewater service area, located east of the Belt Highway in St. Joseph, has been highlighted as an area of potential future growth and economic development for the City of St. Joseph. In addition, the existing wastewater conveyance facilities are beyond their useful life and require improvements in order to maintain adequate wastewater service for the current Eastside area. With the pending need to invest in Eastside infrastructure, it is prudent to take into account City growth over the next 20 years within an extended Eastside wastewater service area (Figure 1, following page 7). Alternatives considered to expand wastewater service in the Eastside service area include either construction of a new water protection facility (WPF) or construction of a wastewater pump station. Wastewater process technologies were evaluated and it was determined that biological nutrient removal (BNR) with filtration is the most cost effective process for the Eastside area if a new WPF is recommended. Two potential sites for future wastewater infrastructure were identified and evaluated (Figure 1). Three alternatives were developed to provide the conveyance and treatment of future wastewater flows on the Eastside. The following provides a summary of the elements of each alternative:

- **Alternative 1 – Eastside WPF at North Site** (Figure 9)
  - Interceptor and trunk sewers to route wastewater flow to North site
  - Package pump station and 10 inch force main to route southern flows to North site
  - BNR with filtration WPF (6 million gallons per day (mgd) average flow)
  - Flow equalization basin (12 million gallons (MG))
  - North site land acquisition (320 acres assumed)
  - Decommissioning of Faraon Street and Easton Road Pump Stations

- **Alternative 2 – Eastside WPF at South Site** (Figure 10)
  - Interceptor and trunk sewers to route wastewater flow to South site
  - BNR with filtration WPF (6 mgd average flow)
  - Flow equalization basin (12 MG)
  - South site land acquisition (320 acres assumed)
  - Decommissioning of Faraon Street and Easton Road Pump Stations

- **Alternative 3 – Eastside Pump Station at North Site** (Figure 11)
  - Interceptor and trunk sewers to route wastewater flow to North site
  - Eastside Pump Station (8 mgd to existing WPF, 16 mgd to flow equalization basin)
  - 24 inch force main from Eastside Pump Station to Mitchell Basin
  - 24 inch force main from Eastside Pump Station to flow equalization
  - Flow equalization basin (16 MG)
  - North site land acquisition (320 acres assumed for future WPF build-out)
  - Decommissioning of Faraon Street and Easton Road Pump Stations

A triple bottom line analysis was conducted to evaluate each of the alternatives, encompassing project capital investment, operation and maintenance (O&M) costs, net present worth, as well as social and environmental non-economic factors. Based on this analysis, Alternative 3 – Eastside Pump Station at North Site is recommended for implementation. Figure ES-1 presents the cumulative triple bottom line analysis score for each alternative. Table ES-1 presents the results of the project capital, O&M, and net present worth analysis for each of the alternatives.

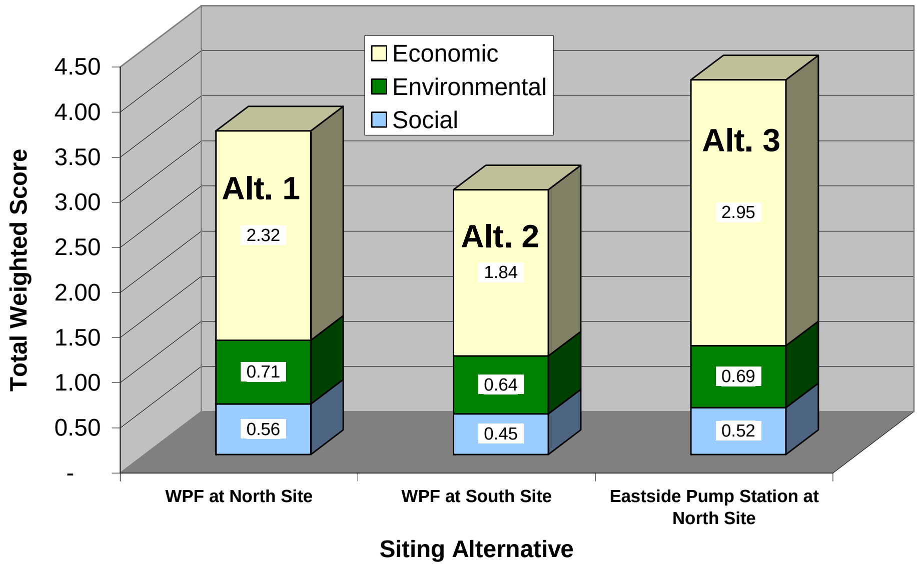


Figure ES-1 - Eastside WPF Assessment Triple Bottom Line Analysis Scores

Table ES-1 Eastside Wastewater Service Alternatives Total Project Net Present Worth [1]			
	Alternative 1 WPF at North Site, $	**Alternative 2 WPF at South Site, $**	**Alternative 3 Eastside Pump Station at North Site, $**
Net Project Capital Present Worth [2]	167,258,000	197,577,000	127,759,000
O&M Present Worth [3]	36,228,000	37,893,000	27,693,000
Total Net Present Worth	**203,486,000**	**235,470,000**	**155,452,000**

1. Costs given in May 2009 dollars. Present worth calculated with 20-year life cycle costs at 5% interest.
2. Net project capital present worth represents the present worth of project costs less the remaining value of facilities at the end of the 20-year life cycle. Service life for determination of replacement frequency and salvage value was projected as follows: structures – 50 years; equipment, electrical, instrumentation and controls – 20 years.
3. O&M costs were assumed to escalate at 5% per year.

Triple bottom line scores for each of the alternatives are as follows: Alternative 1 – 3.59, Alternative 2 – 2.93, and Alternative 3 – 4.15. As demonstrated by the results of this analysis, Alternative 3 – Eastside Pump Station at North site is the highest ranking alternative, scoring over 13 percent higher than the next highest alternative. Alternative 3 is found to be more than 20 percent less than the next closest alternative from both a capital cost and an O&M cost standpoint. Similarly, Alternative 3 is the lowest cost option on the basis of net present worth. The net present worth of the new Eastside Pump Station alternative ($155 million) is approximately $48 million less expensive than the next closest alternative over the 20-year life cycle.

It is recommended that the City implement the following initial facilities for the North site. An approximate opinion of probable project cost for the initial phase is given in Table ES-2.

- North site land acquisition
- Eastside Pump Station (with pumps to flow equalization initially phased to match flow equalization size)
- Flow equalization basin (initially phased at 3 MG, no cover or odor control)
- 24 inch force main from Eastside Pump Station to existing Faraon Street force main (existing Faraon Street force main should be inspected once flow equalization basin is installed to determine condition of line)
- Interceptor and trunk sewers from Faraon Street and Easton Road Pump Stations to Eastside Pump Station
- Decommissioning of Faraon Street and Easton Road Pump Stations

Table ES-2
Initial Phase of Eastside Pump Station
Summary of Opinion of Probable Project Costs [1]

Item	$
Eastside Interceptor Sewer	24,576,000
Trunk Sewer from Existing Faraon Street Pump Station to Eastside Interceptor	1,160,000
Trunk Sewer from Easton Road Pump Station to Eastside Interceptor	8,979,000
Flow Equalization Basin (3 MG)	3,750,000
Eastside and Flow Equalization Basin Pump Station	8,667,000
Force Main from Eastside Pump Station to Existing Faraon Street Pump Station	4,524,000
Demolish Existing Pump Stations	175,000
Flood Protection/Fill (placeholder) [2]	296,000
Site Remediation (placeholder) [2]	0
Subtotal	*52,127,000*

Table ES-2
Initial Phase of Eastside Pump Station
Summary of Opinion of Probable Project Costs [1]

Item	$
Electrical, I&C, Sitework, Utilities, and Contractor General Requirements [3]	13,064,000
Subtotal	*65,191,000*
Contingency [4]	16,298,000
Land Acquisition (placeholder) [2]	4,000,000
Opinion of Probable Construction Cost	**85,489,000**
Engineering, Legal, and Administration [5]	17,098,000
Opinion of Total Project Cost	**102,587,000**

1. All costs presented in May 2009 dollars (ENR BCI = 4773).
2. Site related costs are placeholders and must be revised following final siting study of the selected area. Land acquisition costs based on $12,500/acre as projected by City staff.
3. Electrical and instrumentation and controls (I&C) projected at 25% of the total of all equipment and structure costs. Sitework projected at 10% of the total of equipment, structures, electrical, and I&C costs. Utility projections based on Black & Veatch experience and distance to closest power connection as provided by KCP&L. Contractor general requirements projected at 12% of the total of equipment, structures, electrical, I&C, sitework, and utility costs. Sitework and electrical and I &C percentages only applied to WPF facilities, pump stations, and flow equalization basins; these multipliers were not applied to the conveyance improvements.
4. Project contingency is projected at 25% of the total of all equipment, structures, electrical, I&C, sitework, utilities, contractor general requirements, flood protection/fill, and site remediation costs.
5. Engineering, legal, and administration (ELA) costs are projected at 20% of the total of all equipment, structures, electrical, I&C, sitework, utilities, contractor general requirements, flood protection/fill, site remediation costs, contingency, and land acquisition.

Odor control issues at the current Faraon Street Pump Station are of significant concern to the City. Costs for the proposed Eastside Pump Station include the construction of a chemical calcium nitrate (BIOXIDE®) feed system for odor control. Prior to the design of the Eastside Pump Station, a pilot study of the BIOXIDE® feed system at the Faraon Street Pump Station is recommended to ensure odor control issues at the existing pump station are addressed in the design for the new station.

It is likely that construction of a new Eastside WPF may be warranted after 2030. The City should monitor residential, commercial, and industrial development throughout the City and determine when additional treatment capacity expansion is required. When additional treatment capacity is needed, the north site could be expanded to include a new Eastside WPF. When a new WPF is implemented on the North site, the Eastside Pump Station can be reconfigured to serve as the influent pump station for the new WPF.

2.0 Purpose of Study

The Eastside wastewater service area, located east of the Belt Highway in St. Joseph, has been highlighted as an area of potential future growth and economic development for the City of St. Joseph. In addition, the existing wastewater conveyance facilities are beyond their useful life and require improvements in order to maintain adequate wastewater service for the current Eastside area. The purpose of this technical memorandum is to analyze various alternatives for providing continued and enhanced wastewater service to the eastside of St. Joseph as described in Phase 320 – 102 River Watershed Wastewater Service Assessment of the Facilities Plan scope.

The objectives of this assessment include:

- Establishing criteria for assessing the benefits of a potential Eastside WPF.
- Public education and involvement related to the Eastside WPF siting alternatives.
- Developing Eastside WPF siting alternatives.
- Identifying, evaluating, and selecting treatment processes for the potential Eastside WPF.
- Assessing existing conveyance system and determining requirements to meet future needs.
- Presenting results of alternatives evaluations and life cycle cost comparisons.
- Conducting a triple bottom line assessment of alternatives.

The alternatives presented in this memorandum are based on serving the residential population and commercial/industrial contributions projected for the Eastside area through the 20-year planning horizon as documented in TM-WW-1 – Existing Conveyance and Water Protection Facility Assessment.

3.0 Eastside Flow Projections

3.1 Service Area

The scope of wastewater conveyance and treatment required for the Eastside area depends upon the service area and how much development occurs within its boundaries. Figure 1 presents the proposed Eastside service area as developed in conjunction with City staff. The service area consists of drainage basins for the 102 River, Candy Creek, and a small portion of the Platte River. In Figure 1, the light pink area represents the existing Eastside service area. The darker pink regions were identified by City staff as having the potential for significant future development. The determination of these potential service area extensions is presented in more detail in TM-WW-1 – Existing Conveyance and Water Protection Facility Assessment.

The proposed Eastside service area boundary as shown in Figure 1 was developed to encompass all of the existing service area and potential service area extensions. It also includes areas contiguous to the service area extensions within the same basin.

3.2 Eastside 2030 Flow Projections

Year 2030 Eastside wastewater flow projections were developed for the service area described previously and as shown in Figure 1. Historical flow data provided by the City for Eastside industries and the Faraon Street Pump Station were used to establish current average flow rates. Eastside industrial flows were subtracted from the historical Faraon Street Pump Station flow data (current average of 2 to 3 mgd annually) in order to determine the current per capita residential/commercial flow contribution of 114 gallons per capita day (gpcd). This per capita data loading falls within the normal range observed in other municipalities and is deemed appropriate to calculate future wastewater flows.

City-provided traffic analysis zone (TAZ) data were used in combination with City staff guidance to determine a projected population for 2030 of approximately 28,300 people within the existing service area and potential service area extensions. The residential/commercial contribution to projected Eastside flows was calculated by multiplying the 114 gpcd flow rate by the Year 2030 projected populations for the existing and extended service areas as shown in Table 1.

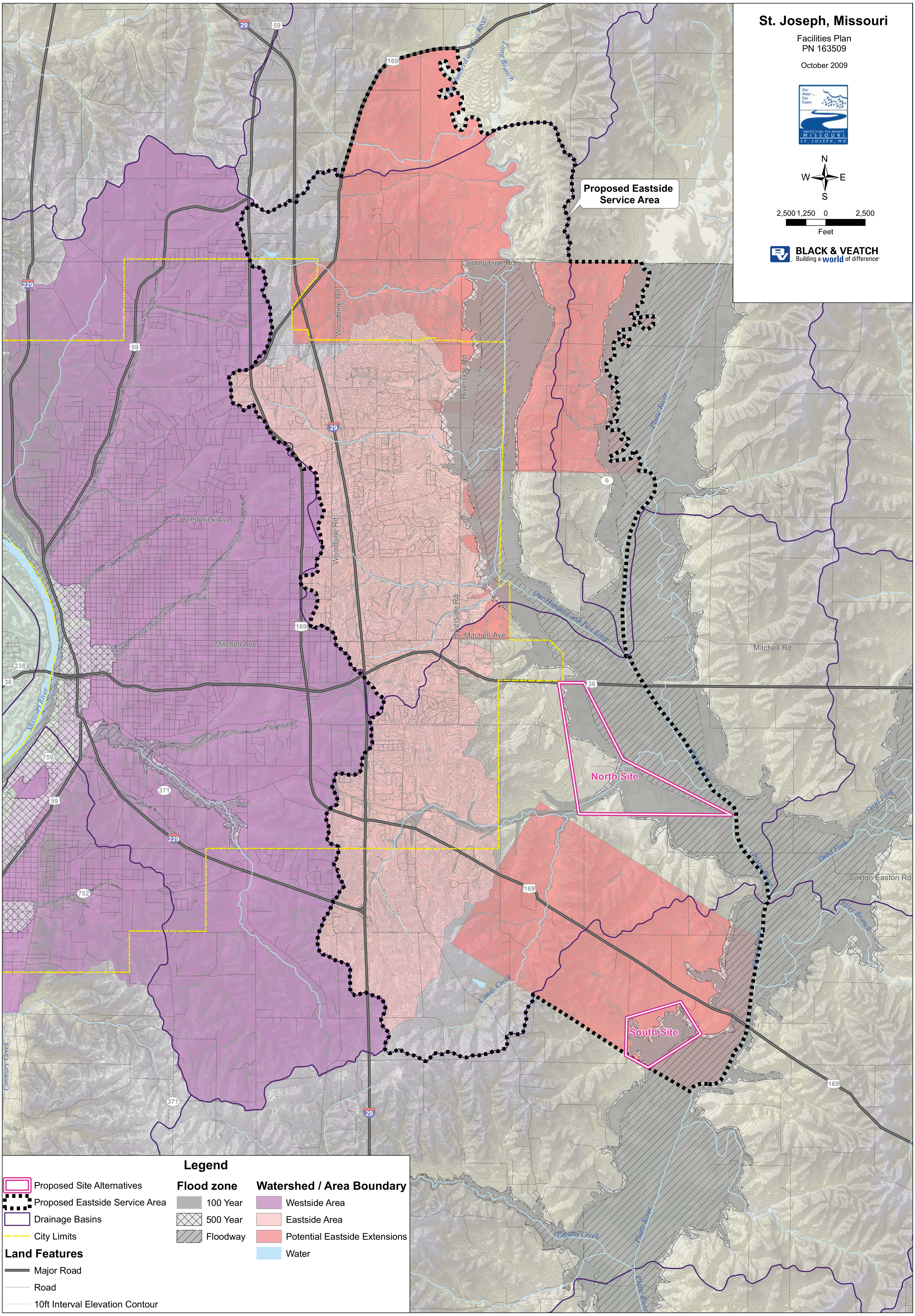


Figure 1

PROPOSED EASTSIDE SERVICE AREA

Industrial flows were determined based on historical records from 2006 to 2008. While Sara Lee Foods and Heartland Hospital have experienced large growth, indicated by an increase in discharge flow over the past couple of years, it is estimated that the increase will not continue based on physical size limitations of the existing facilities. Therefore, the average of the industrial flows from 2006 to 2008 (0.84 mgd) was used as an estimate of the base industrial flow in 2030 for the existing service area; it was also approximated that future industries to be located in the service area extensions would contribute a similar flow to that currently seen within the existing service area. In further discussions with City staff, it was decided to add 0.4 mgd for potential future industrial flows to the industrial flows within the existing service area to allow for growth within this region as presented in Table 1.

Table 1
Projected 2030 Eastside Annual Average Flows

	Projected Population	Residential/ Commercial Flow, mgd	Industrial Flow, mgd	Potential Future Industrial Flow [1], mgd	Total, mgd
Existing Service Area	17,400	1.98	0.84	0.4	3.22
Service Area Extensions	10,900	1.24	0.84 [2]	---	2.08
Existing + Extension Areas	**28,300**	**3.22**	**1.68**	**0.4**	**5.30**

1. Based on discussions with City staff, it was decided that an additional 0.4 mgd of flow should be included in the projections to allow for additional industrial growth within the existing service area.
2. Future industrial flow from the service area extensions was approximated to be equivalent to that from the existing service area.

As shown in Table 1, the projected 2030 annual average residential, commercial, and industrial flow for the existing service area and the service area extensions is 5.30 mgd. This projected annual average flow was rounded up, resulting in the recommendation that all proposed alternatives to process Eastside flows provide 6 mgd (average flow) of capacity to serve the proposed Eastside service area through planning year 2030. For economic purposes and to allow better matching of facilities to growth, construction of alternatives should be phased with the initial phase consisting of facilities for 4 mgd of annual average flow. For new Eastside WPF alternatives, two 2 mgd liquid treatment trains would be provided initially. As areas within the watershed are sewered and development continues, an additional 2 mgd of capacity would be constructed to meet the Year 2030 total average design capacity of 6 mgd.

The conveyance system and preliminary treatment facilities at the WPF must be sized to handle peak hour flows. A planning level estimate of peak hour flow from the Eastside area is projected to be four times the annual average flow or 24 mgd. This estimate of the peak flow is based on a review of the historical pumping records at the Faraon Street Pump Station. The historical data indicate a ratio of peak hour to annual average flow of 3.8. This ratio falls within a range that would be expected based on literature and other Black & Veatch projects for a separate wastewater collection system of this size. This ratio is conservative with respect to the guidelines presented in the Missouri Department of Natural Resources (MDNR) Design Guide; these guidelines would result in a peaking factor of less than three for the Eastside service area. For the purposes of this evaluation, the peaking factor has been rounded to four and used to approximate peak flows coming to a future Eastside WPF or pump station. This 4 to 1 peak to average flow ratio is within the range of existing flow monitoring data presented in the April 2006 East Side Sanitary Sewer Flow and Rainfall Analysis performed by Bartlett & West.

The basis for the projected 2030 Eastside flows is documented in more detail in the interim memorandum Eastside Water Protection Facility Design Flows, dated August 27, 2009, given in Appendix A. This information will also be incorporated within the Facilities Plan in TM-WW-1 – Existing Conveyance and Water Protection Facility Assessment.

3.3 Eastside Conveyance Capacity Determination

As described in Section 3.2, wastewater treatment facilities are typically evaluated and sized based on the population and flow projections within a 20-year planning horizon. Due to the significant costs and pipeline right-of-way requirements, conveyance system infrastructure is typically sized to provide capacity over an extended planning horizon, often considering the "ultimate" build-out potential of the service area. If computer modeling is not performed to predict the "ultimate" capacity required for a new conveyance system, area-based unit flow values can be used to predict peak flows.

Typical unit flow values for these types of analyses vary widely depending on location and type of land development. The interim memorandum, Eastside Conveyance Sizing Basis, dated August 27, 2009, provides a summary of various unit flows considered. Included in that summary is an ultimate build-out design curve used by Johnson County Wastewater in Johnson County, Kansas. The results of this analysis and discussions with Black & Veatch infrastructure planning personnel suggests the Johnson County, Kansas basis is considered a reasonable, conservative estimate of ultimate build-out for new growth areas in the Midwest. This build-out design curve, shown in Figure 2, estimates ultimate peak flow by applying a sliding scale between 0.013 to 0.020 cubic feet per second per acre (cfs/acre) based on the accumulated upstream tributary area.

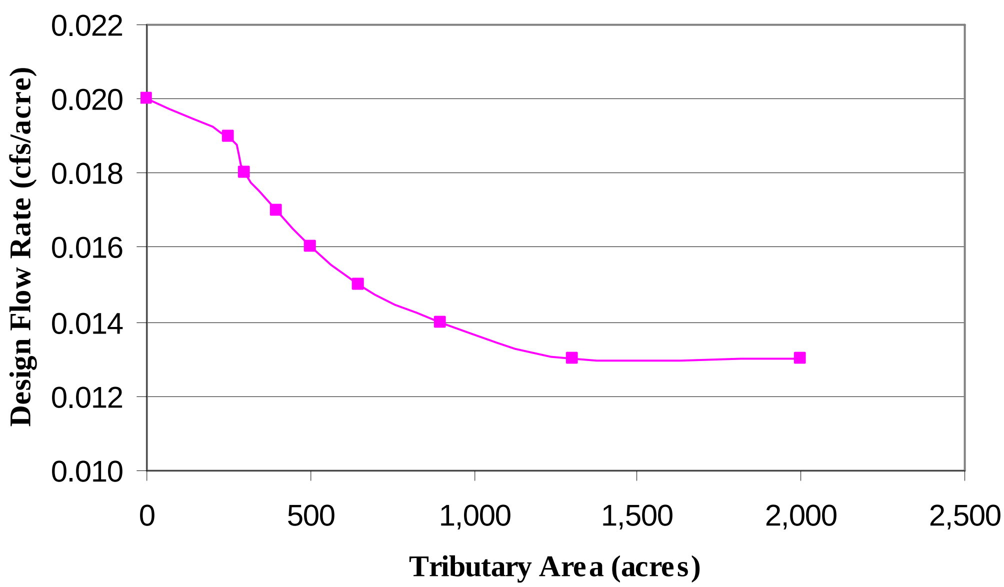


Figure 2
Johnson County, KS Build-out Design Curve

Since much of the area within the proposed Eastside service area is currently undeveloped, providing infrastructure in the initial phase of construction to meet the full ultimate build-out seems overly aggressive. It is recommended that one pipeline be constructed to provide one-half of the ultimate design capacity for the Eastside service area. Utilizing one-half of the ultimate design basis shown in Figure 2 provides a good balance between sizing the system to provide adequate capacity to meet the needs of the future while limiting investment in infrastructure that is currently unnecessary. If future growth occurs to the extent predicted by the full build-out approach, parallel interceptor sewers could be constructed to provide this additional capacity.

Further detail on the basis for sizing the conveyance system is included in the interim memorandum, Eastside Conveyance Sizing Basis, included in Appendix A of this technical memorandum.

4.0 Process Technology Alternatives

Alternatives considered for wastewater service on the Eastside include construction of a new WPF in the Eastside area. This section presents the wastewater treatment process alternatives considered for the Eastside WPF and provides a treatment process recommendation for the proposed new facility. Siting locations, conveyance system development, and alternatives other than new treatment facilities for processing Eastside flows are presented later in this memorandum.

4.1 Anticipated Regulatory Requirements

A new WPF located in the Eastside area would discharge to either the One Hundred and Two (102) River or the Platte River. It has been Black & Veatch's experience that more restrictive discharge limits may be applied to a new facility discharge, such as that for the proposed Eastside WPF, in order to limit the degradation of the receiving stream. The 102 and Platte Rivers are smaller than the Missouri River; it is anticipated that discharge limits into either of these rivers would be lower than those established for flows into the Missouri River. For the process technology evaluation, the following anticipated permit limits were assumed: 5 mg/L biochemical oxygen demand (BOD), 5 mg/L suspended solids, 10 mg/L total nitrogen, and 1 mg/L total phosphorus.

4.2 Wastewater Process Development

Three liquid process alternatives for the proposed Eastside WPF were developed. Influent flows and loads for the new facility were developed for the Eastside service area as summarized in Table 2.

Table 2
Eastside WPF Design Flows and Loads

Parameter	Average	Max Month	Peak Hour
Flow, mgd	6.0	9.2	24.0
Total Suspended Solids, ppd	8,000	10,400	--
Biochemical Oxygen Demand, ppd	8,000	10,400	--
Ammonia Nitrogen, ppd	800	880	--
Total Kjeldahl Nitrogen, ppd	800	880	--
Total Phosphorus, ppd	200	220	--
mgd – million gallons per day	ppd – pounds per day		

The liquid treatment options evaluated are: 1) biological nutrient removal (BNR) with filtration, 2) membrane bioreactors (MBR), and 3) wetland treatment and disposal. The BNR and MBR options were designed to send thickened waste activated sludge (TWAS) in tanker trucks (4 percent total solids) to the existing Missouri River WPF for solids processing. The following sections indicate the process alternatives considered in more detail. The selection of the recommended treatment process will be presented as an independent evaluation from the siting assessment. The total cost of the recommended alternative, including site, conveyance, and treatment will be presented later in this memorandum.

4.2.1 Biological Nutrient Removal with Filtration Process

The first process configuration considered uses a BNR process with filtration to meet BOD and nutrient goals followed by disinfection and reaeration. The basic flow configuration is shown in Figure 3.

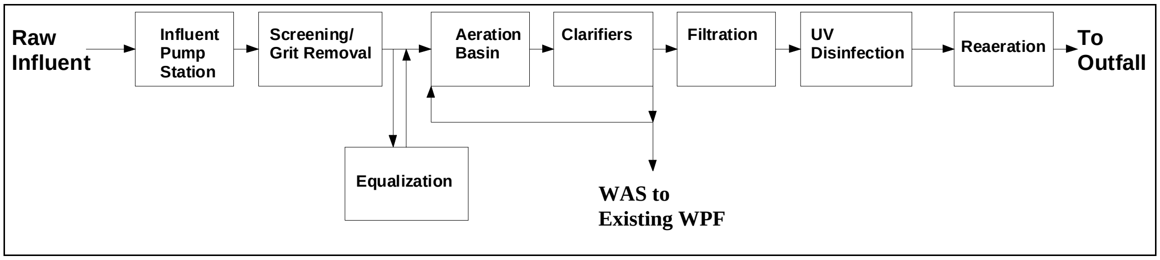


Figure 3 – Schematic of Biological Nutrient Removal with Filtration

The proposed process configuration of the aeration basin consists of anaerobic and anoxic zones at the front of the process train for phosphorus removal and denitrification. Nitrified mixed liquor at the end of the oxic zone is recycled to the anoxic zone for denitrification. The anaerobic zone at the front of the basin provides an environment that causes the release of phosphorus which is taken up at the front of the oxic zone in biological phosphorus removal. Figure 4 shows a flow schematic of the aeration basin zones.

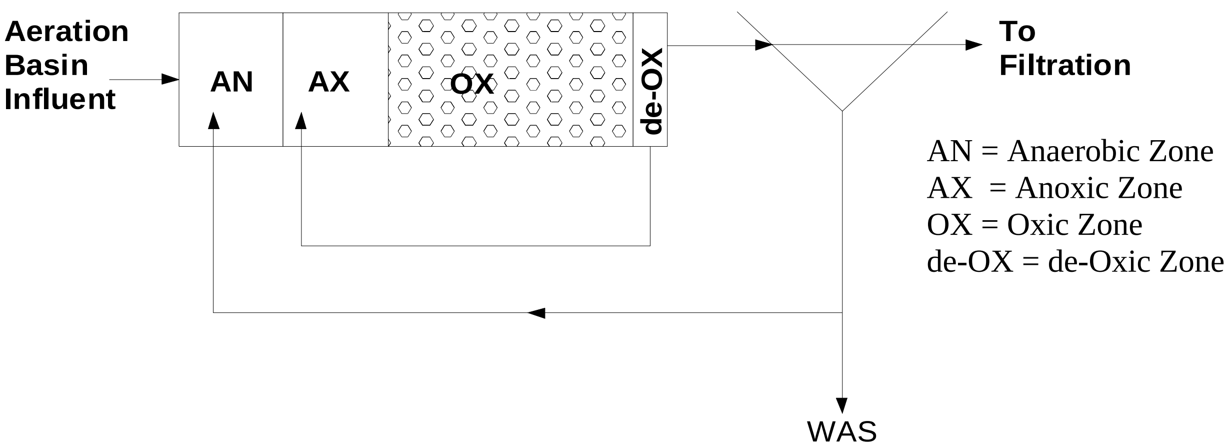


Figure 4 – Aeration Basin Schematic for Biological Nutrient Removal with Filtration

The BNR with filtration process would consist of:

- Preliminary Treatment: Influent Screens, Grit Removal, Flow Equalization
- Secondary Treatment: BNR Basins, Secondary Clarifiers, Blower Building
- Tertiary Treatment: Cloth Disk Filters

- Disinfection: UV Disinfection
- Reaeration: Cascade Aerator

Peak hourly flow to the WPF would be 24 mgd from the conveyance system and through the preliminary treatment at the WPF. The WPF design is based on two times the average flow, or 12 mgd, passing through the process trains during peak events. The remainder of the peak flow would be diverted to a flow equalization basin to prevent high peaking factors from impacting the biological process of the liquid process trains. Peak flows greater than two times the average through the WPF would both reduce the performance of the biological system and require significantly larger secondary facilities. The flow equalization basin was sized for two back-to-back 12 hour duration storms, resulting in a volume of 12 MG. Table 3 summarizes the facilities required for the BNR with filtration process.

Table 3
BNR with Filtration Process – Design Criteria

Facilities	Number	Value, Each
Screens	3 (2 duty, 1 standby)	12.0 mgd
Grit Removal Basins	2	12.0 mgd
Equalization Basin	1	12.0 MG
Influent Pumps	5 (4 duty, 1 standby)	6.0 mgd
Activated Sludge Basin	3	
Anaerobic Volume		0.08 MG
Anoxic Volume		0.38 MG
Oxic Volume		1.83 MG
Total Volume		2.29 MG
Nitrified Recycle Pumps	3 (3 duty)	6.0 mgd
Anoxic Recycle Pumps	3 (3 duty)	2.0 mgd
Blowers	4 (3 duty, 1 standby)	3,090 scfm
Secondary Clarifiers	3	90 ft diameter
RAS Pumps	4 (3 duty, 1 standby)	3.1 mgd

Table 3 BNR with Filtration Process – Design Criteria		
Facilities	**Number**	**Value, Each**
WAS Pumps	2 (1 duty, 1 standby)	500 gpm
Disc Filters	4 (3 duty, 1 standby)	10 discs/filter
UV Disinfection	2 Banks/Channel	15 mJ/cm2
Cascade Aerator	1	8 steps

4.2.2 Membrane Bioreactor Process

The second process configuration considered uses MBRs for biological treatment. The overall plant schematic is very similar to the BNR process. MBRs eliminate the clarification and filtration steps required by the BNR with filtration configuration. Figure 5 provides a conceptual schematic of this process configuration.

