City of St. Joseph, Missouri

Facilities Plan

Technical Memorandum No. TM-WW-1

Existing Conveyance and Water Protection Facility Assessment

By

Work Order No. 09-001
B&V Project 163509

June 4, 2010

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Existing Conveyance and Water Protection Facility Assessment

1.0 Executive Summary

The City of St. Joseph is serviced by one Water Protection Facility (WPF) located in the southern portion of the City. The wastewater conveyance system contains a combined sewer system on the west and a separated system on the east. This technical memorandum provides an assessment of the existing WPF and associated conveyance system and will provide the basis for evaluating treatment facilities and conveyance systems for the remainder of the Wastewater Facilities Plan. An overview of the existing conveyance system and WPF is provided herein. The study area and existing conveyance system are shown in Figure 1 (following page 4).

This memorandum provides an analysis of historical WPF flow and load data for all flows entering the WPF including flows to the WPF headworks as well as dedicated industrial flows. Table ES-1 provides a summary of historical annual average influent flows and loads for the WPF.

Table ES-1
Historical WPF Annual Average Influent Flows and Loads by Source

Parameter	WPF Headworks	SSJISD	National Beef Leathers	Triumph Foods
Flow, mgd	15	2	1	2
Total Suspended Solids, ppd	38,342	3,439	568	1,262
Biochemical Oxygen Demand, ppd	28,434	10,491	215	2,561
Ammonia Nitrogen, ppd	-- [1]	568	4,726	1,772

1. The symbol "--" indicates data not available.

A projection of future flows and loads from the existing service area was prepared based on a 20-year planning period with Year 2030 established as the planning year. Traffic analysis zone (TAZ) population data provided by the City as well as discussions with City staff were used to project populations within the service area over the 20-year planning period as shown in Table ES-2. Table ES-3 summarizes projected flows and loads to the WPF in Year 2030 based on the population projections for the existing service area.

Table ES-2
Population Projections for 2010 and 2030

Service Area	Population	
	2010	2030
Westside	63,900	66,700
Eastside	13,400	17,400
Total	*77,300*	*84,100*

Table ES-3
Projected 2030 WPF Annual Average Influent Flows and Loads by Source

Parameter	WPF Headworks	SSJISD	National Beef Leathers	Triumph Foods
Flow, mgd	15.6	1.9	1.0	1.9
Total Suspended Solids, ppd	25,000	3,400	600	1,300
Biochemical Oxygen Demand, ppd	25,000	11,000	200	2,600
Ammonia Nitrogen, ppd [1]	2,500	600	2,400 [2]	1,800
TKN Nitrogen, ppd [1]	3,000	-- [3]	--	--
Phosphorous, ppd [1]	400	--	--	--

1. Loadings estimated by multiplying the per capita loadings presented in Table 14 by the 2030 population projections given in Table ES-2.
2. Projected ammonia nitrogen loading for National Beef Leathers assumes a 50% reduction from historical loadings based on the implementation of a CO_2 system currently in progress.
3. The symbol "--" indicates data cannot be determined at this time.

Based on this analysis, it appears the existing capacity of the WPF can process the projected 2030 annual average flows as the permitted design flow is 27 mgd; however, process upgrades will be required to meet future regulatory requirements, such as the need for disinfection, ammonia removal, and phosphorus removal.

A capacity assessment of major process units indicates that portions of the WPF could potentially treat additional flow if bottlenecks, such as hydraulic restrictions at the grit basins, were removed. In addition, a preliminary assessment of the effluent hydraulic profile was conducted. This analysis suggests an effluent pump station will likely be necessary to meet the Missouri Department of Natural Resources' (MDNR) requirement that the WPF remain fully operational under conditions of the 25-year flood as additional process units, such as disinfection, are added to the WPF. The fact that temporary pumping of the WPF effluent is currently required to send effluent to the river during 100-year flood events offers further support that the facility's hydraulic profile is already constrained. Further investigation of the effluent pump station is included in Technical Memorandum (TM) TM-WW-7 – Hydraulic Analysis and Effluent Pump Station. The goal of any required effluent pumping improvements will be to minimize costs by relying on gravity flow whenever possible.

TM-WW-2 – Eastside Wastewater Service Assessment develops flow projections for the existing Eastside service area as well as City-identified service area extensions. TM-WW-2 also provides recommendations for potential dedicated Eastside infrastructure, including treatment and conveyance improvements.

2.0 Purpose of Study

The purpose of this memorandum is to document work performed under Phase 300 – Existing Conveyance and Treatment Plant Assessment of the Scope of Services. This memorandum documents Black & Veatch's assessment of existing facilities and conditions at the WPF and the associated conveyance system. The assessment will provide the basis for evaluating treatment facilities and conveyance improvements to meet the City's future needs. The objectives of this assessment include:

- Describe existing conveyance and treatment facilities within the service area, including capacity and condition.
- Identify potential hydraulic WPF bottlenecks for future investigation.
- Collect and evaluate existing flow and load data to the WPF.
- Utilize City furnished population and historical flow and load data to project future flows and loads at the existing WPF for a 20-year planning horizon.

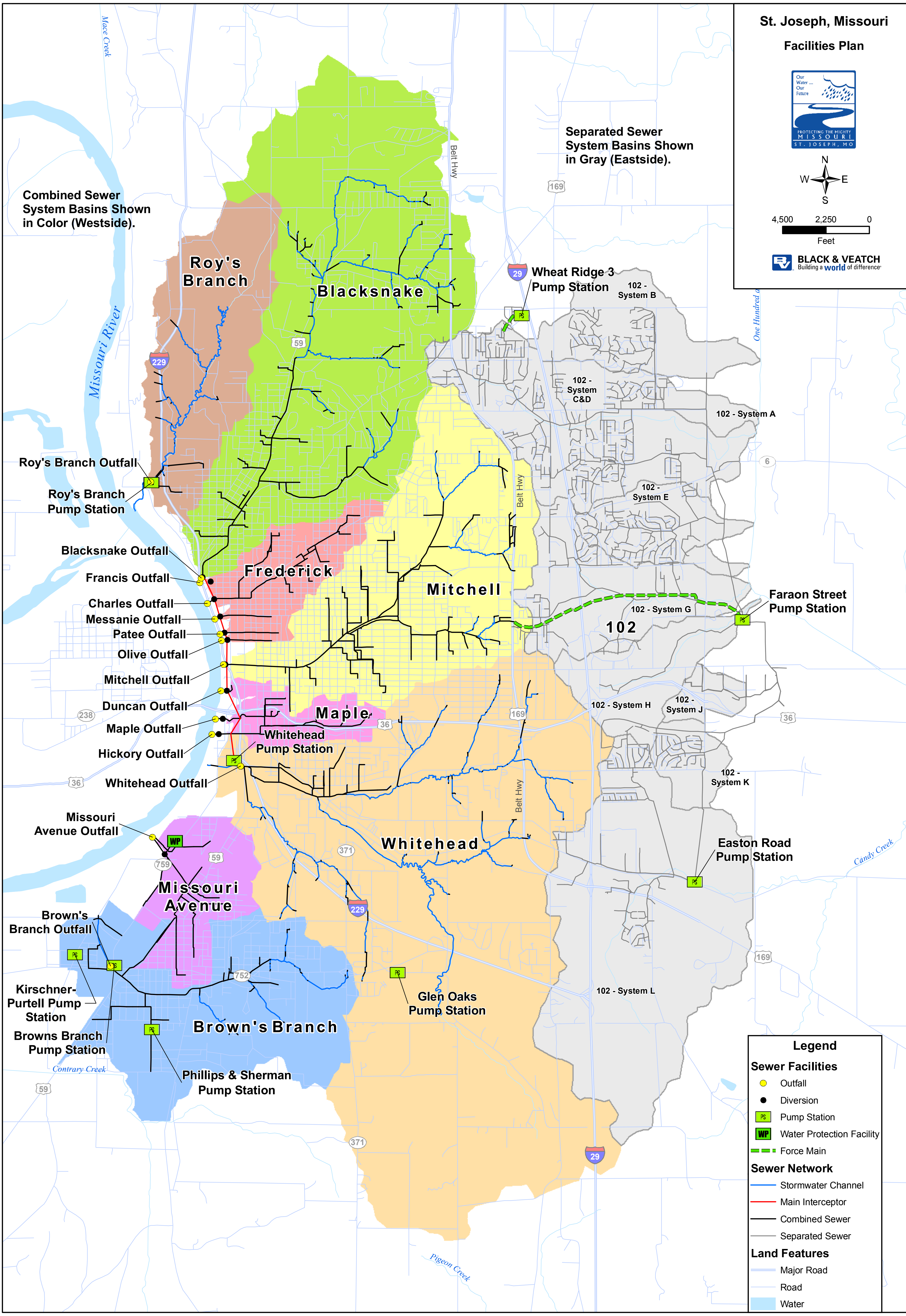
As part of this assessment, existing reports, process data, planned improvements, and staff interviews were utilized to collect baseline information to identify areas for potential process improvements or upgrades. The sizes of the existing process units were reviewed against code and references to establish treatment capacities of the existing liquid and solids treatment facilities. Subsequent technical memoranda within the Facilities Plan will present improvements to address wet weather, ammonia removal, and disinfection to meet future regulatory requirements. Hydraulic issues within the WPF were identified in order to determine future areas for study when considering the feasibility of facility improvements. Future wastewater flows to the WPF were projected based on historical data and anticipated future growth. This memorandum serves as the technical basis for the remainder of the wastewater facilities assessment tasks.

3.0 Overview of Existing Wastewater Conveyance System

The wastewater conveyance system within St. Joseph contains both combined and separated systems with the Belt Highway nominally serving as the divider between the two sewer systems. The following sections discuss the western and eastern portions of the collection system. Figure 1 provides an overview of the study area and conveyance system.

3.1 Western Conveyance System

The combined sewer portion of the system (colored areas on Figure 1) is primarily located in the western part of the City and drains naturally to the Missouri River. The western service area occupies approximately 23,200 acres and contains nearly 300 miles of sewers. Three Smith & Loveless package pump stations (Glen Oaks, Phillips & Sherman, and Kirschner-Purtell) pump localized flow to the larger pump stations as depicted in Figure 1. Table 1 summarizes the characteristics of the Westside pump stations.



STUDY AREA & EXISTING CONVEYANCE SYSTEM

Figure 1

Table 1
Summary of Westside Pump Stations

Pump Station	Installed Capacity, mgd	Firm Capacity, mgd	Number of Pumps	Emergency Back-up Power?
Whitehead [1]	57.60	45.00	5	No
Brown's Branch [2]	6.55	4.32	2	No
In-plant Influent [3]	9.00	6.19	3	No
Glen Oaks [4]	0.44	0.22	2	Yes
Phillips & Sherman [4]	0.28	0.14	2	No
Kirschner-Purtell [4]	0.58	0.29	2	Yes

1. Whitehead pump capacities based on the following assumptions: water level at grit basins = 818.5, wetwell elevation = 783.2, C-Value = 100. A pump test has not been performed to refine these assumptions. Firm capacity assumes 2 pumps on the 42 inch force main and 1 pump on the 36 inch force main are in service.
2. Brown's Branch pump capacities based on the following assumptions: gravity sewer elevation = 815, wetwell elevation = 799, C-Value = 100. A pump test has not been performed to refine these assumptions.
3. In-plant Influent pump capacities based on the following assumptions: water level at grit basins = 818.5, wetwell elevation = 791.1, C-Value = 100. A pump test has not been performed to refine these assumptions. Firm capacity assumes 1 of the largest (3,000 gpm) pumps out of service.
4. Installed capacity not verified for package pump stations.

