HDR

Wastewater Systems Preliminary Engineering and Summary

Final

December, 2013

WASTEWATER SYSTEMS PRELIMINARY ENGINEERING AND ANALYSIS SUMMARY

PREPARED FOR:
CITY OF JUNCTION CITY, KANSAS

PREPARED BY:
HDR ENGINEERING, INC.

FINAL: DECEMBER, 2013

HDR NO. 0000213666

DONALD E. LINDEMAN
LICENSED
12435
KANSAS
PROFESSIONAL ENGINEER
12/31/13

Table of Contents

Executive Summary 1
1 Introduction 1-1
1.1 Purpose 1-1
1.2 Scope 1-1
1.3 List of Abbreviations 1-2
2 Existing Facilities 2-1
2.1 Wastewater Collection Sewersheds 2-1
2.1.1 East WWTP Sewershed 2-1
2.1.2 Southwest WWTP Sewershed 2-1
2.2 East WWTP Treatment Process 2-1
2.2.1 Preliminary Treatment 2-4
2.2.2 Primary Treatment 2-4
2.2.3 Secondary Treatment 2-4
2.2.4 Biosolids Treatment Process 2-5
2.3 Southwest WWTP Treatment Process 2-6
2.3.1 Industrial Pretreatment 2-9
2.3.2 Domestic Preliminary Treatment 2-10
2.3.3 Combined Secondary Treatment 2-10
2.3.4 Biosolids Treatment 2-11
3 Wastewater Flows and Loads 3-1
3.1 Introduction 3-1
3.2 Historical Flows and Loads 3-1
3.2.1 East WWTP 3-1
3.2.2 Southwest WWTP 3-5
3.3 Flows and Loads Projections – Previous Work 3-8
3.4 Population Projections 3-10
3.5 Design Flows and Loads 3-11
3.5.1 East WWTP 3-11

3.5.2 Southwest WWTP Domestic Flows and Loads 3-11
3.5.3 Southwest WWTP Industry Flows and Loads 3-12
3.5.4 Southwest WWTP Secondary Influent Flows and Loads 3-12
4 Permit Limits 4-1
4.1 Existing Permit Limits 4-1
4.2 Future Permit Requirements 4-2
5 Immediate Needs 5-1
5.1 East WWTP 5-1
5.2 Southwest WWTP 5-1
6 Nutrient Removal Planning 6-1
6.1 Introduction 6-1
6.2 Nutrient Removal Overview 6-3
6.3 East WWTP Alternatives analysis 6-5
6.3.1 Biological Nutrient Removal 6-5
6.4 Southwest WWTP Alternatives analysis 6-11
6.4.1 Biological Nutrient Removal with Chemical Polish 6-11
6.4.2 Integrated Fixed Film Activated Sludge 6-16
6.4.3 Recommended Nutrient Removal System 6-21
7 Biosolids Planning 7-1
7.1 East WWTP – Biosolids Treatment 7-1
7.1.1 General 7-1
7.1.2 Biosolids Production 7-1
7.1.3 Process Upgrades Needed 7-2
7.2 Southwest WWTP – Biosolids Treatment 7-2
7.2.1 General 7-2
7.2.2 Biosolids Production 7-4
7.2.3 Alternative 1 – Rebuilding Existing Process, Lime Stabilization and Decant 7-4
7.2.4 Alternative 2 – Reed Beds 7-6
7.2.5 Alternative 3 – Aerobic Digestion 7-8
7.2.6 Recommendations 7-11

8 Project Prioritization and Construction Phasing 8-1
8.1 Phase I 8-1
8.1.1 East WWTP 8-1
8.1.2 Southwest WWTP 8-3
8.2 Phase II 8-6
8.2.1 East WWTP 8-6
8.2.2 Southwest WWTP 8-7
8.3 Phase III 8-8
8.3.1 East WWTP 8-8
8.3.2 Southwest WWTP 8-9
9 Cost Estimate 9-1
9.1 East WWTP Improvements Capital Costs 9-1
9.2 Southwest WWTP Improvements Capital Costs 9-3

List of Tables

Table 1-1: List of Abbreviations 1-2
Table 3-1: East WWTP Summary of Flows and Loads 3-4
Table 3-2: SW WWTP Summary of Flows and Loads 3-8
Table 3-3: East WWTP, 2026 Option 1 - Design Flows and Loads 3-9
Table 3-4: Southwest WWTP, 2026 Option 1 - Design Flows and Loads 3-9
Table 3-5: Southwest WWTP, 2026 Option 1 - Activated Sludge System Design Flows and Loads 3-9
Table 3-6: Southwest WWTP, Design Flows and Loads 3-10
Table 3-7: East WWTP, 2026 Design Flows and Loads 3-11
Table 3-8: Southwest WWTP, 2026 Design domestic Flows and Loads 3-11
Table 3-9: Calculated Southwest WWTP, Industrial Flows and Loads 3-12
Table 3-10: Southwest WWTP DAF Effluent* 3-12
Table 3-11: Southwest WWTP Secondary Influent Design Flows and Loads 3-13
Table 4-1: East WWTP NPDES Permit Limit Summary 4-1
Table 4-2: Southwest WWTP NPDES Permit Limit Summary 4-2
Table 5-1: Immediate Needs for the East WWTP 5-1
Table 6-2: Immediate Needs for the Southwest WWTP 5-1
Table 6-1: 2026 Design Year Influent Flows and Pollutant Concentrations 6-2
Table 6-2: East WWTP Biological Nutrient Removal Operating Summary 6-7
Table 6-3: East WWTP Biological Nutrient Removal Design Summary 6-8
Table 6-4: Southwest WWTP Biological Nutrient Removal Operating Summary 6-13
Table 6-5: Southwest WWTP Biological Nutrient Removal Design Summary 6-14
Table 6-6: Opinion of Probable Cost for Southwest Plant Biological Nutrient Removal 6-16
Table 6-7: Southwest Plant IFAS Operating Summary 6-18
Table 6-8: Southwest Plant IFAS Design Summary 6-19
Table 6-9: Opinion of Probable Cost for Southwest Plant IFAS Biological Nutrient Removal 6-20
Table 6-10: Cost Comparison of Nutrient Removal Alternatives 6-21
Table 7-1: Junction City East WWTP Solids Production 7-1
Table 7-2: Junction City Southwest WWTP Solids Production 2026 Design Year 7-4
Table 7-3: Opinion of Probable Cost for Rehabilitation 7-6
Table 7-4: Reed Beds Sizing - Land Required 7-8
Table 7-5: Aerobic Digestion Sizing - Land Required 7-9
Table 7-6: Opinion of Probable Cost for Aerobic Digester Alternative 7-10
Table 7-7: Comparison of Estimated Costs of Biosolids Processing Alternatives 7-11
Table 8-1: Phase I Recommended Projects for the East WWTP 8-1
Table 8-2: Phase I Recommended Projects for the Southwest WWTP 8-3
Table 8-3: DAF Performance without Chemical Addition 8-5
Table 8-4: DAF Performance with Chemical Addition 8-5

Table 8-5: Phase II Recommended Projects for the East WWTP 8-6
Table 8-6: Phase II Recommended Projects for the Southwest WWTP 8-7
Table 9-1: East WWTP Proposed Capital Improvements - Phase I, II, and III Projects 9-2
Table 9-2: Southwest WWTP Proposed Capital Improvements - Phase I, II, and III Projects 9-4

List of Figures

Figure 2-1: East WWTP Aerial Plan View 2-2
Figure 2-2: East WWTP Process Flow Diagram 2-3
Figure 2-3: Southwest WWTP Aerial Plan View 2-7
Figure 2-4: Southwest WWTP Process Flow Diagram 2-8
Figure 3-1: East WWTP Historical Flow Data 3-2
Figure 3-2: East WWTP Historical BOD_5 Load Data 3-2
Figure 3-3: East WWTP Historical TSS Load Data Full Scale 3-3
Figure 3-4: East WWTP Historical TSS Load Data Focus 3-3
Figure 3-5: East WWTP Historical NH_3 Load Data 3-4
Figure 3-6: SW WWTP - Three Years Historical Industrial Flows 3-5
Figure 3-7: SW WWTP - Three Years Historical Domestic Flows 3-6
Figure 3-8: SW WWTP - Three Years Historical BOD_5 Loading 3-6
Figure 3-9: SW WWTP - Three Years Historical TSS Loading 3-7
Figure 3-10: SW WWTP - Three Years Historical Ammonia Loading 3-7
Figure 3-11: Population Projections 3-10
Figure 6-1: Nitrogen Removal Processes 6-3
Figure 6-2: Phosphorous Removal Processes 6-4
Figure 6-3: East WWTP Flow Schematic 6-6
Figure 6-4: East WWTP Biological Nutrient Removal Preliminary Site Layout 6-9
Figure 6-5: BNR Basin Design Flow Through 6-10
Figure 6-6: Southwest Plant Biological Nutrient Removal Flow Schematic 6-11
Figure 6-7: Proposed BNR Alternative and Aerobic Digestion for Biosolids Treatment 6-15
Figure 6-8: Southwest Plant IFAS Flow Schematic 6-17
Figure 7-1: Proposed Sludge Storage Tanks with BNR Alternative 7-5
Figure 7-2: Reed Bed System 7-7

Appendices

APPENDIX A - FLOWS & LOADS ANALYSIS

APPENDIX B - COST DETAILS

EXECUTIVE SUMMARY

Junction City has two wastewater treatment plants (WWTPs) to serve the municipal sector and industries. The East WWTP was constructed in 1954; its most recent upgrade was completed in 2000. The Southwest WWTP was constructed in 1996 and upgraded in 2006. The East WWTP treats primarily municipal wastewater while the Southwest WWTP was built primarily to meet industrial waste treatment needs.