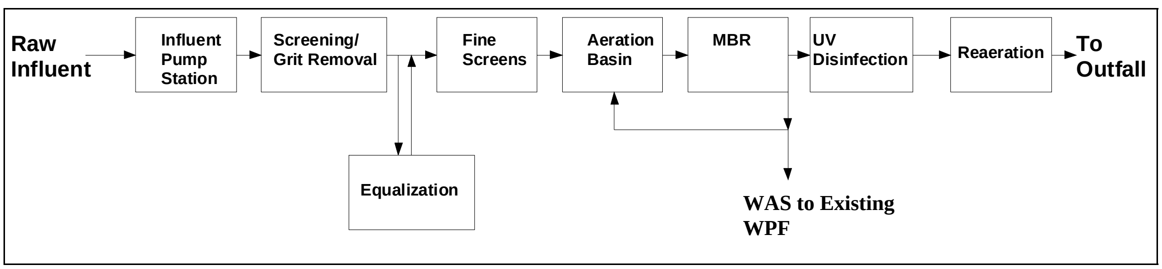


Figure 5 – Schematic of Membrane Bioreactor

Several unique process considerations need to be addressed in the MBR design. Since solids accumulate in the membrane zone, a solids recycle stream is normally directed to the process influent, which serves as the return activated sludge (RAS). However, the concentrated mixed liquor in the membrane zone will have a high dissolved oxygen concentration of 5 to 7 mg/L due to the aggressive aeration required to agitate the membranes to minimize fouling. To avoid returning dissolved oxygen to the anaerobic or anoxic zones, this mixed liquor will be returned to the oxic zone. An internal recycle from the de-oxic zone would be directed to the anoxic zones. Finally, anoxic mixed liquor would be recycled to the anaerobic zones. Figure 6 shows a flow schematic of the aeration basin zones.

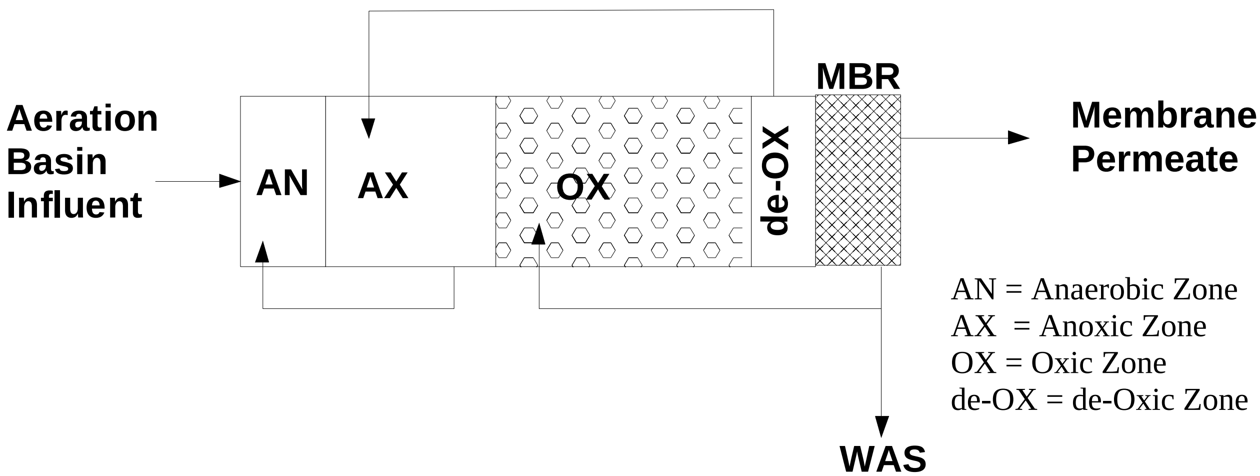


Figure 6 – Aeration Basin Schematic for Membrane Bioreactor

The MBR process would consist of:

- Preliminary Treatment: Influent Screens, Grit Removal, Flow Equalization, Fine Screens
- Secondary Treatment: BNR Basins, MBR, Blower Building
- Disinfection: UV Disinfection
- Reaeration: Cascade Aerator

Peak flow defines the number of membranes required; therefore, a greater amount of flow equalization would be provided for the membrane bioreactor alternative to prevent membrane costs from increasing significantly. The design is based on 1.5 times the average flow, or 9 mgd, passing through the process trains during peak events with the remainder of flow sent to the flow equalization basin. The flow equalization basin is sized for two back-to-back 12 hour duration storms resulting in a volume of 15 MG. Table 4 summarizes the required facilities for the MBR process.

Table 4
MBR Process – Design Criteria

Facilities	Number	Value, Each
Screens	3 (2 duty, 1 standby)	12.0 mgd
Grit Removal	2	12.0 mgd
Equalization Basin	1	15.0 MG
Influent Pumps	5 (4 duty, 1 standby)	6.0 mgd
Fine Screens	3 (2 duty, 1 standby)	4.5 mgd
Activated Sludge Basin	3	
Anaerobic Volume		0.08 MG
Anoxic Volume		0.27 MG
Oxic Volume		0.55MG
MBR Basin		0.15 MG
Total Volume		1.05 MG
Nitrified Recycle Pumps	3 (3 duty)	6.0 mgd
Anoxic Recycle Pumps	3 (3 duty)	2.0 mgd
Blowers	4 (3 duty, 1 standby)	1,090 scfm
Membrane Bioreactor	6 Trains	10 modules/train
RAS Pumps	4 (3 duty, 1 standby)	12.0 mgd
WAS Pumps	2 (1 duty, 1 standby)	153 gpm
UV Disinfection	2	15 mJ/cm2
Cascade Aerator	1	8 steps

4.2.3 Wetlands Treatment System Process

The final process configuration considered use of wetlands treatment in place of BNR with filtration. This process relies on a natural system (vegetation and land) to assimilate carbon, phosphorus, and nitrogen within the vegetation. To meet the effluent phosphorus and bacteria (E. coli) limits, filtration and disinfection will be required following wetland treatment. Figure 7 provides a conceptual schematic of this process.

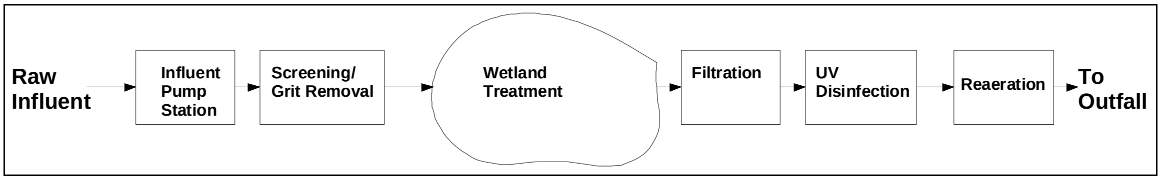


Figure 7 – Schematic of Wetlands Treatment System

The wetlands treatment system process would consist of:

- Preliminary Treatment: Influent Screens, Grit Removal, Flow Equalization
- Wetland Treatment: Land Application
- Tertiary Treatment: Cloth Disk Filters
- Disinfection: UV Disinfection
- Reaeration: Cascade Aerator

Wetlands treatment is a simple process; however, this simplicity comes at the cost of lack of process control of treatment and a lack of proven ability to meet the goal effluent requirements. In addition, the vast amount of land required for this system is prohibitive from both a space and cost standpoint. Following wetland treatment, the effluent must still be filtered and disinfected prior to discharge. Table 5 summarizes the facilities required for the wetlands treatment process.

Table 5
Wetlands Treatment Process – Design Criteria

Facilities	Number	Value, Each
Screens	3 (2 duty, 1 standby)	12.0 mgd
Grit Removal	2	12.0 mgd
Flow Equalization	1	540 MG
Wetlands		990 acres
Disc Filters	4 (3 duty, 1 standby)	12 discs/filter
UV Disinfection	2	15 mJ/cm2
Cascade Aerator	1	8 steps

As shown in Table 5, approximately 990 acres of land are required for the wetlands processes alone; the overall footprint of the facility is likely to be over 1,000 acres. At a cost of $12,500 per acre provided by the City, the cost of land alone, without buffer, for this approach is $12.5 million. A primary purpose of considering a new Eastside WPF is to promote economic development. The footprint of this treatment alternative would remove a great deal of developable land from the Eastside service area. Additionally, it would likely be difficult to acquire this much contiguous property. Due to the nature of the treatment process, public access from the entire facility would need to be restricted and a large buffer would likely need to be procured, resulting in even greater space and land acquisition requirements.

As the natural process is highly dependent on temperature, it slows significantly during winter. This approach would require enough flow equalization to store the average flow for approximately three months when the natural process would not be adequate to treat the flow, resulting in the need for 540 MG of flow equalization. Construction of this volume of flow equalization is also extremely costly and space prohibitive.

Due to the reasons presented, utilization of a wetlands system for treatment of the Eastside flows is not considered a viable treatment approach. Therefore, the wetlands treatment system will not be considered for further evaluation or costing.

4.2.4 Solids Handling

The solids quantities used in this evaluation were developed as part of the modeling conducted for the liquid process evaluations. The projected waste activated sludge (WAS) quantities for BNR with filtration and MBR are summarized in Table 6.

Table 6
Eastside WPF Design Solids Quantities

Process	Item	Units	Average	Max Month
BNR with Filtration	WAS	ppd	7,200	14,817
	WAS Total Solids	mg/L	4,000	6,500
	WAS Flow	gpd	215,827	273,319

Table 6 Eastside WPF Design Solids Quantities				
Process	**Item**	**Units**	**Average**	**Max Month**
MBR	WAS	ppd	6,852	14,470
	WAS Total Solids	mg/L	10,000	10,000
	WAS Flow	gpd	82,162	173,501

These sludge quantities are not large enough to warrant dedicated solids processing facilities designed to produce a sludge suitable for disposal. As the existing WPF has sufficient solids handling capacity to accept sludge from the Eastside WPF, it is recommended that solids produced at the Eastside WPF should be sent to the existing WPF for treatment. The solids handling capability of the existing WPF will be presented further in TM-WW-6 – Biosolids Facilities.

It was initially determined that two means of transporting solids from the Eastside WPF to the existing WPF would be evaluated: 1) pumping of WAS and 2) truck hauling of TWAS. Concerns arose with the concept of WAS pumping over a long distance. While the sludge generated at the Eastside WPF would not contain primary solids (no primary clarifiers), the WAS would likely contain stringy and other difficult to pump materials that can cause solids deposition and plugging issues within a force main over five miles in length. Further complicating the solids deposition issue is that it would be difficult to size the line for appropriate flushing during operation with low solids flows, while maintaining a minimum 6 inch force main diameter. It is likely some type of holding tank and automated control system would need to be designed to allow for holding of solids and timed release to provide adequate line flushing; another option would be to mix the solids with WPF effluent to dilute the solids and increase velocity in the line to the existing WPF. High pumping head requirements due to changes in elevation and compensation for line losses in a long force main would likely require the use of positive displacement pumps, typically resulting in additional maintenance. Based on the City's current concerns in other locations related to solids disposition in lines and desire for lower maintenance equipment, the alternative of pumping WAS to the existing WPF for treatment was screened out from further evaluation. Black & Veatch solids handling experience indicates that hauling TWAS is generally less expensive than WAS pumping, especially in cases where a long force main is involved. Therefore, only thickening and hauling of solids to the existing WPF will be considered for further costing and evaluation.

Several technologies are available for WAS thickening. WAS solids settle less readily than primary solids and are, therefore, not well suited to gravity thickening. Consequently, mechanical thickening processes are typically used for WAS thickening. WAS concentrations typically range from 0.25 to greater than 1.0 percent total solids and can be thickened to solids concentrations of 3 to 5 percent total solids. The most popular mechanical thickening technologies include gravity belt thickening, rotary drum thickening, and dissolved air flotation thickening (DAF).

After reviewing each technology and considering the Eastside WPF sludge characteristics, DAF thickening was selected over other technologies, for the following reasons:

- The Eastside WPF is likely to be operated as a satellite facility and DAF requires less consistent operational attention than other technologies considered,
- Lower polymer usage,
- Relatively smaller footprint, and
- The existing operational experience with DAF technology at the existing WPF.

This design includes three DAF units, which are sized at a solids loading rate of 0.45 pound solids per hour per square foot of surface area (pph/sf). At this loading rate, the solids capture rate can reach 90 to 95 percent without polymer addition. However, polymer feed capability would be provided to offer more operational flexibility. When one DAF unit is down for maintenance, the other units would be able to process the full solids load with the addition of polymer. The conceptual design criteria and thickened solids characteristics are listed in Table 7.

Table 7
Eastside WPF Solids Loadings and DAF Design Criteria

Parameter	Unit	BNR Max Month	BNR Average	MBR Max Month	MBR Average
WAS					
WAS Quantity	ppd	14,817	7,200	14,470	6,852
	gpd	273,319	215,827	173,501	82,162
WAS Total Solids	%	0.65	0.4	1.0	1.0
DAF Unit					
DAF Surface Area	sf/unit	460	460	460	460
Number of Units	ea	3 (2)	3 (2)	3 (2)	3 (2)
Operating Schedule	hr - day	24 - 7	24 - 7	24 - 7	24 - 7
DAF Solids Loading Rate	pph/sf	0.45 (0.67)	0.22 (0.33)	0.44 (0.66)	0.21 (0.31)
DAF Hydraulic Loading Rate	gpm/sf	0.14 (0.21)	0.11 (0.16)	0.09 (0.13)	0.04 (0.06)
Solids Capture Rate	%	95	95	95	95
Polymer Dosage	lb/dt	0 (8 to 10)	0 (8 to 10)	0 (8 to 10)	0 (8 to 10)
TWAS					
TWAS Total Solids	%	4.0	4.0	4.0	4.0
TWAS Quantity	ppd	14,076	6,840	13,747	6,509
	gpd	42,200	20,500	41,200	19,500
TWAS Storage	day	3	3	3	3
TWAS Storage Tank	gallon	126,600	61,500	123,600	58,500
Truck Capacity	gal/truck	4,000	4,000	4,000	4,000
Truck Traffic	trucks/day	10.6	5.1	10.3	4.9
Subnatant					
Subnatant Flow	gpm	168	139	99	47
Subnatant Wetwell Retention	min	30	30	30	30
Subnatant Wetwell	gallon	5,040	4,170	2,970	1,410

Values in ( ) denote conditions when only two DAF units are in use.
ppd = pounds per day, gpd = gallons per day, sf = square foot, gpm = gallons per minute,
lb/dt = pounds per dry ton

As shown in Table 7, the thickening system design criteria for solids from the BNR and MBR processes are nearly identical at this level of study. As a result, the design requirements for the BNR solids quantities, which are slightly more conservative, will be carried through the remainder of this analysis for the purpose of costing. The DAF thickening option will require the following new facilities at the Eastside WPF:

- Three new circular 24 foot diameter DAF units
- Solids handling building with adjacent truck loading area
  - Centrifugal DAF feed pumps
  - Subnatant well and pumps
  - Progressing cavity thickened solids pumps
- WAS storage tank with submersible mixers
- Thickened solids storage tank with submersible mixers
- Polymer mixing/aging and polymer feed system
- Odor control for entire solids handling facility

4.3 Wastewater Process Evaluation

The following section provides the economic and non-economic evaluations of the two process approaches under consideration for the Eastside WPF.

4.3.1 Economic Evaluation

4.3.1.1 Opinion of Probable Project Cost. A conceptual cost methodology was employed to develop capital project costs for the process approaches considered. All project costs are given in May 2009 dollars (Engineering News Record (ENR) Building Cost Index (BCI) equal to 4773).

Costs of liquid process units and support facilities were determined by building a database of selected similar facilities from previous Black & Veatch projects. The database was then escalated and scaled as appropriate to approximate the facility sizes required for the Eastside WPF. Flow equalization basins were sized as indicated previously in this section. Equalization basin costs are based on providing basins with covers and odor control systems. Costs for DAF units and other solids processing facilities were developed based on Black & Veatch project experience.

In the absence of geotechnical information for the proposed sites on the Eastside, it was assumed the new facilities would require pile foundations similar to those at the existing WPF. Piles were assumed to be 70 feet deep.

Table 8 provides a summary of the opinion of probable project costs for each of the process alternatives considered. For each alternative, the WPF discharge outfall line was sized to convey 24 mgd, which is two times the future design peak flow through the process train (12 mgd) to account for potential future expansion at the WPF. It is typically more cost effective to construct a larger effluent line during the initial phase of construction than upsizing the outfall line in the future. This outfall cost is based on an assumed outfall length of 4,000 feet; the cost for the outfall will need to be confirmed once the final site location is determined. Consistent with the Eastside WPF's usage as a satellite facility, each alternative was provided with a multipurpose administration/ maintenance building at a typical unit cost based on square footage. All buildings provided would be brick and block.

In addition to building and process unit costs based on previous project experience, other construction costs were projected by applying a percentage to appropriate project costs as indicated in Footnotes 4 and 5 of Table 8. The cost for electrical and instrumentation and controls (I&C) was projected at 25 percent of the cost of equipment, installation, and structures. This electrical and I&C cost does not include any new or back-up power feeds; these facilities will be reflected in the overall project cost presented later in this memorandum. An allowance of 10 percent was applied for project sitework. Contractor general requirements were projected at 12 percent and contingency was set at 25 percent. Costs related to engineering, legal, and administration are reflected in a 20 percent multiplier applied to all construction costs. Site related costs such as flood protection/fill, site remediation, and land acquisition are site dependent and will be presented later in this memorandum as part of the overall project costs; these costs are not reflected in Table 8.

Table 8
Opinion of Probable Project Cost Comparison for Eastside WPF Process Approaches [1]

Item	BNR with Filtration, $	MBR, $
Screening/Grit Facility	2,100,000	2,100,000
Flow Equalization Basin [2]	21,000,000	25,000,000
Influent Pump Station	6,425,000	6,425,000
Fine Screens	--	840,000
Aeration Basin Splitter Box	150,000	150,000
BNR Basin	9,500,000	5,000,000
MBR Splitter Box	--	150,000
MBR	--	12,500,000
Secondary Clarifier Splitter Box	150,000	--
Secondary Clarifiers	3,600,000	--
Blower Building	1,650,000	1,000,000
RAS/WAS Pump Station	1,151,000	--
Permeate Pump Station	--	1,151,000
Filters	1,400,000	--
Ultraviolet Light Disinfection	1,200,000	1,200,000
Reaeration	1,300,000	1,300,000
Outfall	2,260,000	2,260,000
Solids (thicken and haul to existing WPF)	5,096,000	5,096,000
Multipurpose Administration and Maintenance Building	1,000,000	1,000,000
Total Structure Piling	800,000	800,000
Flood Protection/Fill (placeholder) [3]	--	--
Site Remediation (placeholder) [3]	--	--
Subtotal	*58,782,000*	*65,972,000*
Electrical, I&C, Sitework, Contractor General Requirements [4]	31,742,000	35,624,000
Subtotal	*90,524,000*	*101,596,000*
Contingency [5]	22,631,000	25,399,000
Land Acquisition (placeholder) [3]	--	--
Opinion of Probable Construction Cost	**113,155,000**	**126,995,000**
Engineering, Legal, and Administration [6]	22,631,000	25,399,000
Opinion of Total Project Cost	**135,786,000**	**152,394,000**

1. All costs presented in May 2009 dollars (ENR BCI = 4773).
2. Flow equalization basins sized at 12 MG for BNR and 15 MG for MBR.
3. Site related costs will be developed as part of the overall project cost and are not reflected here.
4. Electrical and instrumentation and controls (I&C) projected at 25% of the total of all equipment and structure costs. The electrical and I&C cost does not include any new or back-up power feeds; these facilities will be projected in the overall project costs. Sitework projected at 10% of the total of equipment, structures, electrical, and I&C costs. Contractor general requirements projected at 12% of the total of equipment, structures, electrical, I&C, and sitework costs.

Table 8 Opinion of Probable Project Cost Comparison for Eastside WPF Process Approaches [1]		
Item	**BNR with Filtration, $**	**MBR, $**
5. Project contingency is projected at 25% of the total of all equipment, structures, electrical, I&C, sitework, and contractor general requirements. 6. Engineering, legal, and administration (ELA) costs are projected at 20% of the total of all equipment, structures, electrical, I&C, sitework, contractor general requirements, and contingency. Overall project ELA will be presented as part of the overall project costs later in this memorandum.		

Based on the project capital cost summary presented in Table 8, the BNR with filtration process has the lowest total capital cost. The total capital cost for BNR with filtration is 12 percent less than that for MBR. This is reasonable in that MBR requires additional process units beyond those required for BNR with filtration. Based on the summary presented in Table 8, the BNR with filtration process is the lowest capital cost liquid treatment approach for the Eastside WPF.

4.3.1.2 Opinion of Probable O&M Cost. Projections of operations and maintenance (O&M) costs were determined for each alternative. O&M costs were calculated based on providing an average annual treatment of 6 mgd.

Table 9 presents the unit costs employed for O&M cost development. Unit costs shown in Table 9 for power and labor were provided by the City. The remaining unit costs are based on Black & Veatch experience with similar operating facilities. Annual O&M costs for each alternative calculated were determined by applying the unit costs to O&M requirements based on previous Black & Veatch project experience. The annual O&M costs for each alternative are given in Table 10. Major O&M costs for the Eastside WPF include power, labor, equipment repair and spare parts replacement, hauling of solids to the existing WPF for treatment which includes the labor for a driver, and the polymer usage for a liquid emulsion polymer feed system. Cost of polymer usage is based on adding polymer to the DAF system 10 percent of the time since polymer is only required when one DAF tank is out of service.

Table 9
Eastside WPF O&M Unit Costs [1]

Power [2]	$0.10/kW-hr
Labor (including benefits and overhead) [2]	$32.78/hr
Maintenance and Spare Parts	Cost factors based on 6 mgd average flow
Polymer	$10/gallon
Solids Hauling	$0.58/mile

1. All costs provided in May 2009 dollars. Except for those indicated as City provided, all unit costs based on Black & Veatch project experience.
2. Units costs based on data provided by the City.

Table 10
Annual O&M Costs for Eastside WPF Process Approaches
(Average Flow of 6 mgd)

	BNR with Filtration, $	MBR, $
Power	475,000	532,000
Labor	875,000	943,000
Maintenance and Spare Parts	232,000	232,000
Chemicals	58,000	58,000
Solids Hauling	26,000	26,000
Total	**1,666,000**	**1,791,000**

Based on the summary provided in Table 10, the O&M costs for BNR with filtration are 8 percent less than those for MBR. Power costs for MBR are higher than those for BNR due to the fact that the MBR requires scouring equipment, additional recycle, and permeate pumps. Labor for MBR is also slightly higher because while MBR requires less day-to-day operator attention, it is a more complex system, requiring more instrumentation, electrical, and mechanical support; this results in higher overall labor costs for MBR. However, at this level of study, alternatives within 10 percent of each other are considered equivalent. The results of the analysis suggest that O&M costs associated with either alternative for the Eastside WPF can be considered as equivalent for the purposes of this study.

4.3.2 Non-Economic Considerations

Many important factors beyond cost affect the selection of a treatment process for a given application. A comparison of BNR and MBR technologies utilizing several non-economic criteria is provided in the following sections.

4.3.2.1 Operator Attention. Unlike a BNR system, the MBR does not require the same level of operator attention to control the system for adequate settling. This reduces the amount of day-to-day attention for MBR versus what is required for the BNR process; however, due to its greater complexity, the MBR process will require additional instrumentation, electrical, and mechanical support, resulting in higher overall labor requirements.

4.3.2.2 Routine Maintenance. Due to the requirement of membrane cleaning, the MBR will require more routine maintenance time than the BNR process.

4.3.2.3 Mechanical Complexity. The MBR process includes significantly more valves and pumps than the BNR process, increasing the mechanical complexity of the facility.

4.3.2.4 Operational Complexity. Although operators will need to be less concerned with settling characteristics for the MBR than for the BNR, the MBR technology requires more specialized knowledge of the treatment process when compared to BNR. Operator process knowledge gained from operating the existing WPF will be more directly applicable to the BNR process than it would to the MBR process. More specialized operator training would be required for the MBR process.

4.3.2.5 Proven Technology. BNR has been applied effectively in countless facilities for many years. MBRs are relatively new; however, the number of installations has grown dramatically in the last five years, leading to multiple examples of well-operating facilities.

4.3.2.6 Reliability. Due to the absolute barrier nature of the MBR, this technology offers a high degree of reliability for maintaining biomass and effluent quality. However, because there are more mechanical systems the increased complexity does diminish the mechanical reliability of the process versus that for the BNR.

4.3.2.7 Effluent Quality. Table 11 summarizes the effluent quality that can be anticipated from each of the liquid process alternative treatment methods. As indicated in Table 11, the MBR process provides the higher quality effluent; however, both technologies produce effluent that would meet the anticipated Eastside WPF discharge limits.

Table 11
Summary of Projected Effluent Quality for BNR and MBR

Alternative	Biochemical Oxygen Demand, mg/L	Suspended Solids, mg/L	Total Phosphorous, mg/L	Total Nitrogen, mg/L
BNR with Filtration	5-10	5-10	1-2	8-10
MBR	2-5	2-5	0.5-1.5	5-8

4.3.2.8 Facility Footprint. In MBR technology, the use of filtration units reduces the aeration basin volume required. This is because an MBR system can be operated at higher concentrations than a conventional BNR basin, which reduces the overall BNR basin volume required for the MBR process. In addition, the MBR process eliminates the need for secondary clarifiers and filtration. As a result, an MBR facility typically has a 20 to 40 percent smaller footprint than a BNR facility of similar capacity.

4.4 Process Recommendation

It is recommended that the proposed Eastside WPF utilize BNR with filtration for the liquid treatment process and that the facility thicken solids to facilitate hauling to the existing WPF for solids treatment. This recommendation is based on the results of the economic and non-economic analyses of the comparison between BNR and MBR technologies.

The BNR process is 12 percent less costly on a capital basis than the MBR process and the O&M costs for BNR and MBR are considered equivalent at this level of study. Therefore, the BNR process has a lower life cycle cost than the MBR process.

From a non-economic perspective, the MBR facility has a higher degree of mechanical and operational complexity, accompanied by the associated mechanical reliability issues. The BNR process is less complicated to operate than MBR and more similar in operation to the facilities at the existing WPF. The main advantage of an MBR facility is it is able to achieve higher effluent quality with a smaller footprint; this is important if space availability is a concern. Both BNR and MBR can meet the anticipated permit limits for a new Eastside WPF. The land available at the potential site locations is sufficient so as not to require a more compact, yet more complex, technology. Therefore, BNR with filtration is the recommended alternative. To provide future operational flexibility, the proposed BNR facilities could be constructed so that the secondary clarifiers could be converted to MBRs in the event that future permit effluent limitations become more stringent than is currently anticipated.

For the remainder of the analysis presented in this memorandum, costs presented for the new Eastside WPF will reflect the costs developed for the BNR process with filtration.

5.0 Alternatives for Treatment of Eastside Flows

This section presents the various siting alternatives for processing of flows from the Eastside service area. None of the potential siting locations are limited by land space. The proposed site alternatives do not require the application of small footprint treatment technology to be considered a viable site. Therefore, the site alternative selection is an independent decision from determination of the treatment processes to be utilized. This section will only present development and evaluation of siting alternatives. Evaluation of process treatment alternatives was provided in Section 4.0 of this memorandum.

5.1 Alternative Development

Presently, wastewater flows from the existing Eastside service area (light pink on Figure 1) are conveyed by gravity and through a series of small pump stations to the existing Faraon Street Pump Station. The Faraon Street Pump Station then pumps all Eastside flows over the ridge separating western and eastern St. Joseph (located nominally along the Belt Highway) into a gravity sewer in the Mitchell Basin. Within the Mitchell Basin, the Eastside flows travel by gravity to the Whitehead Pump Station, which then pumps flows to the existing WPF located in the southwestern portion of the City. As the Eastside area continues to develop, additional flows will be generated as presented in Section 3.2.

The existing Faraon Street Pump Station is beyond its useful life and the City wishes to plan for additional service areas within the Eastside. As a result, there are advantages to building new wastewater infrastructure in the eastern portion of the City; new infrastructure could take over the function of aging existing facilities as well as open up additional wastewater service areas on the Eastside. This new infrastructure could take the form of a dedicated Eastside WPF which would receive and treat Eastside flows, eliminating the need for these flows to be pumped to the existing WPF on the west side of the City for treatment. Alternatively, a new pump station, replacing the current functionality of the existing Faraon Street Pump Station, could be built on the Eastside to continue to convey flows generated on the east to the existing WPF for treatment. This new station would fill a similar role as the existing Faraon Street Pump Station, but would be located to eliminate the Easton Road Pump Station and serve an expanding Eastside service area by gravity. The Faraon Street Pump Station has outlived its useful life despite all attempts by City staff to maintain it; due to its age and rapidly deteriorating condition, continued use of the existing Faraon Street Pump Station was not considered a viable alternative and will not be considered for use in the alternatives.

5.1.1 Site Selection

Based on review of the Eastside service area, it appears prudent to locate wastewater infrastructure relatively close to the 102 River and Platte River, and as far south as possible to increase the service area that can flow to the site by gravity. While it is ideal to locate such infrastructure at the lowest elevation possible, permitting and protecting infrastructure from flooding within the floodway are challenges that must be met. As a result, the study area was examined for low lying sites that could service a large area by gravity, but lie outside of the floodway. Locating facilities within the flood plain is acceptable assuming all flood plain requirements are met.

Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM maps) were utilized to pinpoint low lying areas along the 102 and Platte Rivers that are located outside of the floodway. Locations along the Platte River were considered more desirable because they are located further south. The topography along the Platte River results in fairly steep river banks. This means that in many locations the width of the flood plain is not much wider than that of the floodway, providing little low-lying flat land available outside of the floodway on which to site wastewater infrastructure. Based on the map based inspection, two locations, indicated as the north site and the south site on Figure 1, do provide adequate low-lying space outside the floodway to be considered for the siting of wastewater infrastructure.

A site visit was conducted on July 28, 2009, for a visual inspection of the two sites highlighted from the map review – the north and south sites as shown in Figure 1. The north site, shown in Figure 8, is accessible from south of the site by Saxton Easton Road, which extends along privately owned railroad tracks. The north site is bisected by Candy Creek just west of the Platte River. The land use appears to be primarily agricultural farmland. Based on the driving inspection, the north site appears suitable for further consideration for the siting of future wastewater infrastructure.