Flow into the combined sewer system consists of sanitary sewage, stormwater, and stream flow from Blacksnake Creek and Whitehead Creek. A main sewer interceptor, ranging in diameter from 3 to 4.5 feet, runs from north to south along the Missouri River. The main interceptor collects combined flows generated in Roy's Branch, Blacksnake, Frederick, Mitchell, Maple, and Whitehead Basins at 12 various diversion structures along the main interceptor as shown in Figure 1. During dry weather conditions, flow from the northern and eastern portions of the City is conveyed through the main interceptor to the Whitehead Pump Station, which then pumps flows to the WPF located at the southern end of the City through 36 and 42 inch force mains. The firm capacity of the Whitehead Pump Station is 45.0 million gallons per day (mgd).

The Whitehead Pump Station has two pumps dedicated to the 36 inch force main and three pumps dedicated to the 42 inch force main, with no ability for cross-connection. During an on-site visit with WPF staff, it was indicated that the 42 inch force main is typically employed, with the 36 inch main serving as a back-up. When pump station modifications were made in the late 1970s, City staff was told that the power supply limited the number of pumps that could be run at any given time. Therefore, City staff has never operated more than three pumps simultaneously. The electrical limitations of the Whitehead Pump Station were investigated and are documented in detail within TM-CSO-9 – Whitehead Pump Station Improvements. Based on this investigation, it appears that the pump station could operate four pumps simultaneously.

During wet weather events, the combined sewer system can receive flow rates that exceed the capacity of the conveyance system, the pumping capacity of the Whitehead Pump Station, and the treatment capacity of the WPF. Under these circumstances, WPF staff operating strategy is to maximize pumping to the effective operational limit of the WPF. The remaining flow is discharged as combined sewer overflow (CSO) through diversion structures to the Missouri River. These CSOs and methods to reduce CSO volumes are presented in greater detail in Volume 1 of the Facilities Plan – CSO Control Facilities Assessment.

The main interceptor sewer was designed in 1960 to deliver a peak flow of 45 mgd to the Whitehead Pump Station. As a part of the CSO Long Term Control Plan 2008 Update, the capacity of the main interceptor was reviewed. A review indicated that the main interceptor, when surcharged, can convey 80 mgd to the Whitehead Pump Station. As the firm capacity of the Whitehead Pump Station is limited to 45.0 mgd, the main interceptor is able to convey more flow to the pump station than can be pumped to or received by the WPF.

Combined sewage from the southern portion of St. Joseph is pumped from the Brown's Branch Pump Station to a gravity sewer upstream of the Missouri Avenue Diversion Structure and then flows by gravity to the In-plant Influent Pump Station for treatment at the WPF. The Brown's Branch Pump Station has two pumps for an installed capacity of 6.55 mgd. With only one pump running, the station's firm capacity is 4.32 mgd; space for the addition of a third pump is available. During wet weather conditions, combined sewage in excess of the Brown's Branch Pump Station capacity is discharged through the Brown's Branch Diversion Structure to the Missouri River.

3.2 Eastern Conveyance System

The conveyance system for the eastern portion of the City consists of separated sewers (gray area on Figure 1). Flows in this region naturally drain to the One Hundred and Two River. The eastern service area consists of the 9,000 acre 102 River Watershed and contains nearly 100 miles of sewers. A network of three pump stations collects the flow within the Eastside sewer system and sends it through a system of force main and gravity sewer lines to the Faraon Street Pump Station. One package Smith & Loveless pump station, Wheatridge 3, serves the residential area in the northern portion of the 102 River Watershed as indicated on Figure 1.

The Easton Road Pump Station pumps flows from the southern portion of the 102 River Watershed over the ridge to allow flow by gravity for the remainder of the distance to the Faraon Street Pump Station. The Easton Road Pump Station has two 1.44 mgd pumps, providing a firm pumping capacity of 1.44 mgd. The City is budgeting for a near-term project to increase pump station capacity and/or shave peaks during wet weather events at the Easton Road Pump Station.

The Faraon Street Pump Station pumps all flows from the 102 River Watershed over the ridge into the Missouri River Watershed. Pumped flow is conveyed through the Mitchell Basin to the main interceptor via the Mitchell CSO Diversion Structure as shown on Figure 1. The interceptor carries the flow to the Whitehead Pump Station, which pumps to the existing WPF as previously described. The Faraon Street Pump Station contains three pairs of pumps, each operating in series. The firm capacity of the pump station (with two pairs of pumps in operation) is 6.91 mgd. Table 2 summarizes the characteristics of the Eastside pump stations.

Table 2
Summary of Eastside Pump Stations

Pump Station	Installed Capacity, mgd	Firm Capacity, mgd	Number of Pumps	Emergency Back-up Power?
Faraon Street [1]	8.06	6.91	6 (3 pairs each in series)	Yes
Easton Road [2]	2.88	1.44	2	Yes
Wheatridge 3 [3]	0.24	0.12	2	No

1. Faraon Street pump capacities based on the following assumptions: discharge elevation = 1005, wetwell elevation = 814, C-Value = 100. A pump test has not been performed to refine these assumptions.
2. Easton Road installed capacity not verified with both pumps running as changes to impellers and reroute of force main have occurred. No field verification was performed on this station.
3. Installed capacity not verified for package pump station.

4.0 Overview of Existing Water Protection Facility

The City of St. Joseph is serviced by one WPF, located northwest of the intersection of Lower Lake Road and Stockyards Expressway in southern St. Joseph. The WPF is located in close proximity to its receiving stream, the Missouri River. The land use surrounding the WPF is primarily industrial. Figure 2 provides an aerial view of the WPF.

4.1 Historical Water Protection Facility Development

The original WPF, constructed in 1965 at the present site, consisted of aerated grit basins and primary clarifiers. Solids removed from the primary basins were stabilized by anaerobic digestion and dewatered on drying beds before disposal.

In conjunction with the construction of the original WPF, the collection system was upgraded to intercept and direct sanitary wastewater to the new primary treatment facility. Previously, all wastewater was discharged untreated to the Missouri River. The Whitehead, Brown’s Branch, and In-plant Influent Pump Stations were constructed during the same period to convey wastewater to the WPF.

In 1978, the WPF was expanded and upgraded by the addition of a primary clarifier and full secondary treatment. The secondary facilities consisted of three redwood media roughing trickling filters (now converted to plastic media), three complete mix activated sludge aeration basins, and three secondary clarifiers.

300' 150' 0 300' 600'

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AERIAL VIEW OF WATER PROTECTION FACILITY

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FIGURE 2

BFIGBORD
FBFIGBORD

CYGNET ID: 163509-1000-WWTUP-C-N00017B4Q

Sludge processing facilities included dissolved air flotation (DAF) for thickening secondary sludge. Vacuum filters were originally installed for dewatering secondary sludge; however these have since been converted to the DAF units. Thickened primary and secondary solids are further stabilized using anaerobic digesters.

Ancillary facilities were also constructed. These included an intermediate pump station, return sludge pump stations, utility water pump station, and chemical precipitation basins.

In 1978, the Faraon Street Pump Station and associated force main were constructed to transport the wastewater flow generated in the eastern portion of the City to the WPF. The pump station remains at its original firm capacity of nearly 7 mgd.

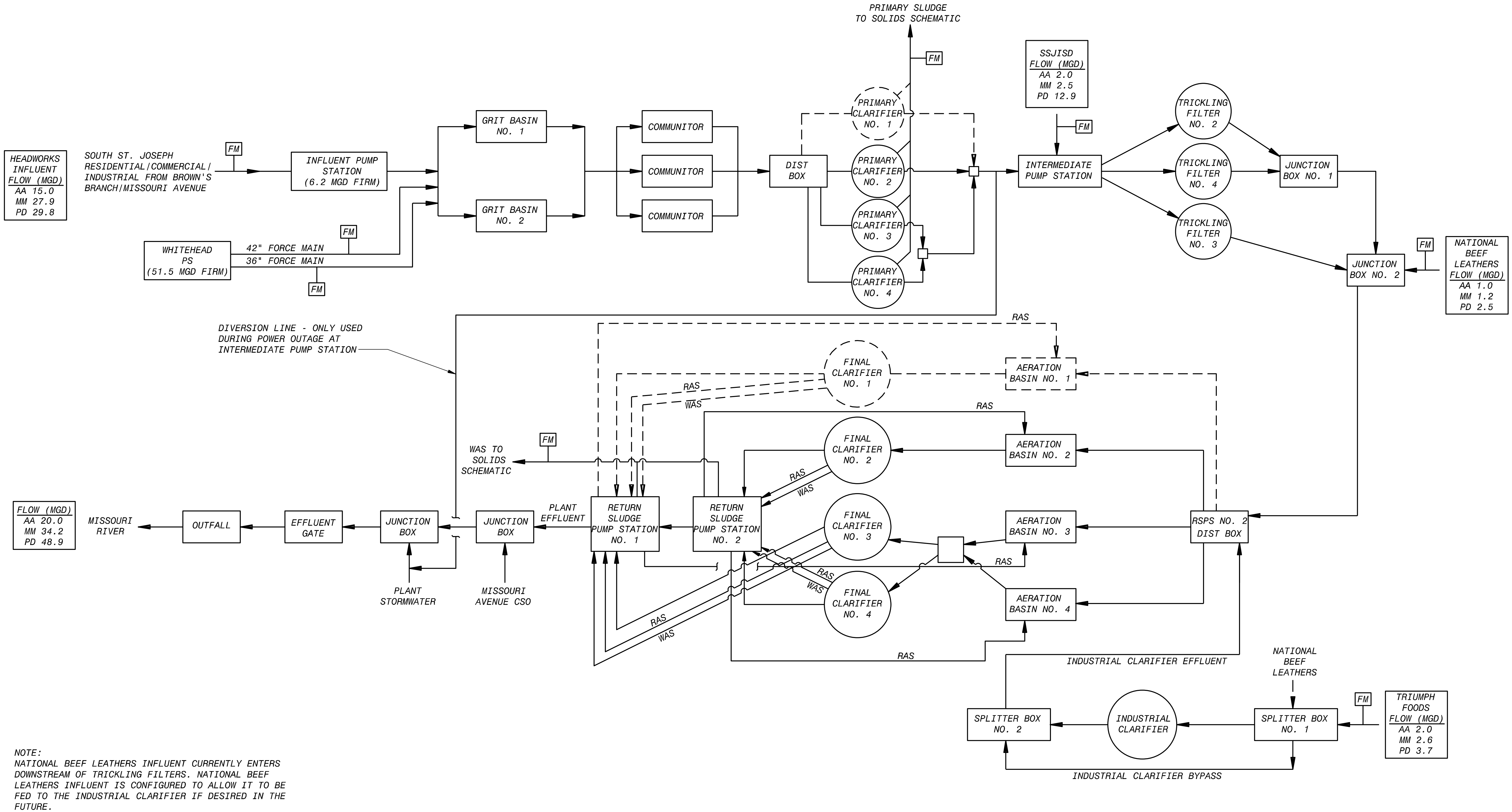
An expansion in 2007 at the WPF included the addition of an industrial primary clarifier to receive direct flows from industrial sources. A thermophilic digester and associated blend/surge tank were also constructed at this time.