For a number of years capital improvements and maintenance have been delayed due to the financial position of the City. At this time, the financial position of the City is improving and there are several infrastructure needs at the East and Southwest WWTPs that need to be addressed. The purpose of this report is to evaluate each WWTP and provide recommended capital improvement projects. Projects will be recommended for the following reasons:

- Provide safety to staff
- Give adequate reliability to the process to maintain continued permit compliance
- Expand the capacity of the facilities to meet growth demands
- Meet future discharge permit effluent requirements

Projects that are identified as a result of this evaluation will be prioritized based on criticality and phased for design and construction over the next several years as funds allow. The water system phasing will be completed in combination with phased projects at the East and Southwest Wastewater Treatment Plants.

The scope of the engineering analysis includes evaluation of the existing facilities, determination, and prioritization of projects needed to address safety and reliability, evaluation of capacity needs, recommendation of projects to address capacity needs, and evaluation and recommendation of projects to support nutrient removal. Projects are split between the East and Southwest WWTPs and between Phase I, Phase II, and Phase III for a Capital Improvements Plan (CIP).

<u>Immediate Needs</u>

Immediate needs are extremely high priority equipment replacement projects necessary to maintain reliable and/or safe operation of the WWTPs. These projects need to be completed as soon as possible in order to avoid discharge permit violations and to protect operations staff, because of inadequate capacity or no redundancy remaining. Equipment to be replaced as immediate needs should be completed during the current fiscal year, 2013.

Immediate needs at East WWTP are as follows:

- Replace gas detection/monitoring equipment at the Headworks Building
- Replace a failed bearing at one of the secondary clarifiers

Immediate needs at the Southwest WWTP are as follows:

- Replace mixers for Sludge Stabilization Tanks #1 and #2 (total of 4 mixers)
- Replace one WAS pump
- Replace two of the pumps at the Domestic Influent Pump Station
- Replace DAF recycle pumps (total of 2)
- Replace chlorine dosing pumps (total of 3)
- Replace gas detection/monitoring equipment in the Domestic Screening area
- Replace room lighting in both the Domestic Screening and Industrial Screening areas

Nutrient Removal Planning

It is anticipated that more restrictive effluent limitations for ammonia will be implemented over upcoming NPDES permit cycles for both the East and Southwest WWTPs. There is not currently an effluent limit for nutrients (total nitrogen and/or total phosphorous), however a nutrient limit is anticipated to be included in future permits (Nutrient Removal Study by Olsson Engineering in 2012) and was included for the 2026 design year evaluation. Alternatives to provide nutrient removal were evaluated for both WWTPs.

Review of the East WWTP effluent data show low effluent phosphorus concentrations at the plant already, which results from the existing waste stream characteristics and the use of lime stabilization for biosolids treatment. As a result of the already low effluent concentrations, it is recommended that chemical phosphorus removal using alum be provided and used as needed as a “polishing” step to meet future phosphorus limits.

In order to meet future total nitrogen limits at the East WWTP, a biological nitrogen removal process is needed. Upgrades to the existing system have been evaluated with the goal to utilize as much of the existing equipment and basins as practical. The following facilities are required to incorporate biological nitrogen removal:

- Baffling of the aeration basin to create a new 0.15 MG anoxic zone in each aeration basin. A total anoxic zone volume of 0.3 MG.
- Baffling of the aeration basin to create a new 0.1 MG aerobic zone in each aeration basin. A total aerobic zone volume of 0.2 MG.
- MLR pumping improvements
- Alum storage and feed system
- Methanol storage and feed system

The Southwest WWTP has a significant industrial wastewater contribution including a high phosphorus loading. Preliminary evaluation of chemical phosphorous removal shows that chemical-only removal is not feasible due to the significant phosphorus load; the annual chemical cost has been estimated to be $2.75 million, which translates to a 20-year present worth value of roughly $41 million. Therefore, two

alternatives were evaluated for nutrient removal: 1) biological nutrient removal with chemical polish, and 2) integrated fixed film activated sludge. The alternative of biological nutrient removal with chemical polish has the lowest life cycle cost and is therefore the recommended alternative for meeting future nitrogen and phosphorus limits at the Southwest WWTP. The following facilities are required to incorporate biological nitrogen removal:

- Construction of a new 0.5 MG anaerobic basin
- Conversion of the existing final clarifiers to anoxic basins
- New post-anoxic and post-aerobic basins
- Two new final clarifiers
- Methanol and ferric storage and feed systems

Biosolids Planning

The current biosolids processing facilities at the East WWTP consist of a sludge mixing tank, lime stabilization, and three lime storage tanks. The current system requires significant repairs and replacements that are planned to be spread out over the next three to five years. Many of the equipment replacements are recommended for the Phase 1 construction taking place during the fiscal years 2014 and 2015. This project addresses replacing equipment that has reached the end of its design life and updating the tanks, pumps, and lime feed system so they operate properly as well as offer appropriate reliability. Additional equipment replacement should occur in a Phase II construction project taking place during fiscal years 2015, 2016, and 2017.

Additional sludge storage is needed to meet KDHE requirements at the projected design solids production. The East WWTP would need an additional 0.72 MG of storage along with the existing 0.69 MG to meet this requirement. This translates to either one, 0.72 MG tank, or two 0.36 MG tanks.

The current biosolids processing facilities at the Southwest WWTP consist of two sludge stabilization basins, a lime feed system (not currently in use or operational), and a sludge storage basin. In order to provide adequate biosolids stabilization to support the Southwest WWTP's needs, biosolids upgrades are required. Three alternatives were reviewed: 1) Rehabilitate the existing lime stabilization process; 2) Install a reed bed system; and 3) Install aerobic digesters.

Based on a present worth analysis of capital project costs and annual operations and maintenance costs, the life cycle cost of the lime stabilization and aerobic digestion alternatives is essentially the same. There is insufficient footprint available at the plant for reed beds, therefore the reed bed alternative not developed further. Aerobic digestion is recommended due to several benefits including no chemical handling requirements, ease of operation, and lower maintenance for plant staff.

The existing sludge storage tank would be retrofitted into an aerobic digester operated at a water depth of 20 feet. A 1.52 MG new aerobic digester, partitioned into four units, is proposed to meet the balance of the aerobic digestion requirement.

Recommended Projects and Phasing

The following is a summary of the recommended projects by phase:

East WWTP: Phase 1 Projects

- Repair/rehabilitation of odor control systems at the Headworks and Primary Clarifiers
- Replace wet well cover at the Influent Pump Station
- Replace doors, repair/replace HVAC, and repair/replace electrical at the Headworks
- Replace doors, replace air lift pump, repair/replace HVAC, repair/replace electrical at the Grit Removal
- Replace three (3) primary sludge pumps and install two (2) grinders at the Primary Clarifiers
- Replace primary sludge piping at the Primary Clarifiers
- Rehabilitate Primary Clarifier and Primary Clarifier Splitter Structure
- Install blower VFDs and aeration instrumentation for the Activated Sludge System
- Rehabilitate two (2) Secondary Clarifiers and install algae cleaning system for the Secondary Clarifiers
- Rehabilitate biosolids, replace two (2) volumetric lime feeders, replace two (2) lime feed pumps/mixers, replace two (2) lime slurry pumps, replace air compressor, replace blending tank, replace two (2) sludge transfer pumps, replace two (2) WAS in-line grinders, replace sludge storage tank blower #2, and replace lime room HVAC for the biosolids system
- Install new SCADA system for the Site

Southwest WWTP: Phase 1 Projects

- Install industrial influent emergency diversion for the Industrial Screen
- Rebuild rotary screen for the Industrial Screen
- Replace two (2) Domestic Influent Pumps
- Install fine bubble diffuser system for the Activated Sludge System
- Replace blowers and controls, and add enclosure for the Activated Sludge System
- Replace DO, ORP, and pH probes for the Activated Sludge System
- Replace two (2) RAS pumps and one (1) WAS pump for the Activated Sludge System
- Rebuilding sludge transfer pumps for the biosolids system
- Repair/replace HVAC, repair/replace lighting, repair/replace roof and structural as required, replace DAF units at the Industrial DAF
- Install and replace a new pH stabilization system (acid/base feed) at the Industrial pH Control

East WWTP: Phase 2 Projects

- Install two (2) fine screens, install two (2) washer/compactor and baggers, and replace handrail and grating at the Headworks
- Replace anoxic mixer for the Activated Sludge System
- Replace aeration diffuser system for the Activated Sludge System
- Replace three (3) RAS pumps for the Activated Sludge System
- Replace two (2) WAS pumps for the Activated Sludge System
- Replace one (1) scum pump for the Activated Sludge System
- Rehabilitate/recoat blending tank exterior, rehabilitate/recoat sludge storage tank exterior, replace two (2) sludge transfer pumps, replace one (1) blend tank blower, replace two (2) sludge storage tank blowers, and construct new 1.6 MG sludge storage tank for the Activated Sludge System
- Remodel laboratory/locker room at the site

Southwest WWTP: Phase 2 Projects

- Rebuild or replace Domestic Influent Screen
- Rebuild blowers at Equalization Tank 2
- Rebuild mixers at Equalization Tank 1
- Rehabilitate Equalization Tank 1
- Replace anoxic zone mixer for the Activated Sludge System
- Replace one (1) scum pump for the Activated Sludge System
- Retrofit existing Sludge Storage Tank into an Aerobic Digester and construct a new 1.52 MG Aerobic Digester

East WWTP: Phase 3 Projects

- Baffling of the aeration basin to create a new 0.3 MG anoxic zone
- Baffling of the aeration basin to create a new 0.2 MG aerobic zone
- MLR pumping improvements
- Alum storage and feed system
- Methanol storage and feed system

Southwest WWTP: Phase 3 Projects

- Construction of a new 0.5 MG anaerobic basin
- Conversion of the existing final clarifiers to anoxic basins
- New post-anoxic and post-aerobic basins
- Two new final clarifiers
- Methanol and ferric storage and feed systems

The tables below show the recommended projects, phasing of the projects, and capital cost estimates.