Figure 8 – View of North Site from Saxton Easton Road, Looking North

An attempt was also made to visually inspect the south site as part of the site visit. However, lack of public access roads made it impossible to get close enough to get a clear visual inspection of the site itself. The site is visually buffered from surrounding areas by trees and topography. Several established single family residences are located to the northeast of the proposed site. Subsequent review of aerial photography and land use maps indicates this site is comprised of mainly agricultural land and farm home sites. The south site location allows the facility to potentially service more service area by gravity. Nothing in the site visit indicated it would not be a feasible siting alternative; therefore, the south site will be considered further for siting of future wastewater infrastructure.

Based on the map evaluation and the site inspection, no other feasible areas for siting wastewater infrastructure were identified.

5.1.2 Overview of Alternatives

Based on the results of the site visit, three alternatives were developed to provide the conveyance and treatment of future flows on the Eastside. The following provides a summary of the elements of each alternative:

- **Alternative 1 – Eastside WPF at North Site**
    - Interceptor and trunk sewers to route wastewater flow to North site
    - Package pump station and 10 inch force main to route southern flows to North site
    - BNR with filtration WPF (6 mgd average flow)
    - Flow equalization basin (12 MG)
    - North site land acquisition (320 acres assumed)
    - Decommissioning of Faraon Street and Easton Road Pump Stations

- **Alternative 2 – Eastside WPF at South Site**
    - Interceptor and trunk sewers to route wastewater flow to South site
    - BNR with filtration WPF (6 mgd average flow)
    - Flow equalization basin (12 MG)

- South site land acquisition (320 acres assumed)
- Decommissioning of Faraon Street and Easton Road Pump Stations

* **Alternative 3 – Eastside Pump Station at North Site**
  - Interceptor and trunk sewers to route wastewater flow to North site
  - Eastside Pump Station (8 mgd to existing WPF, 16 mgd to flow equalization basin)
  - 24 inch force main from Eastside Pump Station to Mitchell Basin
  - 24 inch force main from Eastside Pump Station to flow equalization
  - Flow equalization basin (16 MG)
  - North site land acquisition (320 acres assumed for future WPF build-out)
  - Decommissioning of Faraon Street and Easton Road Pump Stations

The following sections provide a conceptual overview of the proposed conveyance infrastructure required to serve each of the alternatives, including pump station, flow equalization, and odor control requirements for Alternative 3. A conceptual overview of the process treatment and flow equalization for the new WPF included in Alternatives 1 and 2 was developed previously in Section 4.0. Consideration of non-economic factors and public feedback is also presented. The economic evaluation is presented with the overall project costs later in this memorandum.

5.1.3 Alternative 1 – Eastside WPF at North Site

A conceptual layout of the proposed wastewater conveyance system to serve a new Eastside WPF located at the north site is presented in Figure 9. An Eastside interceptor sewer is proposed to extend along the 102 River in the northern portion of the Eastside service area and along the Platte River south of the confluence of the Platte and 102 Rivers. This main interceptor, ranging in size from 36 inches to 96 inches, was sized

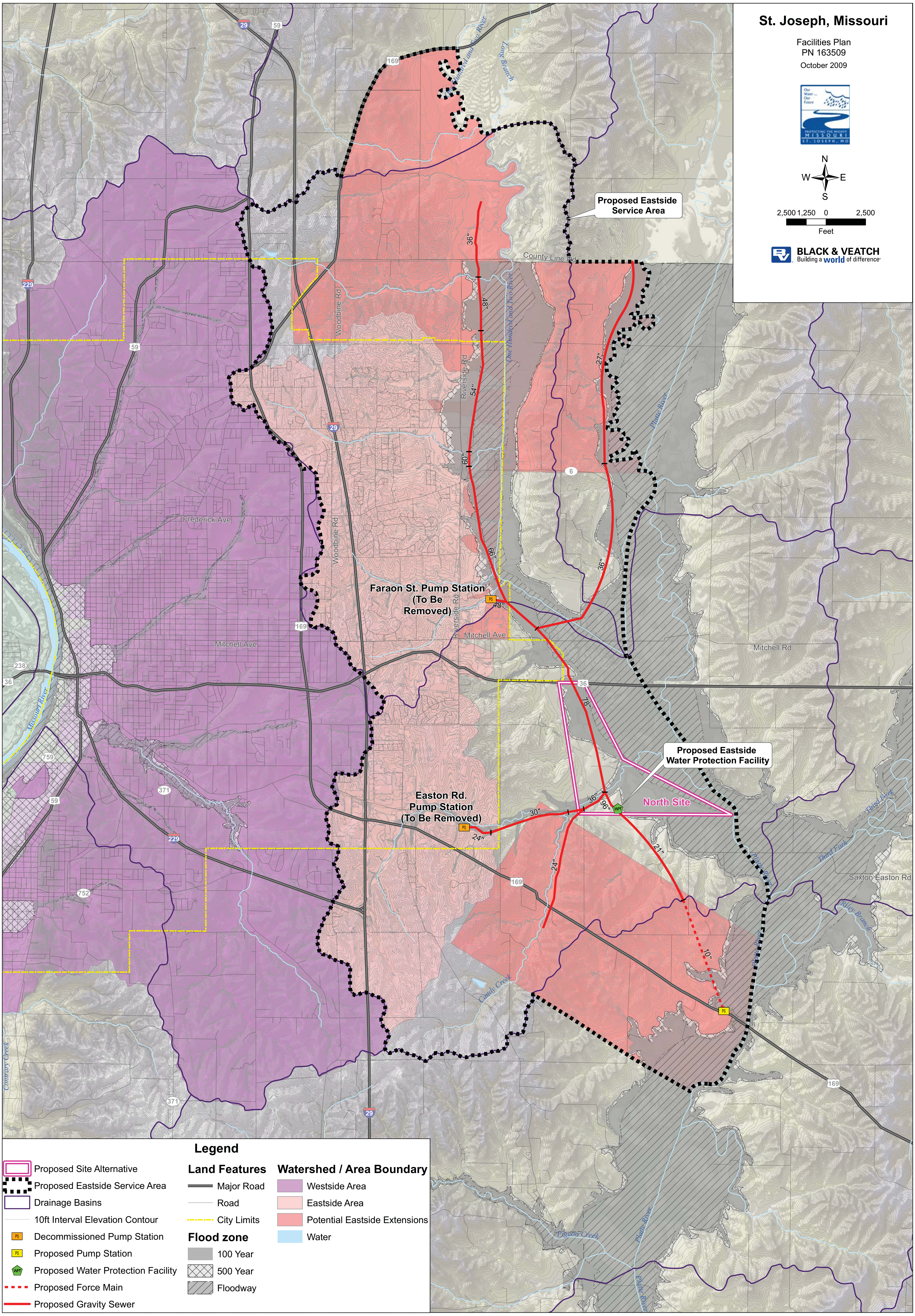


Figure 9

ALTERNATIVE 1 - EASTSIDE WATER PROTECTION FACILITY AT NORTH SITE

to convey flows described in Section 3.3. Trunk sewers are also shown to collect the flow from the area between the rivers north of the confluence of the Platte and 102 Rivers as well as the areas currently served by the Faraon Street and Easton Road Pump Stations. If a new Eastside WPF were to be constructed, the existing Faraon Street and Easton Road Pump Stations would be decommissioned with flows from their service areas able to flow by gravity to the Eastside interceptor sewer. As the Eastside interceptor is extended to the north, the Wheat Ridge 3 Pump Station would eventually be decommissioned as well.

Flows from the far southeast portion of the proposed service area by the Platte River would require pumping by a small package pump station (0.5 mgd average flow, 2 mgd peak flow) over the ridgeline into a gravity sewer in the Candy Creek Basin for delivery to the WPF as shown in Figure 9. The conveyance system evaluation was based on determining the size of sanitary sewers that are 24 inches and larger, as shown in Figure 9. One exception is the 21 inch line in the southeast portion of the service area, which is shown to illustrate how the flows from the southeast enter the proposed WPF. All conveyance infrastructure shown on Figure 9 will be included in the determination of the opinion of probable project cost.

5.1.4 Alternative 2 – Eastside WPF at South Site

Figure 10 presents a conceptual layout of the conveyance system required to convey flows to a new WPF at the south site. The Eastside interceptor and gravity trunk sewers are identical to that proposed in Alternative 1 north of the intersection of Saxton Easton Road and Candy Creek, nominally the location of the north site presented in Alternative 1. Flows from the north are all collected at the location of the north site and then flow by gravity to the southern site shown in the southeast of the Eastside service area. Only gravity sewers 24 inches and greater are shown in Figure 10. All conveyance infrastructure shown on Figure 10 will be included in the determination of the opinion of probable project cost.

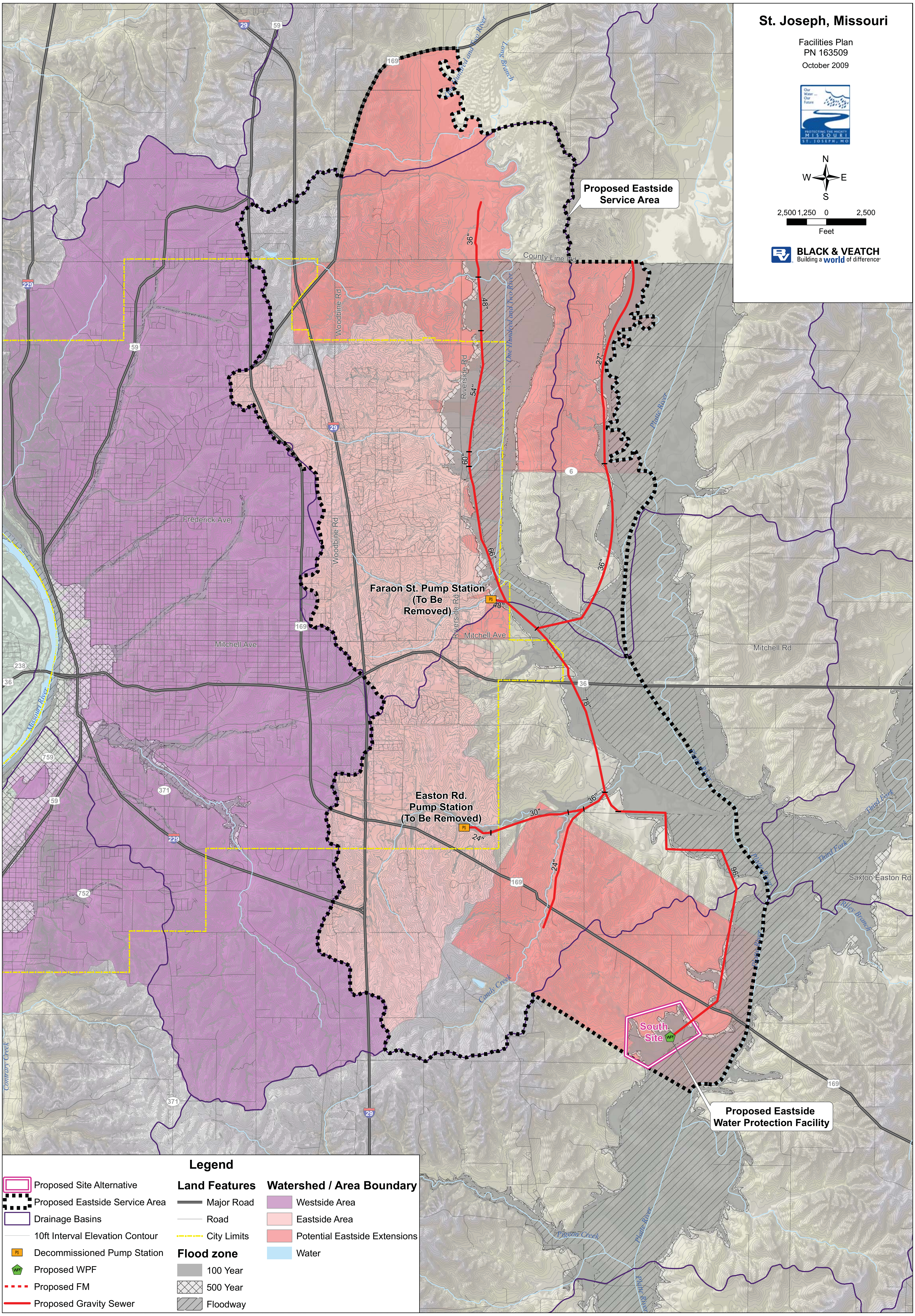


Figure 10

ALTERNATIVE 2 - EASTSIDE WPF AT SOUTHERN SITE

5.1.5 Alternative 3 – Eastside Pump Station at North Site

Figure 11 presents a conceptual layout of the conveyance system required to convey flows to a new Eastside Pump Station located at the north site. Conveyance infrastructure for this alternative is essentially identical to that presented in Figure 9 for Alternative 1. This alternative differs from Alternative 1 in that once all flows are conveyed to the north site, the new Eastside Pump Station pumps flows through the force main shown to the location of the existing Faraon Street Pump Station and then through the route of the existing Faraon Street force main to the Mitchell Basin. Once in the Mitchell Basin, flows travel by gravity through the existing gravity system to the Whitehead Pump Station and then on to the existing WPF. All conveyance infrastructure shown on Figure 11 will be included in the determination of the opinion of probable project cost.

5.1.5.1 Eastside Pump Station and Equalization Basin. Both of the alternatives which include constructing a new WPF on the Eastside include flow equalization basins for the management of peak flows as previously presented. An analysis was also undertaken to determine the flow equalization basin requirements in the case of building a new pump station on the Eastside. Initially, it was envisioned that the Eastside Pump Station would pump flows directly to the existing WPF. This would require the force main to extend from lower to higher elevation about five and a half miles from the Eastside Pump Station to the main City ridgeline, nominally located along Belt Highway. From this point on, the force main would essentially run downhill for several more miles to the existing WPF. Black & Veatch pumping experts expressed concerns about the operability as well as the odor potential along the entire length of a force main extending downhill over such a long length. As odors are already a significant concern with the Faraon Street force main, it was decided that a downhill portion of the force main should not be built. Therefore, Alternative 3 continues the existing practice of pumping Eastside flows uphill to the area of the Belt Highway and then utilizing the existing gravity system in Mitchell Basin to convey flows to the existing WPF.

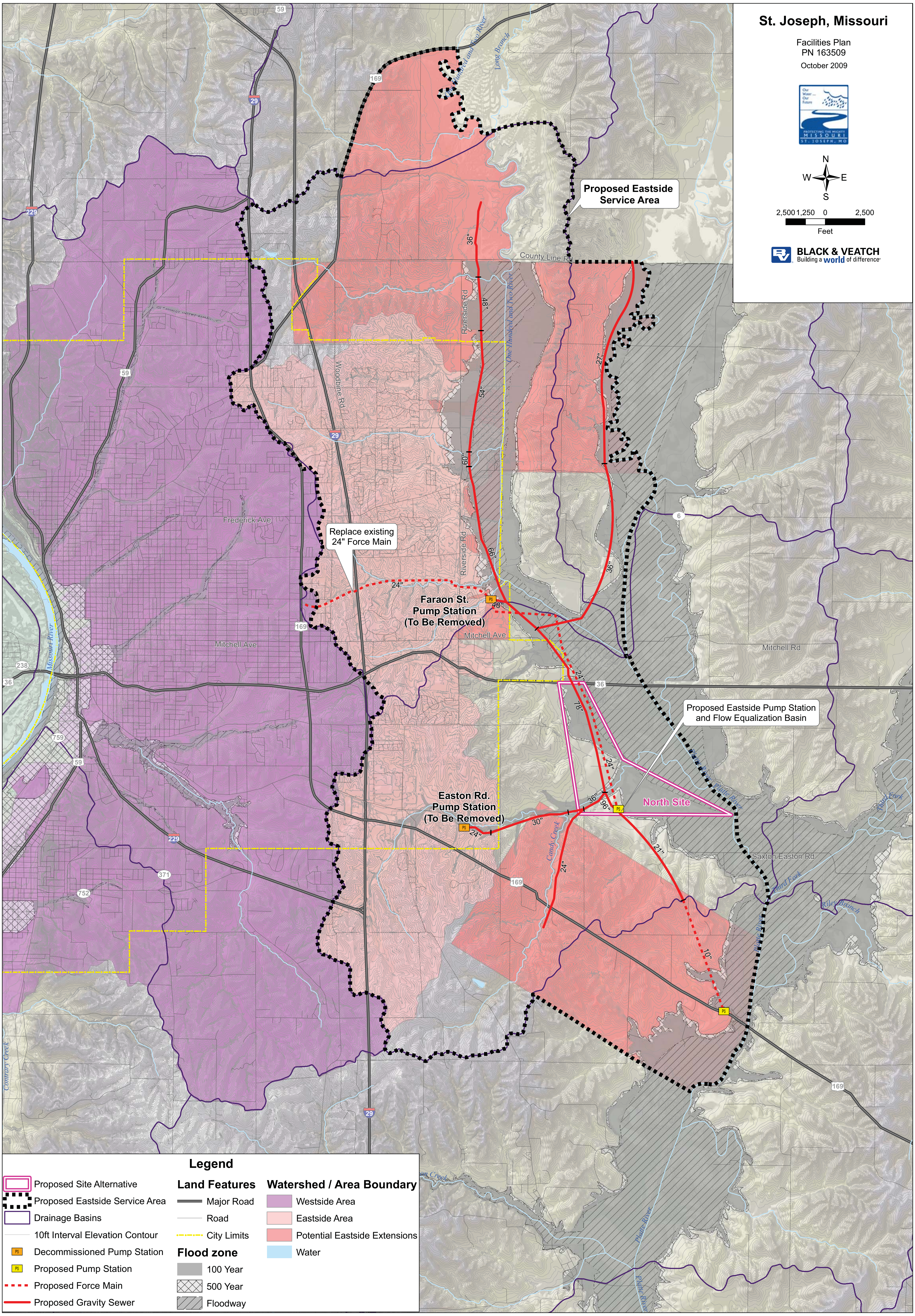


Figure 11

ALTERNATIVE 3 - EASTSIDE PUMP STATION AT NORTH SITE

Since this alternative continues to discharge Eastside flows to the gravity system in Mitchell Basin, it was determined that flows from the new Eastside system should not be greater that those currently experienced within the Mitchell system. The existing annual average flow from the Faraon Street Pump Station is between 2 to 3 mgd. Applying the four to one peak to average flow ratio developed previously, this suggests that a maximum of 8 mgd currently flows from the Eastside to the Mitchell Basin. This approximation of 8 mgd peak pumped from the Eastside to the Westside is further supported by the fact that the total installed pumping capacity of the Faraon Street Pump Station is 8 mgd. An additional check was completed to determine how this flow in combination with the average dry weather flow in Mitchell compared to the height at which the weir at the Mitchell Avenue Diversion Structure would be overtopped. It was determined that 8 mgd of flow from the Eastside when added to existing Mitchell Avenue flows would result in a flow of about 50 percent of that which overtops the diversion structure weir. Therefore, it was determined that this amount of flow still provides enough factor of safety against overflows during dry weather flow. Therefore, the maximum flow from the Eastside Pump Station was limited to 8 mgd.

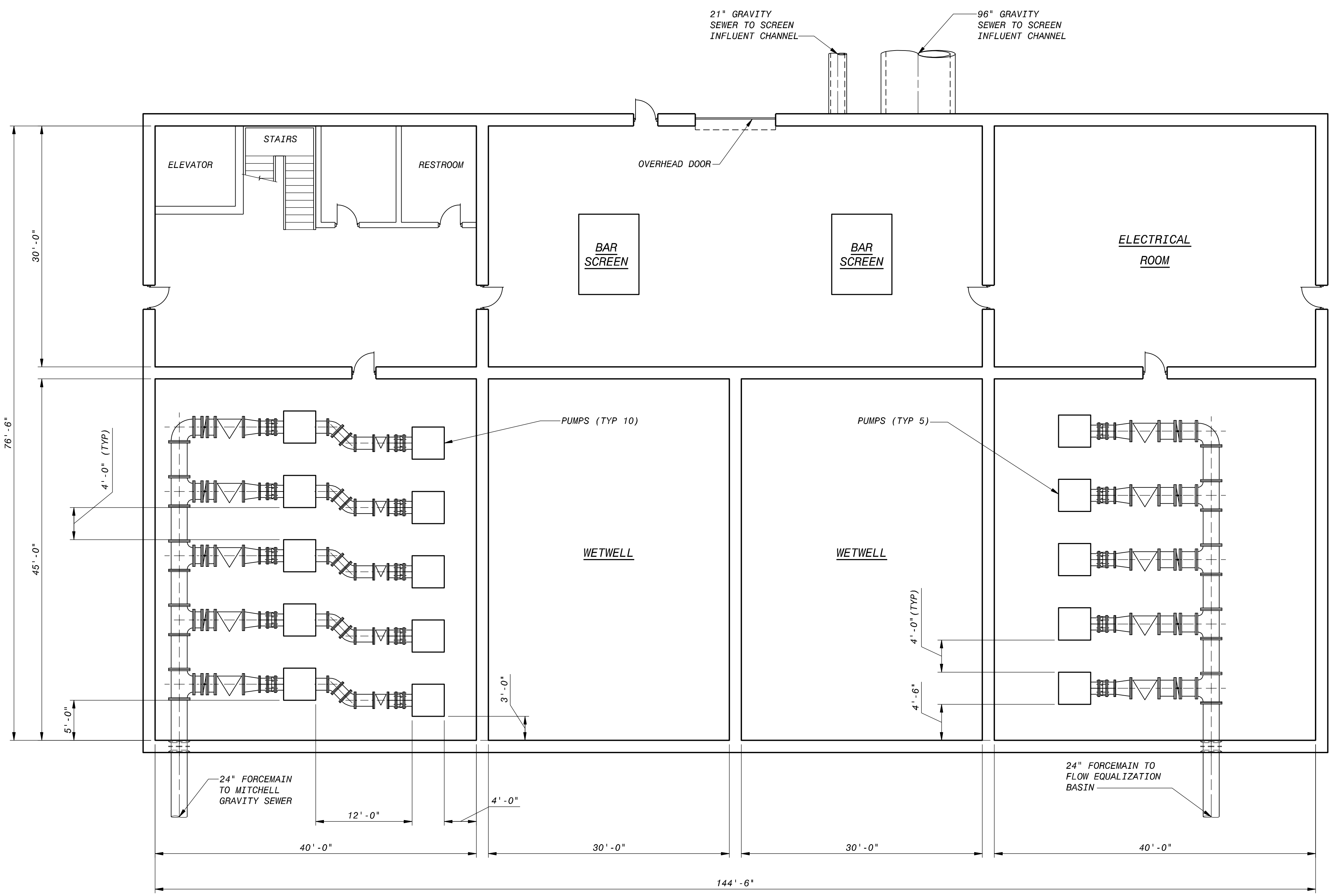
During wet weather, 2030 peak hourly flows at the Eastside facility are estimated to be 24 mgd as presented in Section 3.2. If the Eastside Pump Station can pump 8 mgd, an additional 16 mgd of flow will be received that must be equalized. The Eastside flow equalization basin was sized in the same manner as those proposed for the new Eastside WPF alternatives. This method, assuming back-to-back 12-hour duration storms, results in an equalization basin volume at the pump station site of 16 MG.

Investigation of the pumping requirements to convey flow from the Eastside Pump Station to the existing WPF showed that the high head requirement due to elevation and long pumping distance of the system was beyond what single wastewater pumps would be able to provide; therefore, pumps in series would be required. Pumping head requirements to the proposed flow equalization basin, located in the vicinity of the pump station, would be much less. Therefore, two separate pumping systems will be required – one with pumps in series to pump from the Eastside Pump Station to the Mitchell gravity sewer and another to pump peak flow to the nearby equalization basin. Costs developed for the Eastside Pump Station will reflect both pumping system requirements. Figure 12 shows a proposed conceptual layout for the Eastside Pump Station.

5.1.5.2 Odor Control for Eastside Pump Station. The existing Faraon Street Pump Station receives septic wastewater, and hydrogen sulfide (H_2S) emissions have significantly corroded the existing enclosed wetwell. Additional sulfide is generated in the force main and odor and corrosion problems have been reported at the discharge manhole located at 32nd and Olive Street. To control the sulfide, the City implemented liquid-phase treatment using ferric chloride ($FeCl_3$); however, City staff indicate that the $FeCl_3$ has contributed to the degradation of the existing gravity sewer line that receives flows from the Faraon Street force main. City staff also note that the $FeCl_3$ has not been completely effective in controlling H_2S emissions.

As previously presented, consideration was given for an alternative which includes constructing a new Eastside Pump Station to serve the current functionality of the Faraon Street Pump Station. This station would be located further east than the existing Faraon Street Pump Station, resulting in a longer force main. The proposed force main from the Eastside Pump Station would discharge at a similar location to the discharge of the existing Faraon Street force main. As a result, if Alternative 3 is selected, an odor control strategy for flows from the proposed Eastside Pump Station must be established. The City has suggested that alternative chemical treatment methods be evaluated and that an open type wetwell be given consideration at the Eastside Pump Station as an alternative to an enclosed wetwell as currently exists at the Faraon Street Pump Station.

5.1.5.2.1 Existing Odor Conditions. A basic evaluation of the existing odor conditions at the Faraon Street Pump Station was performed to estimate current sulfide concentrations and check current chemical dosage rates. Sulfide generation in the force main can be calculated using the Pomeroy/Parkhurst sulfide model as referenced in the United Sates Environmental Protection Agency (USEPA) Design Manual "Odor Corrosion Control in Sanitary Sewerage Systems and Treatment Plants", 1985. The dissolved sulfide generation rate is affected by detention time, BOD, and temperature.



EASTSIDE PUMP STATION PLAN

1/16" = 1'-0"

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP

CYGNET ID: 163509-1000-WWTCN-C-N0001BR82
SAVED: JOR47995, 10/7/2009 1:51:41 PM
DWG VER #: 1.5
PLOTTED: JOR47995, 11/23/2009 8:18:39 AM
USER: CYGNETADMI
SW: Figure_12.dwg
XREF1 ID: ES-Screening_G_F_Sections.dwg
XREF2 ID:
XREF3 ID:
XREF4 ID:
XREF5 ID:

BLACK & VEATCH Corporation
Kansas City, Missouri

ST. JOSEPH, MISSOURI
FACILITIES PLAN
CONCEPTUAL EASTSIDE PUMP STATION LAYOUT

DESIGNED: KBZ
DETAILED: WDA
CHECKED:
APPROVED:
DATE:

PROJECT NO.
163509

FIG 12

SHEET
OF

FAFIGBORD
D5000

An increase in temperature increases the metabolic rate of the bacteria and the rate of sulfide production. The term "effective BOD" has been used as a convenient way to combine the temperature and BOD effects. The "full pipe" or force main form of the equation is presented below (where D/4 represents the hydraulic radius):

$$S_2 = S_1 + (M)(t)[EBOD(D/4 + 1.57)]$$

Where:

- S_2 = predicted sulfide concentration at time t_2; mg/L
- S_1 = sulfide concentration at time t_1; mg/L
- $t = t_2 - t_1$ = flow time in a given sewer reach with constant slope, diameter, and flow; hr
- M = specific sulfide flux coefficient; 1×10^{-3} m/hr
- D = pipe diameter; ft
- EBOD = BOD x $1.07^{(T-20)}$ = effective BOD; mg/L
- BOD = standard BOD_5; mg/L
- T = temperature; ° C

An M factor of 1×10^{-3} m/hr is generally reasonable for force mains in which conditions are favorable for sulfide buildup (i.e. infrequent flow, low velocities, high temperatures, long retention times, very low dissolved oxygen, and moderate to high BOD).

A spreadsheet force main sulfide generation model was used with input data as shown in Table 12. The results of the spreadsheet model are also shown in Table 12. The resultant dissolved sulfide concentration is 4.6 mg/L, or 96 pounds per day, which is typical for force mains of this length. The concentration of gaseous H_2S will vary depending on the outlet conditions and the ventilation conditions.

Table 12
Summary of Hydrogen Sulfide Model Input and Output

Input Parameters	**Current**	**Future**
Average Flow, mgd	2.5	6
Average BOD, mg/L	200	200
Average Temperature, ° C	20	20
Force Main Diameter, ft	2	2
Force Main Length, ft	12,500	30,000
Model Results		
Sulfide Generation, mg/L	4.6	4.6
Sulfide Load, ppd	96	230
$FeCl_3$ Requirements		
Fe Requirement, ppd	336	805
Volume 38% Solution, gpd	223	536
BIOXIDE® Requirements		
NO_3-O Requirement, ppd	691	1,656
Volume Solution, gpd	197	473

Existing chemical dosage requirements were determined assuming a 38 percent solution of ferric chloride is used. The iron to sulfide dosage ratio is typically about 3.5 to 1, so 336 ppd of Fe is needed, which equals 223 gpd of 38 percent solution. Operators indicated that they are currently feeding 10 gph, which is 240 gpd. This is very close to the calculated value, so the model was applied to determine future dosage requirements. It is noted that even at the current dosage rate of 10 gph, the City still reports odor issues. While the odor issues could be due to inadequate dosing at times, samples would need to be evaluated to confirm adequacy of the current dosage as well as that predicted by the model.

5.1.5.2.2 Future Odor Conditions. The new Eastside Pump Station will be constructed farther southeast to replace the functionality of the existing Faraon Street Pump Station, resulting in an extended force main. The future force main is estimated to be approximately 30,000 feet in length and will eventually convey the 4 to 6 mgd annual average flow through a 24 inch pipe.

Theoretical sulfide generation values were calculated and are shown in Table 12. It can be seen that the longer force main generates over twice as much sulfide due to the greater length and longer residence time involved. Treating the higher sulfide requires

536 gpd of 38 percent ferric chloride solution. Due to the higher sulfide generation rate, controlling sulfide and odor from a new, relocated pump station will cost more in the future regardless of the treatment method used.

5.1.5.2.3 Liquid-Phase Treatment Alternatives. There are several types of control measures that have been employed to treat sulfide in the liquid phase. Air and pure oxygen have been employed to reduce sulfide formation and oxidize existing sulfide, but oxygen also reacts with organics in the wastewater, so depletion is rapid and multiple injection stations are needed. This requires considerable capital expenditure for equipment with continued maintenance requirements, so air and oxygen are not well suited for this application.

The two most common chemicals used for sulfide and corrosion control in collection systems are iron salts and nitrate salts (BIOXIDE®). The following paragraphs describe iron salts and nitrate salts in greater detail, including their chemistry, process description, and operation and maintenance considerations. The major advantages and disadvantages are presented for both chemicals, along with typical dosage rates.

Iron Salts

Iron and other metals can chemically combine with dissolved sulfide to form relatively insoluble precipitates. The iron salt precipitates are in the form of black or reddish-brown floc that does not deposit in the collection system, but readily settles with other solids at the treatment plant. Both ferrous and ferric metal salts can react with dissolved sulfide. The following four types of iron salt solutions are commercially available: ferrous sulfate, ferrous chloride, ferric sulfate, and ferric chloride. The addition of the sulfate-based salts has been questioned, because sulfate can be reduced to sulfide. However, this is not typically a concern in municipal wastewater systems because sulfate is typically present in excess and sulfide generation is not increased significantly.