4.2 Water Protection Facility Description

The latest issued National Pollutant Discharge Elimination System (NPDES) permit (effective date of June 19, 2009) for the WPF indicates that the permitted design flow is 27 mgd.

4.2.1 Liquid Treatment Facilities

Figure 3 provides a schematic of the liquid treatment system. Influent flow enters the WPF at several different locations in the treatment process. The majority of the flow enters the headworks of the WPF and consists of residential, commercial, industrial, and wet weather flows. The headworks receives flow from the Whitehead Pump Station and the In-plant Influent Pump Station. As previously presented in this technical memorandum, flows from the Whitehead Pump Station normally enter the WPF through the 42 inch force main; the 36 inch force main is only utilized in emergencies. The remainder of the flow to the WPF headworks is pumped by the In-plant Influent Pump Station through an 18 inch force main (pump station capacity described in Table 1). In addition, the WPF processes dedicated industrial flows from Triumph Foods, National Beef Leathers (formerly Prime Tanning), and the South St. Joseph Industrial Sewer District (SSJISD). Flows from these



NOTE:
NATIONAL BEEF LEATHERS INFLUENT CURRENTLY ENTERS DOWNSTREAM OF TRICKLING FILTERS. NATIONAL BEEF LEATHERS INFLUENT IS CONFIGURED TO ALLOW IT TO BE FED TO THE INDUSTRIAL CLARIFIER IF DESIRED IN THE FUTURE.

LEGEND

———— EXISTING

– – – – POTENTIAL FUTURE

ST. JOSEPH WASTEWATER FACILITIES PLAN

EXISTING LIQUID SCHEMATIC WATER PROTECTION FACILITY

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FIGURE 3

wholesale industrial customers enter the WPF at various locations downstream of the primary clarifiers as shown on Figure 3.

All flow entering the WPF headworks passes through an inlet channel and splits into two influent channels, each leading to an aerated grit basin (two basins total), where the grit/inorganics settle from the wastewater and the organics are kept in suspension by aeration. The inorganics that settle in the grit basin are moved across the basin floor to a sump by a grit screw.

Wastewater from the grit basins exits over a weir into a common channel. The channel divides into three channels leading to the communitors that grind any solid materials to allow the flow to pass through the downstream processes. The wastewater is then recombined and flows to the primary clarifier flow splitter.

The primary clarifier flow splitter proportions the flow equally to three primary clarifiers; space and tie-ins are provided to serve a potential future fourth primary clarifier. Although currently only used during a power outage at the Intermediate Pump Station (IPS), a line tying primary clarifier effluent to the WPF effluent exists, allowing flow to divert around the secondary treatment portion of the facility.

The primary clarifiers are circular concrete structures equipped with mechanical collection equipment. The solids that settle in the clarifiers are moved by the collection equipment to a central sludge hopper for removal and further treatment as presented in the following section on solids treatment facilities. Scum that floats on the surface of the clarifier is collected and removed at a scum box.

In 2007, an industrial clarifier was constructed in the location previously reserved for the potential addition of a fourth trickling filter. Currently, pretreated flow from Triumph Foods is the only wastewater stream fed to the industrial clarifier. Flow from National Beef Leathers may also be directed to the industrial clarifier if needed. Wastewater from the SSJISD may be piped to the industrial clarifier, but feed rates cannot be monitored with the current piping configuration. Sludge from the industrial clarifier is pumped by the Industrial Sludge Pump Station to the solids treatment facilities presented in the following section.

Effluent from the primary clarifiers flows to the wetwell of the IPS and is lifted to a box on the top of the trickling filters (adjacent to the IPS) where it is combined with pretreated flow from the SSJISD Pump Station. The combined waste streams flow to the trickling filter distribution box where flow is equally proportioned to each of the three trickling (roughing) filters.

The trickling filters are circular structures that contain a deep bed of plastic media modules. Flow entering the filters drives rotating distributor arms, propelling the arms, and distributing the wastewater to continuously dose the plastic media. The combination of ample air, moisture, and food promotes the growth of a microbial film on the media, which removes some of the soluble organics from the wastewater as it trickles through the layers of media.

Trickling filter effluent is combined with pretreated flow from National Beef Leathers and effluent from the industrial clarifier. This stream is conveyed to the aeration basin distribution box where it is combined with return activated sludge from the final clarifiers and equally proportioned to three aeration basins. In the aeration basins, the combined flow is vigorously mixed by diffused air and the microorganisms in the liquid remove both soluble and suspended organics to reduce the biochemical oxygen demand (BOD). Space and tie-ins for a potential fourth aeration basin have been provided; however, the space provided for the potential fourth aeration basin is less than that utilized for each of the three existing basins.

Flow from each of the aeration basins is typically sent to a dedicated final clarifier; however flows from Aeration Basin Nos. 3 and 4 may be sent to either Final Clarifier Nos. 3 or 4. Each final clarifier is a circular structure equipped with mechanical collection equipment consisting of rapid uptake sludge collection pipes. Space and tie-ins for a potential fourth clarifier have been provided.

The effluent from the final clarifiers is combined and discharged through a 60 inch final clarifier effluent line. This line enters a junction box where it is combined, during wet weather events, with flow from the Missouri Avenue CSO into the 96 inch WPF outfall line. Prior to crossing the river levy through an effluent gate structure, the 96 inch outfall is intercepted with the WPF stormwater line; this combined flow discharges to the Missouri River via the WPF outfall.

4.2.2 Solids Treatment Facilities

A schematic of the solids treatment system at the WPF is depicted on Figure 4. Waste activated sludge (WAS) is pumped from the final clarifiers to the aerobic digesters by the Return Sludge Pump Stations. The aerobic digesters are not utilized for digestion. Instead, they are simply aerated flow-through basins. From the aerobic digesters, the WAS is pumped to one or more of three DAF units for thickening. The thickened waste activated sludge (TWAS) is then pumped to the TWAS holding tank for flow equalization.

Sludge and scum collected in the primary clarifiers is pumped by the Primary Sludge Pump Stations to the blending/surge tank where they are combined with TWAS. The combined sludge is then fed to the main thermophilic digester (135° F) where microorganisms in the digester, utilizing the organic constituents of the sludge and scum as food, anaerobically digest the sludge to a reduced quantity of stabilized material.

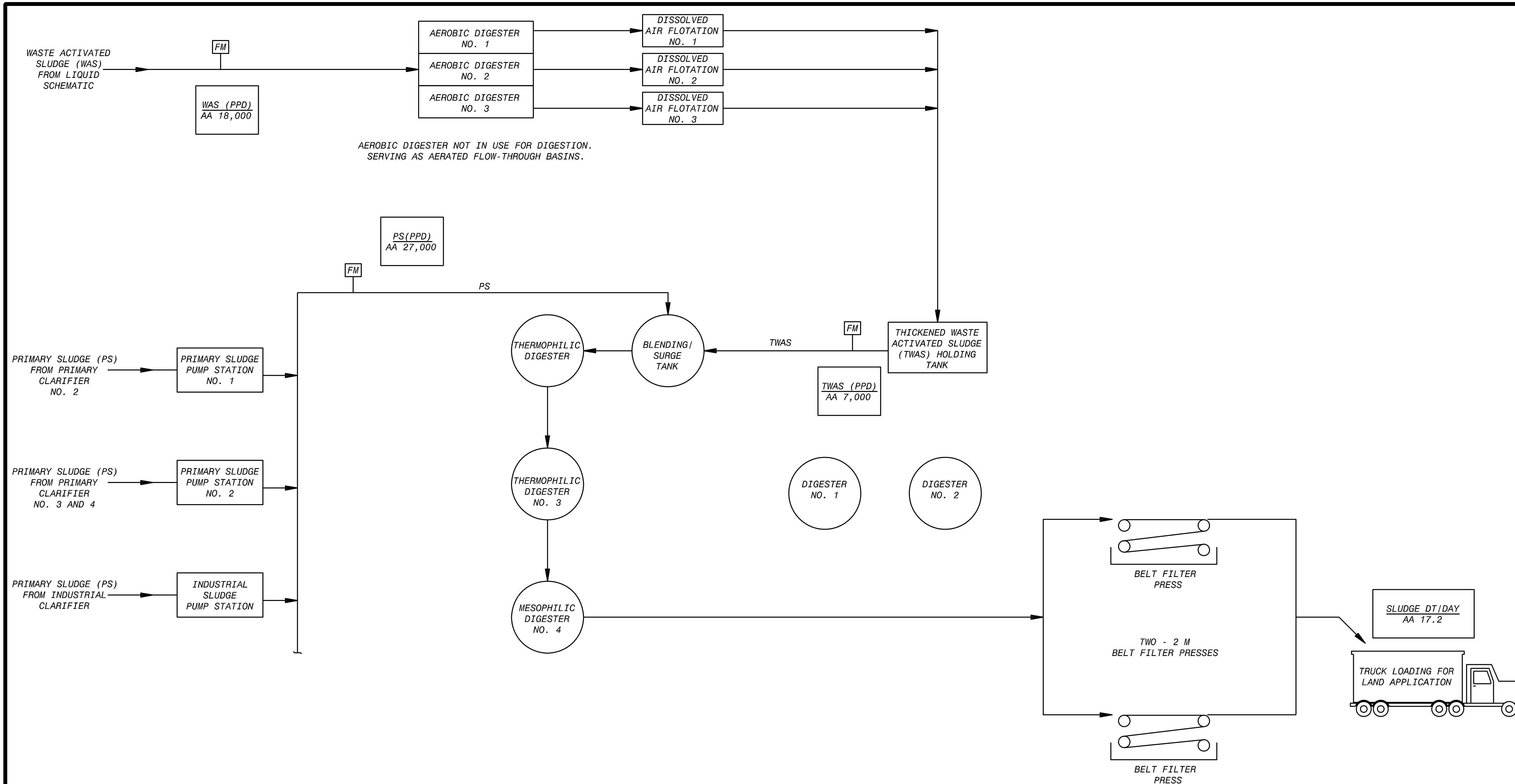
The sludge is then pumped to Thermophilic Digester No. 3 where the sludge is further digested at approximately 122° F. The sludge stream is then pumped to Mesophilic Disgester No. 4 where it resides at approximately 110° F. Digester Nos. 1 and 2 are currently out of service. The digested sludge is pumped from the mesophilic digester to two 2 meter belt filter presses for dewatering. The dewatered sludge is loaded by conveyors onto trucks for land application on agricultural land surrounding the Rosecrans Memorial Airport.

Aside from the space reserved within the WPF boundary for the potential future units described above, the open space contiguous to the WPF for expansion is limited.

4.3 Water Protection Facility Capacity Assessment

MDNR has developed design guidelines for treatment process units. These guidelines were published on February 28, 1999 as “Rules of Department of Natural Resources, Division 20 – Clean Water Commission, Chapter 8 – Design Guides, 10 CSR 20.” These guidelines provide a basis for setting the capacity of treatment process units.

The major unit processes at the WPF were reviewed against the MDNR guidelines, where applicable. For unit processes not specifically covered by the MDNR guidance, other references for design guidelines, such as the Water Environment



LEGEND

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FIGURE 4

BFIGBORDBW
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Federation's (WEF) Manual of Practice 8 (MOP 8), were consulted. Table 3 summarizes the results of this capacity review for each of the major process treatment units at the WPF. These treatment guidelines, while not the only gauge of compliance, serve as indicators upon which MDNR judges the capacity of the facility. Variance from the guidelines presented would require the City to provide a satisfactory basis of how the permit requirements could be met under the deviating operating conditions. Therefore, Table 3 provides a good starting point for assessing the treatment capacity of the WPF's major process units.