		PHASE		
FACILITIES		**1 (2014 - 2015)**	**2 (2015 - 2017)**	**3 (2019 - 2021)**
INFLUENT PUMP STATION		$41,000	$0	$0
HEADWORKS BUILDING		$130,000	$706,000	$0
GRIT BUILDING		$45,000	$0	$0
PRIMARY CLARIFIERS		$420,000	$0	$0
PRIMARY SLUDGE PUMP STATION		$282,000	$0	$0
ANOXIC BASIN		$0	$47,000	$0
AERATION BASINS		$185,000	$266,000	$0
SECONDARY CLARIFIERS		$502,000	$0	$0
RAS/WAS PUMP STATION		$0	$235,000	$0
SLUDGE SYSTEM		$298,000	$344,000	$1,681,000
SITE		$475,000	$483,000	$0
BNR Improvements		$0	$0	$1,029,000
SUBTOTAL		$2,378,000	$2,081,000	$2,710,000
Mobilization, Bonding and General Requirements	5.0%	$119,000	$104,000	$136,000
Overhead and Profit	10.0%	$238,000	$208,000	$271,000
SUBTOTAL		$2,735,000	$2,393,000	$3,117,000
Contingency	25.0%	$684,000	$598,000	$779,000
SUBTOTAL		$3,419,000	$2,991,000	$3,896,000
Engineering, Legal, Administrative	20.0%	$684,000	$598,000	$779,000
TOTAL		$4,103,000	$3,589,000	$4,675,000

East WWTP – Engineer's Opinion of Probable Construction Cost

		Phase		
FACILITIES		**1 (2014 - 2015)**	**2 (2015 - 2017)**	**3 (2019 - 2021)**
FLOW DIVERSION STRUCTURE		$41,000	$0	$0
SCREENING - INDUSTRIAL AND DOMESTIC		$163,000	$153,000	$0
ACID FEED SYSTEM		$20,000	$0	$0
EQUALIZATION BASINS		$0	$169,000	$0
DISSOLVED AIR FLOTATION		$557,000	$0	$0
BNR		$0	$0	$3,843,000
SELECTOR BASIN		$0	$46,000	$0
AERATION SYSTEM		$899,000	$0	$0
SECONDARY CLARIFIERS		$3,083,000	$0	$0
WAS/RAS/SCUM		$41,000	$16,000	$0
SLUDGE SYSTEM		$0	$6,175,000	$0
SUBTOTAL		**$4,804,000**	**$6,559,000**	**$3,843,000**
Mobilization, Bonding and General Requirements	5.0%	$240,000	$328,000	$192,000
Overhead and Profit	10.0%	$480,000	$656,000	$384,000
SUBTOTAL		$5,524,000	$7,543,000	$4,419,000
Contingency	25.0%	$1,381,000	$1,886,000	$1,105,000
SUBTOTAL		$6,905,000	$9,429,000	$5,524,000
Engineering, Legal, Administrative	20.0%	$1,381,000	$1,886,000	$1,105,000
TOTAL		$8,286,000	$11,315,000	$6,629,000

Southwest WWTP – Engineer's Opinion of Probable Construction Cost

1 INTRODUCTION

The City of Junction City, Kansas is located in Geary County Kansas along Interstate 70 at the confluence of the Smoky Hill and Republican Rivers. The City has a current population of approximately 25,000 people.

Junction City has two wastewater treatment plants (WWTPs) to serve the municipal sector and industries. The East WWTP was constructed in 1954; its most recent upgrade was completed in 2000. The Southwest WWTP was constructed in 1996 and upgraded in 2006. The East WWTP treats municipal wastewater while the Southwest WWTP was built primarily to meet industrial waste treatment needs. Both facilities are contract operated under contract by Veolia Water North America (Veolia Water). HDR was retained by the City to evaluate both wastewater treatment plants and provide recommended capital improvements.

1.1 PURPOSE

For a number of years capital improvements and maintenance have been delayed due to the financial position of the City. At this time, the financial position of the City is improving and there are several infrastructure needs at the East and Southwest WWTPs that need to be addressed. The purpose of this report is to holistically evaluate each WWTP and provide recommended capital projects. Projects will be recommended for the following reasons:

- Provide safety to staff
- Give adequate reliability to the process to maintain continued permit compliance
- Expand the capacity of the facilities to meet growth demands
- Meet future discharge permit effluent requirements

Projects that are identified as a result of this evaluation will be prioritized based on criticality and phased over the next several years as funds allow. The final phasing will be completed in combination with projects at the water treatment plant to be within established funds.

1.2 SCOPE

The scope includes evaluation of the existing facilities, determination, and prioritization of projects needed to address safety and reliability, evaluation of capacity needs, recommendation of projects to address capacity needs, and evaluation and recommendation of projects to support nutrient removal. Projects are split between the East and Southwest WWTPs and between Phase I, Phase II, and Phase III.

1.3 LIST OF ABBREVIATIONS

The table below gives a list of standard abbreviations used throughout this text.

Table 1-1: List of Abbreviations

Abbreviation	Definition	Abbreviation	Definition
BNR	Biological Nutrient Removal	KDHE	Kansas Department of Health and Environment
BOD	Biochemical Oxygen Demand	MD/AA	Ratio of Maximum Day to Average Annual
BOD_5	Five-day BOD	mg/L	Milligrams per Liter
$cBOD_5$	Carbonaceous BOD_5	MG	Million gallons
CWA	Clean Water Act	MGD	Million gallons per day
DO	Dissolved Oxygen	MM/AA	Ratio of Maximum Month to Average Annual
EPA	U.S. Environmental Protection Agency	NPDES	National Pollutant Discharge Elimination System
EQ	Equalization	POTW	Publicly Owned Treatment Works
FOG	Fats, Oils and Grease	RAS	Return Activated Sludge
ft	Feet	SF	Square feet
ft/sec	Feet per second	SOUR	Specific Oxygen Uptake Rate
gal	Gallons	TKN	Total Kjeldahl Nitrogen
gpd	Gallons per day	TSS	Total Suspended Solids
gpm	Gallons per minute	WWTP	Wastewater Treatment Plant
IFAS	Integrated Fixed-Film Activated Sludge		

2 EXISTING FACILITIES

2.1 WASTEWATER COLLECTION SEWERSHEDS

2.1.1 East WWTP Sewershed

Junction City's East WWTP is located along Grant Avenue approximately 0.5 miles northeast of the intersection of Grant Avenue and Washington Street. The East WWTP primarily treats wastewater from the domestic population of Junction City. All of the domestic wastewater except for contributions from newer development in the southwestern edge of the City is conveyed to the East WWTP for treatment.

2.1.2 Southwest WWTP Sewershed

Junction City's Southwest WWTP is located on Industrial Street just southwest of Highway 77 and 40. The Southwest WWTP primarily treats industrial wastewater. One of its major contributors is Armour-Eckrich meat processing facility. The Southwest WWTP treats industrial waste from Armour-Eckrich and others, along with domestic flow from the area southwest of Ash Street.

2.2 EAST WWTP TREATMENT PROCESS

The East Wastewater Treatment Plant was built in 1954 and most recently upgraded in 2000. An aerial plan view of the East WWTP is shown in Figure 2-1. The East WWTP is rated to treat a 2.5 MGD dry weather design flow and a 7.0 MGD peak flow. The plant is operated by Veolia Water under an operations contract with the City. The East WWTP currently uses activated sludge with a selector to remove conventional pollutants, ammonia nitrogen, and total nitrogen. Primary and waste activated sludge is stabilized by lime addition and stored on site prior to transport to the Southwest WWTP for further storage and final disposal by land application. The process flow diagram for the East WWTP is shown in Figure 2-2.