Iron salts typically have a low pH and some solutions are classified as corrosive. The liquid solutions can be stored in fiberglass-reinforced polyester, high-density cross-linked polyethylene, or rubber-lined steel tanks with spill containment. The freezing point depends on the solution strength, so suppliers can reduce solution strength in winter to avoid crystallization of the product. Tank insulation may be required in some regions. Iron salts are corrosive and attack most metals rapidly. All wetted parts should be of Hastalloy C, titanium, or tantalum. Aluminum, brass, and stainless steel are readily attacked and should never be used in contact with full strength solutions. There may be concern at wetwell applications having submerged pumps or pumps with stainless steel impellers and other wetted parts. If the chemical is not sufficiently diluted by the bulk flow, prolonged contact with the stainless steel can cause pitting and etching and may require increased pump maintenance. To ensure that the chemical is adequately diluted under low flow conditions, it is a good design practice to use a flow-paced feed control or timers.

Iron salts are fast acting and are often applied just upstream of a treatment plant to remove sulfide before flows enter the headworks facilities. Greater benefits in odor and corrosion control are obtained when iron is added upstream in the collection system. Iron salts do not react with the organic materials in wastewater, so they can be overdosed at one upstream location to treat long reaches of collection system. The iron precipitate settles rapidly in a quiescent basin, but in the collection system it remains suspended in the flow and does not form deposits. The iron precipitate adds to the overall solids production at the treatment plant with the volume dependent on the amount of sulfide treated. Even in systems with high sulfide concentrations, the added solids are typically less than 5 percent of the overall solids.

For force main treatment, iron salts can be added directly to a pump station wetwell or to the gravity main entering the station. When long reaches are to be treated and a large quantity of iron salts is needed, as in the case of the force main from the proposed Eastside Pump Station, the injection site should have adequate wastewater flow at all times to dilute the chemical and avoid corrosion problems. The chemical piping should direct the solution to the wastewater flow without contacting concrete or metal surfaces in manholes or wetwells.

The solubility of ferrous sulfide at typical wastewater pH values only allows control of H_2S to between 0.05 and 0.1 mg/L. Even if excess ferrous salt is added, the dissolved sulfide concentration will not be lowered below this level. In most cases, this level of treatment is satisfactory to prevent odors and corrosion. However, in areas of turbulence, H_2S release may still be a problem. In areas of localized pH depression, such as industrial discharges and anaerobic waste streams in which the pH drops below 6.5, ferrous sulfide partially dissociates and may release sulfide to the wastewater.

Recently, it has been noted that iron salts have an advantage over nitrate salts and oxidant chemicals because iron salts do not affect the generation of volatile fatty acids (VFA) in the collection system, which is beneficial for BNR processes.

Nitrate Addition

Nitrate addition controls dissolved sulfide by two different reaction modes, prevention and removal. In the prevention mode, nitrate is added to fresh wastewater to be used as a substitute source of oxygen. The facultative and obligate anaerobic bacteria, which are responsible for odor and sulfide generation, use dissolved oxygen, nitrate, and sulfate as oxygen sources, in that order of preference. Typically, dissolved oxygen in wastewater is rapidly depleted and there is little nitrate present. Sulfate is typically abundant, so the bacteria reduce sulfate to sulfide, which causes odor and leads to corrosion problems. When nitrate is added to wastewater, the bacteria use it instead of sulfate. This results in the production of nitrogen gas and other nitrogenous compounds rather than sulfide.

In the removal reaction, nitrate can be added to septic wastewater to remove dissolved H_2S from wastewater by a biochemical process, which converts the sulfide to sulfate. The nitrate supplies oxygen to bacteria present in wastewater to metabolize H_2S and other reduced sulfur compounds. The use of nitrate to remove pre-existing dissolved sulfide was developed and patented by USFilter's Davis Products (now part of Siemens) and is marketed under the trade name BIOXIDE®. The BIOXIDE® product is typically an aqueous solution of calcium nitrate containing 3.5 pounds per gallon (lb/gal) of nitrate-oxygen.

In prevention mode, nitrate prevents the formation of sulfide by acting as a preferential oxygen source to sulfate. In this process, 1.2 parts of nitrate are used and zero parts of sulfide are produced for every mole of carbon consumed. On a mass basis, 7.2 pounds of NO_3-O are needed per pound of sulfide prevented. For the BIOXIDE®

product, this translates to 2.1 gallons per pound (gal/lb) sulfide prevented. This represents the minimal stoichiometric requirements for prevention given the simplest form of organic matter; actual dosage rates tend to be higher.

The removal mechanism uses naturally occurring bacteria to biochemically oxidize dissolved sulfide in the presence of nitrate. The dissolved sulfide may be generated upstream of the nitrate application point or may enter the line downstream through a lateral branch. Nitrate addition causes the biochemical oxidation of sulfide with 1.6 parts of nitrate used for every mole of sulfide removed. On a mass basis, this requires 2.4 pounds of NO_3-O per pound of sulfide removed. For BIOXIDE®, this requires 0.7 gal/lb sulfide removed.

It should be noted that the removal reaction is a biochemical process, so sulfide reduction is not instantaneous and a reaction time of one to two hours may be required for optimal effectiveness. The removal mechanism requires one-third the amount of nitrate as the prevention mechanism. Maximizing the removal mechanism with the BIOXIDE® product is achieved by careful selection of the application sites by the supplier.

Nitrate has the advantage of being one of the safest of all the sulfide control chemicals to handle. Generally, nitrate salt solutions are considered to be non-hazardous substances and are not included on either federal USEPA or state Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) lists. The material commonly used for BIOXIDE® is also exempt from federal Department of Transportation placard requirements. Personal protective equipment is still required from a safety and handling aspect, requiring the use of goggles and gloves. A typical nitrate injection station consists of a high-density cross-linked polyethylene tank, metering pump(s), control panel, valves, and polyvinyl chloride (PVC) piping. Numerous configurations and materials are available for non-hazardous chemical storage systems including horizontal, low-profile, or upright vertical tanks. The final selection depends on local aesthetic and public relations requirements.

Nitrate can be injected directly to force main discharges; however, this requires high-pressure positive displacement pumps. It is common to add nitrate directly to the pump station wetwell or upstream of the gravity interceptor. The chemical addition can then be accomplished with standard chemical feed pumps such as bellows-type pumps.

The nitrate solution does not adversely affect equipment or components of pumping stations.

One disadvantage of nitrate salts compared to iron salts is that it provides an oxygen source to the biomass in the collection system and decreases the generation of VFAs, which is beneficial for BNR processes.

5.1.5.2.4 Sulfide and Odor Control Recommendations. The raw capital costs, before escalation factors, for a new chemical feed station are typically $200,000 for a 5,000 gallon fiberglass storage tank, containment structure, feed pumps, and instrumentation. The BIOXIDE® feed facility would require two 5,000 gallon tanks, so the capital costs would increase to $260,000 if fiberglass tanks were used. However, the nitrate salts are non-hazardous, so double-walled polypropylene tanks may be an option to further reduce costs. An operating cost comparison was prepared for ferric chloride and BIOXIDE® chemicals for both current and future conditions as shown in Table 13.

Table 13
Odor Control Chemical Requirements and Probable Annual Costs

Condition	Sulfide, ppd	Volume, gpd	Unit Cost [1], $/gal	Annual Cost, $/year
Existing				
Ferric Chloride	96	223	1.50	122,000
BIOXIDE®	96	197	2.60	187,000
Future				
Ferric chloride	230	536	1.50	293,000
BIOXIDE®	230	473	2.60	449,000

1. Unit costs based on Black & Veatch experience, actual cost may vary.

As shown in Table 13, the BIOXIDE® chemical is more expensive than iron salts, but offers the advantages of being safer to handle and non-corrosive to the system. Iron salts are less expensive, but they add solids to the wastewater at the rate of about 800 pounds per day under future conditions, so there is a cost associated with the subsequent handling and disposal of the solids. Both chemicals will provide satisfactory sulfide control, but BIOXIDE® typically reduces sulfide to a lower level than iron salts, so it offers slightly superior sulfide and odor control. While BIOXIDE® does have the potential to reduce VFA formation, it is not anticipated based on the City's wastewater characteristics that this will introduce any problems with implementation of BNR treatment at the existing WPF.

Due to the corrosion problems the City is currently experiencing with the use of iron salts, use of BIOXIDE® offers clear advantages and is the recommended alternative for odor control at the proposed Eastside Pump Station. The cost of a BIOXIDE® system will be included in the costs presented later in this memorandum for Alternative 3 to address pump station odor control issues; however, a pilot study of the BIOXIDE® feed system at the existing Faraon Street Pump Station is recommended to confirm the effectiveness prior to implementing any odor control system at the Eastside Pump Station.

5.2 Siting Criteria Development

In addition to economic factors, siting of a new WPF or pump station should also include an evaluation of non-economic factors. New facilities will have an impact on the existing community surrounding the selected site. New facilities will also impact the future development of the community. Many of the perceived negative impacts of a new WPF can be mitigated through the increased use of technological solutions and attention to aesthetic improvements; however, these mitigation measures typically result in an increase in the project cost. Selection of a site that lessens the current and future impacts on the surrounding community typically results in a facility that is considered a "good neighbor" at the lowest overall cost. A triple bottom line analysis is designed to balance the social, environmental, and economic drivers of a project and provides a useful tool in evaluating the non-economic impacts of a decision. The results of the triple bottom line analysis will be presented later in this memorandum.

The following sections present the development of siting criteria for the siting analysis, providing a description of each of the preliminary criteria determined. A draft set of siting criteria were developed based on discussions with City staff and previous Black & Veatch siting project experience. The criteria were broken into the three elements of the triple bottom line analysis – social, environmental, and economic. Results of requests for public feedback are also presented.

5.2.1 Social

Criteria within this subcategory include the following community and quality of life impacts of siting the new facility:

- Visual Impacts. Locations/facilities that are less visible are preferred.
- Noise Control. Locations/facilities that are a greater distance from residential and non-industrial commercial areas are preferred.
- Odor Control at Site. Locations that are a greater distance from residential and non-industrial commercial areas are preferred. Locations that have a lower likelihood of prevailing winds carrying odors to residential and non-industrial commercial areas are preferred.
- Odor Control at Discharge. Facilities which limit exposure to odors within the collection system are preferred.
- Lighting Control. Locations/facilities that are a greater distance from residential and non-industrial commercial areas are preferred.
- Surrounding Land Use. Locations in which the facility would be more compatible with current and future land uses and zoning of surrounding areas are preferred.
- Property Considerations. Locations/facilities with fewer houses requiring purchase are preferred.
- Traffic Considerations. Locations/facilities that have truck routes that are the shortest distance to a main highway or road are preferred.

5.2.2 Environmental

Criteria within this subcategory include the following impacts of the siting of the facility on the environment:

- Water Quality. Locations with the lowest impact on water quality are preferred.
- Endangered Species. Locations without the historical presence of endangered species are preferred.

- Historical Resources. Locations without any known historical resources are preferred.
- Wetland Impacts. Locations that are not Federal or State designated wetlands are preferred.
- Site Contamination. Locations without the historical presence of groundwater or soil contamination are preferred.
- Ease of Permitting. Locations without any unusual permitting circumstances are preferred.

5.2.3 Economics

Criteria within this subcategory include the following economic impacts of the siting of the facility:

- Life cycle Costs. Locations/facilities which support the lowest life cycle costs are preferred.
- Potential Service Area by Gravity. Locations with the greatest area that can flow to the site by gravity are preferred.
- Maximizes Use of Existing Infrastructure. Locations/facilities that provide greater utilization of existing infrastructure are preferred.
- Site Utilization. Locations that would allow the most efficient facility layout are preferred. Locations that allow the greatest ability to expand are preferred.
- Floodplain Considerations. Locations with the fewest acres in the floodplain are preferred. Locations accessible during localized flooding are preferred.
- Reserve Treatment Capacity. Alternatives that increase City-wide reserve treatment capacity are preferred.
- Economic Development. Locations/facilities that will serve areas planned for future development are strongly preferred.

5.2.4 Public Involvement

A public meeting targeting stakeholders on the Eastside was conducted on May 19, 2009. A white paper summarizing the criteria, or evaluation factors, was provided. This document is included in Appendix B of this report. In order to simplify the presentation, the evaluation factors were divided into Community Factors and Technical Factors. The Community Factors, such as Visual Impacts and Surrounding Land Use, were intended for public comment on which factors may have the greatest impact on the Eastside community. Technical Factors, such as Potential Service Area by Gravity, can be determined quantitatively by engineering study and were provided for public information only. No additions or deletions from the preliminary list of evaluation factors were suggested at the May 19 Eastside Public Meeting; however, it should be noted, attendance at this meeting was limited. A summary of the meeting notes can be found in Appendix B.

The Eastside evaluation factors were presented to the Water Protection Program Community Advisory Panel on September 24, 2009 in order to receive panelist feedback on the preliminary criteria. The criteria were well-received; no recommendations for additions or deletions were provided.

In July 2009, the City utilized ETC Institute to conduct a statistically valid survey of St. Joseph residents' opinions on various wastewater and stormwater issues. One question was directly related to the potential of a new Eastside WPF, asking "How supportive would you be of the City of St. Joseph building a new wastewater treatment plant on the Eastside of the City if the new plant supported the following:

- Supported new industry
- Kept flows out of the combined sewers
- Reduced odors in central St. Joseph
- Growth on the Eastside of the City?"

The responses of those surveyed indicated that they would be most supportive of the plant if it supported new industry (71 percent), kept flows out of combined sewers (66 percent), reduced odors in central St. Joseph (62 percent), and if it promoted growth on the east side of the City (54 percent). Overall, St. Joseph residents seem supportive of the possibility of building a new WPF on the Eastside.

6.0 Wastewater Service Alternatives Evaluation

This section summarizes the wastewater service alternatives evaluation and total project costs for the three alternatives summarized in Section 5.1.2:

- Alternative 1 – Eastside WPF at North Site
- Alternative 2 – Eastside WPF at South Site
- Alternative 3 – Eastside Pump Station at North Site

The total project costs in this section include the required conveyance system elements as shown on the alternative figures, the WPF or pump station as appropriate, and site related costs.

6.1 Summary of Total Project Capital Costs

Table 14 summarizes the project capital costs for each wastewater service alternative. All project costs are given in May 2009 dollars (ENR BCI equal to 4773). For the alternatives where a new WPF is included, the costs represent those of the BNR process with filtration as recommended in Section 4.4. For alternatives where a new pump station is included, a conceptual cost estimating methodology was employed to develop project capital costs for the alternatives considered. Piping within the pump stations was based on the provision of Victaulic piping according to City preference; pump costs were based on the provision of Eddy current drives.

Building areas required for the pump station were estimated based on a conceptual layout of pumping equipment. Building costs were determined assuming brick and block wall construction. Flow equalization basins were sized as previously described; the basins are assumed to be covered and odor controlled. Odor control costs were developed for the BIOXIDE® feed system and related tankage as provided in Section 5.1.5.2.4.

Costs for conveyance infrastructure were projected by unit costs developed based on the diameter-inch of pipe. Unit costs for gravity sewer systems are based on concrete pipe with either cement mortar or epoxy lining appropriate for carrying sewage flows, with higher costs applied for deeper sewers. The Eastside interceptor sewer was estimated as 20 to 30 feet deep. The trunk sewer carrying flow from east of the 102 River was estimated as 10 to 20 feet below grade. Trunk sewers from the existing Faraon Street and Easton Road Pump Station service areas were also estimated at 10 to 20 feet deep. Only gravity sewer pipes 24 inches and greater are included in the costs, except for the smaller sewer in the southeast portion of the service area which is needed for connectivity of the system. Force main costs were based on the provision of ductile iron pipe. The force main and gravity sewer unit costs include seeding, sodding, and site restoration. The unit costs applied for gravity sewers and force mains do not include T-Loc or other corrosion-resistant linings; it is anticipated the application of a corrosion-resistant lining would add approximately 15 percent to the unit costs presented in this memorandum.

In addition to building, structure, conveyance, and equipment costs projected directly, other construction costs were projected by applying a percentage to appropriate project costs as indicated in Footnotes 5 and 6 of Table 14. The cost for electrical and instrumentation and controls (I&C) was projected at 25 percent of the cost of equipment, installation, and structures at WPF, pump station, and flow equalization facilities; this percentage was not applied to conveyance infrastructure. An allowance of 10 percent was applied for project sitework for WPF, pump station, and flow equalization facilities. Costs of providing utilities to either green-field site was based on Black & Veatch project experience in combination with information obtained from Kansas City Power & Light (KCP&L) related to the distance to electrical infrastructure for each of the proposed sites. Based on this communication, it was determined the north site is roughly one mile from an existing electrical substation, while the south site is approximately two miles from existing infrastructure. Contractor general requirements were projected at 12 percent and contingency was set at 25 percent. Costs related to engineering, legal, and administration are reflected in a 20 percent multiplier applied to all construction costs.

Additional site related costs are also reflected in the capital costs given in Table 14. The costs reflected in the table are shown as placeholders as a detailed site reconnaissance has not been undertaken as part of this study. Site area for alternatives involving a new WPF assume the site in the future could be used for an expanded 12 mgd (average flow) WPF facility (twice the anticipated 2030 capacity). Based on this assumption, a 12 acre site under future expanded conditions was developed. The flood protection line item estimates the amount of earth fill required to raise the elevation of the operating facilities, such as the proposed WPF or pump station, two feet above the 100-year flood elevation. As the sites considered are located on primarily agricultural land with no known environmental history, it was assumed no site remediation costs would be incurred. This assumption would need to be verified with more detailed site study prior to land acquisition. Land acquisition costs were projected at $12,500 per acre per preliminary guidance from the City, based on the purchase price of land for the Eastside industrial park. Actual land costs may vary from this value. Determination of site related costs must be revisited once more detailed site information is collected prior to land acquisition.

Appendix C presents additional details of the development of the conceptual capital costs.

Table 14
Eastside Wastewater Service Alternatives
Summary of Opinion of Probable Project Costs [1]

Item	Alternative 1 WPF at North Site, $	Alternative 2 WPF at South Site, $	Alternative 3 Eastside Pump Station at North Site, $
Eastside Interceptor Sewer	54,226,000	54,226,000	54,226,000
Trunk Sewer from Existing Faraon Street Pump Station to Eastside Interceptor	1,160,000	1,160,000	1,160,000
Trunk Sewer from Easton Road Pump Station to Eastside Interceptor	8,979,000	8,979,000	8,979,000
Trunk Sewer from across River to Eastside Interceptor	9,937,000	9,937,000	9,937,000
Southern Eastside Interceptor Sewer	--	38,196,000	--
Southern Package Pump Station	331,000	--	331,000
Force Main and/or Trunk Sewer for Southern Flows	1,832,500	--	1,832,500
Eastside WPF [2]	37,781,500	37,781,500	--
Flow Equalization Basin [3]	21,000,000	21,000,000	25,300,000
Eastside and Flow Equalization Basin Pump Station	--	--	8,982,000
Force Main from Eastside Pump Station	--	--	7,956,000

Table 14
Eastside Wastewater Service Alternatives
Summary of Opinion of Probable Project Costs [1]

Item	Alternative 1 WPF at North Site, $	Alternative 2 WPF at South Site, $	Alternative 3 Eastside Pump Station at North Site, $
Existing Pump Station Demolition	175,000	175,000	175,000
Flood Protection/Fill (placeholder) [4]	3,935,000	4,356,000	359,000
Site Remediation (placeholder) [4]	--	--	--
Subtotal	*139,357,000*	*175,810,500*	*119,237,500*
Electrical, I&C, Sitework, Utilities, and Contractor General Requirements [5]	42,762,000	47,781,000	30,488,000
Subtotal	*182,119,000*	*223,591,500*	*149,725,500*
Contingency [6]	45,530,000	55,898,000	37,432,000
Land Acquisition (placeholder) [4]	4,000,000	4,000,000	4,000,000
Opinion of Probable Construction Cost	**231,649,000**	**283,489,500**	**191,157,500**
Engineering, Legal, and Administration [7]	46,330,000	56,698,000	38,232,000
Opinion of Total Project Cost	**277,979,000**	**340,188,000**	**229,390,000**

1. All costs presented in May 2009 dollars (ENR BCI = 4773).
2. Eastside WPF cost based on the recommended treatment alternative – BNR process with filtration and solids thickening and hauling to the existing WPF for solids treatment.
3. Flow equalization basins for Alternatives 1 and 2 are sized for 12 MG. The flow equalization basin for Alternative 3 is sized for 16 MG.
4. Site related costs are placeholders and must be revised following final siting study of the selected area. Land acquisition costs based on $12,500/acre as projected by City staff.
5. Electrical and instrumentation and controls (I&C) projected at 25% of the total of all equipment and structure costs. Sitework projected at 10% of the total of equipment, structures, electrical, and I&C costs. Utility projections based on Black & Veatch experience and distance to closest power connection as provided by KCP&L. Contractor general requirements projected at 12% of the total of equipment, structures, electrical, I&C, sitework, and utility costs. Sitework, electrical, and I &C percentages only applied to WPF facilities, pump stations, and flow equalization basins; these multipliers were not applied to the conveyance improvements.
6. Project contingency is projected at 25% of the total of all equipment, structures, electrical, I&C, sitework, utilities, contractor general requirements, flood protection/fill, and site remediation costs.
7. Engineering, legal, and administration (ELA) costs are projected at 20% of the total of all equipment, structures, electrical, I&C, sitework, utilities, contractor general requirements, flood protection/fill, site remediation costs, contingency, and land acquisition.

Based on the project capital cost summary for each alternative presented in Table 14, Alternative 3 has the lowest total project capital cost. The total capital cost for Alternative 3 is over 20 percent and 45 percent less than that for Alternatives 1 and 2, respectively. When elements of the conveyance system that are common to alternatives are removed from the total capital cost, the capital cost of Alternative 3 is more than 30 percent and 70 percent less than Alternatives 1 and 2, respectively. Based on the summary presented in Table 14, the new Eastside Pump Station on the north site clearly emerges as the lowest project capital cost when compared to either alternative involving the construction of a new Eastside WPF.

6.2 Summary of Total Project O&M Costs

Total O&M costs were developed for each alternative to include the O&M associated with operating the new WPF (for those alternatives) as well as the associated conveyance system. O&M costs applied to alternatives with an Eastside WPF are based on the BNR process with filtration and solids thickening and hauling to the existing WPF for treatment as described for the recommended alternative in Section 4.0.

O&M costs for the conveyance system were developed based on the unit costs presented in Table 15. Unit costs shown in Table 15 for power and labor were provided by the City. The remaining unit costs are based on Black & Veatch experience with similar operating facilities. Annual O&M costs for each alternative were determined by applying the unit costs to O&M requirements based on usage estimates for 6 mgd average flow and previous Black & Veatch project experience. The annual O&M costs for each alternative are given in Table 16. Major O&M costs for the WPF are presented in Section 4.3.1.2. Major O&M costs for the conveyance system include power, labor, equipment repair and spare parts replacement at the pump stations, conveyance system maintenance, and chemicals for odor control at the pump station.

Table 15
Eastside Conveyance System O&M Unit Costs [1]

Power [2]	$0.10/kW-hr
Labor (including benefits and overhead) [2]	$32.78/hr
Maintenance and Spare Parts	• Pump Station – 5% of equipment cost • Gravity sewer and force main – 0.5% of capital cost
BIOXIDE® for Odor Control	$2.60/gallon

1. All costs provided in May 2009 dollars. Except for those indicated as City provided, all unit costs based on Black & Veatch project experience.
2. Units costs based on data provided by the City.

Table 16
Annual Total Project O&M Costs by Alternative
(Average Flow of 6 mgd)

	Alternative 1 WPF at North Site, $	Alternative 2 WPF at South Site, $	Alternative 3 Eastside Pump Station at North Site, $
Power	556,000	475,000	635,000
Labor	878,000	875,000	17,000
Maintenance and Spare Parts	613,000	795,000	529,000
Chemicals	58,000	58,000	449,000
Solids Hauling Costs	26,000	26,000	--
Total	**2,131,000**	**2,229,000**	**1,630,000**

Based on the O&M cost summary for each alternative presented in Table 16, Alternative 3 has the lowest total O&M cost. The O&M cost for Alternative 3 is at least 30 percent less than the O&M for either Alternative 1 or 2. This cost differential was expected in that it is reasonable that it would cost more to operate a new treatment facility than a new pump station.

6.3 Summary of Total Project Net Present Worth Costs

The project capital and O&M costs presented previously were utilized to develop the life cycle costs of each alternative on a present worth basis. The present worth provides the equivalent amount of money that must be invested at a given interest rate at the start of the project in order to provide all funds necessary to construct, operate, and maintain the facilities and equipment throughout the study period of the project. The net present worth of an alternative is the sum of the present worth of the project capital and O&M costs less any remaining value of facilities at the end of the project's design life. By capturing both project capital and O&M expenses associated with the project, the net present worth method allows the City to understand the full life cycle costs associated with each of the alternatives.

Table 17 presents a summary of the estimated net present worth costs developed for each alternative. A 20-year study period was utilized in the present worth calculations; 2009 was assumed as "Year 0" for consistency of present worth calculations throughout the Facilities Plan. For the phased implementation of the WPF and Eastside

Pump Station capacity, it was assumed that the capacity upgrade from 4 mgd to 6 mgd occurred ten years into the study period in 2019. The initial phase construction includes full build-out of buildings for a 6 mgd WPF capacity with equipment phased for installation of the initial 4 mgd of capacity in 2009 and the incremental 2 mgd of capacity installed in 2019. Individual treatment trains and flow equalization basins were constructed in phases, two 2 mgd trains in the initial construction and one additional 2 mgd train constructed in the second phase. Phasing of O&M costs was approximated as two-thirds of the costs presented in Table 16 for Years 0 to 9 and at the full value presented in Table 16 for Years 10 to 20. A five percent interest rate was applied for the present worth analysis. Service life for determination of replacement frequency and salvage value was estimated as follows: structures – 50 years and equipment, electrical, instrumentation and controls – 20 years.

Table 17
Eastside Wastewater Service Alternatives
Total Project Net Present Worth [1]

	Alternative 1 WPF at North Site, $	Alternative 2 WPF at South Site, $	Alternative 3 Eastside Pump Station at North Site, $
Net Project Capital Present Worth [2]	167,258,000	197,577,000	127,759,000
O&M Present Worth [3]	36,228,000	37,893,000	27,693,000
Total Net Present Worth	**203,486,000**	**235,470,000**	**155,452,000**

1. Costs given in May 2009 dollars. Present worth calculated with 20-year life cycle costs at 5% interest.
2. Net project capital present worth represents the present worth of project costs less the remaining value of facilities at the end of the 20-year life cycle. Service life for determination of replacement frequency and salvage value was projected as follows: structures – 50 years; equipment, electrical, instrumentation and controls – 20 years.
3. O&M costs were assumed to escalate at 5% per year.

From Table 17, it can be seen that Alternative 3 – Eastside Pump Station at the North Site, offers the lowest overall present worth cost; the net present worth value is more than 30 percent less than that of the next lowest cost alternative. This result is expected based on the capital and O&M cost comparisons presented in Sections 6.1 and 6.2, respectively; Alternative 3 has the lowest capital and O&M costs of the alternatives considered. Therefore, the Eastside Pump Station is the lowest cost alternative for Eastside wastewater service requirements during the 20 year study period.

Appendix C provides additional detail on the calculation of the net present worth for each alternative.

6.4 Results of Triple Bottom Line Analysis

A triple bottom line analysis workshop was held with City staff on September 28, 2009; the results of this workshop are presented in Table 18. The workshop group assigned category weight factors to each of the three categories (social, environmental, and economic) as shown in Figure 13.

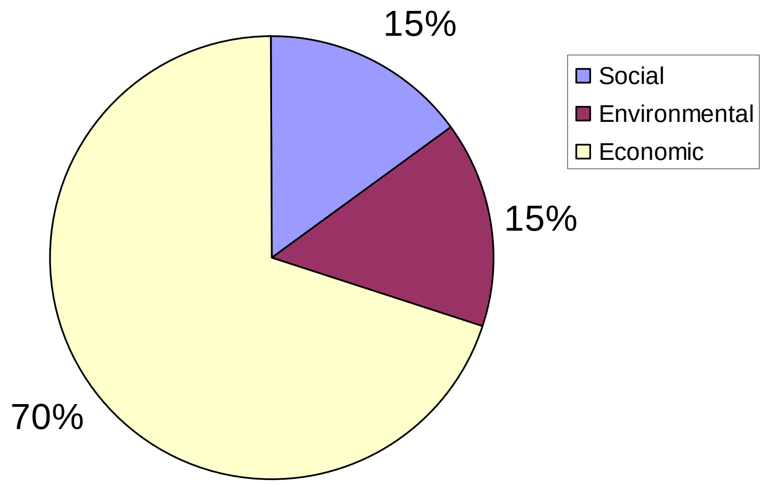


Figure 13. Triple Bottom Line Category Weight Factors

Once the category weight factors were assigned, the group assigned weight factors to the criteria that were previously developed and presented to the public as shown in Section 5.2. The intent of the criteria weight factors is to allocate the percentage assigned to the overall category amongst the criteria included within that category. For example, as shown in Table 18, the weight factor assigned for visual impacts allocated 1 percent of the overall 15 percent assigned to the social category to visual impacts. This weighting was completed with all of the criteria assigned, effectively dividing the 100 percent of the overall decision amongst all the contributing criteria.