Table 3
Rated Process Unit Capacities

Treatment Unit	Description (Quantity – Nominal Operating Dimensions) [1]	Basis	Annual Average Design Criteria (Source)	Annual Average Design Capacity	Peak Design Criteria (Source)	Peak Design Capacity
Grit Basins	2 – 30 ft x 30 ft x 13 ft SWD	-- [2]	6 minutes residence time (B&V Engineering Manual)	84 mgd [3]	3 minutes residence time (B&V Engineering Manual)	128 mgd [3]
Primary Clarifiers	3 – 120 ft dia x 8 ft SWD	Total surface area: 33,930 sq ft	Surface overflow rate: [4] 1,000 gpd /sq ft (10 CSR 20-8.160(4)(B)(1))	33.9 mgd	Peak hourly surface overflow rate: 1,500 gpd/sq ft (10 CSR 20-8(4)(B)(1))	50.9 mgd
Industrial Clarifier	1 – 100 ft dia x 8 ft SWD	Total surface area: 7,850 sq ft	Surface overflow rate: 1,000 gpd /sq ft (10 CSR 20-8(4)(B)(1))	7.9 mgd	Peak hourly surface overflow rate: 1,500 gpd /sq ft (10 CSR 20-8(4)(B)(1))	11.8 mgd
Trickling Filters [5]	3 – 101.5 ft dia x 20.8 ft SWD	Total surface area: 24,270 sq ft	Wetting rate plus recycle operating range: 1.0 – 3.0 gpm/sq ft 34.9 – 104.8 mgd (WEF MOP 8 – Figure 12.2, p. 12-18)			
		Total volume: 505 kcf	BOD loading rate operating range: 100 - 300 ppd/kcf 50,500 – 151,000 ppd BOD (WEF MOP 8 – Table 12.1, p. 12-9)			

Table 3
Rated Process Unit Capacities

Treatment Unit	Description (Quantity – Nominal Operating Dimensions) [1]	Basis	Annual Average Design Criteria (Source)	Annual Average Design Capacity	Peak Design Criteria (Source)	Peak Design Capacity
Aeration Basins [5]	3 – 200 ft x 50 ft x 17 ft SWD	Total volume: 510 kcf	BOD loading rate: 40 ppd/kcf (10 CSR 20-8.180(4)(C)(1))	20,400 ppd BOD	--	--
			F/M Ratio – 0.2 – 0.5 lb BOD/ lb MLVSS/day (10 CSR 20-8.180(4)(C)(1))	--	--	--
			MLSS: 3,000 mg/L in aeration basin (10 CSR 20-8.180(4)(C)(1))	--	--	--
Final Clarifiers	3 – 160 ft dia x 15 ft SWD	Total surface area: 60,300 sq ft	Surface overflow rate: 600 gpd/sq ft (based on ½ of peak hour rate)	36.2 mgd	Peak hourly surface overflow rate: 1,200 gpd /sq ft (10 CSR 20-8(4)(3))	72.4 mgd
			--	--	Peak flow solids loading rate: 50 ppd/sq ft (10 CSR 20-8(4)(3))	3,000,000 ppd
Anaerobic Digesters	4 – 85 ft dia x 27.4 ft SWD	Total volume: 622 kcf (4 operating)	Volatile solids loading rate: 80 ppd VSS/kcf (10 CSR 20-8)	49,800 ppd VSS	--	--
		--	Volatile solids destruction: 38%	--	--	--
Main Thermophilic Digester	1 – 95 ft dia x 34 ft SWD	Total volume: 241 kcf	Volatile solids loading rate: 80 ppd/kcf (10 CSR 20-8)	19,300 ppd VSS	--	--
Aerobic Digester	6 cells – 166 ft x 50 ft x 16.75 ft SWD	Not currently in service as aerobic digester; used as a WAS surge tank				
TWAS Holding	20 ft x 18 ft x 7.25 ft SWD	--	--	--	--	--

Table 3
Rated Process Unit Capacities

Treatment Unit	Description (Quantity – Nominal Operating Dimensions) [1]	Basis	Annual Average Design Criteria (Source)	Annual Average Design Capacity	Peak Design Criteria (Source)	Peak Design Capacity
Dissolved Air Flotation Thickener	3 – 80 ft x 21 ft x 10 ft SWD	Total surface area: 5,040 sq ft	0.42 to 0.5 pph for WAS with polymer (B&V Engineering Manual 150.10)	2,000 – 2,500 pph	--	--
Belt Filter Press	2 – 2 meter presses	--	2,350 lb dry solids per hr, each Minimum cake dry solids: 25% (Equipment Specifications)	20,000 lb dry solids/ calendar day (based on 32 hrs operation/ week)	--	--
Biosolids Holding Pad	Used for storage only – not for drying					

1. Depth given is side water depth (SWD).
2. The symbol "--" indicates data not available or not applicable.
3. Hydraulics currently limit the capacity of the aerated grit basins. Based on City staff experience, SWD in the influent channels and basins limits the capacity of the grit basins to 27 mgd.
4. Primary clarifiers were designed for 800 gpd/sq ft surface overflow rate (resulting in a 27 mgd annual average design capacity).
5. Ratings given for carbonaceous removal only.

Hydraulics currently limit the capacity of the aerated grit basins. Based on Staff experience, side water depth in the influent channels and basins limits the capacity of the grit basins to 27 mgd. It can be seen from Table 3 that portions of the WPF may be able to provide treatment capacity beyond the current permitting and operational limits. Previous evaluation and modeling efforts of the existing WPF system verify the capacity limits as determined by the MDNR guidelines, suggesting that portions of the WPF could potentially treat additional flow. A dynamic process model of the WPF is being developed and calibrated to determine how peak flows impact facility performance. Once calibrated, this model will serve as a tool to investigate the impacts of proposed new unit processes to guide process decisions throughout the development of the remainder of the Wastewater Facilities Plan.

4.4 Review of Existing Hydraulics

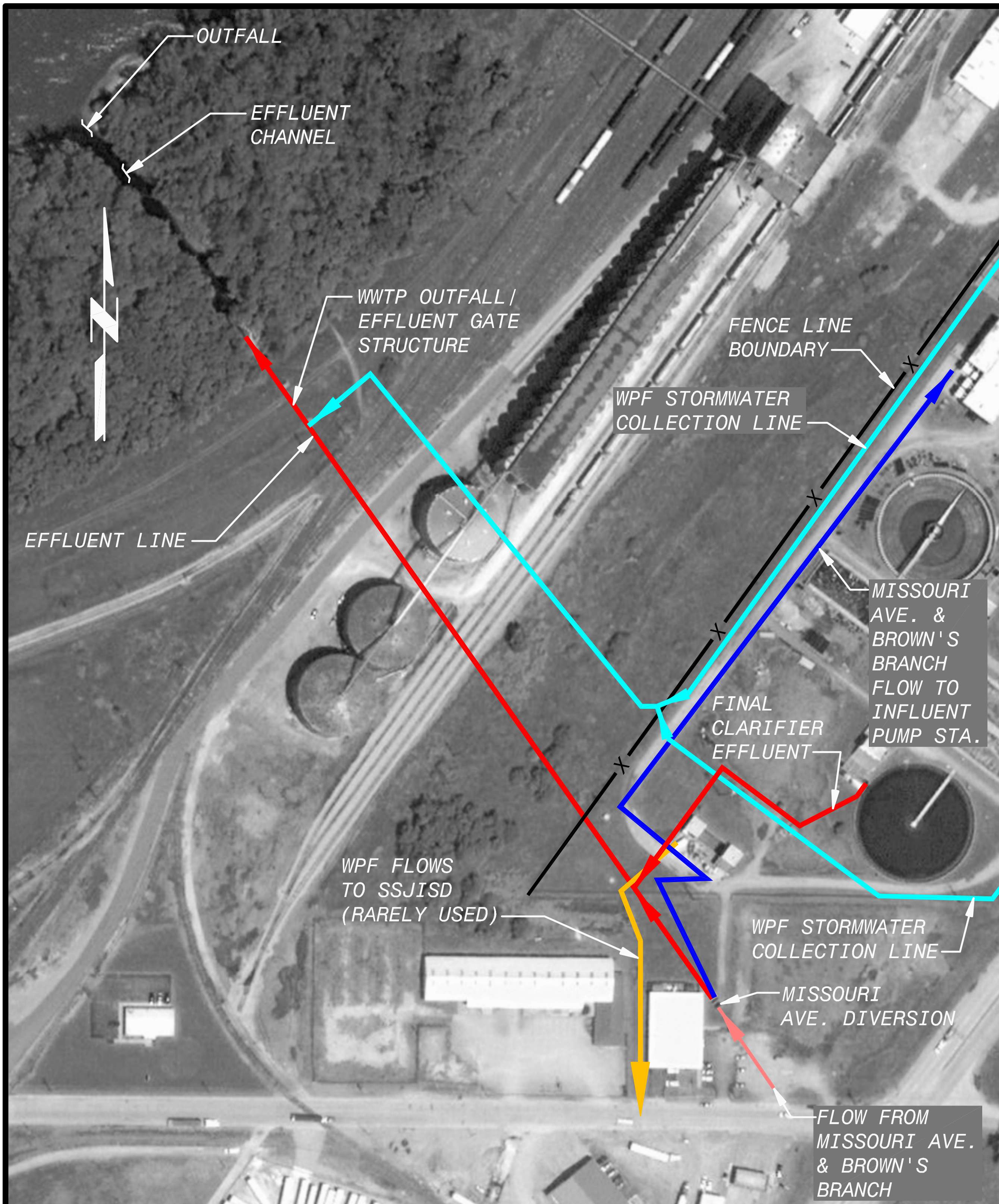
The existing WPF hydraulics will be an important issue going forward in the development of the Wastewater Facilities Plan. Several potential hydraulic issues will require investigation and resolution throughout the development of the recommended WPF improvements. A summary of these potential hydraulic bottlenecks or areas requiring further study are summarized in the remainder of this section.

4.4.1 Water Protection Facility Effluent Hydraulics

The most significant existing WPF hydraulic issue is related to the ability of the WPF to discharge effluent during significant wet weather events. On a few occasions in the past, temporary effluent pumping has been required during times of high water level in the Missouri River.

Figure 5 provides an overview of the contributing flows to the 96 inch WPF effluent line (shown in red), which discharge via the WPF outfall to the Missouri River. From Figure 5, it can be seen that effluent from the final clarifiers ties into the WPF effluent line at a junction box downstream of the Missouri Avenue Diversion Structure. In addition to WPF effluent, the effluent line serves as the discharge conveyance for Missouri Avenue CSO flows as well as stormwater collected within the WPF. During typical dry weather operation, the Missouri Avenue Diversion Structure sends flows generated in the southern portion of the City to the WPF for treatment via the In-plant Influent Pump Station (line shown in dark blue). During wet weather events, the Missouri Avenue Diversion Structure continues to send flow (up to 8 mgd) to the In-plant Influent Pump Station, but the remainder of the CSO flow enters the WPF effluent line for discharge to the Missouri River. In addition, stormwater collected within the WPF (shown in light blue) discharges into the WPF outfall just upstream of the effluent gate structure.