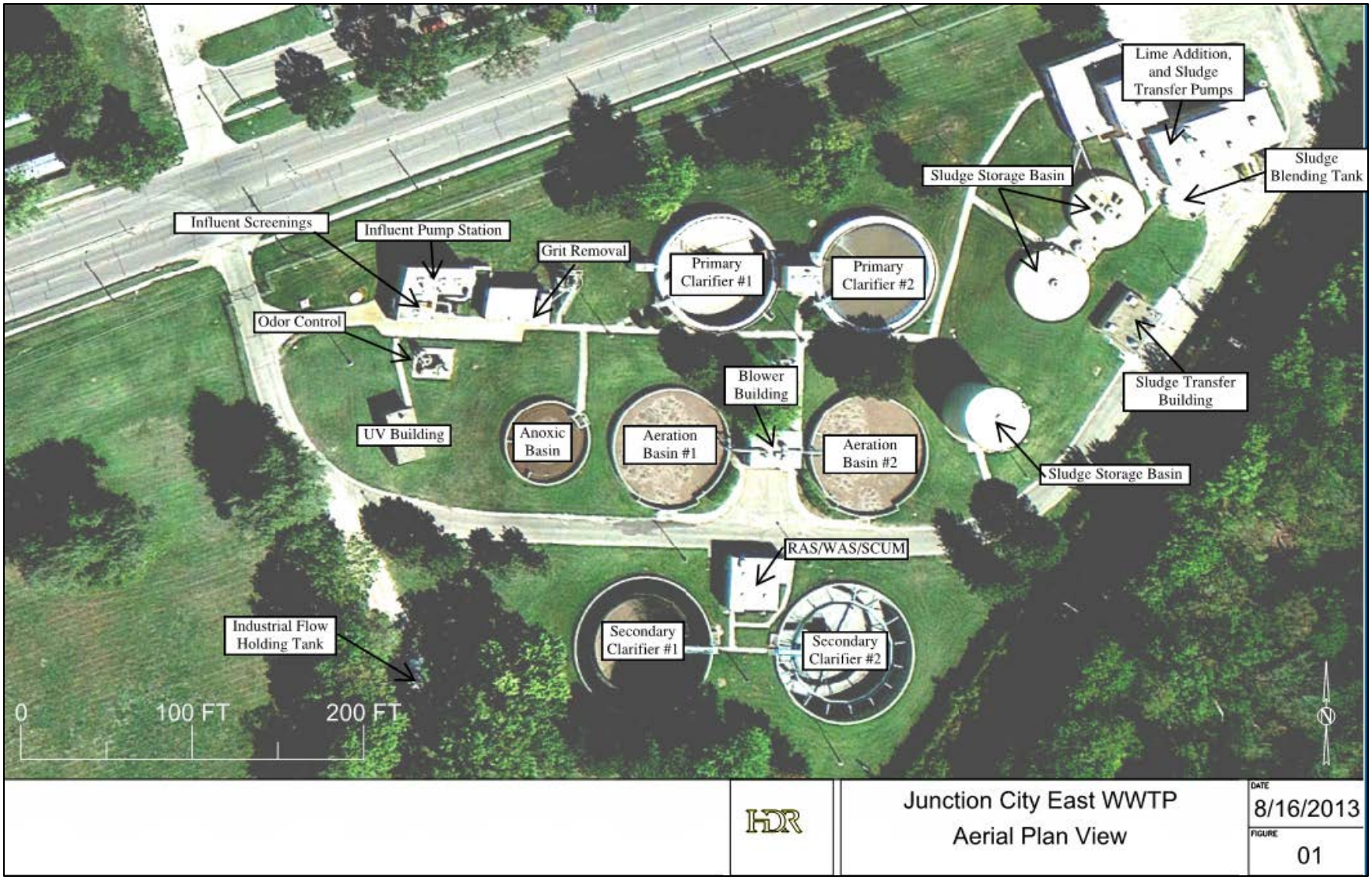


Figure 2-1: East WWTP Aerial Plan View

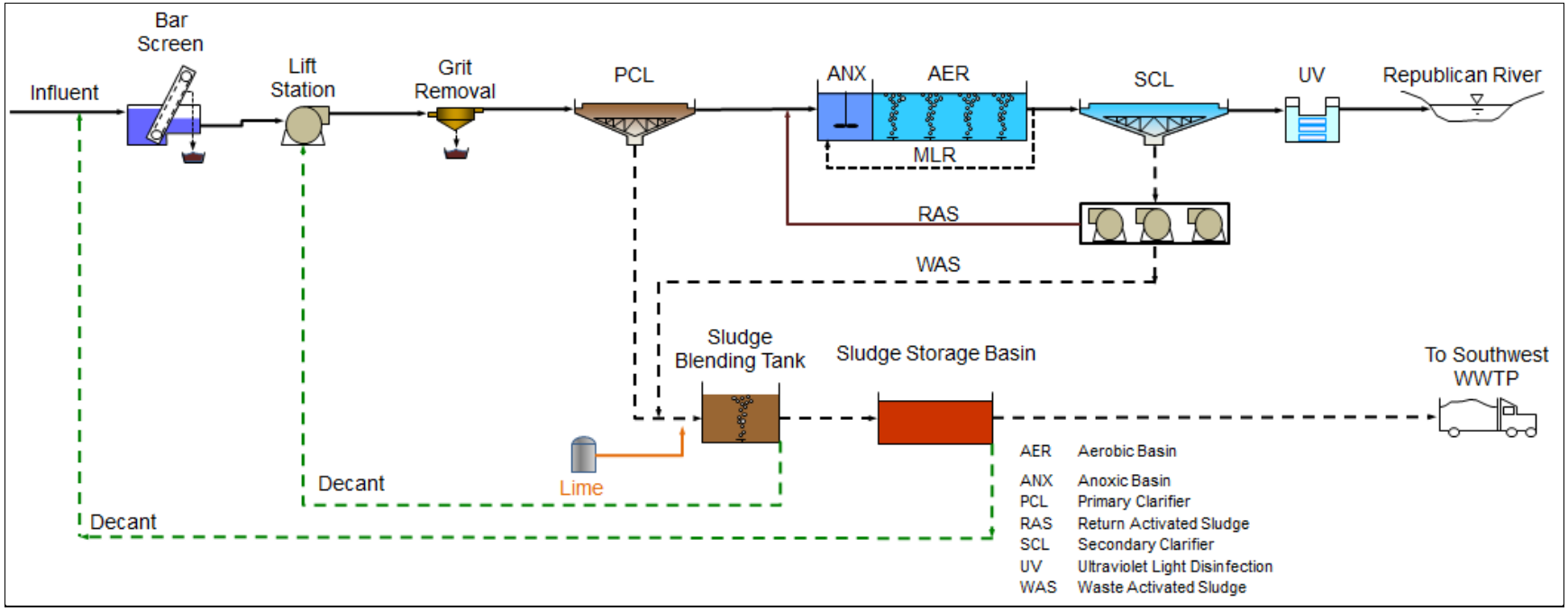


Figure 2-2: East WWTP Process Flow Diagram

2.2.1 Preliminary Treatment

The East WWTP pretreatment process includes two mechanical coarse bar screens, influent pump station consisting of three dry pit, centrifugal pumps, and a vortex grit chamber.

2.2.1.1 Mechanical Bar Screens

The mechanical bar screens are ½-inch John Meunier screens and are located in the same complex as the influent pump station. Each screen is sized for a peak flow of 7 MGD. The mechanical bar screens remove trash, rags, and large solids. The screened solids are conveyed to a dumpster for landfill disposal.

2.2.1.2 Influent Pump Station

The screened wastewater flows by gravity to the influent pump station wet well. The three dry pit, centrifugal pumps convey wastewater from the wet well to the vortex grit chamber. The pumps are Flygt dry pit centrifugal pumps with a firm capacity of 10.5 MGD and firm capacity of 7.0 MGD at a total dynamic head (TDH) of 34.5 feet. Two of the pumps use variable frequency drives with a third constant speed pump to accommodate peak flows.

2.2.1.3 Vortex Grit Removal

The Mectan vortex grit unit has a rated flow capacity of 7.0 MGD and uses rotating paddles to keep organic solids in suspension while settling out the grit. The settled grit is conveyed to a dewatering screw and dumpster for landfill disposal. The liquid removed in the dewatering screws flows through a decant drain system to the influent pump station wet well.

2.2.2 Primary Treatment

Following grit removal, the wastewater flows into a splitter structure that splits flow between the two primary clarifiers. Each clarifier has a diameter of 70 feet, sidewater depth of 7.5 feet, and has a peripheral weir and covered weir launders. There are three pumps for primary sludge and scum removal. Grinders are located upstream of the pumps to breakdown rags and large solids that could damage the pumps.

The primary effluent flows from the primary clarifiers to the aeration basin splitter box. The aeration basin splitter box can be configured to discharge to the anoxic basin or bypass the anoxic basin and direct flow to the aeration basins.

2.2.3 Secondary Treatment

Secondary treatment consists of an anoxic selector, aeration basins, final clarifiers, and UV disinfection. Key equipment in secondary treatment includes the anoxic basin surface mixer, blowers for the aeration basins, return and waste activated sludge pumps.

2.2.3.1 Anoxic Basin

The 0.25 MG anoxic basin acts as a selector to reduce growth of filamentous organisms, and provides some nitrogen removal through denitrification. A 10 HP direct drive surface mixer in the basin is used for

mixing. Sludge recycle from the secondary clarifiers is pumped via the RAS pumps, into the anoxic basin. Anoxic basin effluent flows to the aeration basins.

2.2.3.2 Aeration Basins

Effluent from the anoxic basin is mixed and aerated in the aeration basins to biologically remove BOD and convert ammonia-nitrogen to nitrate-nitrogen. There are two aeration basins, each with a volume of 0.46 MG and water depth of 16 ft. There are three 150 HP blowers with a total aeration capacity of 5,000 cfm @ 8.25 psi that supplies air to a grid of fine bubble disc diffusers. Effluent from the aeration basins flows to the secondary clarifiers. Aeration basin effluent flow is split to the clarifiers by a splitter structure integral to each basin.