Table 18
Eastside Site Alternatives Triple Bottom Line Ranking

	Evaluation Factor	Category Weight Factor	Description	Criteria Weight Factor	Weight Percentage	Alternative 1: WPF at North Site	Alternative 2: WPF at South Site	Alternative 3: Eastside Pump Station at North Site
Evaluation Factor Scores by Alternative								
						Alternative Scores		
Social		**15%**			**15.0%**			
1	Visual Impacts		Locations/facilities that are less visible are preferred	1	1.0%	4	5	5
2	Noise Control		Locations/facilities that are a greater distance from residential and non-industrial commercial areas are preferred	1	1.0%	4	3	5
3	Odor Control at Site		Locations/facilities that are a greater distance from residential and non-industrial commercial areas are preferred Locations/facilities that have a lower likelihood of prevailing winds carrying odors to residential and non-industrial commercial areas are preferred	3	3.0%	3	2	4
4	Odor Control at Discharge		Facilities which limit the exposure to odors within the collection system are preferred	3	3.0%	5	5	2
5	Lighting Control		Locations/facilities that are a greater distance from residential and non-industrial commercial areas are preferred	1	1.0%	4	2	4
6	Surrounding Land Use		Locations/facilities in which the facility would be more compatible with current and future land uses of surrounding areas are preferred	2	2.0%	4	2	4
7	Property Considerations		Locations/facilities with fewer houses requiring purchase are preferred	2	2.0%	3	2	3
8	Traffic Considerations		Locations/facilities that have truck routes that are the shortest distance to a main highway or road are preferred	2	2.0%	3	3	3
					0.0%			
				Subtotal Score (Social)		**0.56**	**0.45**	**0.52**
Environmental		**15%**			**15.0%**			
1	Water Quality		Locations/facilities with the lowest impact on water quality are preferred	2	4.3%	5	5	4
2	Endangered Species		Locations without the historical presence of endangered species are preferred	1	2.1%	5	5	5
3	Historical Resources		Locations without any known historical resources are preferred	1	2.1%	5	5	5
4	Wetland Impacts		Locations that are not Federal or State designated wetlands are preferred	1	2.1%	4	1	4
5	Site Contamination		Locations without the historical presence of groundwater or soil contamination are preferred	1	2.1%	5	5	5
6	Ease of Permitting		Locations/facilities without any unusual permitting circumstances are preferred	1	2.1%	4	4	5
					0.0%			
				Subtotal Score (Environmental)		**0.71**	**0.64**	**0.69**
Economic		**70%**			**70.0%**			
1	Life Cycle Costs		Locations/facilities which support the lowest life cycle costs are preferred	19	35.0%	3	1	5
2	Potential Service Area by Gravity		Locations with the greatest area that can flow to the site by gravity are preferred	5	9.2%	4	5	4
3	Maximizes Use of Existing Infrastructure		Locations/facilities that provide greater utilization of existing infrastructure are preferred (this includes existing collection system and ease of transportation to the existing WPF)	2	3.7%	1	1	3
4	Site Utilization		Locations that would allow the most efficient facility layout are preferred Locations with the greatest ability to expand are preferred	3	5.5%	5	4	5
5	Floodplain Considerations		Locations with the fewest acres in the floodplain are preferred Locations accessible during localized flooding are preferred	3	5.5%	2	4	2
6	Reserve Treatment Capacity		Alternatives that increase City-wide reserve treatment capacity are preferred	2	3.7%	5	5	1
7	Economic Development		Locations/facilities that will serve areas planned for future development are strongly preferred	4	7.4%	4	5	4
					0.0%			
				Subtotal Score (Economic)		**2.32**	**1.84**	**2.95**
Total Score		**100%**			**100%**	**3.59**	**2.93**	**4.15**

Alternative Scores: 5 = Most Favorable, 4 = Somewhat Favorable, 3 = Neutral, 2 = Somewhat Unfavorable, 1 = Most Unfavorable

With weights established for the categories and criteria, each alternative was assigned a score for each of the criteria according to the scale presented in Table 19.

Table 19
Description of Triple Bottom Line Alternative Scores

Alternative Score	Description
5	Most Favorable
4	Somewhat Favorable
3	Neutral
2	Somewhat Unfavorable
1	Most Unfavorable

The following sections summarize the basis for assignment of alternative scores within each category.

6.4.1 Social Criteria

6.4.1.1 Visual Impacts. Due to topography and screening with trees, the south site is less visible than the north site. This caused Alternative 2 to be ranked above Alternative 1. In Alternative 3, the pump station will have a much smaller visual impact than a new WPF; therefore, Alternative 3 was ranked more favorably than Alternative 1 at the north site.

6.4.1.2 Noise Control. The south site is located closer to existing homes than the north site. Therefore, facilities at the north site (Alternative 1) were ranked more favorably than those at the south site (Alternative 2). The pump station included in Alternative 3 will have a lower noise emission than a new treatment facility; therefore Alternative 3 was ranked more favorably than Alternative 1 at the north site.

6.4.1.3 Odor Control at Site. The rankings for this criterion follow the same rationale as those for noise control. The south site is located closer to homes and is expected to have a larger odor impact than at the north site, causing Alternative 1 to be more favorable than Alternative 2. It is anticipated that the pump station of Alternative 3 will have fewer odor impacts than a new treatment facility and, therefore, received the most favorable ranking. Odor is anticipated to be a greater cause for community concern than noise, so the rankings were dropped one score below those for noise control.

6.4.1.4 Odor Control at Discharge. Odor issues at the discharge of the existing force main from the Faraon Street Pump Station are an ongoing concern for neighbors in this vicinity. While it is assumed that the pump station and force main of Alternative 3 will include adequate odor control, the potential to emit odors at the discharge locations still exists. Alternatives 1 and 2 were ranked most favorable with regard to this category as no discharge odors would exist with the construction of a new Eastside WPF.

6.4.1.5 Lighting Control. As the south site is closer to existing homes, it is anticipated that lighting issues would have more of a negative impact on Alternative 2 than Alternatives 1 and 3. It was determined that both Alternatives 1 and 3 would have roughly equivalent lighting impacts at the north site.

6.4.1.6 Surrounding Land Use. The south site is nearer to existing homes, making new wastewater infrastructure located in this area less compatible with surrounding land use than at the north site. This resulted in Alternatives 1 and 3 located at the north site ranked as more favorable than Alternative 2 at the south site.

6.4.1.7 Property Considerations. In either the north or south site locations, there are nearby existing dwellings; however, there are more houses closer on the south site than on the north site. While it is not clear that houses would need to be purchased in order to implement wastewater facilities in either location, the presence of a greater number of dwellings located closer to the proposed facility on the south site is of greater concern. This results in a less favorable ranking for Alternative 2 than for Alternatives 1 and 3.

6.4.1.8 Traffic Considerations. For the south site, Highway 169 is closer than the highway access for the north site; however, the south site is in closer proximity to an established group of homes. It was determined that each of the alternatives was neutral with respect to traffic due to the fact that the south site provided a shorter distance to a highway route, but introduced the possibility of more traffic through a neighborhood than the north site.

6.4.2 Environmental Criteria

6.4.2.1 Water Quality. As a new WPF located in either the north or south sites would be required to meet water quality standards by permit, Alternatives 1 and 2 were considered most favorable with respect to water quality impacts. Eastside flows under Alternative 3 would be pumped to the existing Combined Sewer Overflow (CSO) system for treatment at the existing WPF. Since this alternative introduces the possibility of the discharge of Eastside flows to the Missouri River through the CSO system, Alternative 3 was ranked less favorable in comparison to the other alternatives which keep all Eastside flow within the separated system.

6.4.2.2 Endangered Species. Correspondence obtained from the U.S. Fish and Wildlife Service (USFWS) and the Missouri Department of Conservation indicate there is no known presence of threatened or endangered species on either site. As a result, all alternatives were ranked most favorable. Appendix D presents the documentation received by the agencies.

6.4.2.3 Historical Resources. Publicly available data of National Historic Registry Properties and Districts indicate there are no such properties or districts within either site. Data provided directly to the City for planning purposes by the State Historic Preservation Office indicates there are no known archeological resources on either the north or south sites.

6.4.2.4 Wetland Impacts. Data available from the USFWS indicates the presence of significant wetland areas on the south site, including wetlands classified as freshwater forested/shrub wetlands which require the highest level of mitigation if destroyed. A few pockets of freshwater emergent wetlands are present on the north site. The presence of wetlands on the south site is considered significant and would interfere with construction or require significant mitigation at ratios of likely greater than one-to-one. Therefore, Alternative 2 was ranked most unfavorable. The wetlands on the north site would likely not need to be disturbed in order to construct the facilities proposed in Alternatives 1 and 3; therefore, these alternatives were ranked somewhat favorable. Figures showing the location of known wetlands on each of the sites are provided in Appendix D.

6.4.2.5 Site Contamination. A review of state, federal, and additional environmental databases was conducted for Black & Veatch by Environmental Data Resources, Inc. (EDR). The results of this search indicated no known areas of contamination on either the north or the south site. Therefore, all alternatives were ranked most favorable. The EDR data for the investigated sites is provided in Appendix D.

6.4.2.6 Ease of Permitting. It was determined that a new Eastside Pump Station and flow equalization basin would be easier to permit than a new WPF in either location. Therefore, Alternative 3 was ranked more favorable than either Alternatives 1 or 2.

6.4.3 Economic Criteria

6.4.3.1 Life Cycle Costs. As presented in Section 6.3, the alternatives ranked from least to greatest with respect to life cycle cost are Alternative 3, Alternative 1, and Alternative 2. The least favorable ranking for this criterion was based on the alternative with the greatest life cycle cost.

6.4.3.2 Potential Service Area by Gravity. The south site can serve a slightly larger service area by gravity than the north site. As a result, Alternative 2 was ranked more favorably than Alternatives 1 and 3.

6.4.3.3 Maximizes Use of Existing Infrastructure. Alternative 3 utilizes treatment capacity at the existing WPF, while Alternatives 1 and 2 involve the construction of new treatment capacity. However, Alternative 3 does not reuse the existing Faraon Street Pump Station or force main. As a result, Alternative 3 was ranked as neutral with respect to this criterion, with Alternatives 1 and 2 ranking most unfavorable.

6.4.3.4 Site Utilization. The proposed facilities could fit on either of the proposed sites. The north site provides a more flexible site to incorporate future growth and deal with unknowns that may arise throughout the project. As a result, Alternatives 1 and 3 were ranked more favorably with respect to site utilization.

6.4.3.5 Floodplain Considerations. Based on discussions with City staff, access roads to the north site have a greater potential to flood during heavy rain events than those of the south site. As a result, Alternative 2 was ranked more favorably than Alternatives 1 and 3.

6.4.3.6 Reserve Treatment Capacity. Alternatives 1 and 2 involve the construction of new Eastside wastewater treatment facilities, therefore treatment capacity at the existing WPF is conserved and reserve treatment capacity would be available. The construction of a new Eastside WPF would allow the existing WPF capacity currently used for processing flows from the Eastside to be available for economic development purposes on the Westside. This would be valuable to the City if a very large industry or a number of smaller industries intended to locate in the Westside area. As a result, Alternatives 1 and 2 rank most favorably for reserve treatment capacity when compared with Alternative 3. Since Alternative 3 utilizes capacity at the existing WPF for treatment of Eastside flows, it was ranked most unfavorable with respect to reserve capacity.

It is important to note that the planning horizon for wastewater facilities is 20 plus years and that even the most conservative historical periods have shown a clear record of steady industrial growth in the community. This record of success underscores the possible need to continue to plan for the expansion of system treatment capacity to support development.

6.4.3.7 Economic Development. All alternatives will serve all areas within the proposed Eastside service area. The south site has the potential to open up additional south watersheds in the future. As a result, Alternative 2 was ranked more favorably in comparison to Alternatives 1 and 3.

6.4.4 Results of Triple Bottom Line Analysis

Table 20 presents a summary of the overall triple bottom line scores for each alternative. Figure 14 provides a breakdown of the contributions by category to the overall score for each alternative. Alternative 3 received the highest overall score, followed by Alternative 1, with Alternative 2 ranking the lowest. Based on the triple bottom line analysis, Alternative 3 – Eastside Pump Station provides the best alternative to meet the three drivers – social, environmental, and economic.

Table 20
Eastside Wastewater Service Alternatives
Summary of Triple Bottom Line Analysis Overall Scores

Alternative 1 WPF at North Site	Alternative 2 WPF at South Site	Alternative 3 Eastside Pump Station at North Site
3.59	2.93	4.15

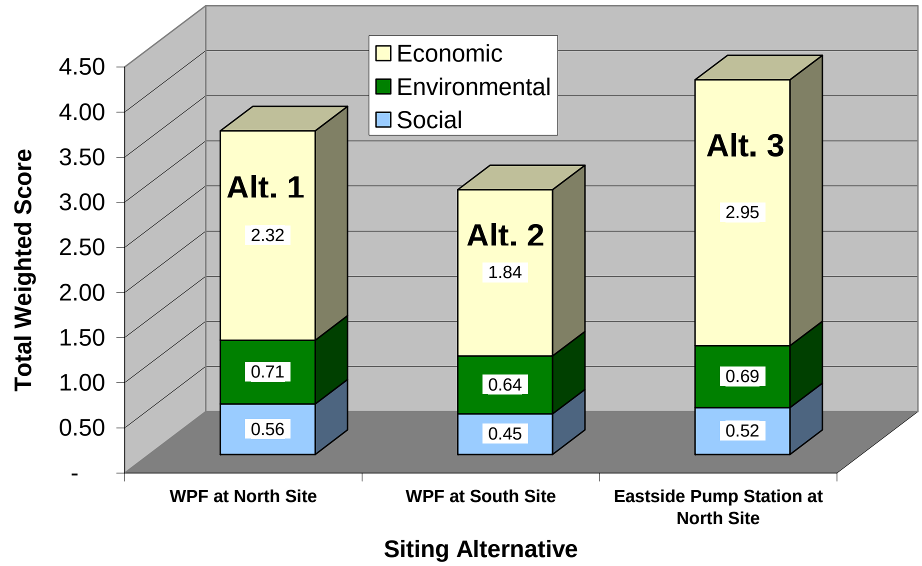


Figure 14 - Eastside WPF Assessment Triple Bottom Line Analysis Scores

7.0 Conclusions and Recommendations

The City of St. Joseph intends to plan for City growth over the next 20 years within an extended Eastside wastewater service area as shown in Figure 1. Alternatives considered to expand wastewater service in the Eastside include either construction of a new WPF or construction of a wastewater pump station. Wastewater process technologies were evaluated and it was determined that BNR with filtration is the most cost effective process for the Eastside area if a new WPF is recommended. Two sites, shown as the north and south sites in Figure 1, were identified and evaluated for the potential location of future wastewater infrastructure. Three alternatives were developed to provide the conveyance and treatment of future wastewater flows on the Eastside. The following provides a summary of the elements of each alternative:

- **Alternative 1 – Eastside WPF at North Site** (Figure 9)
  - Interceptor and trunk sewers to route wastewater flow to North site
  - Package pump station and 10 inch force main to route southern flows to North site
  - BNR with filtration WPF (6 mgd average flow)
  - Flow equalization basin (12 MG)

- North site land acquisition (320 acres assumed)
- Decommissioning of Faraon Street and Easton Road Pump Stations

- **Alternative 2 – Eastside WPF at South Site** (Figure 10)
  - Interceptor and trunk sewers to route wastewater flow to South site
  - BNR with filtration WPF (6 mgd average flow)
  - Flow equalization basin (12 MG)
  - South site land acquisition (320 acres assumed)
  - Decommissioning of Faraon Street and Easton Road Pump Stations

- **Alternative 3 – Eastside Pump Station at North Site** (Figure 11)
  - Interceptor and trunk sewers to route wastewater flow to North site
  - Eastside Pump Station (8 mgd to existing WPF, 16 mgd to flow equalization basin)
  - 24 inch force main from Eastside Pump Station to Mitchell Basin
  - 24 inch force main from Eastside Pump Station to flow equalization
  - Flow equalization basin (16 MG)
  - North site land acquisition (320 acres assumed for future WPF build-out)
  - Decommissioning of Faraon Street and Easton Road Pump Stations

Based on the results presented in the triple bottom line analysis, Alternative 3 – Eastside Pump Station at North Site is the highest ranking alternative by more than 13 percent according to the selection criteria encompassing social, environmental, and economic considerations. Based on the net present worth analysis, Alternative 3 is the lowest cost option. The net present worth of the Eastside Pump Station alternative

($155 million) is approximately $48 million less expensive than the next closest alternative over the 20-year life cycle.

It is recommended that the City implement the following initial facilities for the North site. An approximate opinion of probable project cost for the initial phase is given in Table 21.

- North site land acquisition
- Eastside Pump Station (with pumps to flow equalization initially phased to match flow equalization size)
- Flow equalization basin (initially phased at 3 MG, no cover or odor control)
- 24 inch force main from Eastside Pump Station to existing Faraon Street force main (existing Faraon Street force main should be inspected once flow equalization basin is installed to determine condition of line)
- Interceptor and trunk sewers from Faraon Street and Easton Road Pump Stations to Eastside Pump Station
- Decommissioning of Faraon Street and Easton Road Pump Stations

Table 21
Initial Phase of Eastside Pump Station
Summary of Opinion of Probable Project Costs [1]

Item	$
Eastside Interceptor Sewer	24,576,000
Trunk Sewer from Existing Faraon Street Pump Station to Eastside Interceptor	1,160,000
Trunk Sewer from Easton Road Pump Station to Eastside Interceptor	8,979,000
Flow Equalization Basin (3 MG)	3,750,000
Eastside and Flow Equalization Basin Pump Station	8,667,000
Force Main from Eastside Pump Station to Existing Faraon Street Pump Station	4,524,000
Demolish Existing Pump Stations	175,000
Flood Protection/Fill (placeholder) [2]	296,000
Site Remediation (placeholder) [2]	0
Subtotal	*52,127,000*
Electrical, I&C, Sitework, Utilities, and Contractor General Requirements [3]	13,064,000
Subtotal	*65,191,000*

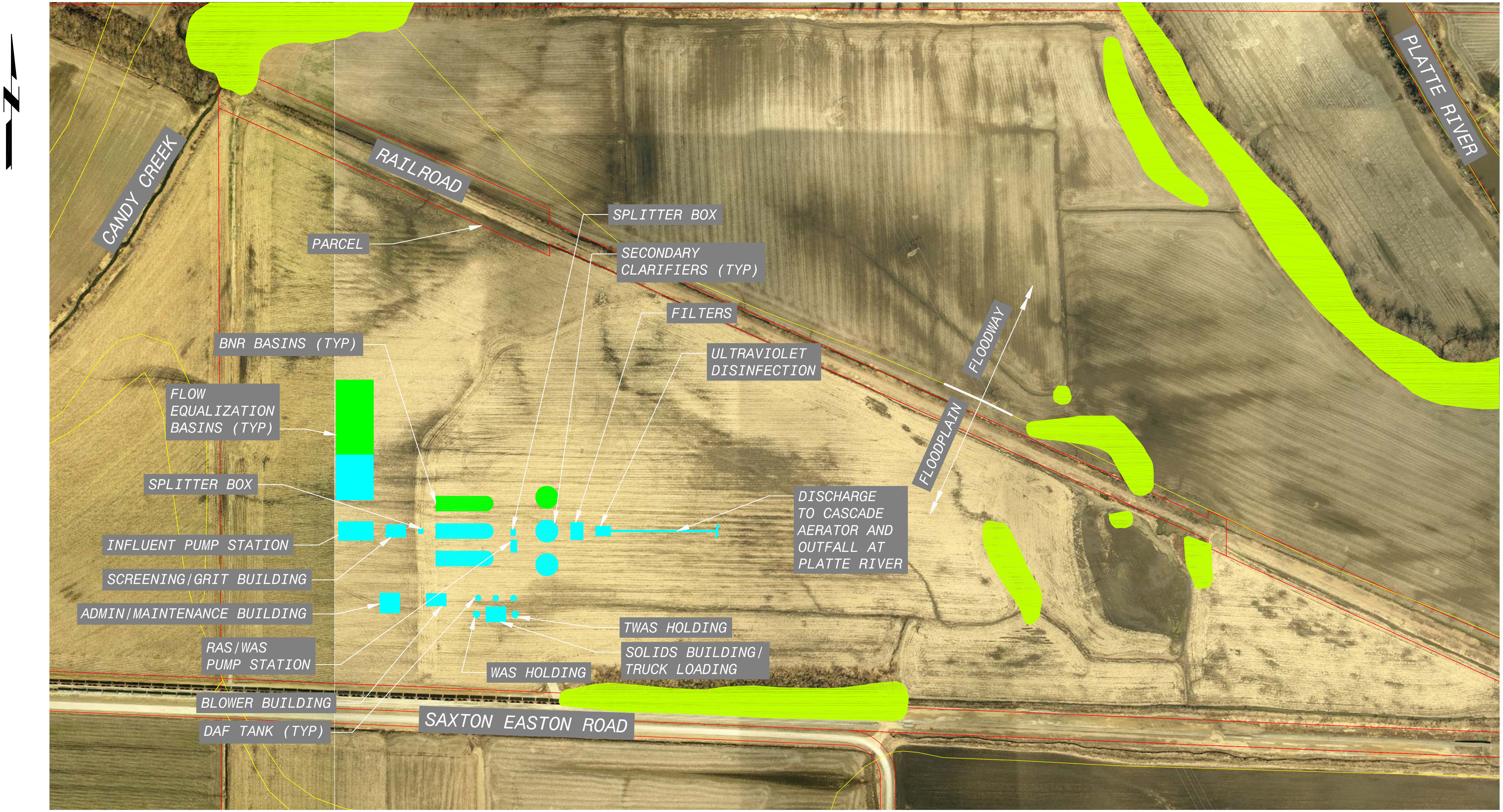
Table 21
Initial Phase of Eastside Pump Station
Summary of Opinion of Probable Project Costs [1]

Item	$
Contingency [4]	16,298,000
Land Acquisition (placeholder) [2]	4,000,000
Opinion of Probable Construction Cost	**85,489,000**
Engineering, Legal, and Administration [5]	17,098,000
Opinion of Total Project Cost	**102,587,000**

1. All costs presented in May 2009 dollars (ENR BCI = 4773).
2. Site related costs are placeholders and must be revised following final siting study of the selected area. Land acquisition costs based on $12,500/acre as projected by City staff.
3. Electrical and instrumentation and controls (I&C) projected at 25% of the total of all equipment and structure costs. Sitework projected at 10% of the total of equipment, structures, electrical, and I&C costs. Utility projections based on Black & Veatch experience and distance to closest power connection as provided by KCP&L. Contractor general requirements projected at 12% of the total of equipment, structures, electrical, I&C, sitework, and utility costs. Sitework and electrical and I &C percentages only applied to WPF facilities, pump stations, and flow equalization basins; these multipliers were not applied to the conveyance improvements.
4. Project contingency is projected at 25% of the total of all equipment, structures, electrical, I&C, sitework, utilities, contractor general requirements, flood protection/fill, and site remediation costs.
5. Engineering, legal, and administration (ELA) costs are projected at 20% of the total of all equipment, structures, electrical, I&C, sitework, utilities, contractor general requirements, flood protection/fill, site remediation costs, contingency, and land acquisition.

Odor control issues at the current Faraon Street Pump Station are of significant concern to the City. Costs for the proposed Eastside Pump Station include the construction of a BIOXIDE® feed system for odor control. Prior to the design of the Eastside Pump Station, a pilot study of the BIOXIDE® feed system at the Faraon Street Pump Station is recommended to ensure odor control issues at the existing pump station are addressed in the design for the new station. In addition, more detailed flow monitoring on the Eastside is recommended to confirm peak flow values for sizing pump station, conveyance, and flow equalization infrastructure.

It is likely that construction of a new Eastside WPF may be warranted after 2030. The City should monitor residential, commercial, and industrial development throughout the City and determine when additional treatment capacity expansion is required. When additional treatment capacity is needed, the north site could be expanded to include a new Eastside WPF. When a new WPF is implemented on the North site, the Eastside Pump Station can be reconfigured to serve as the influent pump station for the new WPF. Figure 15 provides a conceptual layout of a WPF located on the north site.



LEGEND

- PARCEL BOUNDARY
- FLOODWAY/FLOODPLAIN BOUNDARY
- IDENTIFIED WETLANDS
- PHASE 1 (4 MGD WPF)
- PHASE 2 (ADDITIONAL 2 MGD WPF)

400' 0 400' 800'
1"=400'

BLACK & VEATCH Corporation
Kansas City, Missouri

ST JOSEPH, MISSOURI
FACILITIES PLAN
PN 163509
CONCEPTUAL SITE PLAN
WATER PROTECTION FACILITY
ON NORTH SITE

FIGURE 15

8.0 References

The following references were utilized in preparation of this memorandum:

- Eastside Water Protection Facility Design Flows Memorandum (Black & Veatch, August 27, 2009).
- Eastside Conveyance Sizing Basis Memorandum (Black & Veatch, August 27, 2009).
- Wastewater Treatment Plant Improvements, R-32 drawings (DRG/CDM, July 21, 2004).
- Geotechnical Engineering Report (L. Robert Kimball, 1973).
- Odor Corrosion Control in Sanitary Sewerage Systems and Treatment Plants (USEPA Design Manual, 1985).
- Division 20 – Clean Water Commission, Chapter 8 – Design Guides (MDNR, February 28, 1999).
- East Side Sanitary Sewer Flow and Rainfall Analysis for the City of St. Joseph, Buchanan County, Missouri (Bartlett & West, April 2006).

Appendix A

Eastside Flow Projection Documentation

Eastside Water Protection Facility
Design Flows Memorandum

Memorandum

From: Page Burks
To: Andy Clements, City of St. Joseph, Missouri
Date: August 27, 2009
Re: Eastside Water Protection Facility Design Flows

Introduction

This memorandum provides the basis for sizing the proposed Eastside Water Protection Facility (WPF) to meet future needs through a planning year of 2030. The 102 River Watershed encompasses the newer, eastern portion of the City. Currently, all wastewater flow is collected in a separate sanitary sewer system which is conveyed to the Faraon Street Pump Station. From the Faraon Street Pump Station, the flow is pumped to the combined sewer system within the Mitchell Basin where it flows by gravity to the Whitehead Pump Station.

Historical Flows

Historical flow data from the Faraon Street Pump Station was examined to establish the existing average daily flow being generated in the 102 River Watershed. Table 1 presents the average daily flows from the pump station since 2005. To determine the per capita residential flows, the major industrial user flows in the 102 River Watershed were determined and subtracted from the total flow as shown in Table 1. The industrial user flows are based on water consumption records. For 2008, the industrial users contributed 0.963 mgd of the 2.449 mgd average flow pumped from the Faraon Street Pump Station.

Traffic analysis zone (TAZ) population projection data was used to estimate the domestic population to be served in the 102 River Watershed. This data indicates approximately a one percent annual growth rate in the domestic population in the 102 River service area through 2030. Using this population data, the 2008 per capita wastewater flow generated in the 102 River Watershed is 114 gpcd.

Table 1
Historical Flows in 102 River Watershed

Year	Faraon Street PS AA, mgd	Industrial Users: Sara Lee Foods, mgd	Cintas, mgd	Johnson Controls, mgd	Heartland Hospital, mgd	International Paper, mgd	TEVA, mgd	News Press, mgd	Grey Auto, mgd	IU Total, mgd	Domestic Flow (AA - IU Total), mgd	Population	Domestic Per Capita Flow, gpcd
2005	2.139											12,400	
2006	1.748	0.373	0.036	0.047	0.086	0.031	0.053	0.002	0.004	0.632	1.117	12,600	89
2007	2.280	0.636	0.036	0.054	0.107	0.035	0.049	0.002	0.004	0.923	1.357	12,800	106
2008	2.449	0.667	0.038	0.050	0.123	0.035	0.044	0.002	0.003	0.963	1.487	13,000	114
2009	2.399		0.042	0.033		0.031	0.049	0.002	0.002	0.159	2.240	13,200	

Notes:
2009 data not available for Sara Lee Foods and Heartland Hospital
AA = Annual Average
IU = Industrial Users

Projected Flows

Future domestic flows were determined using the projected 2030 population in the existing 102 River service area of 17,400 and the existing (2008) per capita generation rate of 114 gpcd. This results in an average domestic flow rate of 1.98 mgd. Development of population numbers and delineation of existing and future 102 River service areas are included in TM-WW-1. The 2008 per capita generation rate of 114 gpcd was selected for this evaluation as it is the most conservative rate over the historical data period.

While Sara Lee Foods and Heartland Hospital have experienced large growth indicated by an increase in discharge flow over the past couple of years, it is estimated that the increase will not continue based on the size of the available production area. Therefore, the average of the industrial flows from 2006 to 2008 (0.84 mgd) was used as an estimate of the base industrial flow in 2030. Combining both domestic and industrial flows, the predicted 2030 flow for the existing 102 River service area would be 2.82 mgd (1.98 mgd from domestic and 0.84 mgd from existing industrial sources). In discussions with City staff, it was decided to add a safety factor of 0.4 mgd for a total of 3.22 mgd from the existing 102 River service area in 2030.

City staff identified six additional growth areas in the 102 River Watershed that will impact the flow in 2030. One of these areas has been identified as the location of a potential new industrial park. Using TAZ data and City guidance, the total build-out population of the additional six areas would be 21,700. City staff estimate that the six additional areas will be 50 percent developed by 2030 resulting in a population of 10,850 for the planning period. Therefore, the 2030 average domestic flow for these new areas would be 1.24 mgd using a population of 10,850 and a per capita flow rate of 114 gpcd. Similar to the existing 102 River service area, City staff estimate that the new areas would have 0.84 mgd of industrial flow for a total of 2.08 mgd from the new areas (1.24 mgd + 0.84 mgd).

The projected annual average flows for both the existing 102 River service area and the six additional growth areas are summarized in Table 2. As indicated in this table, the total projected 2030 flow for the expanded 102 River Watershed would be 5.30 mgd.

Table 2
Projected 2030 Annual Average Flows in 102 River Watershed

	Domestic Flow, mgd	Industrial Flow, mgd	Safety Factor, mgd	Total, mgd
Existing Service Areas	1.98	0.84	0.4	3.22
Additional Growth Areas	1.24	0.84	---	2.08
Existing + Growth Areas	**3.22**	**1.68**	**0.4**	**5.30**

Recommendations

Based on a 2030 projected annual average flow of 5.30 mgd, it is recommended to provide a 6 mgd (average flow) WPF to serve the 102 River Watershed through planning year 2030. For economic purposes and to allow better matching of facilities to growth, construction of the WPF would be phased with the initial phase consisting of two 2 mgd liquid treatment trains for an initial design capacity of 4 mgd. As areas within the watershed are sewered and residential/industrial development grows, a third 2 mgd train would be constructed for a total average design capacity of 6 mgd.

A planning level estimated peak flow received at the WPF is projected to be 4 times the average flow or 24 mgd. The estimate of the peak flow is based on a review of the historical pumping records at the Faraon Street Pump Station. The historical data indicates a ratio of annual average to peak day flow of 3.8. This ratio appears to fall within ranges that would be expected based on other Black & Veatch projects and literature for a separate collection system. For the purposes of this evaluation, the peaking factor has been rounded to 4.

If the City proceeds with implementation of an Eastside WPF, it is recommended that flow monitoring be conducted prior to design to verify the anticipated annual average and peak flow conditions for the proposed WPF.

Eastside Conveyance Sizing Basis Memorandum

Memorandum
From: Page Burks
To: Andy Clements, City of St. Joseph, Missouri
Date: August 27, 2009
Re: Eastside Conveyance Sizing Basis

Introduction

This memorandum provides the basis for sizing the new Eastside wastewater conveyance system to meet future needs. Typically, conveyance infrastructure is designed for ultimate build-out or some planning horizon beyond that utilized for sizing the related treatment facilities.

Conveyance Capacity and Peaking Factor Determination

This section provides information on the development of peak wastewater flows at various locations within the proposed Eastside conveyance system and Water Protection Facility (WPF). As established in the August 27, 2009 memorandum, the proposed average daily flow to the Eastside WPF within the 20-year planning horizon is 6 million gallons per day (mgd). The estimated peak flow received at the WPF is projected to be 4 times that amount or 24 mgd. The estimate of the peak flow received at the WPF is based on a review of the historical pumping records at the Faraon Street Pump Station. The historical data indicates a ratio of annual average to peak day flow of 3.8. This ratio appears to fall within ranges that would be expected based on other Black & Veatch projects and literature for a separate collection system. For the purposes of this evaluation, the peaking factor has been rounded to 4.