WPF operations personnel report that during significant wet weather events forecasted to result in river levels of 27 feet (El. 815.19) or greater, the WPF is required to close the effluent discharge gate at the levee to prevent the river from backing flow into the WPF. This gate is owned by the South St. Joseph Drainage and Levee District, but operated and maintained by WPF personnel. In order to continue WPF operation



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APPROX SCALE IN FEET

ST. JOSEPH WASTEWATER FACILITIES PLAN

OVERVIEW OF CONTRIBUTIONS TO WATER PROTECTION FACILITY EFFLUENT

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FIGURE 5

CYGNET ID: 163509-1000-WWTUP-C-N00017B4R

AFIGBORD
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during these events, temporary pumps are brought in to pump the combined effluent flow, consisting of WPF effluent, Missouri Avenue CSO discharge, and WPF stormwater, over the levee. This temporary pumping configuration has been required twice since early 1993. Based on a review of historical river level data, at least one additional event showed river levels in the range that additional temporary effluent pumping could have been required. The fact that temporary pumping of the WPF effluent is required to send effluent to the river during 100-year river flood events supports the fact that the facility's hydraulic profile is currently constrained; addition of new process units will exacerbate existing hydraulic issues.

A hydraulic model was created for the portion of the WPF downstream of the final clarifiers to the Missouri River outfall. A hydraulic profile of the entire WPF flow was not created for this initial assessment. Hydraulic models will be reviewed as recommended improvement alternatives for the WPF are identified in order to determine if intermediate pumping will be required to allow flow to pass through new or modified facilities.

The intent of the outfall hydraulic model was to attempt to calibrate the hydraulic profile created by Camp Dresser & McKee, Inc. (CDM) and Delich Roth & Goodwillie, P.A. Engineers (DRG) in their design for the Wastewater Treatment Plant Improvements, R-32. While true reconciliation was not achieved, it was confirmed that the existing WPF hydraulics meet MDNR's requirement of remaining fully operational under conditions of the 25-year flood (10 CSR 20-8.14(3)(A)). While MDNR code only requires the structures, mechanical, and electrical components of the WPF be protected from physical damage during a 100-year flood event, consideration should be given to designing facilities to remain hydraulically fully operational during a 100-year flood event.

The Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps (FIRM) show the Missouri River 100-year flood elevation at the point of the WPF's outfall is approximately El. 815. Thus, the 100-year flood elevation roughly corresponds with the river level at which WPF personnel report needing to close the gate to the effluent channel and bring in temporary pumping to allow discharge of effluent.

The hydraulic model confirms these hydraulic operability issues at the 100-year flood elevation.

As indicated in the current NPDES permit, the WPF will be required to disinfect plant effluent. State regulations require that disinfection improvements be completed on or before December 31, 2013. The addition of a disinfection unit process will increase the headloss experienced through the WPF. As a result, the characteristics of the outfall will become more of a concern when additional headloss from the disinfection unit is introduced into the already constrained hydraulic profile. Based on a conceptual estimate of headloss through the future disinfection process, it is likely that an effluent pump station will be required to discharge WPF effluent to the river at the 25-year flood elevation.

Similar to the addition of disinfection, the potential addition of effluent filtration to meet future phosphorous requirements would introduce additional hydraulic constraints. Technical Memorandum TM-WW-7 – Hydraulic Analysis and Effluent Pump Station includes an investigation of effluent discharge hydraulics in order to determine whether pumping of the effluent discharge is required at all times or only under certain wet weather conditions. The goal will be to reduce costs by relying on gravity flow whenever possible.

Various flow values were entered into the outfall hydraulic model to determine how much flow the existing final clarifiers and downstream facilities could convey without compromising plant performance. Impacts of WPF stormwater and CSO flows from the Missouri Avenue Diversion Structure will be investigated through future analysis. In subsequent technical memoranda, further hydraulic assessments will be required as alternatives to increase the treatment capability are considered.

4.4.2 Additional Hydraulic Considerations

Discussion with WPF operations personnel identified the grit chambers and communitors as hydraulic bottlenecks within the process. These units are limited to 27 mgd to keep the liquid level in the influent channel and basin within allowable side water depth limits. Downstream units, such as the primary clarifiers, appear to be able to handle more flow. Alternative grit treatment technologies are presented in TM-CSO-

12/TM-WW-3 – Screening and Grit Removal Facilities and impacts to the existing hydraulic profile of the plant are considered as well.

In TM-WW-4 – Nutrient Removal Facilities, ammonia removal and denitrification alternatives are investigated. Analysis determined whether existing basins, such as the aerobic digesters, could be utilized to provide additional aeration basin capacity or whether new basins are required. Investigation of the hydraulic considerations are included as part of the analysis.

5.0 Future Identified Upgrades to Existing Facilities

The City of St. Joseph has spent considerable effort identifying future upgrades for the WPF. It is important that these planned upgrades be considered throughout the Wastewater Facilities Plan so that the recommendations of the plan will support and incorporate planned WPF upgrades when possible. The following section presents the upgrades formally identified as part of the capital improvement planning process as well as additional improvements identified by WPF operations personnel.

It is anticipated that the Wastewater Facilities Plan will assess upgrades to the following existing systems. The applicable technical memorandum that addresses the issue is provided in parenthesis:

- Increased hydraulic and grit removal capacity of the WPF grit facilities (TM-CSO-12/TM-WW-3 – Screening and Grit Removal Facilities).
- Potential addition of grit removal facilities at Missouri Avenue for processing of flows from southern St. Joseph (TM-CSO-12/TM-WW-3 – Screening and Grit Removal Facilities).
- SCADA improvements (TM-WW-8 – Instrumentation and Controls).
- Administration Building expansion (TM-WW-9 – Site Considerations, Utilities Improvements, and Ancillary Facilities).
- Maintenance garage repairs and improvements (TM-WW-9 – Site Considerations, Utilities Improvements, and Ancillary Facilities).

On February 17, 2009, Black & Veatch held a conference call with City WPF operations and engineering personnel to identify additional areas of concern or ideas for improvements that may not have been previously presented. The remainder of this section provides additional focus areas or more detail with regard to staff priorities to consider for incorporation within the Wastewater Facilities Plan. This section also provides a reference to the future Wastewater Facilities Plan technical memorandums that will serve to address the highlighted issues.

An immediate staff concern was the need to identify the amount of land required for improvements to the WPF. If additional land beyond that owned by the City is required, it is important to identify this need and start the process early as land acquisition can be very time consuming. The City will be advised as space allocations for proposed improvements are identified, especially in cases where additional land purchases are necessary, in order to allow the City to begin land acquisition in a timely manner.

Eastside pump station capacity and structural integrity are major concerns for City staff. The Easton Road Pump Station is at maximum capacity, while the Faraon Street Pump Station requires significant repairs as well as additional capacity. Capacity assessment of the eastside conveyance system is presented in TM-WW-2 – Eastside Wastewater Service Assessment.

Build-up of snails in the trickling filters is an issue that has major impact on the amount of basin cleaning required at the WPF on an annual basis. Eighty cubic yards of snails are deposited annually in each of the three aeration basins. In addition, the aerobic digesters, anaerobic digesters, and DAF units have to be cleaned more frequently than would be required without this additional snail volume. Currently, there is no way to isolate any of the filters; as a result, individual filters may not be taken off-line to chlorinate for snail removal.

Staff noted that neither the Administration nor Maintenance Buildings have adequate space to meet current needs. Efforts are being made to move off-site sewer maintenance to a location other than the on-site Maintenance Building. Likewise, the office and laboratory space available in the Administration Building are not adequate. For example, it appears much needed office space will be utilized to house the new gas chromatography-mass spectrometry laboratory equipment. These issues will be discussed further with City Staff and proposed improvements presented in TM-WW-9 – Site Considerations, Utility Improvements, and Ancillary Facilities.

The nonpotable water (NPW) system was highlighted as a potential system of concern. It is reported that the NPW system is too reactive in that when the hoses are turned on system pressure immediately drops, engaging the pumps, which then cavitate. The system response needs to be dampened somewhat. Nearly 90 percent of the NPW goes to the DAF unit; the newly installed EDUR pumps have significantly increased demand. The NPW system is assessed in TM-WW-9 – Site Considerations, Utility Improvements, and Ancillary Facilities.

City personnel have highlighted the need for additional staff in order to operate and maintain the WPF and conveyance facilities. Additional staffing needs are primarily in the areas of maintenance; laboratory analyst; Capacity, Management, Operation, and Maintenance (CMOM) program personnel; and grease trap inspector. The Fiscal Year 2011 budget proposes staffing additions for the identified maintenance personnel. Levels of staffing are presented in TM-WW-10 – Staffing Analysis.

6.0 Historical Flows and Loads

An understanding of current wastewater influent data is critical in the projection of the future flows and loads that will be generated within the City of St. Joseph. Raw wastewater influent flows, loads, and related parameters are presented in the following sections. Interpretation of this data will serve as the basis for the projection of future flows and loads.

6.1 Historical Flows

As previously presented, flow enters the WPF at various locations as indicated in Figure 3. Flows from the Whitehead Pump Station and the In-plant Influent Pump Station enter the plant headworks and consist of sanitary, commercial, industrial, and wet weather flows. The following wholesale industrial customer flows enter the facility in multiple locations downstream of the primary clarifiers:

- Flow from the SSJISD enters the WPF downstream of the primary clarifiers.

- Flow from National Beef Leathers enters the WPF downstream of the trickling filters.
- Flow from Triumph Foods enters the WPF through the industrial clarifier.

The SSJISD consists of a variety of industrial members including pet food producers, battery manufacturers, and soy bean refiners. The SSJISD's member industries collectively operate the SSJISD primary clarification plant. Following primary treatment at their facilities, the SSJISD sends their primary effluent to the WPF for secondary treatment. The flow from the SSJISD pretreatment facility enters the WPF and combines with the primary effluent at a junction box located at the top of the trickling filters (adjacent to the IPS).

National Beef Leathers operates a large tanning facility directly north of the WPF. In October 1988, Prime Tanning (former owner of the National Beef Leathers' facility) constructed a lagoon system to remove BOD and reduce the pollutant load entering the WPF from the facility. At the same time, the discharge of waste from Prime Tanning was removed from the City sewer and pumped directly to the WPF downstream of the trickling filters. The relocation of the discharge point was required due to odor problems and corrosion of the concrete structures in the WPF's primary treatment facilities due to the excess hydrogen sulfide gas released from this waste.

Flow from National Beef Leathers is combined with effluent from the trickling filters and then sent to the activated sludge basins. In an alternate mode of operation, flow from National Beef Leathers could be sent to the industrial clarifier for additional treatment prior to entering the activated sludge system. Production from the Prime Tanning facility was reduced in 2008, but the facility has recently been transferred to new ownership (National Beef Leathers) and is anticipated to return to previous historical production levels.

Triumph Foods is one of the world's largest pork processing facilities; the facility also feeds pretreated waste directly to the WPF. The influent stream from Triumph Foods is currently the only stream entering the WPF via the industrial clarifier. The flow rate from Triumph Foods into the clarifier is measured by a magnetic flowmeter. The effluent from the industrial clarifier combines with the trickling filter effluent prior to entering the aeration basins.