2.2.3.3 Secondary Clarifiers

Effluent from the aeration basins gravity flows to two secondary clarifiers each with a diameter of 80 ft. and a water depth of 12 ft. Three return activated sludge (RAS) pumps, each with a capacity of 1.85 MGD, operate on manually controlled VFDs and send a portion of the settled sludge to the anoxic basin. Two waste activated sludge (WAS) pumps each with a capacity of 400 gpm remove sludge from the activated sludge system to the sludge blending tank and the solids treatment system. Floatables and scum from the clarifiers are pumped to the sludge blending tank with a 2 HP scum pump. Clarified effluent flows from the secondary clarifiers to the UV disinfection building.

2.2.3.4 Ultraviolet Disinfection

Effluent from the secondary clarifiers flows to the ultraviolet units for disinfection. The UV disinfection unit uses ultraviolet light to inactivate pathogens. The two channel UV disinfection system has a capacity of 7.0 MGD, 3.5 MGD capacity per channel. The effluent from the UV units is discharged to the Republican River.

2.2.4 Biosolids Treatment Process

The biosolids treatment process for the East WWTP includes one sludge blending tank, a lime feed system, and a sludge loading station. Under the current operational strategy the treated and thickened sludge is sent to the Southwest WWTP for storage prior to land application.

2.2.4.1 Sludge Blending Tank

Solids from the primary and secondary clarifiers are conveyed to the 58,750 gallon sludge blending tank. The sludge blending tank receives a lime slurry solution, to raise the pH to a minimum of 12. The tank is mixed by coarse bubble diffused aeration for a minimum two hours to meet pathogen reduction and vector attraction requirements to achieve a Class B sludge. The stabilized sludge is transferred by one of the two sludge blending tank transfer pumps, each with a rated capacity of 220 gpm, to one of three sludge storage basins. The sludge blending tank can also be allowed to settle and decanted for thickening. The decant flows directly to the influent pump station wet well.

2.2.4.2 Sludge Storage Tanks

The three sludge storage tanks, with capacities of 217,250 gallons, 217,250 gallons, and 255,000 gallons, store the lime stabilized sludge until transfer for disposal. Each sludge storage tank has coarse bubble diffusers for mixing. The sludge storage tanks are also used to settle and thicken the biosolids. The sludge storage tank decant is returned to the influent pump station wet well.

2.3 SOUTHWEST WWTP TREATMENT PROCESS

The Southwest WWTP was built in 1996 and its most recent upgrade was in 2006. An aerial view of the Southwest WWTP is shown in Figure 2-3. The Southwest WWTP is rated to treat a 2.5 MGD average design flow and a 5.5 MGD peak flow. The Southwest WWTP has been built primarily to handle industrial waste and has an industrial pretreatment train and a domestic pretreatment train. The plant is operated by Veolia Water under an operations contract with the City. The Southwest WWTP uses a rotary screen and a DAF system for industrial pre-treatment followed by an activated sludge system with an anoxic selector. Secondary effluent flows through a contact basin where chlorine is dosed for disinfection. Sodium bisulfite is used to remove residual chlorine. After lime treatment, biosolids from the East WWTP are transported to the Southwest WWTP and combined with Southwest WWTP waste solids in the sludge stabilization basins prior to land application. The process flow diagram for the Southwest WWTP is shown in Figure 2-4.