Flows within the conveyance system will have attenuated to some extent by the time they reach the WPF. Consequently, the conveyance system flows are likely to see a higher peak than the peaking factor of 4 applied at the WPF. Without detailed flow monitoring data, Black & Veatch experience suggests a peaking factor of 5 times the average daily WPF flow is a reasonable value to apply to the overall collection system. For the Eastside over the 20-year planning horizon, this results in a 30 mgd peak conveyance flow during storm events for the total service area.

For the alternative where a new Eastside WPF is not constructed, it is assumed that flows to the Faraon Street Pump Station would attenuate in roughly the same manner as they would to a new Eastside WPF. As a result, a peaking factor of 4, equivalent to a peak flow of 24 mgd, could be applied at the Faraon Street Pump Station over the 20-year planning horizon.

The Eastside facility capacity and peaking factor information is summarized in Table 1.

Table 1 Summary of Eastside Facility Capacity and Peaking Factors			
Eastside WPF Average Flow, mgd	**Eastside WPF Peak Flow, mgd**	**Eastside Conveyance Peak Flow, mgd**	**Faraon St. PS Peak Flow, mgd**
6	24 (6 mgd x 4)	30 (6 mgd x 5)	24 (6mgd x 4)
Note: Flows are based on a 20-year planning horizon.			

Conveyance System Sizing

Due to the significant costs and pipeline right-of-way requirements, conveyance system infrastructure is typically sized to provide capacity over an extended planning horizon, often considering the "ultimate" build-out potential of the service area. In order to determine the "ultimate" capacity required for a new conveyance system without the use of computer modeling, a unit flow based on area is typically utilized to estimate the peak flow for sizing the system. Typical unit flow values utilized for these types of analyses vary widely depending on location and type of development. Table 2 summarizes the unit flows presented in various sources.

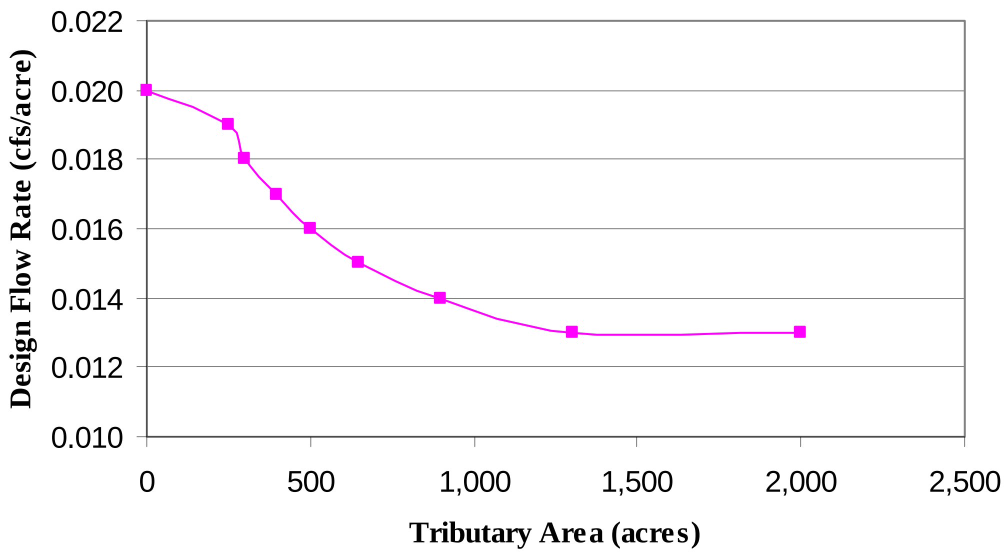
Table 2 Summary of Conveyance Unit Flows by Source		
Source	**Peak Unit Flow, cfs/acre**	**Comments**
Bartlett & West Eastside Sewer Evaluation (2005)	0.02 residential 0.015 commercial/industrial	Based on Kansas City Metropolitan Area Chapter of the American Public Works Association standards
Black & Veatch planning study for Johnson County, Kansas (1990)	0.013 – 0.020 (varies)	Varies based on contributing area, used to estimate build-out of new development areas in Johnson County
St. Joseph Minimum Design Standards (1991)	0.01	0.0015 inflow & infiltration + 0.0085 for low density housing (R1A or R1E, maximum 7 units/acre) *
Midland Engineering Riverside Road Interceptor Sewer Extension (1997)	0.01	Effectively 0.0075 cfs/acre because the unit flow of 0.01 cfs/acre was applied assuming 75% of the acreage outside the floodplain was developable
* Eastside population density is estimated at less than 3 people per acre.		

If the maximum unit flow of 0.02 cfs/acre is applied to the total proposed service area for the Eastside (excluding floodways), this results in a total peak flow of 340 mgd. This is more than 10 times the peak flow anticipated in the conveyance system for the initial 20-year planning period (30 mgd). While this would clearly provide an "ultimate" capacity, it seems this basis would add a great deal of cost for conveyance facilities that would not be fully utilized for many years into the future.

Recommendation

Based on discussions with Black & Veatch infrastructure planning personnel, the Johnson County, Kansas basis is considered a reasonable conservative estimate of ultimate build-out for new growth areas. Figure 1 provides the referenced sliding scale curve used to predict ultimate development flows in Johnson County. Since a large amount of the area within the proposed Eastside service area is currently undeveloped, providing infrastructure in the initial phase of construction to meet the full ultimate build-out seems overly aggressive. It is Black & Veatch's recommendation to use one-half of the Johnson County, Kansas unit flow basis for interceptor sewers and pump stations. Utilizing one-half of the basis provides a good balance between sizing the system to provide adequate capacity to meet the needs of the future while limiting investment in infrastructure which is currently unnecessary. If growth in the future does occur to the extent predicted by the full build-out approach, parallel interceptor sewers would be installed to provide this additional capacity.

Figure 1
Johnson County, KS Build-out Design Curve



Appendix B

Eastside Public Involvement Documentation

Community Factors to Consider
White Paper

St. Joseph, Missouri
Water Protection Program
Eastside Stakeholder Meeting

Community Factors to Consider for Location of a Potential New Water Protection Facility

Background

The costs and benefits of a new Water Protection Facility (WPF) east of the Belt Highway will be evaluated as part of the Facilities Plan. After the engineering study and financial analysis regarding a new WPF are complete, a recommendation will be provided to the St. Joseph City Council. The City Council will determine if a new WPF should be constructed.

If the decision is made to construct a new WPF, many factors must be considered regarding where to locate the new facility. The City of St. Joseph is seeking input from Eastside stakeholders (those who will be most affected by a new WPF) on the factors that may have the greatest impact the Eastside community. These factors are called "Community Factors."

Input from Eastside stakeholders will be provided to the Water Protection Program Community Advisory Panel for consideration. The Community Advisory Panel will provide recommended Water Protection Facility location criteria to the City Council.

The following section summarizes the draft Community Factors that will be discussed by Eastside stakeholders. Please note that the criteria are not listed in order of importance. The final section of this document describes additional technical factors that will be considered.

Draft Community Factors

A. Visual Impacts
- Locations that are less visible are preferred.
- Costs and benefits of improvements that will help blend the facilities into the surroundings will be considered.

B. Noise Control
- Locations that are a greater distance from residential and non-industrial commercial areas are preferred.
- Costs and benefits of technologies that further minimize noise will be considered.

C. Odor Control
- Locations that are a greater distance from residential and non-industrial commercial areas are preferred.
- The likelihood of prevailing winds to carry odors to residential and non-industrial commercial areas will be considered.
- Costs and benefits of technologies that further minimize odors will be considered.

D. Lighting Control
- Locations that are a greater distance from residential and non-industrial commercial areas are preferred.
- Costs and benefits of technologies that further minimize the impact of facility lighting will be considered.

E. Surrounding Land Use
- Compatibility with current and future land uses of surrounding areas will be considered.
- Locations within current or future industrial corridors are preferred.

F. Traffic Considerations
- Locations that have truck routes that are the shortest distances to the main highway or roadway are preferred.

G. Economic Development
- Locations that will serve areas planned for future development are strongly preferred.
- Locations that will serve the largest area by gravity, minimizing future build-out costs are preferred.

H. Environmental Factors
- Locations with the lowest impact on water quality are preferred.
- Locations without the historical presence of endangered species are preferred.
- Locations without any known archeological or historical resources are preferred.
- Locations that are not Federal or State designated wetlands are preferred.
- Locations with no known groundwater contamination are preferred.
- Locations without any unusual permitting circumstances are preferred.

I. Land Considerations
- Locations with fewer property owners are preferred.
- Properties already listed for sale on the real estate market are preferred.
- Locations with the lowest acquisition and site development costs are preferred.
- Locations with fewer homes or existing structures are preferred.
- Locations that allow the most efficient layout for a facility are preferred.
- Locations with the ability expand are preferred.
- Locations with the fewest acres in the floodplain are preferred.

Technical Factors

The following factors are technical in nature and are provided for Eastside stakeholders' information.

A. Potential Service Area by Gravity
- Locations with greater area that can flow from the upper areas of the watershed to the site by gravity are preferred.

B. Maximize Use of Existing Infrastructure
- The proximity/utilization of the existing collection system connections will be considered.
- The proximity/ease of transportation to the existing WPF will be considered.
- Locations that provide greater utilization of existing infrastructure are preferred.

C. Access to Utilities
- Proximity to existing utility infrastructure (power, gas, potable water, and telecommunications) will be considered.
- Locations closest to two electrical substations are strongly preferred.
- Locations closer to high pressure gas and potable water supplies are strongly preferred.

Eastside Stakeholders
Meeting Notes

ST. JOSEPH, MISSOURI
WATER PROTECTION PROGRAM

EASTSIDE STAKEHOLDERS MEETING

TUESDAY, MAY 19, 2009
4:00-6:00 P.M.
FREDERICK AVENUE BAPTIST CHURCH, ROOM 112
5502 FREDERICK AVENUE, ST. JOSEPH, MISSOURI

MEETING NOTES

I WELCOME & INTRODUCTIONS

Bruce Woody, Public Works Department Director, introduced City staff members that were present as well as the project consultant team from Black & Veatch and Shockey Consulting who will be working on the project.

II FACILITIES PLAN OVERVIEW

Matt Schultze, Black & Veatch, gave an overview of the Facilities Plan. He stated that the Facilities Plan includes three different, but related, assessment studies:

- *Combined Sewer Overflow Control Facilities Assessment*
- *Stormwater Detention Basin Facilities Assessment*
- *Water Protection Facilities Assessment*

Mr. Schultze explained some of the issues on the eastside of the City. He stated that east of the Belt Highway, one pipe carries wastewater and another separate pipe carries stormwater. This type of sewer system is called a separate sewer system (SSS). He stated that a service area assessment will be conducted for the eastside that will:

- *Establish assessment criteria for potential Eastside Water Protection Facility (WPF);*
- *Identify and evaluate sites for potential Eastside WPF;*
- *Evaluate and select treatment process for potential WPF;*
- *Evaluate conveyance requirements; and*
- *Determine life cycle costs of alternatives.*

Participant Question: Where would the discharge go to?

Response: The 102 or the Platte River. There are pluses and minuses to both. It's not just about the best technology, but finding the best location too.

Participant Question: Is it a lot cheaper to build a plant over here?

Response: A cost estimate for building a new plant on the eastside has not been completed, so we don't know the answer to that question yet.

Participant Question: Is the plant at capacity now? Will we have to put money into the existing plant anyway?

Response: We are looking at upgrades at the existing facility. We'll present that information at future meetings. The Community Advisory Panel will also look at funding options.

Participant Question: If you don't build one, will it cost money regardless because of the upgrades?

Response: Yes. The existing WPF will require upgrades regardless of whether or not a new facility is built on the eastside. The upgrades required on the conveyance system on the eastside of the City will vary depending on whether or not a new facility is constructed there. Our initial thought is that it will cost more to build the facility on the eastside than make upgrades to the existing system, but we need to perform the cost calculations and to weigh all the pros and cons.

Participant Comment: The plant on the westside would probably last longer if a lot of water isn't pumped over.

Response: Currently, the plant has capacity to handle existing sanitary flow generated on both the east and west sides of the City.

Participant Question: When would something be built?

Response: We have to start upgrading pump stations in the next few years, but we wouldn't have to do much of those upgrades if the proposed Eastside Water Protection Facility was built.

Participant Question: How far out would you plan for?

Response: We'll keep an eye on the future. We would plan for the anticipation of future growth to the north. We have worked with the City to obtain population and growth projections for 2030.

III REVIEW LOCATION CRITERIA & RECEIVE FEEDBACK

Sheila Shockey, Shockey Consulting Services, discussed some location factors by walking through a document with drafted community and technical factors. She asked if there were any comments.

Participant Comment: We don't want to get too close to the floodplain.

Participant Comment: Even if building a new facility is more expensive, I think it would be worth it to allow for future growth.

Participant Comment: I don't think this project is on the radar of area neighbors yet.

Participant Comment: I think it would be viewed negatively at first because we haven't had any sewer issues. Why should we pay more?

IV ADJOURN

Appendix C

Eastside Wastewater Alternatives Opinion of Probable Cost Documentation

Opinion of Probable Capital Cost Breakdown

St. Joseph, Missouri
TM-WW-2 - Eastside Wastewater Service Assessment
Alternative 1 - WPF at North Site

Item Description	Units	Unit Cost	Quantity	Total Cost
Eastside Interceptor Sewer				
Gravity Sewer (20-30 ft average depth)				
36-inch Concrete	lin ft	612.00	7,500	4,590,000
36-inch Manhole	each	10,000.00	15	150,000
36-inch Tunneled Creek Crossing	lin ft	1,080.00	100	108,000
36-inch Road Tunneled Crossing (County Line)	lin ft	1,080.00	50	54,000
48-inch Concrete	lin ft	816.00	3,750	3,060,000
48-inch Manhole	each	10,000.00	8	80,000
54-inch Concrete	lin ft	918.00	8,125	7,458,750
54-inch Manhole	each	20,000.00	17	340,000
54-inch Road Tunneled Crossing (Cook)	lin ft	1,620.00	50	81,000
60-inch Concrete	lin ft	1,020.00	1,250	1,275,000
60-inch Manhole	each	20,000.00	3	60,000
60-inch Tunneled Creek Crossing	lin ft	1,800.00	100	180,000
66-inch Concrete	lin ft	1,122.00	12,500	14,025,000
66-inch Manhole	each	20,000.00	25	500,000
66-inch Tunneled Creek Crossing (2)	lin ft	1,980.00	200	396,000
66-inch Tunneled Road Crossing (Frederick)	lin ft	1,980.00	100	198,000
78-inch Concrete	lin ft	1,326.00	11,250	14,917,500
78-inch Manhole	each	20,000.00	23	460,000
78-inch Tunneled Creek Crossing	lin ft	2,340.00	100	234,000
78-inch Tunneled Road Crossing (Mitchell)	lin ft	2,340.00	50	117,000
78-inch Tunneled Road Crossing (36 Highway)	lin ft	2,340.00	300	702,000
96-inch Concrete	lin ft	1,632.00	3,125	5,100,000
96-inch Manhole	each	20,000.00	7	140,000
Eastside Interceptor Sewer Subtotal				*54,226,000*
Trunk Sewer from Existing Faraon Street Pump Station to Eastside Interceptor				
Gravity Sewer (10-20 ft average depth)				
48-inch Concrete	lin ft	576.00	1,875	1,080,000
48-inch Manhole	each	20,000.00	4	80,000
Trunk Sewer from Faraon to Interceptor Subtotal				*1,160,000*
Trunk Sewer from Existing Easton Road Pump Station to Eastside Interceptor				
Gravity Sewer (10-20 ft average depth)				
24-inch Concrete	lin ft	288.00	14,375	4,140,000
24-inch Manhole	each	10,000.00	29	290,000
30-inch Concrete	lin ft	360.00	5,625	2,025,000
30-inch Manhole	each	10,000.00	12	120,000
30-inch Tunneled Creek Crossing	lin ft	900.00	100	90,000
36-inch Concrete	lin ft	432.00	5,000	2,160,000
36-inch Manhole	each	10,000.00	10	100,000
36-inch Tunneled Road Crossing (Saxton Easton)	lin ft	1,080.00	50	54,000
Trunk Sewer from Easton to Interceptor Subtotal				*8,979,000*
Trunk Sewer from Across River to Eastside Interceptor				
Gravity Sewer (10-20 ft average depth)				
27-inch Concrete	lin ft	324.00	12,500	4,050,000
27-inch Manhole	each	10,000.00	25	250,000
27-inch Tunneled Road Crossing (Cook)	lin ft	810.00	50	40,500
36-inch Concrete	lin ft	432.00	8,125	3,510,000
36-inch Manhole	each	10,000.00	17	170,000
36-inch Tunneled Road Crossing (Frederick)	lin ft	1,080.00	50	54,000
36-inch Concrete	lin ft	432.00	3,750	1,620,000
36-inch Manhole	each	10,000.00	8	80,000
36-inch Tunneled River Crossing (102 River)	lin ft	1,080.00	150	162,000
Trunk Sewer from Across River to Interceptor Subtotal				*9,937,000*
Southern Package Pump Station				
Package Southern Pump Station	LS		280,000	280,000
Earthwork				
Excavation	cu yd	20.00	198	4,000
Compacted Fill	cu yd	25.00	23	1,000

St. Joseph, Missouri
TM-WW-2 - Eastside Wastewater Service Assessment
Alternative 1 - WPF at North Site

Item Description		Units	Unit Cost	Quantity	Total Cost
	Granular Fill	cu yd	35.00	12	-
Concrete					
	Slab on Grade/Footings	cu ft	530.00	11	6,000
	Pump and Tank Pads	cu ft	630.00	-	-
	Walls	cu ft	850.00	34	28,000
	Suspended Slab and Beams	cu ft	950.00	11	11,000
	Embedded Accessories	LS			1,000
	Southern Pump Station Subtotal				*331,000*
Force main and/or Trunk Sewer for Southern Flows					
Force Main					
	10-inch Ductile Iron Pipe	lin ft	100.00	3,750	375,000
	10-Inch Tunneled Road Crossing (Whitson)	lin ft	300.00	50	15,000
Gravity Sewer					
	21-inch concrete (6-10 ft deep)	lin ft	210.00	6,250	1,312,500
	21-inch Manhole	each	10,000.00	13	130,000
	Force Main/Trunk Sewer from Southern Pump Station Subtotal				*1,832,500*
New Eastside WPF					
	Cost developed separately				
	Eastside WPF Subtotal				*37,781,500*
New Eastside Flow Equalization Basin (12 MG)					
	Cost developed separately				
	Eastside Flow Equalization Basin Subtotal				*21,000,000*
Demolish Existing Pump Stations					
	Demolish Faraon Street PS				150,000
	Demolish Easton Road PS				25,000
	Demolition Subtotal				*175,000*
	Alternative Subtotal				*135,422,000*
Electrical, Instrumentation, & Controls		LS	25%		14,822,000
	Subtotal				*150,244,000*
Sitework (including access road)		LS	10%		7,413,000
	Subtotal				*157,657,000*
Utilities					
	Power (to WPF)	LS			750,000
	Water (to WPF)	LS			424,000
	Gas (to WPF)	LS			212,000
	Power (to southern package PS)	LS			50,000
	Subtotal				*159,093,000*
General Requirements		LS	12%		19,091,000
Flood Protection/Fill (placeholder)		cu yd	25.00	157,380	3,935,000
Site Remediation (placeholder)		cu yd	150.00	-	-
	Subtotal				*182,119,000*
Contingency		LS	25%		45,530,000
Land Acquistion (placeholder)		acre	12,500.00	320	4,000,000
Permanent Conveyance Easement (included in ELA)					
Temporary Construction Easement (included in ELA)					
	Opinion of Probable Construction Cost				**231,649,000**
Engineering, Legal, & Administration		LS	20%		46,330,000
	Opinion of Probable Project Cost				**277,979,000**

Assumed Structure for Service Life Assessment
Assumed Equipment for Service Life Assessment

Notes:
1. Gravity sewer and force main unit costs include seeding, sodding, and site restoration.

St. Joseph, Missouri
TM-WW-2 - Eastside Wastewater Service Assessment
Alternative 2 - WPF at South Site

Item Description	Units	Unit Cost	Quantity	Total Cost
Eastside Interceptor Sewer				
Gravity Sewer (20-30 ft average depth)				
36-inch Concrete	lin ft	612.00	7,500	4,590,000
36-inch Manhole	each	10,000.00	15	150,000
36-inch Tunneled Creek Crossing	lin ft	1,080.00	100	108,000
36-inch Tunneled Road Crossing (County Line)	lin ft	1,080.00	50	54,000
48-inch Concrete	lin ft	816.00	3,750	3,060,000
48-inch Manhole	each	10,000.00	8	80,000
54-inch Concrete	lin ft	918.00	8,125	7,458,750
54-inch Manhole	each	20,000.00	17	340,000
54-inch Tunneled Road Crossing (Cook)	lin ft	1,620.00	50	81,000
60-inch Concrete	lin ft	1,020.00	1,250	1,275,000
60-inch Manhole	each	20,000.00	3	60,000
60-inch Tunneled Creek Crossing	lin ft	1,800.00	100	180,000
66-inch Concrete	lin ft	1,122.00	12,500	14,025,000
66-inch Manhole	each	20,000.00	25	500,000
66-inch Tunneled Creek Crossing (2)	lin ft	1,980.00	200	396,000
66-inch Tunneled Road Crossing (Frederick)	lin ft	1,980.00	100	198,000
78-inch Concrete	lin ft	1,326.00	11,250	14,917,500
78-inch Manhole	each	20,000.00	23	460,000
78-inch Tunneled Creek Crossing	lin ft	2,340.00	100	234,000
78-inch Tunneled Road Crossing (Mitchell)	lin ft	2,340.00	50	117,000
78-inch Tunneled Road Crossing (36 Highway)	lin ft	2,340.00	300	702,000
96-inch Concrete	lin ft	1,632.00	3,125	5,100,000
96-inch Manhole	each	20,000.00	7	140,000
Eastside Interceptor Sewer Subtotal				*54,226,000*
Trunk Sewer from Existing Faraon Street Pump Station to Eastside Interceptor				
Gravity Sewer (10-20 ft average depth)				
48-inch Concrete	lin ft	576.00	1,875	1,080,000
48-inch Manhole	each	20,000.00	4	80,000
Trunk Sewer from Faraon to Interceptor Subtotal				*1,160,000*
Trunk Sewer from Existing Easton Road Pump Station to Eastside Interceptor				
Gravity Sewer (10-20 ft average depth)				
24-inch Concrete	lin ft	288.00	14,375	4,140,000
24-inch Manhole	each	10,000.00	29	290,000
30-inch Concrete	lin ft	360.00	5,625	2,025,000
30-inch Manhole	each	10,000.00	12	120,000
30-inch Tunneled Creek Crossing	lin ft	900.00	100	90,000
36-inch Concrete	lin ft	432.00	5,000	2,160,000
36-inch Manhole	each	10,000.00	10	100,000
36-inch Tunneled Road Crossing (Saxton Easton)	lin ft	1,080.00	50	54,000
Trunk Sewer from Easton to Interceptor Subtotal				*8,979,000*
Trunk Sewer from Across River to Eastside Interceptor				
Gravity Sewer (10-20 ft average depth)				
27-inch Concrete	lin ft	324.00	12,500	4,050,000
27-inch Manhole	each	10,000.00	25	250,000
27-inch Tunneled Road Crossing (Cook)	lin ft	810.00	50	40,500
36-inch Concrete	lin ft	432.00	8,125	3,510,000
36-inch Manhole	each	10,000.00	17	170,000
36-inch Tunneled Road Crossing (Frederick)	lin ft	1,080.00	50	54,000
36-inch Concrete	lin ft	432.00	3,750	1,620,000
36-inch Manhole	each	10,000.00	8	80,000
36-inch Tunneled River Crossing (102 River)	lin ft	1,080.00	150	162,000
Trunk Sewer from Across River to Interceptor Subtotal				*9,937,000*
Southern Eastside Interceptor Sewer				
Gravity Sewer (20-30 depth)				
96-inch	lin ft	1,632.00	22,500	36,720,000

St. Joseph, Missouri
TM-WW-2 - Eastside Wastewater Service Assessment
Alternative 2 - WPF at South Site

Item Description	Units	Unit Cost	Quantity	Total Cost
96-inch Manhole	each	20,000.00	45	900,000
96-inch Tunneled Road Crossing (169)	lin ft	2,880.00	200	576,000
Southern Eastside Interceptor Sewer Subtotal				*38,196,000*
New Eastside WPF				
Cost developed separately				
Eastside WPF Subtotal				*37,781,500*
New Eastside Flow Equalization Basin (12 MG)				
Cost developed separately				
Eastside Flow Equalization Basin Subtotal				*21,000,000*
Demolish Existing Pump Stations				
Demolish Faraon Street PS				150,000
Demolish Easton Road PS				25,000
Demolition Subtotal				*175,000*
Alternative Subtotal				*171,455,000*
Electrical, Instrumentation, & Controls	LS	25%		14,739,000
Subtotal				*186,194,000*
Sitework (includes access road)	LS	10%		7,416,000
Subtotal				*193,610,000*
Utilities				
Power	LS			1,500,000
Water	LS			424,000
Gas	LS			212,000
Subtotal				*195,746,000*
General Requirements	LS	12%		23,490,000
Flood Protection/Fill (placeholder)	cu yd	25.00	174,240	4,356,000
Site Remediation (placeholder)	cu yd	150.00	-	-
Subtotal				*223,592,000*
Contingency	LS	25%		55,898,000
Land Acquistion (placeholder)	acre	12,500.00	320	4,000,000
Permanent Conveyance Easement (included in ELA)				
Temporary Construction Easement (included in ELA)				
Opinion of Probable Construction Cost				**283,490,000**
Engineering, Legal, & Administration	LS	20%		56,698,000
Opinion of Probable Project Cost				**340,188,000**

Assumed Structure for Service Life Assessment
Assumed Equipment for Service Life Assessment

Notes:
1. Gravity sewer and force main unit costs include seeding, sodding, and site restoration.

Item Description	Units	Unit Cost	Quantity	Total Cost
Eastside Interceptor Sewer				
Gravity Sewer (20-30 ft average depth)				
36-inch Concrete	lin ft	612.00	7,500	4,590,000
36-inch Manhole	each	10,000.00	15	150,000
36-inch Tunneled Creek Crossing	lin ft	1,080.00	100	108,000
36-inch Tunneled Road Crossing (County Line)	lin ft	1,080.00	50	54,000
48-inch Concrete	lin ft	816.00	3,750	3,060,000
48-inch Manhole	each	10,000.00	8	80,000
54-inch Concrete	lin ft	918.00	8,125	7,458,750
54-inch Manhole	each	20,000.00	17	340,000
54-inch Tunneled Road Crossing (Cook)	lin ft	1,620.00	50	81,000
60-inch Concrete	lin ft	1,020.00	1,250	1,275,000
60-inch Manhole	each	20,000.00	3	60,000
60-inch Tunneled Creek Crossing	lin ft	1,800.00	100	180,000
66-inch Concrete	lin ft	1,122.00	12,500	14,025,000
66-inch Manhole	each	20,000.00	25	500,000
66-inch Tunneled Creek Crossing (2)	lin ft	1,980.00	200	396,000
66-inch Tunneled Road Crossing (Frederick)	lin ft	1,980.00	100	198,000
78-inch Concrete	lin ft	1,326.00	11,250	14,917,500
78-inch Manhole	each	20,000.00	23	460,000
78-inch Tunneled Creek Crossing	lin ft	2,340.00	100	234,000
78-inch Tunneled Road Crossing (Mitchell)	lin ft	2,340.00	50	117,000
78-inch Tunneled Road Crossing (36 Highway)	lin ft	2,340.00	300	702,000
96-inch Concrete	lin ft	1,632.00	3,125	5,100,000
96-inch Manhole	each	20,000.00	7	140,000
Eastside Interceptor Sewer Subtotal				*54,226,000*
Trunk Sewer from Existing Faraon Street Pump Station to Eastside Interceptor				
Gravity Sewer (10-20 ft average depth)				
48-inch Concrete	lin ft	576.00	1,875	1,080,000
48-inch Manhole	each	20,000.00	4	80,000
Trunk Sewer from Faraon to Interceptor Subtotal				*1,160,000*
Trunk Sewer from Existing Easton Road Pump Station to Eastside Interceptor				
Gravity Sewer (10-20 ft average depth)				
24-inch Concrete	lin ft	288.00	14,375	4,140,000
24-inch Manhole	each	10,000.00	29	290,000
30-inch Concrete	lin ft	360.00	5,625	2,025,000
30-inch Manhole	each	10,000.00	12	120,000
30-inch Tunneled Creek Crossing	lin ft	900.00	100	90,000
36-inch Concrete	lin ft	432.00	5,000	2,160,000
36-inch Manhole	each	10,000.00	10	100,000
36-inch Tunneled Road Crossing (Saxton Easton)	lin ft	1,080.00	50	54,000
Trunk Sewer from Easton to Interceptor Subtotal				*8,979,000*
Trunk Sewer from Across River to Eastside Interceptor				
Gravity Sewer (10-20 ft average depth)				
27-inch Concrete	lin ft	324.00	12,500	4,050,000
27-inch Manhole	each	10,000.00	25	250,000
27-inch Tunneled Road Crossing (Cook)	lin ft	810.00	50	40,500
36-inch Concrete	lin ft	432.00	8,125	3,510,000
36-inch Manhole	each	10,000.00	17	170,000
36-inch Tunneled Road Crossing (Frederick)	lin ft	1,080.00	50	54,000
36-inch Concrete (10-20 ft depth)	lin ft	432.00	3,750	1,620,000
36-inch Manhole	each	10,000.00	8	80,000
36-inch River Crossing (102 River)	lin ft	1,080.00	150	162,000
Trunk Sewer from Across River to Interceptor Subtotal				*9,937,000*
Southern Package Pump Station				
Package Southern Pump Station	LS		280,000	280,000
Earthwork				
Excavation	cu yd	20.00	198	4,000
Compacted Fill	cu yd	25.00	23	1,000

St. Joseph, Missouri
TM-WW-2 - Eastside Wastewater Service Assessment
Alternative 3 - Eastside Pump Station at North Site