The City provided historical flow data for all influent streams for the years 2005 to 2008, which were analyzed to characterize the influent flow to the existing WPF. The data analysis included calculating the following parameters based on the historical flow data received:

- Annual Average (AA) Daily Flow. Annual average flow is the total volume of wastewater treated during the year divided by the number of days in the year.
- Maximum Month (MM) Daily Flow. Each month's average flow is the total volume of wastewater treated during the month divided by the days in the month. The maximum month flow is the largest of these monthly average values for a given year or other study basis.
- Peak Day (PD) Flow. Peak day flow is the highest daily average value during the year and is not limited to dry weather flows. Each day's average flow is the total volume of wastewater treated during the given 24-hour period. The peak daily value is the largest of these daily values in a given year or other study basis.
- Peak Hour (PH) Flow. Peak hour flow is the highest hourly flow value during the year or other study basis. MDNR regulations have criteria related to facility sizing based on peak hourly flow.

The following sections describe the various influent flows entering the WPF.

6.1.1 Water Protection Facility Headworks

Table 4 provides a summary of the WPF headworks influent flow between 2006 and 2008. Flow into the WPF headworks includes sanitary, commercial, industrial, and wet weather flows from the Whitehead Pump Station as well as sanitary and wet weather flows routed from the Missouri Avenue Diversion Structure south of the WPF. The influent flow configuration is indicated in Figure 3.

Table 4 Historical WPF Headworks Influent Flow			
Parameter	**2006 [1]**	**2007**	**2008**
Annual Average (AA), mgd	14.1	16.8	23.0
Maximum Monthly Average (MM), mgd	17.1	23.2	27.9
Peak Day Average (PD), mgd	28.7	29.7	29.8
MM:AA	1.21	1.38	1.21
PD:MM	1.68	1.28	1.07
PD:AA	2.04	1.77	1.30
1. Data reported for 2006 does not include January – March.			

6.1.2 Industrial Flows

As presented previously, the flows from the wholesale industrial customers are diverted around the headworks and enter the facility downstream of the primary clarifiers. Table 5 provides a summary of historical wholesale industrial flow rates to the WPF between 2005 and 2008. It can be seen from the table that the peak day peaking factor (PD:AA) for SSJISD is very high. This high value will be analyzed further in the development of the projected flows.

Table 5 Historical Wholesale Industrial Flows [1]			
	SSJISD	**National Beef Leathers**	**Triumph Foods**
Annual Average (AA), mgd	1.89	0.99	1.87
Maximum Monthly Average (MM), mgd	2.54	1.15	2.57
Peak Day Average (PD), mgd	12.86	2.53	3.67
MM:AA	1.34	1.16	1.37
PD:MM	5.06	2.20	1.43
PD:AA	6.80	2.55	1.96
1. Industrial data includes data from January 2005 – November 2008 except as noted: Triumph Foods did not open until January 2006; no 2005 data is provided. In addition, analysis does not include the months of August – October 2007.			

6.2 Historical Wastewater Characteristics

Historical load data covering the years 2005 through 2008 were obtained from the City for the various influent streams entering the WPF. The resulting data set was then analyzed to determine the historical characteristics of the various influent streams to the

WPF. The data analysis required calculating the following parameters based on the flow data received:

- Annual Average (AA) Daily Load. Annual average daily load is the annual average load (pounds per year) of a given constituent in the influent stream divided by the number of days in the year.
- Maximum Month (MM) Daily Load. Each constituent's monthly average flow is the total incoming load in the influent during the month divided by the days in the month. The maximum month load is the largest of these monthly average values for a given year or other study basis.
- Peak Day (PD) Load. Peak day load is the highest daily average value during the year. Each constituent's daily average load is the total mass of the constituent entering the WPF during a given 24-hour period. The peak daily value is the largest of these daily values in a given year or other study basis.

Table 6 provides a summary of the historical characteristics of the raw influent flows by source.

Table 6
Historical [1] WPF Influent Flow Characteristics by Source

Parameter		WPF Headworks	SSJISD	National Beef Leathers	Triumph Foods
Temperature	Maximum Daily Average, ° C	26	-- [2]	--	--
	Maximum Monthly Average, ° C	24	--	--	--
	Average, ° C	17	--	--	--
	Minimum Monthly Average, ° C	10	--	--	--
	Minimum Daily Average, ° C	4	--	--	--
Total Suspended Solids (TSS)	Annual Average (AA), ppd	38,342	3,439	568	1,262
	Maximum Monthly Average (MM), ppd	136,195	8,477	1,921	6,068
	Peak Daily Average (PD), ppd	343,474	31,754	3,972	48,585
	MM:AA	3.55	2.44	3.38	4.80
	PD:MM	2.52	3.75	2.07	8.00
	PD:AA	8.96	9.08	6.99	38.49

Table 6
Historical [1] WPF Influent Flow Characteristics by Source

Parameter		WPF Headworks	SSJISD	National Beef Leathers	Triumph Foods
Biochemical Oxygen Demand (BOD)	Annual Average (AA), ppd	28,434	10,491	215	2,561
	Maximum Monthly Average (MM), ppd	37,786	21,717	811	8,102
	Peak Daily Average (PD), ppd	67,323	64,601	2,591	19,635
	MM:AA	1.33	2.07	3.77	3.16
	PD:MM	1.78	2.97	3.19	2.42
	PD:AA	2.37	6.15	12.05	7.67
Ammonia Nitrogen (NH_3-N)	Annual Average (AA), ppd	--	568	4,726	1,772
	Maximum Monthly Average (MM), ppd	--	1,423	6,171	2,158
	Peak Daily Average (PD), ppd	--	4,051	15,332	5,315
	MM:AA	--	2.50	1.31	1.22
	PD:MM	--	2.84	2.48	2.46
	PD:AA	--	6.80	2.55	1.96

1. Analysis includes data from January 2005 – November 2008, except as indicated below:
- Plant headworks data does not include January – March 2006.
- Triumph Foods did not open until January 2006; no 2005 data are provided. In addition, analysis does not include the months of August – October 2007.

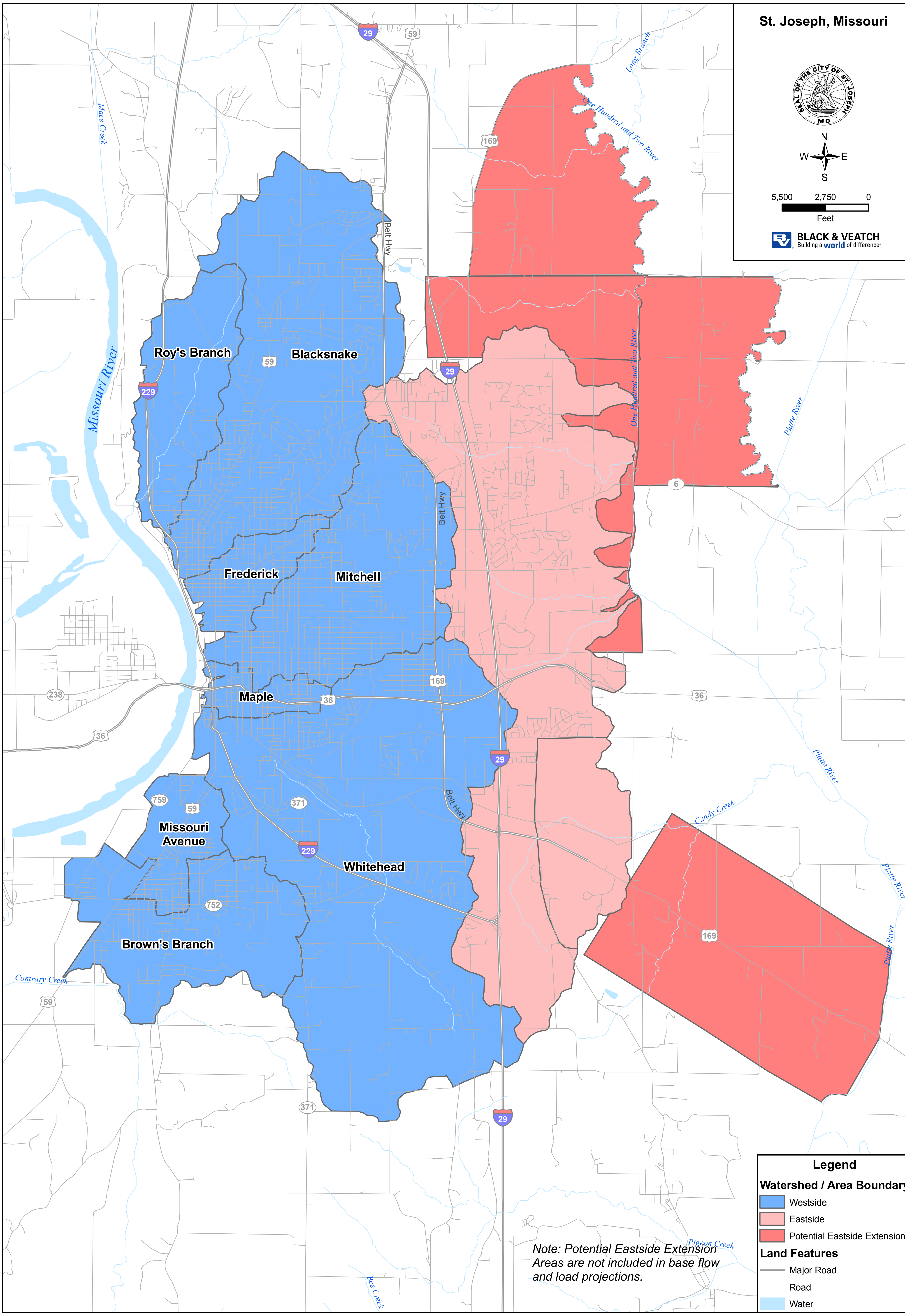
2. The symbol "--" indicates data not available.

7.0 Projected Flows and Loads

Projected flows and loads were developed for the St. Joseph service area over a 20-year planning horizon through Year 2030. The projected flows assume further development within the existing basins that currently serve as tributaries to the existing WPF – Roy's Branch, Blacksnake, Frederick, Mitchell, Maple, Whitehead, Missouri Avenue, Brown's Branch, and 102 River. The total wastewater service area considered for the development of projected wastewater flows is shown in Figure 6 as the combined blue and light red areas.

7.1 Projected Flows

The following sections present the development of projected wastewater flows for the 20-year planning horizon. Flow projections will be provided for Years 2010 and 2030. Future domestic wastewater flows were calculated by establishing a per capita flow factor based on historical flow data and multiplying this factor by the projected service area population. This per capita flow development includes a contribution from general industrial sources; large, wholesale industrial flows will be developed on a case-by-case basis.



PROJECTED WASTEWATER SERVICE AREAS

Figure 6

7.1.1 Population Projections

Data from the 2009 TAZ study by URS Corporation were provided by the City in the form of a GIS shapefile. The data allocated households within Buchanan and Andrew Counties in Missouri and Doniphan County in Kansas among 309 TAZs to provide a baseline number of households for 2000 as well as projections for 2035 under two planning scenarios. The Continued Trend planning scenario reflects a faster rate of growth near the fringe of the Metropolitan Planning Area (MPA) and population redistribution within the MPA. The Smart Growth planning scenario projects more concentrated growth within the MPA boundary than in the Continued Trend scenario. The population projections under both planning scenarios were determined by multiplying the number of households presented within the TAZ study by 2.5318 people per household per the URS study.