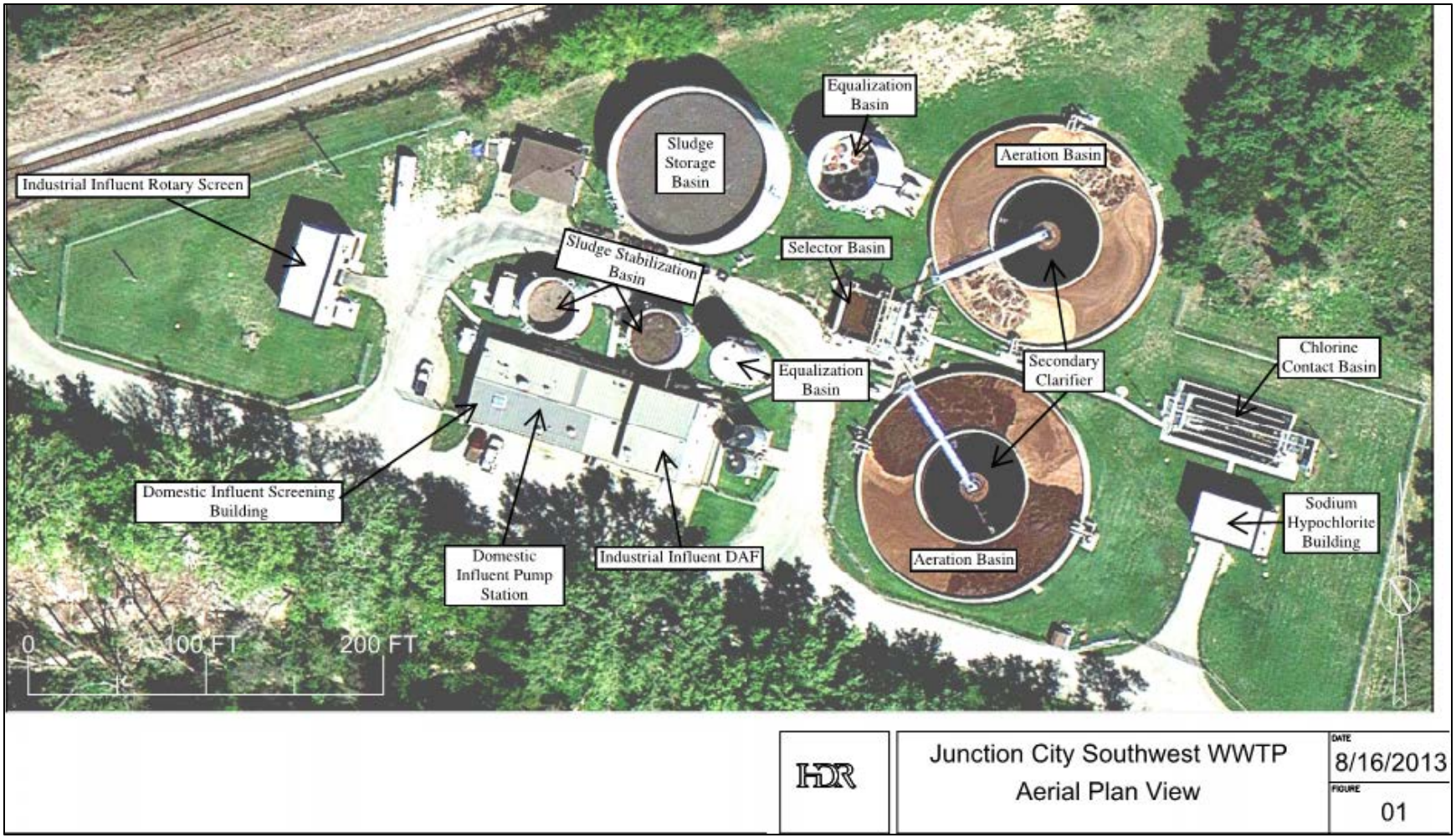


Figure 2-3: Southwest WWTP Aerial Plan View

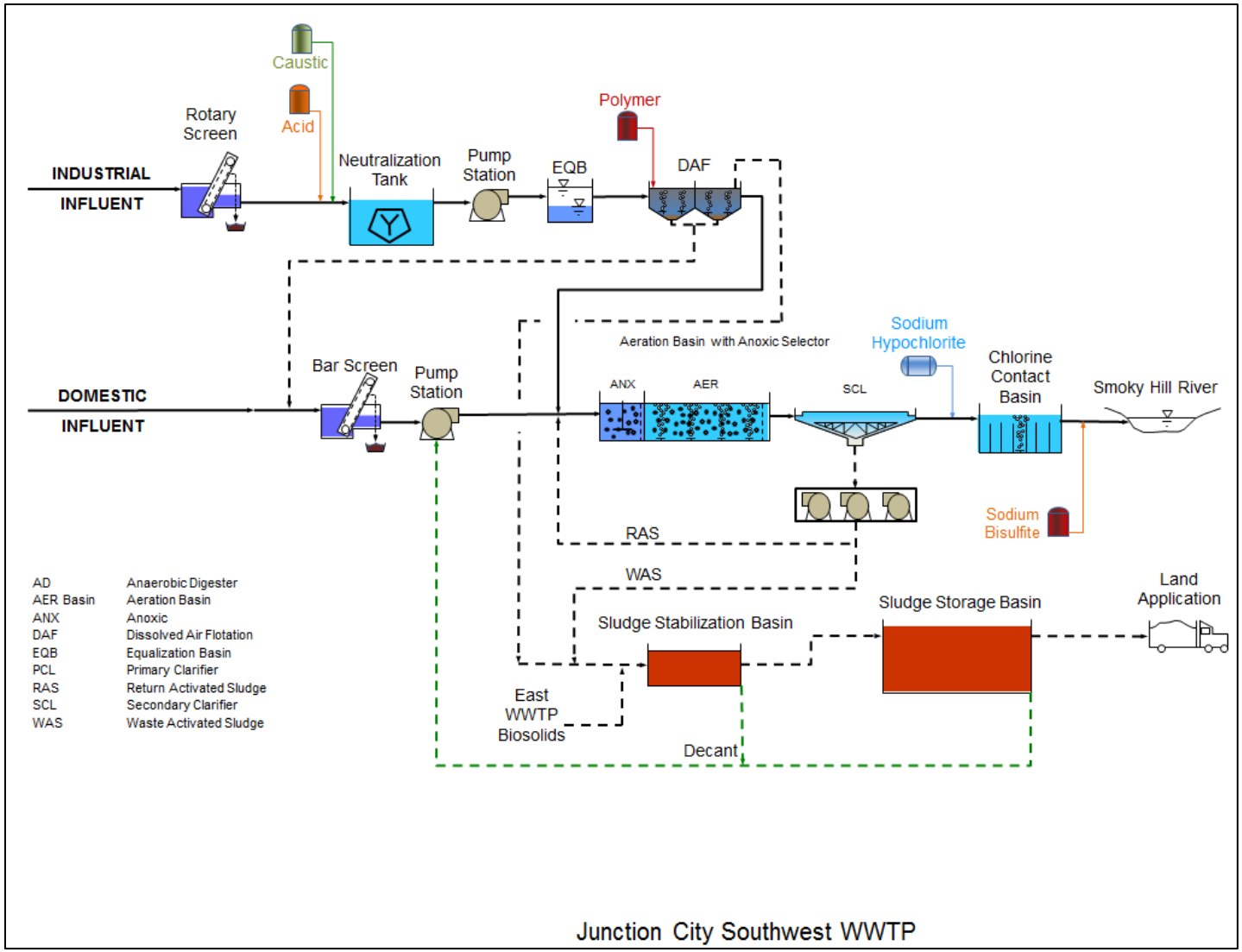


Figure 2-4: Southwest WWTP Process Flow Diagram

2.3.1 Industrial Pretreatment

The industrial primary pretreatment includes one rotary screen, one pH neutralization tank, pump station, two equalization basins, and two DAF units.

2.3.1.1 Rotary Screen

The industrial influent flows into the rotary screen with a screen opening size of 0.015 inches, where screenings are separated from the waste stream.. The rotary screen is rated for a peak flow capacity of 1.0 MGD. Hot water sprayers in the rotary screen help prevent blinding by grease. The screened solids are conveyed to a dumpster for disposal. The screened wastewater flows to the pH neutralization tank.

2.3.1.2 Neutralization Tank

The 1,218 gallon neutralization tank is used to adjust the pH of the incoming screened industrial influent. The neutralization tank was designed to receive sulfuric acid and caustic feed from the existing chemical storage building where the chemicals and feed pumps are stored. The pH for normal operation is designed to vary between 6.5 and 7.5 but during sanitation and cleaning shifts at night at the industrial contributors the pH can increases to as high as 12.5. If the screened industrial wastewater is not fully neutralized in the neutralization tank, additional pH adjustment can be performed in the equalization basins.

2.3.1.3 Industrial Influent Pump Station

The screened and pH neutralized industrial influent is conveyed from the neutralization tank to the industrial influent pump station. The pump station consists of a wet well and three dry pit pumps, each with a capacity of 350 gpm, and conveys the wastewater to the two equalization tanks. The influent pump station can also bypass the equalization tanks and send wastewater directly to the DAF units.

2.3.1.4 Equalization Basins

The equalization basins function as storage during peak flows and offers additional pH adjustment. Equalization Tank 1 has a working volume of 28,000 gallons and is mixed by submersible mixers and is currently out of service. Equalization Tank 2 has a working volume of 102,000 gallons and is mixed by coarse bubble aeration. Effluent from the equalization tanks flows by gravity to the DAF units.

2.3.1.5 Dissolved Air Flotation Units

The two 7,000 gallon DAF units consist of a flotation cell and a flocculation cell. Polymer is added in the flocculation cell of the DAF units to promote coagulation and flocculation of solids. Air is injected from the recycle line into the flotation cell of the DAF unit. The bubbles produced cling to particulate matter, oil, and grease and lift it to the surface creating float. The float is skimmed off the surface by a skimmer and is pumped by two float transfer pumps to the sludge stabilization basins. Coalescing tubes in the DAF also promote the settling of flocculated solids. A small volume of settled solids from the DAF may be collected. In the event settled solids are collected, the settled solids from the DAF unit flow to the domestic influent pump station and are combined with the domestic waste stream for further treatment. The DAF effluent wastewater flows to the selector basin where it is combined with the domestic wastewater stream.

2.3.2 Domestic Preliminary Treatment

The domestic preliminary treatment process includes a mechanical bar screen and the domestic influent pump station.

2.3.2.1 Mechanical Bar Screen

The mechanical bar screen is rated for a flow of 4.5 MGD and receives the domestic influent wastewater and decant from the sludge storage tanks. The mechanical bar screen removes trash, rags, and any large material and transports them to a dumpster for disposal. A bypass channel with a manually cleaned bar rack allows for the mechanical bar screen to be pulled out of service. The screened domestic wastewater then flows to the domestic influent pump station.

2.3.2.2 Domestic Influent Pump Station

The domestic influent pump station consists of four self-priming non-clog centrifugal pumps each with a capacity of 1,125 gpm, three duty pumps and an alternate. Screened domestic wastewater flows from the mechanical bar screens to the pump station. Occasionally, the settled solids from the DAF Units are emptied from the DAF Units and are sent to the domestic influent pump station. The screened wastewater is then pumped to the selector basin for secondary treatment.

2.3.3 Combined Secondary Treatment

The Southwest WWTP uses an anoxic selector basin, aeration basins, secondary clarifiers, and chlorine disinfection secondary treatment.

2.3.3.1 Anoxic Selector Basin

The 94,000 gallon selector basin receives the domestic primary treated effluent, industrial primary treated effluent, and the return activated sludge (RAS) from the secondary clarifiers. The selector basin is important to reduce the growth of filamentous organisms and provides some denitrification for nitrogen removal. Effluent from the selector basin is conveyed to the aeration basins. The current operational strategy has all of the selector basin effluent diverted to the north aeration basin.

2.3.3.2 Aeration Basins

The two aeration basins, each with a volume of 1.24 MG, provide for removal of BOD and convert ammonia to nitrate-nitrogen. The aeration basins and the secondary clarifiers share a common structure in a "bullseye" configuration with the aeration basin in the outer circle and the secondary clarifiers in the center. Effluent from the selector basin flows into the aeration basin and is aerated by two Jet Aeration pumps, each with a capacity of 5,124 GPM at 18 FT TDH. The Jet Aeration pumps are supplied by four common blowers, each 100 HP and 1,250 SCFM. The dissolved oxygen concentration (DO) in the tank is measured by two DO probes. Effluent from the aeration basins flows to the secondary clarifiers.

2.3.3.3 Secondary Clarifiers

The secondary clarifiers are located at the center of the donut shaped aeration basins and have a diameter of 60 FT and sidewater depth of 12 FT. The mixed liquor flows into the center of the clarifier at the bottom of the tank. The solids are allowed to settle and are raked to a center sump by the sweeper arms. The

settled solids form a 1 to 2 FT deep sludge blanket at the bottom of the clarifier. The sludge is then pumped via RAS pumps and WAS pumps to either the anoxic basin or sludge stabilization basins. The return activated sludge (RAS) is pumped by 2 submersible pumps with a capacity of 1,200 gpm each at 12 ft. TDH. The waste activated sludge (WAS) is pumped by 2 submersible pumps with a capacity of 250 gpm each at 45 ft. TDH. The clarified effluent flows over the effluent weirs into the launder and then to the chlorine contact basin. Scum is collected from the top of the tanks by a skimmer arm and is pumped via the scum pump to the sludge stabilization tanks.

2.3.3.4 Chlorine Contact Basin

Effluent from the secondary clarifiers flows to the chlorine contact basin, which provides a contact time of 15 minutes at 5.5 MGD. Sodium hypochlorite is dosed to the contact basin for disinfection. At the end of the contact basin, sodium bisulfite is added to dechlorinate the water prior to discharge to the Smoky Hill River.

2.3.4 Biosolids Treatment

The current biosolids treatment train includes two sludge stabilization basins, lime feed system and a sludge storage basin. The current operation of the biosolids treatment process differs from the original design approach.

2.3.4.1 Sludge Stabilization Basins and sludge storage basin

The sludge from the DAF and the secondary clarifiers are pumped to the two, 100,000 gallons sludge stabilization basins. The sludge stabilization basins are equipped with two, 7.5 HP submersible mixers each to mix the sludge. A lime feed system is installed, but is currently not operational. The lime feed system is intended to be used to stabilize the sludge. The sludge is pumped from the sludge stabilization basins by three sludge transfer pumps, each with a capacity of 600 GPM, to the sludge storage basin. The sludge storage basin is equipped with Jet Aeration Mixers. The 1.33 MG sludge storage basin has an internal diameter of 90 FT and a maximum sidewater depth of 28 ft.