Item Description		Units	Unit Cost	Quantity	Total Cost
	Granular Fill	cu yd	35.00	12	-
Concrete					
	Slab on Grade/Footings	cu ft	530.00	11	6,000
	Pump and Tank Pads	cu ft	630.00	-	-
	Walls	cu ft	850.00	34	28,000
	Suspended Slab and Beams	cu ft	950.00	11	11,000
	Embedded Accessories	LS			1,000
	Southern Pump Station Subtotal				*331,000*
Force Main and/or Trunk Sewer from Southern Package Pump Station					
Force Main					
	10-inch Ductile Iron Pipe	lin ft	100.00	3,750	375,000
	10-Inch Tunneled Road Crossing (Whitson)	lin ft	300.00	50	15,000
Gravity Sewer					
	21-inch Concrete (6-10 ft deep)	lin ft	210.00	6,250	1,312,500
	21-inch Manhole	each	10,000.00	13	130,000
	Force Main/Truck Sewer from Southern Pump Station Subtotal				*1,832,500*
New Eastside Pump Station					
Building Superstructure		sq ft	155.00	5,625	872,000
Screening Building Superstructure		sq ft	190.00	2,100	399,000
Painting		sq ft	6.00	7,725	46,000
Earthwork					
	Structural Excavation	cu yd	20.00	2,619	52,000
	Compacted Fill	cu yd	25.00	474	12,000
	Granular Fill	cu yd	35.00	237	8,000
Piling		each	2,600.00	116	302,000
Sheeting and Dewatering		LS			50,000
Concrete					
	Slab on Grade/Footings		530.00	111	59,000
	Walls		850.00	533	453,000
	Suspended Slab and Beams		950.00	88	83,000
	Embedded Acessories				15,000
Pumps, Motors, Eddy Current Drives					
	each pair pumps 2 mgd at 270' head	ea pair	210,000.00	5	1,050,000
Mechanically Cleaned Bar Screens (1/2")		each	291,200.00	2	582,400
Elevator					200,000
Vertical Rolling Doors					12,000
Ductile Iron Pipe (Victaulic)					
	24-inch Suction Header	lin ft	840.00	75	63,000
	10-inch Suction Lines	lin ft	350.00	175	61,000
Valves					
	24-inch Gates	each	24,000.00	2	48,000
	24-inch Ball Valves	each	50,688.00	2	101,000
	10-inch Check Valve	each	3,000.00	10	30,000
	10-inch Isolation	each	2,100.00	20	42,000
Wetwell Corrosion Liner		sq ft	10.00	6,375	64,000
Bridge Crane (15 ton)		LS			62,000
HVAC		sq ft	35.00	7,725	270,000
Plumbing		sq ft	10.00	7,725	77,000
Fire Protection		sq ft	3.50	7,725	27,000
Odor Control - costed separately		LS			260,000
	Eastside Pump Station Subtotal				*5,300,400*
New Eastside Flow Equalization Pump Station					
Building Superstructure		sq ft	155.00	5,625	872,000
Painting		sq ft	6.00	5,625	34,000
Earthwork					
	Structural Excavation	cu yd	20.00	2,619	52,000
	Compacted Fill	cu yd	25.00	474	12,000
	Granular Fill	cu yd	35.00	237	8,000
Piling		each	2,600.00	116	302,000

Item Description	Units	Unit Cost	Quantity	Total Cost
Sheeting and Dewatering	LS			50,000
Concrete				-
Slab on Grade/Footings		530.00	111	59,000
Walls		850.00	533	453,000
Suspended Slab and Beams		950.00	88	83,000
Embedded Acessories				15,000
Pumps, Motors, Eddy Current Drives				
4 mgd at 80' head	each	105,000.00	5	525,000
Ductile Iron Pipe (Victaulic)				
24-inch Suction Header	lin ft	840.00	75	63,000
10-inch Suction Lines	lin ft	350.00	175	61,000
Ductile Iron Pipe				
24-inch From PS to Flow EQ Basin	lin ft	240.00	1,500	360,000
24-inch from Flow EQ to PS	lin ft	240.00	1,500	360,000
Valves				
10-inch Check Valve	each	3,000.00	5	15,000
10-inch Isolation	each	2,100.00	10	21,000
Wet Well Corrosion Liner	sq ft	10.00	6,375	64,000
HVAC	sq ft	35.00	5,625	197,000
Plumbing	sq ft	10.00	5,625	56,000
Fire Protection	sq ft	3.50	5,625	20,000
Eastside Flow Equalization Pump Station Subtotal				*3,682,000*
Flow Equalization Basin (16 MG)				
Cost developed separately				
Flow Equalization Basin Subtotal				*25,300,000*
Force Main from Eastside Pump Station				
Force Main				
New 24-inch DIP from PS to Exist Faraon St. PS	lin ft	240.00	17,500	4,200,000
24-inch Tunneled Creek Crossing	lin ft	720.00	100	72,000
24-inch Tunneled Road Crossing (36 Highway)	lin ft	720.00	300	216,000
24-inch Tunneled Road Crossing (Mitchell)	lin ft	720.00	50	36,000
Replace Existing 24-inch Faraon St. FM	lin ft	240.00	12,500	3,000,000
24-inch Tunneled Creek Crossings (2)	lin ft	720.00	200	144,000
24-inch Tunneled Road Crossing (Riverside)	lin ft	720.00	50	36,000
24-inch Tunneled Road Crossing (Woodbine)	lin ft	720.00	50	36,000
24-inch Tunneled Road Crossing (I-29)	lin ft	720.00	300	216,000
Flows from Eastside Pump Station Subtotal				*7,956,000*
Demolish Existing Pump Stations				
Demolish Faraon Street PS				150,000
Demolish Easton Road PS				25,000
Demolition Subtotal				*175,000*
Alternative Subtotal				*118,879,000*
Electrical, Instrumentation, & Controls	LS	25%		8,697,000
Subtotal				*127,576,000*
Sitework (including access road)	LS	10%		4,351,000
Subtotal				*131,927,000*
Utilities				
Power (to PS/future WPF)	LS			750,000
Water (to PS/future WPF)	LS			424,000
Gas (to PS/future WPF)	LS			212,000
Power (to southern package PS)	LS			50,000
Subtotal				*133,363,000*
General Requirements	LS	12%		16,004,000
Flood Protection/Fill (placeholder)	cu yd	25.00	14,352	359,000
Site Remediation (placeholder)	cu yd	150.00	-	-
Subtotal				*149,726,000*
Contingency	LS	25%		37,432,000
Land Acquistion (placeholder)	acre	12,500.00	320	4,000,000

St. Joseph, Missouri
TM-WW-2 - Eastside Wastewater Service Assessment
Alternative 3 - Eastside Pump Station at North Site

Item Description	Units	Unit Cost	Quantity	Total Cost
Permanent Conveyance Easement (included in ELA)				
Temporary Construction Easement (included in ELA)				
Opinion of Probable Construction Cost				**191,158,000**
Engineering, Legal, & Administration	LS	20%		38,232,000
Opinion of Probable Project Cost				**229,390,000**

Assumed Structure for Service Life Assessment
Assumed Equipment for Service Life Assessment

Notes:
1. Gravity sewer and force main unit costs include seeding, sodding, and site restoration.

Opinion of Probable Net Present Worth Breakdown

St. Joseph, Missouri
TM-WW-2 - Eastside Wastewater Service Assessment
Alternative 1 - WPF at North Site

Net Present Worth

Capital Project Elements	1st Year Acquired or Installed	Life (Years)	2009 Cost ($)	2009 Cost ($)	2009 Year 0 1.00000	2010 Year 1 0.95238	2011 Year 2 0.90703	2012 Year 3 0.86384	2013 Year 4 0.82270	2014 Year 5 0.78353	2015 Year 6 0.74622	2016 Year 7 0.71068	2017 Year 8 0.67684	2018 Year 9 0.64461	2019 Year 10 0.61391	2020 Year 11 0.58468	2021 Year 12 0.55684	2022 Year 13 0.53032	2023 Year 14 0.50507	2024 Year 15 0.48102	2025 Year 16 0.45811	2026 Year 17 0.43630	2027 Year 18 0.41552	2028 Year 19 0.39573	2029 Year 20 0.37689	TOTAL PRESENT WORTH	REMAINING VALUE 0.37689	NET PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024
Eastside Interceptor Sewer	2009	50	$54,226,000	$54,226,000	$54,226,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$125,902,506		
Trunk Sewer from Existing Faraon Street Pump Station to Eastside Interceptor	2009	50	$1,160,000	$1,160,000	$1,160,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$2,693,300		
Trunk Sewer from Existing Easton Road Pump Station to Eastside Interceptor	2009	50	$8,979,000	$8,979,000	$8,979,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$20,847,538		
Trunk Sewer from Across River to Eastside Interceptor	2009	50	$9,937,000	$9,937,000	$9,937,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$23,071,833		
Southern Package Pump Station																													
Structure	2009	50	$51,000	$51,000	$51,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$118,412		
Equipment	2009	20	$280,000	$280,000	$280,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$1,083,512		$1,083,512		
Force Main and Trunk Sewer from Southern Package Pump Station	2009	50	$1,832,500	$1,832,500	$1,832,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$4,254,718		
New Eastside WPF																													
Phase I (4 mgd)																													
Structure	2009	50	$26,042,800	$26,042,800	$26,042,800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$60,466,451		
Equipment	2009	20	$5,710,783	$5,710,800	$5,710,800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$22,098,994		$22,098,994		
Phase II (additional 2 mgd)																													
Structure	2019	50	$4,318,400	$4,318,400	-	-	-	-	-	-	-	-	-	-	$8,494,946	-	-	-	-	-	-	-	-	-	-		$13,368,676		
Equipment	2019	20	$1,709,517	$1,709,500	-	-	-	-	-	-	-	-	-	-	$3,362,845	-	-	-	-	-	-	-	-	-	-		$3,307,645		
Flow Equalization Basin																													
Phase I (8mgd)																													
Structure	2009	50	$12,600,000	$12,600,000	$12,600,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$29,254,815		
Equipment	2009	20	$1,400,000	$1,400,000	$1,400,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$5,417,558		$5,417,558		
Phase II (additional 4 mgd)																													
Structure	2019	50	$6,300,000	$6,300,000	-	-	-	-	-	-	-	-	-	-	$12,393,054	-	-	-	-	-	-	-	-	-	-		$19,503,210		
Equipment	2019	20	$700,000	$700,000	-	-	-	-	-	-	-	-	-	-	$1,377,006	-	-	-	-	-	-	-	-	-	-		$1,354,390		
Electrical, Instrumentation, and Controls	2009	20	$14,822,000	$14,822,000	$14,822,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$57,356,463		$57,356,463		
Land Acquisition	2009	10,000	$4,000,000	$4,000,000	$4,000,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$15,447,780		
Demolish Existing Pump Stations	2009		$175,000	$175,000	$175,000																								
Utilities	2009		$1,436,000	$1,436,000	$1,436,000																								
Sitework	2009		$7,413,000	$7,413,000	$7,413,000																								
General Requirements	2009		$19,091,000	$19,091,000	$19,091,000																								
Flood Protection/Fill	2009		$3,935,000	$3,935,000	$3,935,000																								
Site Remediation	2009		$0	$0	$0																								
Contingency	2009		$45,530,000	$45,530,000	$45,530,000																								
Construction Subtotal			$231,649,000	$231,649,000	$218,621,100	$0	$0	$0	$0	$0	$0	$0	$0	$0	$25,627,851	$0	$0	$0	$0	$0	$0	$0	$0	$0	$85,956,527				
Engineering, Legal, and Administration 20%	2009		$46,329,800	$46,329,800	$43,724,220	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,125,570	$0	$0	$0	$0	$0	$0	$0	$0	$0	$17,191,305				
Interest During Construction (yrs)		0																											
Opinion of Probable Project Cost			$277,980,000	$277,980,000	$262,350,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$30,753,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$103,148,000		$405,547,801		
Factored Totals					$262,350,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$18,880,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$38,875,000	$320,105,000	$152,846,701	**$167,258,299**	$13,400,000

O&M Elements	2009 Annual Cost ($)	2009 Year Cost ($)	2009 Year 0 1.00000	2010 Year 1 0.95238	2011 Year 2 0.90703	2012 Year 3 0.86384	2013 Year 4 0.82270	2014 Year 5 0.78353	2015 Year 6 0.74622	2016 Year 7 0.71068	2017 Year 8 0.67684	2018 Year 9 0.64461	2019 Year 10 0.61391	2020 Year 11 0.58468	2021 Year 12 0.55684	2022 Year 13 0.53032	2023 Year 14 0.50507	2024 Year 15 0.48102	2025 Year 16 0.45811	2026 Year 17 0.43630	2027 Year 18 0.41552	2028 Year 19 0.39573	2029 Year 20 0.37689	TOTAL PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024
Power	$370,667	$370,700		$389,235	$408,697	$429,132	$450,588	$473,118	$496,773	$521,612	$547,693	$575,077	$905,747	$951,034	$998,586	$1,048,515	$1,100,941	$1,155,988	$1,213,787	$1,274,477	$1,338,201	$1,405,111	$1,475,366		
Labor	$585,333	$585,300		$614,565	$645,293	$677,558	$711,436	$747,008	$784,358	$823,576	$864,755	$907,992	$1,430,088	$1,501,592	$1,576,672	$1,655,506	$1,738,281	$1,825,195	$1,916,455	$2,012,277	$2,112,891	$2,218,536	$2,329,463		
Maintenance & Spare Parts	$408,667	$408,700		$429,135	$450,592	$473,121	$496,777	$521,616	$547,697	$575,082	$603,836	$634,028	$998,594	$1,048,524	$1,100,950	$1,155,997	$1,213,797	$1,274,487	$1,338,211	$1,405,122	$1,475,378	$1,549,147	$1,626,604		
Chemicals	$38,667	$38,700		$40,635	$42,667	$44,800	$47,040	$49,392	$51,862	$54,455	$57,178	$60,036	$94,557	$99,285	$104,249	$109,462	$114,935	$120,682	$126,716	$133,052	$139,704	$146,689	$154,024		
Solids Hauling Costs	$17,333	$17,300		$18,165	$19,073	$20,027	$21,028	$22,080	$23,184	$24,343	$25,560	$26,838	$42,270	$44,383	$46,602	$48,933	$51,379	$53,948	$56,646	$59,478	$62,452	$65,574	$68,853		
Opinion of Probable O&M Cost	$1,420,667		-	$1,491,735	$1,566,322	$1,644,638	$1,726,870	$1,813,213	$1,903,874	$1,999,068	$2,099,021	$2,203,972	$3,471,256	$3,644,819	$3,827,060	$4,018,413	$4,219,333	$4,430,300	$4,651,815	$4,884,406	$5,128,626	$5,385,057	$5,654,310		
Factored Totals			$0	$1,420,700	$1,420,700	$1,420,700	$1,420,700	$1,420,700	$1,420,700	$1,420,700	$1,420,700	$1,420,700	$2,131,050	$2,131,050	$2,131,050	$2,131,050	$2,131,050	$2,131,050	$2,131,050	$2,131,050	$2,131,050	$2,131,050	$2,131,050	**$36,228,000**	$2,907,028

Economic Analysis Criteria:

Interest Rate =	5.00%
Capital Escalation Rate =	7.00%
O&M Escalation Rate =	5.00%
Baseline for costs =	May-09
ENR Building Cost Index =	4773

Net Present Worth = $203,486,000

St. Joseph, Missouri
TM-WW-2 - Eastside Wastewater Service Assessment
Alternative 2 - WPF at South Site

Net Present Worth

Capital Project Elements	1st Year Acquired or Installed	Life (Years)	2009 Cost ($)	2009 Cost ($)	2009 Year 0 1.00000	2010 Year 1 0.95238	2011 Year 2 0.90703	2012 Year 3 0.86384	2013 Year 4 0.82270	2014 Year 5 0.78353	2015 Year 6 0.74622	2016 Year 7 0.71068	2017 Year 8 0.67684	2018 Year 9 0.64461	2019 Year 10 0.61391	2020 Year 11 0.58468	2021 Year 12 0.55684	2022 Year 13 0.53032	2023 Year 14 0.50507	2024 Year 15 0.48102	2025 Year 16 0.45811	2026 Year 17 0.43630	2027 Year 18 0.41552	2028 Year 19 0.39573	2029 Year 20 0.37689	TOTAL PRESENT WORTH	REMAINING VALUE 0.37689	NET PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024
Eastside Interceptor Sewer	2009	50	$54,226,000	$54,226,000	$54,226,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$125,902,506		
Trunk Sewer from Existing Faraon Street Pump Station to Eastside Interceptor	2009	50	$1,160,000	$1,160,000	$1,160,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$2,693,300		
Trunk Sewer from Existing Easton Road Pump Station to Eastside Interceptor	2009	50	$8,979,000	$8,979,000	$8,979,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$20,847,538		
Trunk Sewer from Across River to Eastside Interceptor	2009	50	$9,937,000	$9,937,000	$9,937,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$23,071,833		
Southern Eastside Interceptor Sewer	2009	50	$38,196,000	$38,196,000	$38,196,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$88,683,881		
Trunk Sewer for Southern Flows	2009	50	$0	$0																									
New Eastside WPF																													
Phase I (4 mgd)																													
Structure	2009	50	$26,042,800	$26,042,800	$26,042,800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$60,466,451		
Equipment	2009	20	$5,710,783	$5,710,800	$5,710,800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$22,098,994		$22,098,994		
Phase II (additional 2 mgd)																													
Structure	2019	50	$4,318,400	$4,318,400	-	-	-	-	-	-	-	-	-	-	$8,494,946	-	-	-	-	-	-	-	-	-	-		$13,368,676		
Equipment	2019	20	$1,709,517	$1,709,500	-	-	-	-	-	-	-	-	-	-	$3,362,845	-	-	-	-	-	-	-	-	-	-		$3,307,645		
Flow Equalization Basin																													
Phase I (8 mgd)																													
Structure	2009	50	$12,600,000	$12,600,000	$12,600,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$29,254,815		
Equipment	2009	20	$1,400,000	$1,400,000	$1,400,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$5,417,558		$5,417,558		
Phase II (additional 4 mgd)																													
Structure	2019	50	$6,300,000	$6,300,000	-	-	-	-	-	-	-	-	-	-	$12,393,054	-	-	-	-	-	-	-	-	-	-		$19,503,210		
Equipment	2019	20	$700,000	$700,000	-	-	-	-	-	-	-	-	-	-	$1,377,006	-	-	-	-	-	-	-	-	-	-		$1,354,390		
Electrical, Instrumentation, and Controls	2009	20	$14,739,000	$14,739,000	$14,739,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$57,035,279		$57,035,279		
Land Acquisition	2009	10,000	$4,000,000	$4,000,000	$4,000,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$15,447,780		
Demolish Existing Pump Stations	2009		$175,000	$175,000	$175,000																								
Utilities	2009		$2,136,000	$2,136,000	$2,136,000																								
Sitework	2009		$7,416,000	$7,416,000	$7,416,000																								
General Requirements	2009		$23,490,000	$23,490,000	$23,490,000																								
Flood Protection/Fill	2009		$4,356,000	$4,356,000	$4,356,000																								
Site Remediation	2009		$0	$0	$0																								
Contingency	2009		$55,898,000	$55,898,000	$55,898,000																								
Construction Subtotal			$283,489,500	$283,489,500	$270,461,600	$0	$0	$0	$0	$0	$0	$0	$0	$0	$25,627,851	$0	$0	$0	$0	$0	$0	$0	$0	$0	$84,551,832				
Engineering, Legal, and Administration 20%	2009		$56,697,900	$56,697,900	$54,092,320	$0	$0	$0	$0	$0	$0	$0	$0	$0	$5,125,570	$0	$0	$0	$0	$0	$0	$0	$0	$0	$16,910,366				
Interest During Construction (yrs)		0																											
Opinion of Probable Project Cost			$340,190,000	$340,190,000	$324,550,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$30,753,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$101,462,000		$488,453,856		
Factored Totals					$324,550,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$18,880,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$38,240,000	$381,670,000	$184,093,121	**$197,576,879**	$15,900,000

O&M Elements	2009 Annual Cost ($)	2009 Year Cost ($)	2009 Year 0 1.00000	2010 Year 1 0.95238	2011 Year 2 0.90703	2012 Year 3 0.86384	2013 Year 4 0.82270	2014 Year 5 0.78353	2015 Year 6 0.74622	2016 Year 7 0.71068	2017 Year 8 0.67684	2018 Year 9 0.64461	2019 Year 10 0.61391	2020 Year 11 0.58468	2021 Year 12 0.55684	2022 Year 13 0.53032	2023 Year 14 0.50507	2024 Year 15 0.48102	2025 Year 16 0.45811	2026 Year 17 0.43630	2027 Year 18 0.41552	2028 Year 19 0.39573	2029 Year 20 0.37689	TOTAL PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024
Power	$317,000	$317,000		$332,850	$349,493	$366,967	$385,315	$404,581	$424,810	$446,051	$468,353	$491,771	$774,539	$813,266	$853,930	$896,626	$941,457	$988,530	$1,037,957	$1,089,855	$1,144,347	$1,201,565	$1,261,643		
Labor	$583,000	$583,000		$612,150	$642,758	$674,895	$708,640	$744,072	$781,276	$820,340	$861,357	$904,424	$1,424,468	$1,495,692	$1,570,476	$1,649,000	$1,731,450	$1,818,023	$1,908,924	$2,004,370	$2,104,589	$2,209,818	$2,320,309		
Maintenance & Spare Parts	$530,000	$530,000		$556,500	$584,325	$613,541	$644,218	$676,429	$710,251	$745,763	$783,051	$822,204	$1,294,971	$1,359,720	$1,427,706	$1,499,091	$1,574,046	$1,652,748	$1,735,385	$1,822,155	$1,913,262	$2,008,925	$2,109,372		
Chemicals	$39,000	$39,000		$40,950	$42,998	$45,147	$47,405	$49,775	$52,264	$54,877	$57,621	$60,502	$95,290	$100,055	$105,058	$110,310	$115,826	$121,617	$127,698	$134,083	$140,787	$147,827	$155,218		
Solids Hauling Costs	$17,000	$17,000		$17,850	$18,743	$19,680	$20,664	$21,697	$22,782	$23,921	$25,117	$26,373	$41,537	$43,614	$45,794	$48,084	$50,488	$53,013	$55,663	$58,446	$61,369	$64,437	$67,659		
Opinion of Probable O&M Cost	$1,486,000		-	$1,560,300	$1,638,315	$1,720,231	$1,806,242	$1,896,554	$1,991,382	$2,090,951	$2,195,499	$2,305,274	$3,630,806	$3,812,346	$4,002,964	$4,203,112	$4,413,268	$4,633,931	$4,865,627	$5,108,909	$5,364,354	$5,632,572	$5,914,201		
Factored Totals			$0	$1,486,000	$1,486,000	$1,486,000	$1,486,000	$1,486,000	$1,486,000	$1,486,000	$1,486,000	$1,486,000	$2,229,000	$2,229,000	$2,229,000	$2,229,000	$2,229,000	$2,229,000	$2,229,000	$2,229,000	$2,229,000	$2,229,000	$2,229,000	**$37,893,000**	$3,040,632

Economic Analysis Criteria:

Interest Rate =	5.00%
Capital Escalation Rate =	7.00%
O&M Escalation Rate =	5.00%
Baseline for costs =	May-09
ENR Building Cost Index =	4773

Net Present Worth = $235,470,000

St. Joseph, Missouri
TM-WW-2 - Eastside Wastewater Service Assessment
Alternative 3 - Eastside Pump Station at North Site

Net Present Worth

Capital Project Elements	1st Year Acquired or Installed	Life (Years)	2009 Cost ($)	2009 Cost ($)	2009 Year 0 1.00000	2010 Year 1 0.95238	2011 Year 2 0.90703	2012 Year 3 0.86384	2013 Year 4 0.82270	2014 Year 5 0.78353	2015 Year 6 0.74622	2016 Year 7 0.71068	2017 Year 8 0.67684	2018 Year 9 0.64461	2019 Year 10 0.61391	2020 Year 11 0.58468	2021 Year 12 0.55684	2022 Year 13 0.53032	2023 Year 14 0.50507	2024 Year 15 0.48102	2025 Year 16 0.45811	2026 Year 17 0.43630	2027 Year 18 0.41552	2028 Year 19 0.39573	2029 Year 20 0.37689	TOTAL PRESENT WORTH	REMAINING VALUE 0.37689	NET PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024
Eastside Interceptor Sewer	2009	50	$54,226,000	$54,226,000	$54,226,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$125,902,506		
Trunk Sewer from Existing Faraon Street Pump Station to Eastside Interceptor	2009	50	$1,160,000	$1,160,000	$1,160,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$2,693,300		
Trunk Sewer from Existing Easton Road Pump Station to Eastside Interceptor	2009	50	$8,979,000	$8,979,000	$8,979,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$20,847,538		
Trunk Sewer from Across River to Eastside Interceptor	2009	50	$9,937,000	$9,937,000	$9,937,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$23,071,833		
Southern Package Pump Station																													
Structure	2009	50	$280,000	$280,000	$280,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$650,107		
Equipment	2009	20	$51,000	$51,000	$51,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$197,354		$197,354		
Force main and/or Trunk Sewer for Southern Flows	2009	50	$1,832,500	$1,832,500	$1,832,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$4,254,718		
Flow Equalization Basin																													
Phase I (11 mgd)																													
Structure	2009	50	$15,180,000	$15,180,000	$15,180,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$35,245,086		
Equipment	2009	20	$1,687,000	$1,687,000	$1,687,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$6,528,158		$6,528,158		
Phase II (additional 5 mgd)																													
Structure	2019	50	$7,590,000	$7,590,000	-	-	-	-	-	-	-	-	-	-	$14,930,679	-	-	-	-	-	-	-	-	-	-		$23,496,724		
Equipment	2019	20	$843,000	$843,000	-	-	-	-	-	-	-	-	-	-	$1,658,309	-	-	-	-	-	-	-	-	-	-		$1,631,072		
New Eastside and Flow Equalization Pump Station																													
Phase I (16 mgd)																													
Structure	2009	50	$5,644,000	$5,644,000	$5,644,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$13,104,299		
Equipment	2009	20	$2,813,400	$2,813,400	$2,813,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$10,886,970		$10,886,970		
Phase II (8 mgd)																													
Structure	2019	50	$0	$0																									
Equipment	2019	20	$525,000	$525,000	-	-	-	-	-	-	-	-	-	-	$1,032,754	-	-	-	-	-	-	-	-	-	-		$1,015,792		
Force Main from Eastside Pump Station	2009	50	$7,956,000	$7,956,000	$7,956,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$18,472,326		
Electrical, Instrumentation, and Controls	2009	20	$8,697,000	$8,697,000	$8,697,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$33,654,646		$33,654,646		
Land Acquisition	2009	10,000	$4,000,000	$4,000,000	$4,000,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		$15,447,780		
Demolish Existing Pump Stations	2009		$175,000	$175,000	$175,000																								
Utilities	2009		$1,436,000	$1,436,000	$1,436,000																								
Sitework	2009		$4,351,000	$4,351,000	$4,351,000																								
General Requirements	2009		$16,004,000	$16,004,000	$16,004,000																								
Flood Protection/Fill	2009		$359,000	$359,000	$359,000																								
Site Remediation	2009		$0	$0	$0																								
Contingency	2009		$37,432,000	$37,432,000	$37,432,000																								
Construction Subtotal			$191,157,900	$191,157,900	$182,199,900	$0	$0	$0	$0	$0	$0	$0	$0	$0	$17,621,742	$0	$0	$0	$0	$0	$0	$0	$0	$0	$51,267,128				
Engineering, Legal, and Administration 20%	2009		$38,231,580	$38,231,580	$36,439,980	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,524,348	$0	$0	$0	$0	$0	$0	$0	$0	$0	$10,253,426				
Interest During Construction (yrs)		0																											
Opinion of Probable Project Cost			$229,390,000	$229,390,000	$218,640,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$21,146,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$61,521,000		$337,100,210		
Factored Totals					$218,640,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$12,982,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$23,187,000	$254,809,000	$127,049,524	**$127,759,476**	$10,300,000

O&M Elements	2009 Annual Cost ($)	2009 Year Cost ($)	2009 Year 0 1.00000	2010 Year 1 0.95238	2011 Year 2 0.90703	2012 Year 3 0.86384	2013 Year 4 0.82270	2014 Year 5 0.78353	2015 Year 6 0.74622	2016 Year 7 0.71068	2017 Year 8 0.67684	2018 Year 9 0.64461	2019 Year 10 0.61391	2020 Year 11 0.58468	2021 Year 12 0.55684	2022 Year 13 0.53032	2023 Year 14 0.50507	2024 Year 15 0.48102	2025 Year 16 0.45811	2026 Year 17 0.43630	2027 Year 18 0.41552	2028 Year 19 0.39573	2029 Year 20 0.37689	TOTAL PRESENT WORTH	EQUIVALENT ANNUAL COST 0.08024
Power	$423,000	$423,000		$444,150	$466,358	$489,675	$514,159	$539,867	$566,860	$595,203	$624,964	$656,212	$1,033,534	$1,085,210	$1,139,471	$1,196,444	$1,256,267	$1,319,080	$1,385,034	$1,454,286	$1,527,000	$1,603,350	$1,683,517		
Labor	$11,000	$11,000		$11,550	$12,128	$12,734	$13,371	$14,039	$14,741	$15,478	$16,252	$17,065	$26,877	$28,221	$29,632	$31,113	$32,669	$34,302	$36,017	$37,818	$39,709	$41,695	$43,779		
Maintenance & Spare Parts	$353,000	$353,000		$370,650	$389,183	$408,642	$429,074	$450,527	$473,054	$496,706	$521,542	$547,619	$862,500	$905,625	$950,906	$998,451	$1,048,374	$1,100,792	$1,155,832	$1,213,624	$1,274,305	$1,338,020	$1,404,921		
Chemicals	$299,000	$299,000		$313,950	$329,648	$346,130	$363,436	$381,608	$400,689	$420,723	$441,759	$463,847	$730,559	$767,087	$805,442	$845,714	$887,999	$932,399	$979,019	$1,027,970	$1,079,369	$1,133,337	$1,190,004		
Solids Hauling Costs	$0	$0		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Opinion of Probable O&M Cost	$1,086,000		-	$1,140,300	$1,197,315	$1,257,181	$1,320,040	$1,386,042	$1,455,344	$1,528,111	$1,604,517	$1,684,742	$2,653,469	$2,786,143	$2,925,450	$3,071,722	$3,225,309	$3,386,574	$3,555,903	$3,733,698	$3,920,383	$4,116,402	$4,322,222		
Factored Totals			$0	$1,086,000	$1,086,000	$1,086,000	$1,086,000	$1,086,000	$1,086,000	$1,086,000	$1,086,000	$1,086,000	$1,629,000	$1,629,000	$1,629,000	$1,629,000	$1,629,000	$1,629,000	$1,629,000	$1,629,000	$1,629,000	$1,629,000	$1,629,000	**$27,693,000**	$2,222,158

Economic Analysis Criteria:

Interest Rate =	5.00%
Capital Escalation Rate =	7.00%
O&M Escalation Rate =	5.00%
Baseline for costs =	May-09
ENR Building Cost Index =	4773

Net Present Worth = $155,452,000

Appendix D

Triple Bottom Line Analysis
Back-up Information

Threatened and Endangered Species Correspondence

BLACK & VEATCH
Building a **world** of difference.