The TAZ covers areas within the wastewater service area and beyond. Population within the WPF sewershed was determined by allocating the TAZ household data to match the existing service area feeding the WPF. GIS was utilized to allocate population within the TAZ split along sewershed boundaries based on area. In this manner, population for the baseline year 2000 and population projections for the 2035 Continued Trend/Smart Growth scenarios were determined for the WPF service area.

Population projections for the three-county area were utilized to provide the overall populations for allocation within the TAZ study. These data, which provide population projections in five year increments between the years 2000 and 2035, were also provided by the City. The population from Doniphan County, Kansas was removed from the data set utilized for this study as this county lies outside the service area considered. Percentage growth trends from the remaining two county population data sets were applied to the calculated WPF service area populations to predict the incremental year populations required to associate population with historical flow data.

Table 7 summarizes the projected population for the WPF service area based on analysis of the TAZ data. Populations are provided for the eastern and western portions of the service area as indicated on Figure 6. Table 7 indicates that the Smart Growth scenario represents a slightly higher population for both the western and eastern sides of the City. Therefore, this planning scenario will be utilized as the most conservative basis to develop future flows.

Table 7
TAZ-Based Population Projections for 2010 – 2030 by Service Area

Service Area	Population			
	2000	2010	2030 – CT [1]	2030 – SG [2]
Westside	62,891	63,908	65,245	66,670
Eastside	13,159	13,372	14,640	15,047
Total	*76,050*	*77,280*	*79,885*	*81,717*

1. CT – Continued Trend planning scenario
2. SG – Smart Growth planning scenario

City personnel conducted a review of the TAZ-based 2030 population numbers presented in Table 7. This review suggested that populations presented for the Westside seemed appropriate, but those for the Eastside may not adequately account for new developments in progress as well as ongoing planned growth. Therefore, the population from two new housing developments, each with 450 housing units, was added to the Eastside TAZ-based 2030 population (Table 7) to represent new developments currently in progress or planned for the near future. It was assumed that the population increase representing ongoing planned growth was accounted for within the TAZ analysis. Table 8 presents the results of this refinement analysis for planning years 2010 and 2030; the population projections given in Table 8 will be used to determine flows for the existing wastewater service area throughout the remainder of this memorandum.

Table 8
Refined Population Projections for 2010 and 2030

Service Area	Population	
	2010	2030
Westside	63,900	66,700
Eastside	13,400	17,400
Total	*77,300*	*84,100*

Population projections for the service area extensions on the Eastside (dark red areas on Figure 6) are developed as part of TM-WW-2 – Eastside Wastewater Service

Assessment. The flow projections developed in this technical memorandum encompass the existing wastewater service area, including the City staff added populations discussed above and represented in Table 8.

7.1.2 Per Capita Flow Development

Base per capita flows were developed utilizing the historical influent flow data for the WPF (Table 4). Annual average influent flows for the years 2006 through 2008 were divided by the respective incremental year populations developed as previously presented to calculate the historical per capita flow for each year as shown in Table 9.

Table 9
Historical Per Capita Flow

AA Influent Flow, mgd			**Population**			**Historical Per Capita Flow, gpcd**		
2006	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
14.1	16.8	23.0	76,005	76,324	76,643	186	220	300

gpcd – gallons per capita day

Typical per capita flows for a community such as St. Joseph are expected to range from 100 to 150 gallons per capita day (gpcd). It can be seen from Table 9 that the historical per capita flows are significantly higher than this range. This is due primarily to the fact that the WPF receives a high volume of direct creek inflow during dry weather as well as wet weather flows through the City's combined sewer system. The December 1996 Combined Sewer Overflow Characterization Report by Black & Veatch estimated the dry weather creek flow to be approximately 4 mgd. The base flows in Table 9 were adjusted by subtracting out 4 mgd of creek flow from the AA flows. Table 10 provides the annual adjusted per capita flows for 2006 to 2008 once the 4 mgd creek flow component is removed.

Table 10 Adjusted Per Capita Flow [1] (gpcd)		
2006	**2007**	**2008**
133	168	248
1. Adjusted per capita flow represents historical AA flows minus 4 mgd creek flow divided by the population.		

The data presented in Table 10 shows reasonable agreement between the per capita flow rates for 2006 and 2007; however, those for 2008 are approximately 50 to 85 percent higher. Since the City experienced extreme wet weather conditions in 2008, it was determined that this number was not representative of average flow data. As a result, the adjusted per capita flow for 2008 was excluded and the remaining data averaged to calculate an annual average per capita flow of 150 gpcd. As this result lies at the upper range of typically expected per capita flow values, it was determined to serve as a conservative basis for the flow assessment. This value will be applied in the development of the projected wastewater flows and loads for 2010 and 2030 (excluding creek flows).

The per capita flows presented in Table 10 include commercial/industrial flows (other than those from direct wholesale industrial customers); in TM-WW-2 – Eastside Wastewater Service Assessment, Eastside per capita flow rates are calculated excluding all metered industrial flows.

7.1.3 Industrial Flow Development

The per capita flows presented in Table 10 include the contribution of residential and light commercial/industrial sources; however, the WPF receives up to 30 percent of its maximum composite annual average load from three wholesale industrial customers. Development of projected wholesale industrial flow rates is independent of the per capita loadings presented previously for the residential and light commercial/industrial sources; significant wholesale industrial loadings must be developed on a case-by-case basis.

The three distinct industrial contributors to the WPF are National Beef Leathers, Triumph Foods, and the SSJISD. Based on discussions with City Staff, flow contributions from these industries are projected to remain fairly consistent with historical operations over the 20-year planning horizon. There are no data to suggest that production from the related facilities will vary significantly from the historical norms. While production from the facility previously owned by Prime Tanning has been reduced over the past year, with the transfer to the new ownership of National Beef Leathers, production is expected to return to more typical historical production rates within the next few years.

As no significant changes in the industrial operations are anticipated, historical flow data as presented in Table 5 will serve as the basis for the projected flows. Table 11 gives the projected flows to be utilized throughout the 20-year planning horizon; this table is essentially identical to the previously presented historical flow information. The City is working with the industrial users, particularly with the SSJISD, to help manage the very high peak flows.

Table 11
Projected Wholesale Industrial Flows by Source
2010 – 2030

	SSJISD	National Beef Leathers	Triumph Foods
Annual Average (AA), mgd	1.9	1.0	1.9
Maximum Monthly Average (MM), mgd	2.5	1.2	2.6
Peak Daily Average (PD), mgd	12.9	2.5	3.7
MM:AA	1.3	1.2	1.4
PD:MM	5.1	2.2	1.4
PD:AA	6.8	2.6	2.0

7.1.4 Future Water Protection Facility Service Scenarios

This technical memorandum provides flow projections to the existing WPF based on population forecasts for the existing service area (light blue and light red areas on Figure 6). It is anticipated that the eastern portion of St. Joseph will continue to show growth; therefore, the City desires to investigate the feasibility of constructing new wastewater infrastructure in this region to serve the eastern side of the City, both within the existing Eastside service area as well as potential Eastside service area extensions (light and dark red areas on Figure 6). TM-WW-2 – Eastside Wastewater Service Assessment provides flow projections for both the Eastside and the Eastside service area extensions. TM-WW-2 also provides conceptual Eastside infrastructure alternatives for handling the projected Eastside flows.

In this technical memorandum, the projected existing service area flows to the Missouri River WPF are reported for 2010 and 2030 in order to bracket the 20-year planning horizon. The flows developed in this section will serve as the basis for the remainder of the Wastewater Facilities Plan. If a new WPF is built on the Eastside, flows to the existing WPF facility would be reduced, allowing capacity for additional economic development within the western portion of the City.

7.1.4.1 Existing Service Area Flow Projections to Missouri River WPF. The projected annual average flows to the existing WPF headworks were determined by applying the 150 gpcd to the service area populations projected within the 20-year planning horizon. The resulting projected wastewater flows are indicated in Table 12.

Table 12 also reflects the contributions from the various industrial sources to the WPF flow. As the industrial flows are anticipated to remain fairly constant over the planning horizon, the projected flows for these streams have simply been carried forward from Table 11. Table 12 also sums all of the influent flows entering the WPF at various locations, providing an estimate of the total projected WPF effluent flow.

Table 12
Projected Existing WPF Flows for 2010 and 2030

	2010					2030				
	WPF Headworks [1]	**SSJISD**	**National Beef Leathers**	**Triumph Foods**	**Total Effluent Flow**	**WPF Headworks**	**SSJISD**	**National Beef Leathers**	**Triumph Foods**	**Total Effluent Flow**
Annual Average (AA), mgd	15.6	1.9	1.0	1.9	20.4	15.6	1.9	1.0	1.9	20.4
Maximum Monthly Average (MM), mgd	27.9	2.5	1.2	2.6	34.2	[2]	2.5	1.2	2.6	[2]
Peak Daily Average (PD), mgd	29.8	12.9	2.5	3.7	48.9	[2]	12.9	2.5	3.7	[2]
MM:AA	1.8	1.3	1.2	1.4	-- [3]	--	1.3	1.2	1.4	--
PD:MM	1.1	5.1	2.2	1.4	--	--	5.1	2.2	1.4	--
PD:AA	1.9	6.8	2.6	2.0	--	--	6.8	2.6	2.0	--

1. WPF headworks flows in 2010 include projected per capita flows plus 4 mgd of direct creek flow. Despite the population growth shown in Table 8, the annual average flow in 2030 is shown consistent with that of 2010 due to the 4 mgd of direct creek flow that will be removed from the WPF by the Whitehead and Blacksnake stormwater separation conduit projects prior to 2030. The additional capacity gained by removing these flows could be utilized for additional wet weather treatment and/or economic development within the western portion of the City.
2. Flow to the headworks comes from the Whitehead Pump Station and In-plant Influent Pump Station which receives flow from the Missouri Avenue sewer that serves the southern portion of St Joseph. From the 2008 Long Term Control Plan, it has been established that Phase I improvements will include increasing the capacity of the Whitehead Pump Station to 80 mgd and maintain the current pumping capacity at the In-plant Influent Pump Station of 8 mgd. The 80 mgd of flow from Whitehead Pump Station will be split between the treatment plant and new wet weather treatment facilities that are being evaluated as part of this Facilities Plan. Therefore, maximum month and peak day flows cannot be determined at this time.
3. The symbol “--” indicates data not applicable or cannot be determined at this time.

7.2 Projected Loads

The following sections present the development of projected wastewater characteristics for the 20-year planning horizon within the existing service area.

7.2.1 Per Capita Loading

Annual average per capita loads to the WPF headworks were developed in a method similar to the per capita flows. Base per capita loads for BOD and total suspended solids (TSS) were developed for the influent to the headworks of the WPF utilizing recent influent operational data (Table 6). Annual average influent flows for the years 2006 through 2008 were divided by the respective incremental populations. Table 13 presents the development of the base per capita loads at the WPF headworks; dedicated industrial loadings are not included in the per capita loadings.

Table 13
Development of Base Per Capita Loadings

Parameter	Annual Average Influent Load [1], ppd	Population [1]	Base Per Capita Load [2], ppcd	Typical Per Capita Load, ppcd
TSS	38,342	76,342	0.50	0.20
BOD	28,434	76,342	0.37	0.20

1. Data averaged over the years 2006-2008. Values reported in pounds per day (ppd).
2. Represents loading into WPF headworks only, does not include dedicated industrial loadings. Values reported in pounds per capita day (ppcd).