Under the current operational strategy, lime stabilization is not being used. The lime feed system would require repairs and equipment replacement to return the lime feed system to operation. Thickened sludge from the East WWTP is combined with biosolids from the SW WWTP in sludge stabilization basin 1. In 2005, the south aeration basin started being used for WAS aeration. The WAS pumps convey the secondary clarifier solids to the south aeration basin where WAS is aerated. The aerated WAS then flows to the secondary clarifier where it is thickened. The Kansas Department of Health and Environment had indicated that the use of the south aeration basin for WAS aeration was temporarily allowed while new sludge stabilization basins were being built, but this application could not be applied as a permanent solution. Biosolids meet regulatory requirements based on pathogen and specific oxygen uptake rate testing results.

3 WASTEWATER FLOWS AND LOADS

3.1 INTRODUCTION

The wastewater flows and organic loads provide the primary criteria that act as the sizing basis for designing and constructing wastewater treatment processes. As a result, design flows and loads must be developed prior to sizing of future facilities. Historical plant data provide a basis for development of flows and loads criteria along with population projections and industrial growth expectations. For Junction City, flows and loads projections have recently been performed as part of the Wastewater Facilities Master Plan completed by Burns and McDonnell in 2008 and as part of the Nutrient Removal Study completed by Olsson Engineering in 2012.

In this section, the flows and loads data from the last three years are evaluated, the previous design flows and loads that were previously developed are summarized, and the design flows and loads for this project are identified based on the reports and recent data.

3.2 HISTORICAL FLOWS AND LOADS

3.2.1 East WWTP

East WWTP data have been reviewed and evaluated. The influent data reflect composite samples taken from the headworks building, which includes influent flow and decant flow returned to the influent. The past three years of flow data for the East WWTP are shown in Figure 3-1. Over the three year time period, the total flow appears to have remained relatively constant with a slight reduction. Note that the flow is normally distributed.

Figure 3-2 presents BOD5 loading to the East WWTP for January 2010 through December 2012. During this period, the BOD5 load was between 2,000 and 8,000 lb/d typically with the average annual load of 4,370 lb/d and the maximum month load of 6,490 lb/d as shown in Table 4-1. The industrial BOD5 load varies considerably with an average annual value of approximately 1,440 lb/d and a maximum month load of roughly 3,510 lb/d.

Total suspended solids (TSS) data are shown in Figure 3-3 and Figure 3-4. The average annual and maximum month TSS loads for the WWTP are 4,510and 17,350 lb/d, respectively. Note, most data points for TSS are below 20,000 lb/d, but there is a set of outliers in July 2010 that has strongly skewed the data. This may reflect a high grit flow, an upset or WWTP return streams that affect the influent sampling; i.e. solids decant, tank drains, building drains, etc.

Ammonia loading data is shown in Figure 3-5. For ammonia, the average annual and maximum month loads are 610 and 960. The data are slightly more scattered and show a higher peaking effect for TSS than for flow, BOD5 or ammonia. Again, this may be due to internal return streams within the WWTP.