City of St. Joseph, Missouri
Facilities Plan

B&V Project 163509.0320
B&V File F-1.6
August 12, 2009

Mr. Charlie Scott
Field Supervisor
Department of the Interior
U.S. Fish and Wildlife Service
101 Park DeVille Drive, Suite A
Columbia, Missouri 65203-0057

Subject: Threatened and Endangered Species

Dear Mr. Scott:

Black & Veatch has been retained by the City of St. Joseph to study the potential of constructing a new wastewater treatment facility to serve the eastern portion of the City. As part of the feasibility analysis, Black & Veatch will be conducting a preliminary evaluation of siting alternatives for the potential facility. The site evaluation criteria include consideration of economic, social, and environmental impacts.

The enclosed figure provides a study area map with the preliminary site alternatives indicated in red. Please review the preliminary siting alternatives for known or potential occurrences of state and/or federally protected plants and animals and their habitats. Comments can be mailed to my attention at the letterhead address. If possible, I would like to receive your comments by September 11, 2009. If you have any questions regarding the project or this request, please do not hesitate to contact me at (913) 458-3814 or burksps@bv.com.

Very truly yours,

BLACK & VEATCH CORPORATION

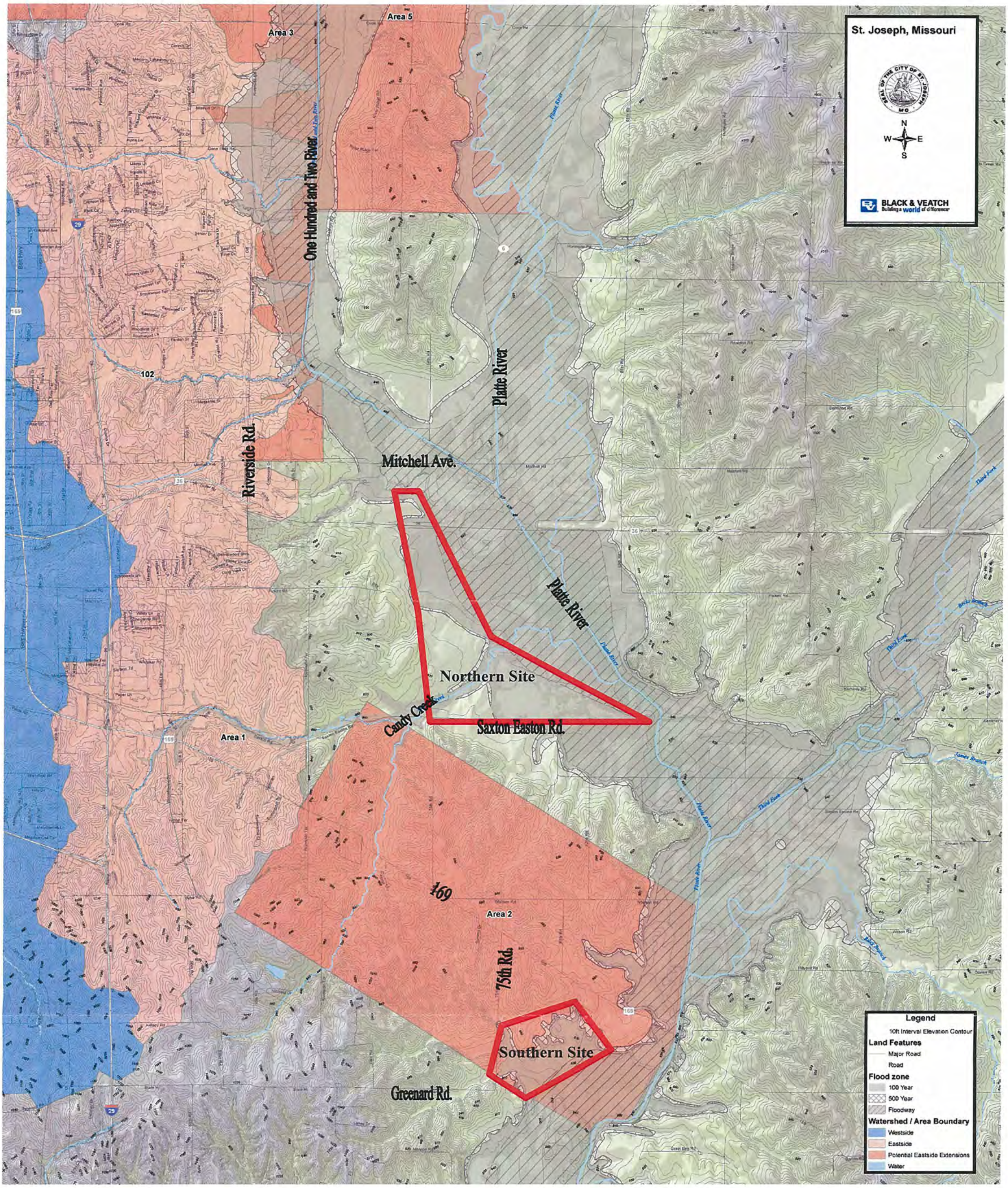
Page S. Burks

Page S. Burks
Project Engineer

psb
Enclosure

Cc: Mr. Andy Clements, City of St. Joseph
Mr. Matt Schultze, Black & Veatch
Ms. Dianne Honomichl, Black & Veatch

St. Joseph, Missouri
Potential Eastside Water Protection Facility
Site Alternatives



BLACK & VEATCH
Building a **world** of difference.

City of St. Joseph, Missouri
Facilities Plan

B&V Project 163509.0320
B&V File F-1.6
August 12, 2009

Mr. Shannon Cave
Missouri Department of Conservation
Public Involvement Coordinator
P.O. Box 180
Jefferson City, Missouri 65102

Subject: Threatened and Endangered Species

Dear Mr. Cave:

Black & Veatch has been retained by the City of St. Joseph to study the potential of constructing a new wastewater treatment facility to serve the eastern portion of the City. As part of the feasibility analysis, Black & Veatch will be conducting a preliminary evaluation of siting alternatives for the potential facility. The site evaluation criteria include consideration of economic, social, and environmental impacts.

The enclosed figure provides a study area map with the preliminary site alternatives indicated in red. Please review the preliminary siting alternatives for known or potential occurrences of state and/or federally protected plants and animals and their habitats. Comments can be mailed to my attention at the letterhead address. If possible, I would like to receive your comments by September 11, 2009. If you have any questions regarding the project or this request, please do not hesitate to contact me at (913) 458-3814 or burksps@bv.com.

Very truly yours,

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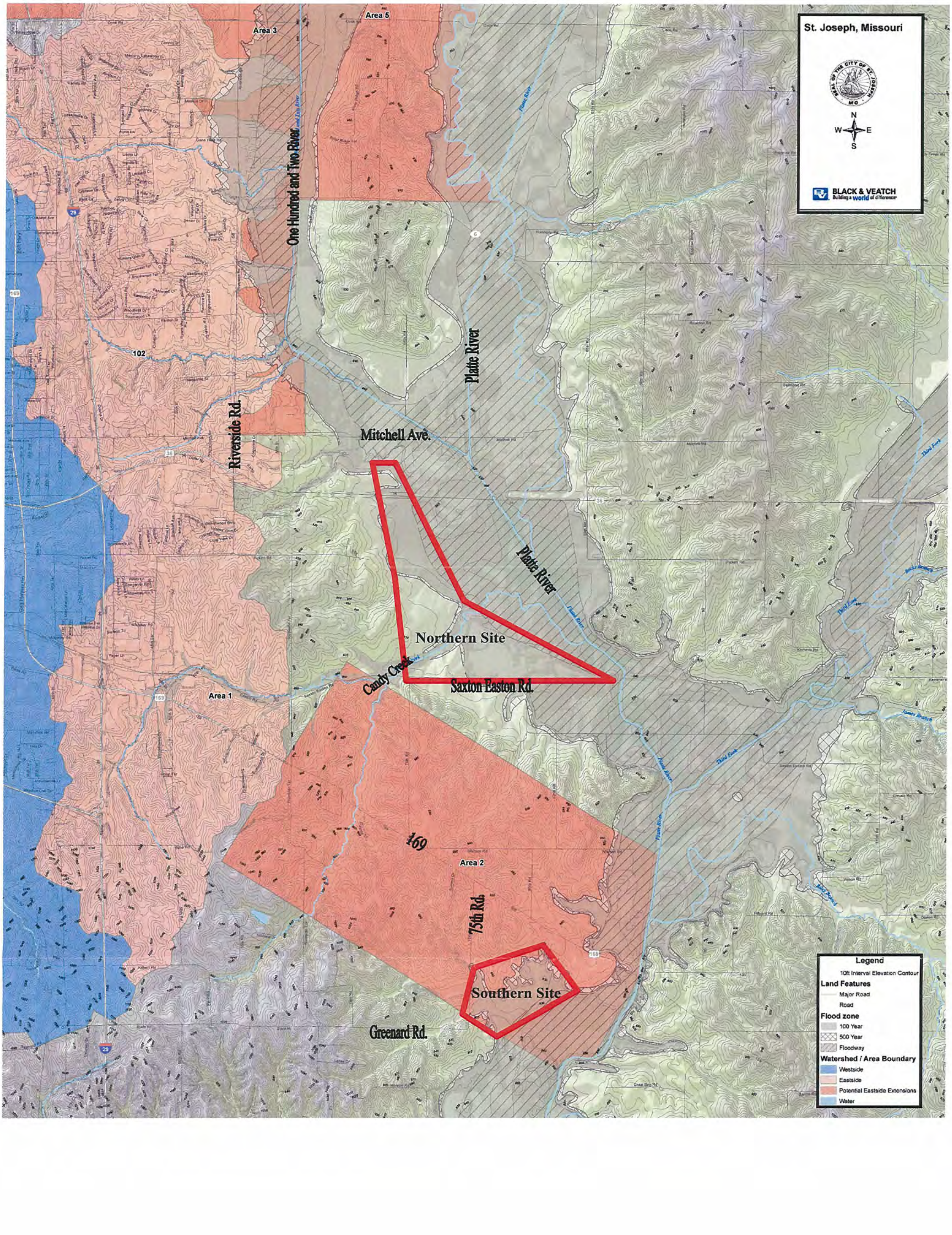
Project Engineer

psb
Enclosure

Cc: Mr. Andy Clements, City of St. Joseph
Mr. Matt Schultze, Black & Veatch
Ms. Dianne Honomichl, Black & Veatch

St. Joseph, Missouri
Potential Eastside Water Protection Facility
Site Alternatives



To: Burks, Page S.
Subject: RE: St. Joseph wastewater/ species list

From: Hilary_Shaw@fws.gov [mailto:Hilary_Shaw@fws.gov]
Sent: Thursday, August 27, 2009 1:02 PM
To: Burks, Page S.
Subject: St. Joseph wastewater/ species list

Ms. Burks:

We have no records of federally-listed threatened or endangered species or critical habitat present at the specific project site.

If you have not already done so, please contact the Missouri Department of Conservation (Policy Coordination Section, P.O. Box 180, Jefferson City, Missouri 65102-0180) for information concerning Missouri Species of Conservation Concern.

Hilary Shaw
Education & Outreach Specialist
Columbia Ecological Services
US Fish and Wildlife Service
573-234-2132 ext 174

Policy Coordination Unit
P. O. Box 180
Jefferson City, MO 65102
Prepared by: Shannon Cave
shannon.cave@mdc.mo.gov
573-522-4115X3250

Missouri Department of Conservation

Heritage Review Report

August 18, 2009; page 1 of 2

Page S. Burks, Project Engineer
Black & Veatch Corporation
8400 Ward Parkway
Kansas City, MO 64114

Project type:	Wastewater Treatment Facility
Location/Scope:	City of St. Joseph
County:	Buchanan
Query reference:	B & B Project 163509.0320, B & V File F-1.6
Query received:	August 17, 2009

Aug 18, 2009

This NATURAL HERITAGE REVIEW is not a site clearance letter. Rather, it indicates whether or not public lands and sensitive resources are known to be located close to and potentially affected by the proposed project.

FEDERAL LIST species/habitats are protected under the Federal Endangered Species Act. ***Consult with the U.S. Fish and Wildlife Service*** *(101 Park Deville Drive Suite A, Columbia, Missouri 65203-0007; 573-234-2132). STATE ENDANGERED species are listed in and protected under the Wildlife Code of Missouri (3CSR10-4.111).*

Records of federal-listed or state-listed (endangered) species or critical habitats near the project site:

Heritage records identify no wildlife preserves, no designated wilderness areas or critical habitats, no state or federal endangered-list species records, and no records of species or habitats tracked due to their rarity (but not listed as endangered) within the indicated boundaries. The same applies to Public Land Survey Sections 3, 4, 5, 8, 9, 10, 15, 16, and 17 of T56N R34W; and Section 16-21 and 27-30 of T57N R34W

The project should be managed to minimize erosion and sedimentation/runoff to nearby streams and lakes, including adherence to any "Clean Water Permit" conditions. Revegetate areas in which the natural cover is disturbed to minimize erosion using native plant species compatible with the local landscape and wildlife needs.

Heritage records were identified at some date and at a more or less precise location. This report includes information about records near but not necessarily on the project site. Animals move and, over time, so do plant communities. To say "there is a record" does not mean the species/habitat is still there. To say that "there is no record" does not mean the project will not encounter something not recorded. On-site verification is the responsibility of the project. Incorporating information from Heritage records into plans can help reduce adverse impacts to sensitive natural resources. However, these records only provide one reference and other information (e.g. wetland or soils maps, on-site inspections or surveys) should be considered. Compare biological and habitat needs of records listed to planned project activities to avoid or minimize impacts. More information may be found at www.mdc.mo.gov/nathis/endangered/ and mdc4.mdc.mo.gov/applications/mofwis/mofwis_search1.aspx. Find contact information on the department's nearest Natural History Biologist at http://www.mdc.mo.gov/nathis/contacts/.

Recommendations related to this project or site (not to specific heritage records):

- The proposed project occurs in the historic range of greater prairie chickens (*tympanuchus cupido*), a bird on the state's list of endangered species. Populations have been in serious decline for decades, and have reached a point where greater prairie chickens could be gone from Missouri within a few years. The dominant factor in their decline is conversion of native prairie habitats to other uses. Other prairie dependent species are also in serious decline for the same reason. Prairie chickens range over a broad territory perhaps nesting, breeding and foraging in grasslands several miles apart. Even if prairie chickens are not present, it is important to conserve as much as possible any grasslands dominated by native plant cover in the project area. See http://mdc.mo.gov/130 for best management recommendations.
- Streams in the area should be protected from soil erosion, water pollution and in-stream activities that modify or diminish aquatic

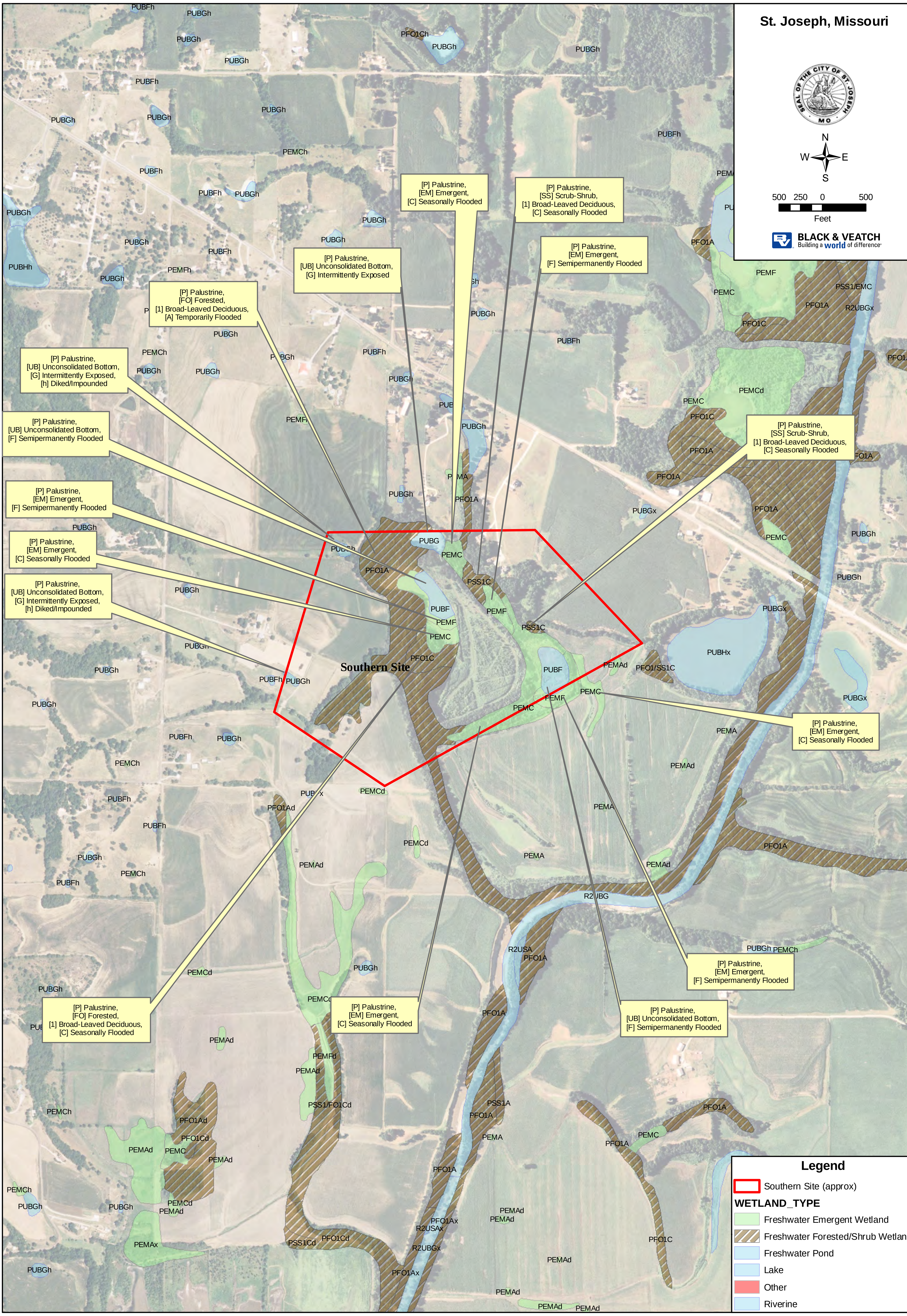
habitats. Best management recommendations relating to streams and rivers may be found at http://mdc.mo.gov/79.

- Invasive exotic species are a significant issue for fish, wildlife and agriculture in Missouri. Seeds, eggs, and larvae may be moved to new sites on boats or construction equipment, so inspect and clean equipment thoroughly before moving between project sites. Especially important at this time is the zebra mussel, known in the Missouri and Mississippi Rivers and Lake of the Ozarks, but missing from many inland streams and most lakes.
  - Remove any mud, soil, trash, plants or animals before leaving any water body or work area.
  - Before leaving a project site, drain water from boats and machinery (that has operated in the water), checking motor cavities, live-well, bilge and transom wells, tracks, buckets, and any other water reservoirs.
  - When possible, wash and rinse equipment thoroughly with hard spray or HOT (104° F or more) water, like that found at a do-it-yourself carwash and dry in the hot sun before using again.

These recommendations are ones project managers might prudently consider based on a general understanding of species needs and landscape conditions. Heritage records largely reflect only sites visited by specialists in the last 30 years. This means that many privately owned tracts could host unknown remnants of species once but no longer common.

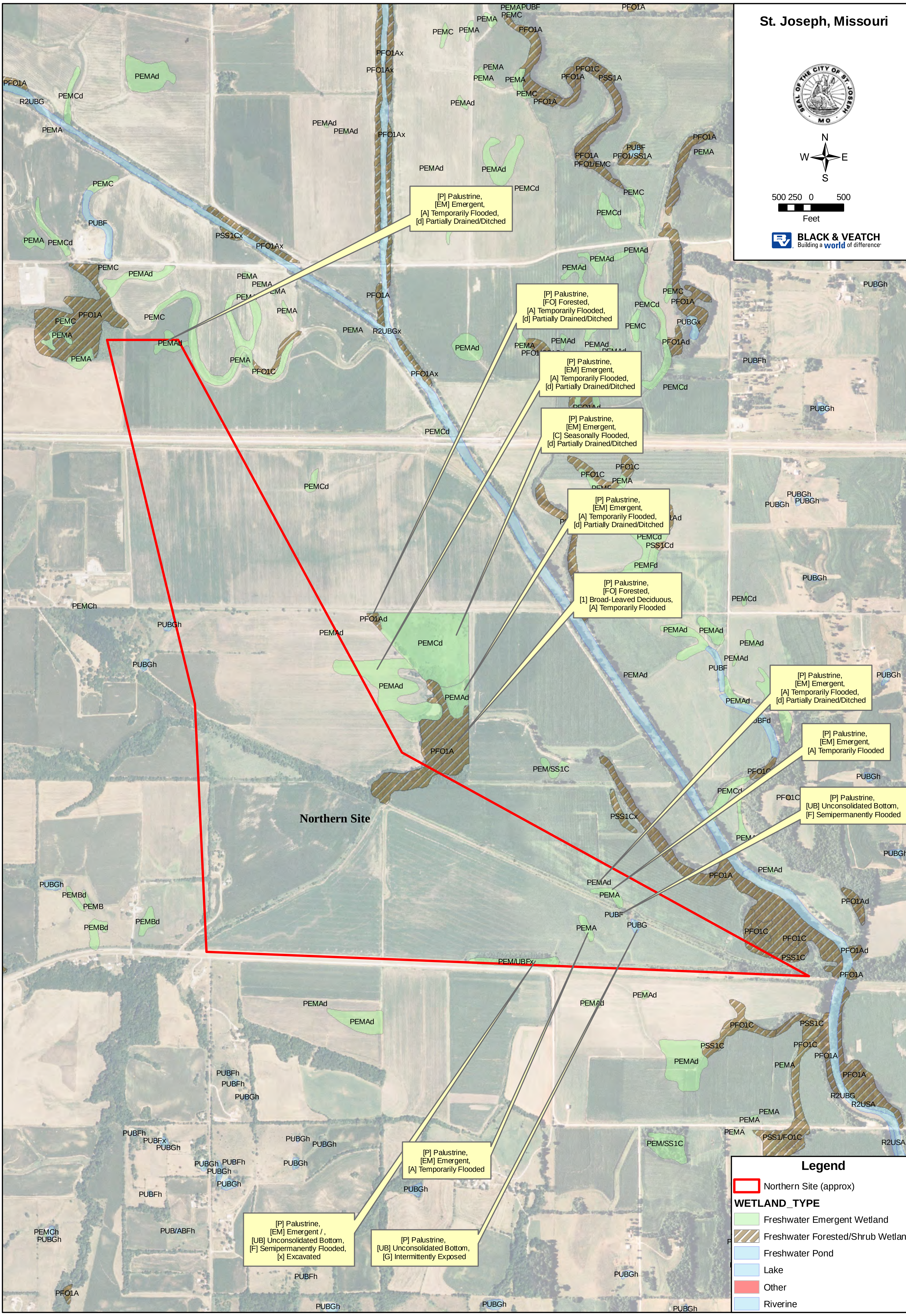
Project managers can pre-screen heritage review requests at http://mdcgis.mdc.mo.gov/heritage/newheritage/heritage.htm. A "Level 1 response" will result in a printable document that will make further submission to MDC or USFWS unnecessary.

Wetlands Locations



STUDY AREA SHOWING USFWS-NWI MAPPING OF EMERGENT WETLANDS, SCRUB/SHRUB & FORESTED WETLANDS

Figure 1

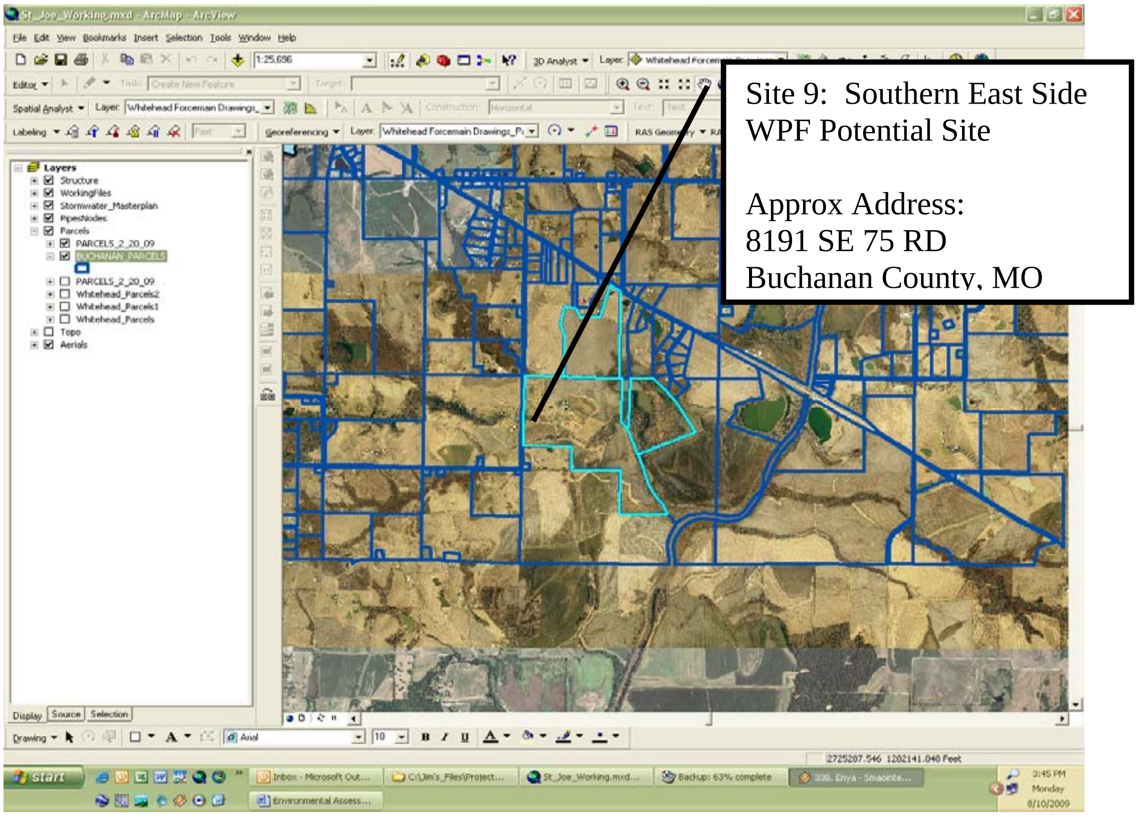


STUDY AREA SHOWING USFWS-NWI MAPPING OF EMERGENT WETLANDS, SCRUB/SHRUB & FORESTED WETLANDS

Figure 2

Environmental Data Resources Reports

Site 9
EDR Report: Inquiry number 2596742.1s, 9/21/2009



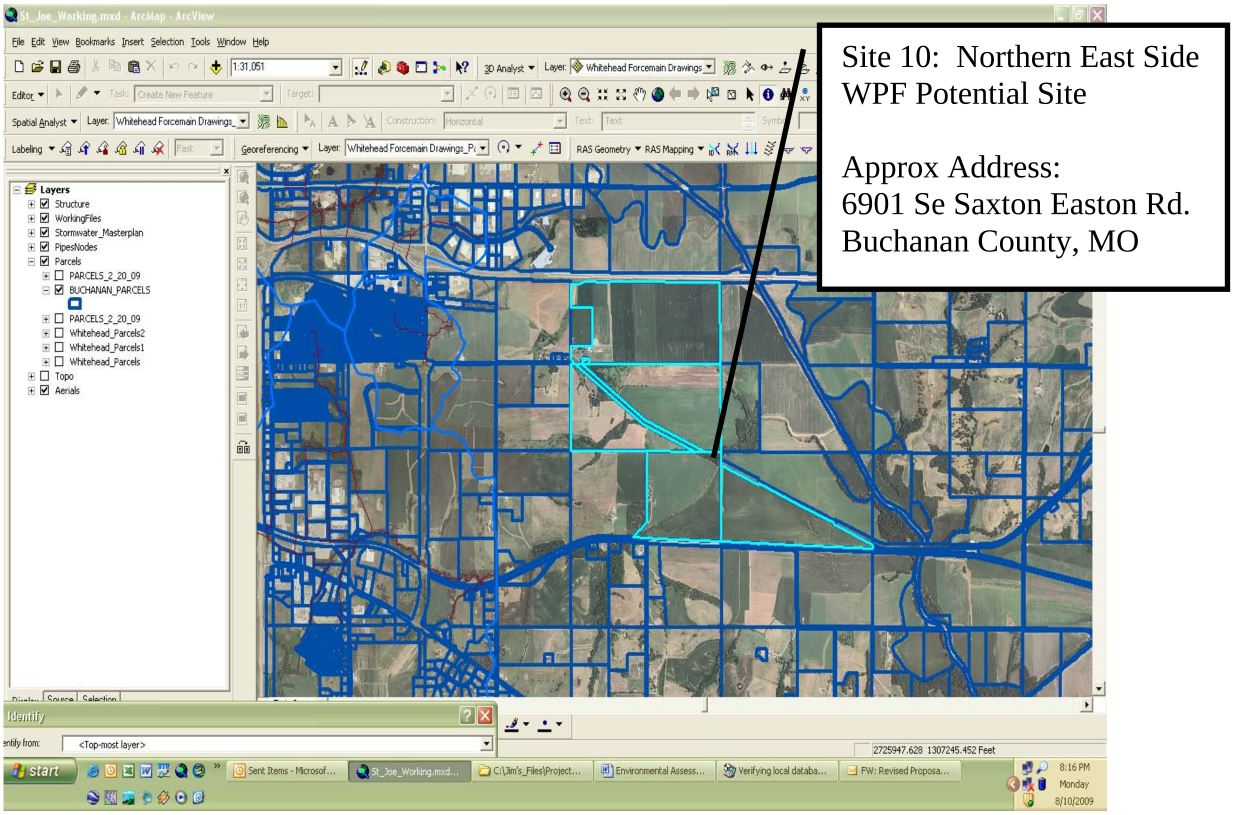
The target property was not listed in any of the environmental databases searched by EDR. In addition, no properties within a 1-mile radius of the target property site boundaries were identified in the databases searched.

The report compiled by EDR identified 40 “orphan" sites for which inadequate information was available to determine the location with respect to the target property. The names of these sites and the database(s) in which they appear are presented in the EDR report.

No environmental/restrictive covenants or environmental liens were identified as being on the target property based on the information obtained through EDR.

Based on a review of the EDR report, no evidence was found that would indicate soil or groundwater contamination above the State of Missouri target levels is present on the property.

Site 10
EDR Report: Inquiry number 2596742.2s, 9/21/2009



The target property was not listed in any of the environmental databases searched by EDR. In addition, no properties within a 1-mile radius of the target property site boundaries were identified in the databases searched.

The report compiled by EDR identified 43 “orphan" sites for which inadequate information was available to determine the location with respect to the target property. The names of these sites and the database(s) in which they appear are presented in the EDR report.

No environmental/restrictive covenants or environmental liens were identified as being on the target property based on the information obtained through EDR.

Based on a review of the EDR report, no evidence was found that would indicate soil or groundwater contamination above the State of Missouri target levels is present on the property.