The calculated loadings in Table 13 are very high compared to typical per capita loads. The high per capita TSS and BOD loadings are likely related to the large influx of sediment and organic matter to the WPF during CSO events as well as the influent of some large industrial contributors (St. Joseph Foods and Lifeline Foods, for example) into the collection system upstream of the WPF headworks. The CSO Facilities Assessment will provide alternatives to mitigate CSO impacts in St. Joseph. As a result, the per capita loadings were adjusted based on Black & Veatch experience to values closer to those typically expected assuming some mitigation of CSO impacts occurs. The applied per capita loadings for TSS and BOD as presented in Table 14 are still higher than the typical per capita loadings as shown in Table 13; this is due to the greater concentration of industrial flows in St. Joseph than the typical community. The applied per capita loadings will need to be revisited once the CSO control improvements are implemented in order to ensure the reductions proposed in Table 14 are being achieved. As operational data does not exist for key design parameters such as ammonia nitrogen**,** Total Kjeldahl Nitrogen (TKN), and phosphorous, per capita loadings based on Black & Veatch experience were utilized for these parameters as well. Table 14 presents the applied per capita loadings for the key design parameters.

Table 14
Applied Per Capita Loadings [1]

Parameter	Applied Per Capita Loading, ppcd
TSS [2]	0.30
BOD [2]	0.30
Ammonia [3]	0.03
TKN [3]	0.04
Phosphorous [3]	0.005

1. Per capita loadings do not include dedicated industrial sources.
2. Per capita loading assumes some mitigation of CSO impacts on TSS and BOD loadings received at the WPF headworks.
3. Ammonia, TKN, and phosphorus per capita loadings based on Black & Veatch experience.

7.2.2 Industrial Load Development

Based on City conversations with the dedicated wholesale industrial partners, projected loadings from the dedicated industrial users are assumed to remain fairly consistent over the 20-year planning horizon, with the exception of ammonia levels from National Beef Leathers. Prime Tanning was recently sold to a new owner, National Beef Leathers. Based on conversations with City staff, the new owner has made a commitment to transition to a new tanning process that utilizes carbon dioxide, decreasing the ammonia generated. The projected ammonia loadings from National Beef Leathers assume a 50 percent reduction from current loadings as a result of this change in operation. With this exception, the projected loadings for all sources summarized in Table 15 are consistent with the historical data presented previously in Table 6.

Table 15
Projected Wholesale Industrial Loadings by Source
2010 – 2030

Parameter		SSJISD	National Beef Leathers	Triumph Foods
Total Suspended Solids (TSS)	Annual Average (AA), ppd	3,400	600	1,300
	Maximum Monthly Average (MM), ppd	8,500	1,900	6,100
	Peak Daily Average (PD), ppd	32,000	4,000	49,000
	MM:AA	2.5	3.2	4.7
	PD:MM	3.8	2.1	8.0
	PD:AA	9.4	6.7	37.7
Biochemical Oxygen Demand (BOD)	Annual Average (AA), ppd	11,000	200	2,600
	Maximum Monthly Average (MM), ppd	22,000	800	8,100
	Peak Daily Average (PD), ppd	65,000	2,600	20,000
	MM:AA	2.0	4.0	3.1
	PD:MM	3.0	3.3	2.5
	PD:AA	6.0	13.0	7.7
Ammonia Nitrogen (NH_3-N)	Annual Average (AA), ppd	600	2,400	1,800
	Maximum Monthly Average (MM), ppd	1,400	3,100	2,200
	Peak Daily Average (PD), ppd	4,100	8,000	5,300
	MM:AA	2.3	1.3	1.2
	PD:MM	2.9	2.6	2.4
	PD:AA	6.8	3.3	2.9

7.2.3 Future Load Scenarios

This section provides projected future load scenarios to the Missouri River WPF based on the existing service area. TM-WW-2 – Eastside Wastewater Service Assessment presents the projected loads for the existing Eastside service areas and service area extensions to be utilized within that technical memorandum to conceptually size future dedicated Eastside infrastructure.

7.2.3.1 Existing Service Area Load Projections to Missouri River WPF.

Projected annual average loads to the headworks of the existing WPF were determined by applying the per capita loadings developed for each parameter (Table 14) to the populations projected within the 20-year planning horizon (Table 8). Maximum month and peak day projected loads for BOD and TSS cannot be determined at this time. As previously presented for flow, the projected maximum month and peak day BOD and TSS loadings are a function of what portion of the future flow from the Whitehead Pump

Station will be sent to the WPF and how much will be sent to the future wet weather treatment facilities. Maximum month and peak day peaking factors for ammonia nitrogen, TKN nitrogen, and phosphorous were established based on Black & Veatch experience as there is no historical data for these parameters. The resulting projected wastewater loadings are indicated in Table 16.

Table 16 also reflects the contributions from the various industrial sources to the WPF loadings. The industrial loads developed and presented in Table 15 are simply carried forward. As the industrial loads are anticipated to remain fairly constant over the planning horizon, the projected loads for these streams remain the same in 2010 and 2030.

Table 16
Projected Existing WPF Loadings for 2010 and 2030

Parameter		2010				2030			
		WPF Headworks	SSJISD	National Beef Leathers	Triumph Foods	Plant Headworks	SSJISD	National Beef Leathers	Triumph Foods
Total Suspended Solids (TSS)	Annual Average (AA), ppd	23,000	3,400	600	1,300	25,000	3,400	600	1,300
	Maximum Monthly Average (MM), ppd	138,000	8,500	1,900	6,100	[1]	8,500	1,900	6,100
	Peak Daily Average (PD), ppd	348,000	32,000	4,000	49,000	[1]	32,000	4,000	49,000
	MM:AA	6.0	2.5	3.2	4.7	-- [2]	2.5	3.2	4.7
	PD:MM	2.5	3.8	2.1	8.0	--	3.8	2.1	8.0
	PD:AA	15.0	9.4	6.7	37.7	--	9.4	6.7	37.7
Biochemical Oxygen Demand (BOD)	Annual Average (AA), ppd	23,000	11,000	200	2,600	25,000	11,000	200	2,600
	Maximum Monthly Average (MM), ppd	38,200	22,000	800	8,100	[1]	22,000	800	8,100
	Peak Daily Average (PD), ppd	68,000	65,000	2,600	20,000	[1]	65,000	2,600	20,000
	MM:AA	1.7	2.0	4.0	3.1	--	2.0	4.0	3.1
	PD:MM	1.8	3.0	3.3	2.5	--	3.0	3.3	2.5
	PD:AA	2.9	6.0	13.0	7.7	--	6.0	13.0	7.7
Ammonia Nitrogen (NH_3-N)	Annual Average (AA), ppd	2,300	600	2,400	1,800	2,500	600	2,400	1,800
	Maximum Monthly Average (MM), ppd	2,600	1,400	3,100	2,200	2,700	1,400	3,100	2,200
	Peak Daily Average (PD), ppd	3,000	4,100	8,000	5,300	3,200	4,100	8,000	5,300
	MM:AA	1.1	2.3	1.3	1.2	1.1	2.3	1.3	1.2
	PD:MM	1.2	2.9	2.6	2.4	1.2	2.9	2.6	2.4
	PD:AA	1.3	6.8	3.3	2.9	1.3	6.8	3.3	2.9

Table 16
Projected Existing WPF Loadings for 2010 and 2030

Parameter		2010				2030			
		WPF Headworks	SSJISD	National Beef Leathers	Triumph Foods	Plant Headworks	SSJISD	National Beef Leathers	Triumph Foods
TKN Nitrogen	Annual Average (AA), ppd	2,700	--	--	--	3,000	--	--	--
	Maximum Monthly Average (MM), ppd	3,000	--	--	--	3,300	--	--	--
	Peak Daily Average (PD), ppd	3,500	--	--	--	3,900	--	--	--
	MM:AA	1.1	--	--	--	1.1	--	--	--
	PD:MM	1.2	--	--	--	1.2	--	--	--
	PD:AA	1.3	--	--	--	1.3	--	--	--
Phosphorous	Annual Average (AA), ppd	400	--	--	--	400	--	--	--
	Maximum Monthly Average (MM), ppd	400	--	--	--	400	--	--	--
	Peak Daily Average (PD), ppd	500	--	--	--	500	--	--	--
	MM:AA	1.1	--	--	--	1.1	--	--	--
	PD:MM	1.2	--	--	--	1.2	--	--	--
	PD:AA	1.3	--	--	--	1.3	--	--	--

1 Flow to the headworks comes from the Whitehead Pump Station and In-plant Influent Pump Station which receives flow from the Missouri Avenue sewer that serves the southern portion of St Joseph. From the 2008 Long Term Control Plan, it has been established that Phase I improvements will include increasing the capacity of the Whitehead Pump Station to 80 mgd and maintain the current pumping capacity at the In-plant Influent Pump Station of 8 mgd. The 80 mgd of flow from Whitehead Pump Station will be split between the treatment plant and new wet weather treatment facilities that are being evaluated as part of this Facilities Plan. Therefore, maximum month and peak day flows cannot be determined at this time.
2 The symbol "--" indicates data not available or cannot be determined at this time.

8.0 Conclusions and Next Steps

This technical memorandum provides an assessment of the existing WPF and conveyance system, which will provide the basis for evaluating treatment facilities and conveyance systems for the remainder of the Wastewater Facilities Plan.

The capacity assessment of major process units is presented and suggests that existing portions of the WPF could potentially treat additional flow with modifications to alleviate bottlenecks. In addition, future technical memorandums will provide recommendations for regulatory driven projects such as the addition of disinfection and nitrification/denitrification.

A preliminary assessment of the effluent hydraulic profile was conducted to determine the hydraulic impact of increasing the flow to the WPF. The preliminary hydraulic assessment suggests an effluent pump station will likely be required to allow the existing flow capacity to discharge during 25-year flood events as additional process units, such as disinfection, are added to the WPF. The fact that temporary pumping must currently be provided at the facility when the river approaches the 100-year river flood elevation suggests the existing hydraulic profile is already constrained. Additional hydraulic assessments and effluent pumping recommendations are provided in TM-WW-7 – Hydraulic Analysis and Effluent Pump Station. The goal of the proposed facilities will be to reduce costs by relying on gravity flow whenever possible.

WPF historical flow and load data are provided. This data in combination with TAZ population projections provided by the City were utilized to develop projected flows and loads within the existing WPF service area over a 20-year planning period. Based on this analysis, it appears the existing capacity of the WPF can process the projected 2030 annual average flows; however, process upgrades will be required to meet future regulatory requirements, such as the need for disinfection. The overall wet weather management strategy will be documented in TM-CSO-10 – Wet Weather Treatment Facilities.

Projected flows and loads for proposed dedicated Eastside infrastructure to service the eastern portion of the City are discussed in TM-WW-2 – Eastside Wastewater Service Assessment. The TM-WW-2 analysis provides flow and load projections for the existing Eastside service area as well as service area extensions indentified by the City.

TM-WW-2 also presents alternatives and recommendations for dedicated Eastside infrastructure improvements.

9.0 References

The following references were utilized in the preparation of this technical memorandum:

- Draft Technical Memorandum – 2035 Population and Employment Projections (URS Corporation, March 11, 2009).
- City of St. Joseph, Missouri Combined Sewer System Long Term Control Plan Update (Black & Veatch, February 14, 2008).