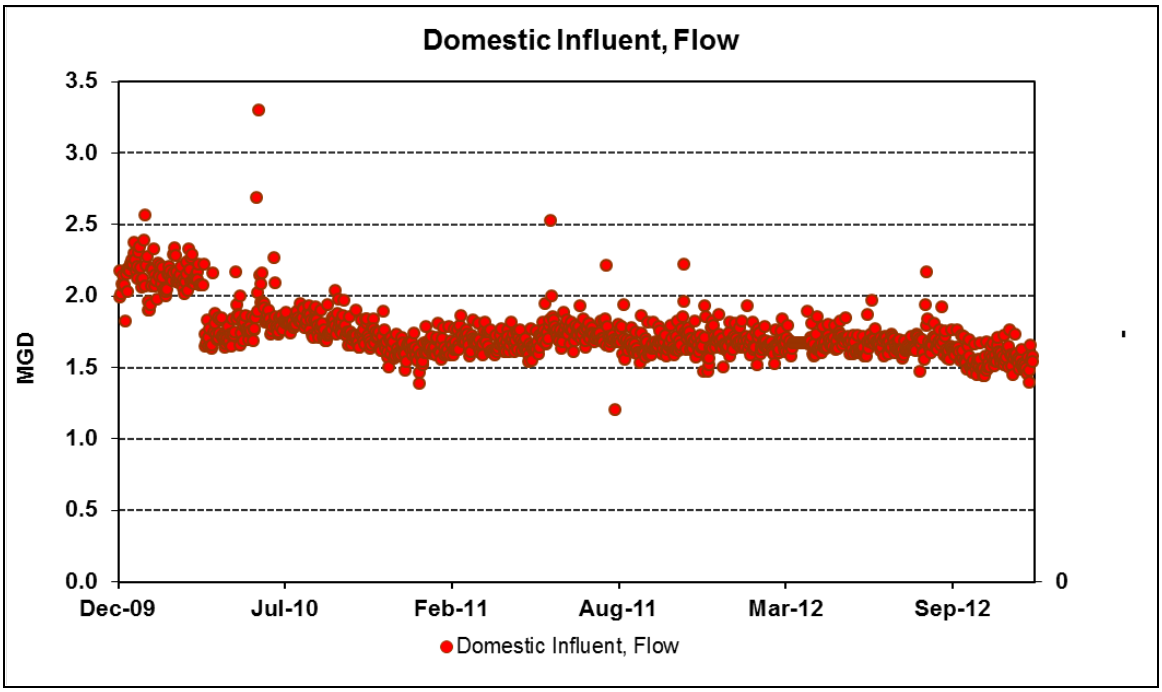


Figure 3-1: East WWTP Historical Flow Data

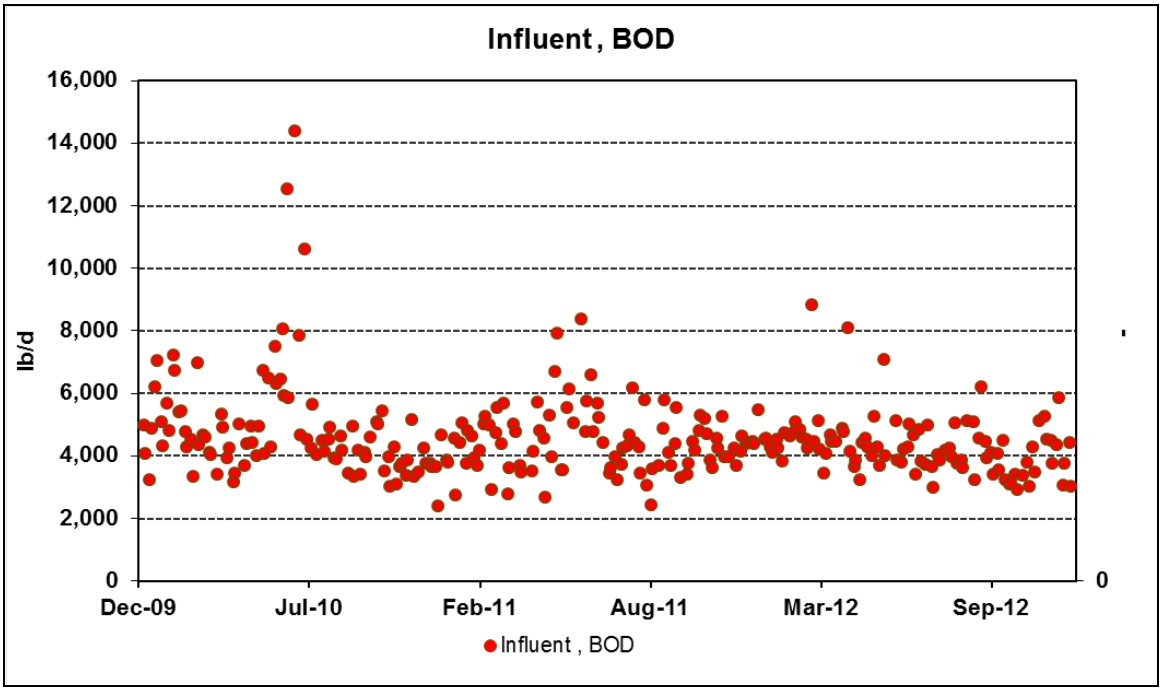


Figure 3-2: East WWTP Historical BOD_5 Load Data

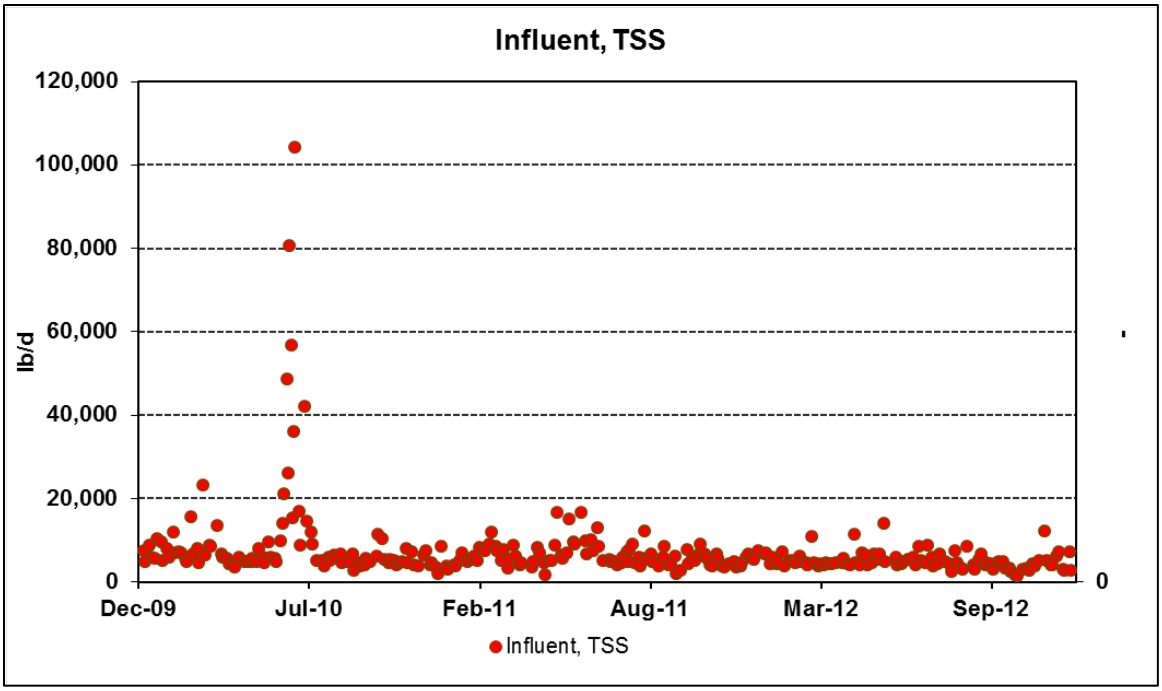


Figure 3-3: East WWTP Historical TSS Load Data Full Scale

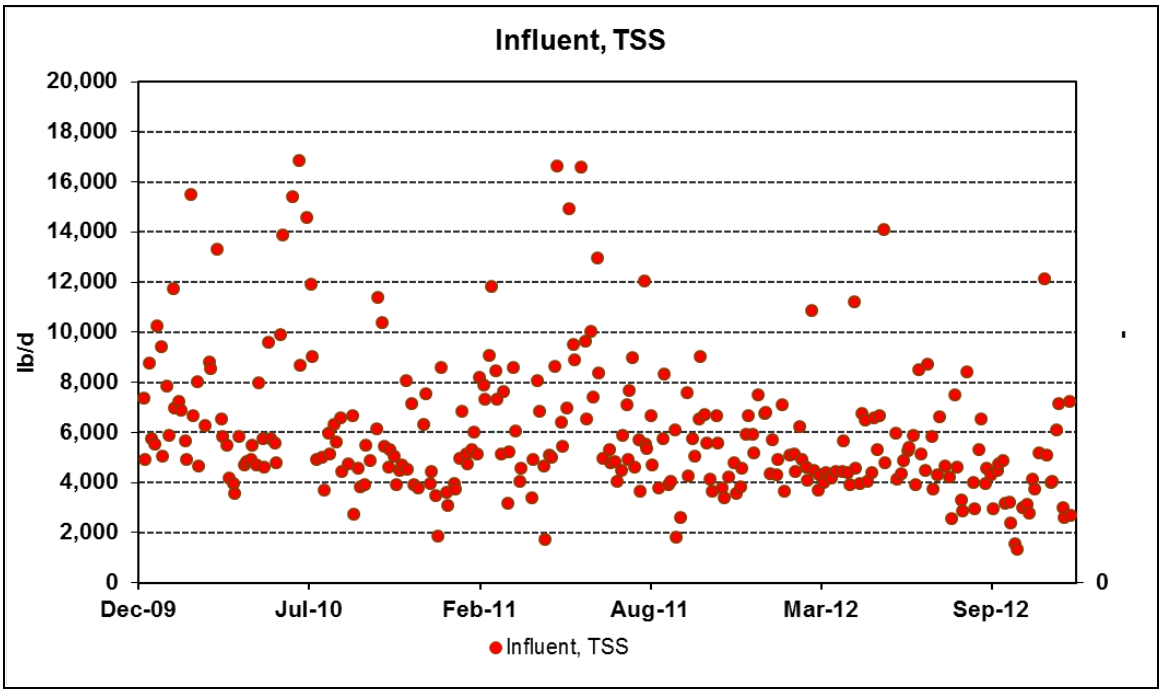


Figure 3-4: East WWTP Historical TSS Load Data Focus

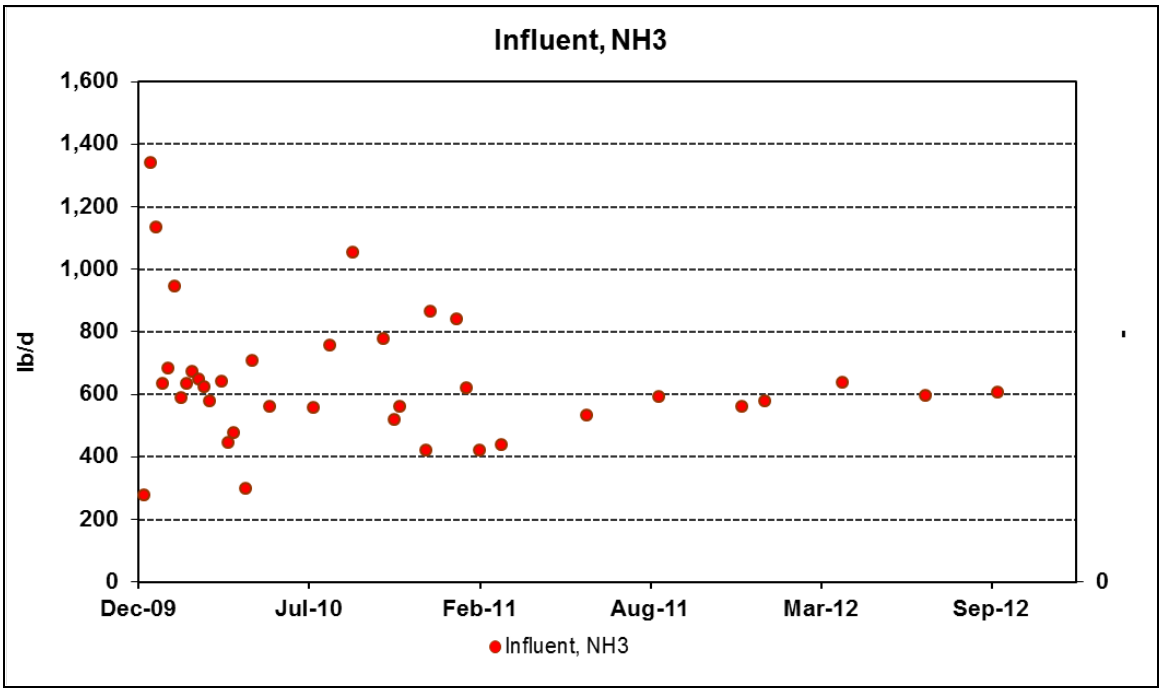


Figure 3-5: East WWTP Historical NH_3 Load Data

Table 3-1 presents a summary of influent flows and loads to the East WWTP; see Appendix A for details of the statistical methodology.

Influent flows and loads were calculated based on available plant operating data from January 2010 to December 2012. A statistical analysis was used to derive annual average, maximum month and maximum day values for influent flow rate, BOD5, and TSS and ammonia. The statistical approach reduces the influence of outlier data and provides a method to develop flows and loads.

Annual average, maximum month and maximum day are defined as the following (based on the aforementioned three-year data set):

- Average annual: Represents the 50% percentile (median) of occurrence or the average of one year.
- Maximum month: Represents the 91.7% (1/12) percentile of occurrence.
- Maximum day: Represents the 99.7% (364/365) percentile of occurrence.

Table 3-1: East WWTP Summary of Flows and Loads

East WWTP		Average Annual	Maximum Month	Maximum Day	Peaking Factors	
					MM/AA	MD/AA
Domestic	Flow, MGD	1.7	2.0	2.3	1.16	1.34
	BOD, lb/d	4,370	6,490	9,680	1.49	2.22
	TSS, lb/d	4,500	17,400	67,400	3.84	14.91
	NH3, lb/d	610	960	1,500	1.57	2.46

3.2.2 Southwest WWTP

The past three years of flow data for the Southwest WWTP are shown in Figure 3-6 and Figure 3-7. Over the three year time period, the total flow appears to have remained relatively constant. When separated between industrial and domestic components, the trend shows a reduced industrial contribution with a gradual increase in the domestic contribution. Note that the industrial flow is not normally distributed, but instead is a split distribution. This appears to represent the difference between industry operating with one shift versus two shifts and operation during the work week versus the weekend.

Figure 3-7 presents BOD5 loading to the Southwest WWTP. The plot shows domestic and industrial loading components; total loading is limited, because most data points represent different days. The domestic BOD5 load is below 1,000 lb/d typically with the average annual domestic load of 295 lb/d and the maximum month domestic load of 985 lb/d as shown in Table 3-2. The industrial BOD5 load varies considerably with an average annual value of approximately 1,444 lb/d and a maximum month load of about 3,514 lb/d. The TSS data are shown in Figure 3-8, and the ammonia loading data are shown in Figure 3-9. The average annual TSS for the domestic and industrial streams are 206 and 813 lb/d, respectively.

For ammonia, the average annual domestic and industrial the data are slightly more scattered for TSS than for BOD5 or ammonia, which may be due to collection system grit that is released during storms. The ammonia loading data show relatively low average annual values with a total of only 76 lb/d, which represents an NH3:BOD5 ratio of 1:22; about one tenth of the typical value. On a per capita basis, the ammonia loading is only about 0.003 lb-N/ (capita*d), which is also about one tenth of the typical value.

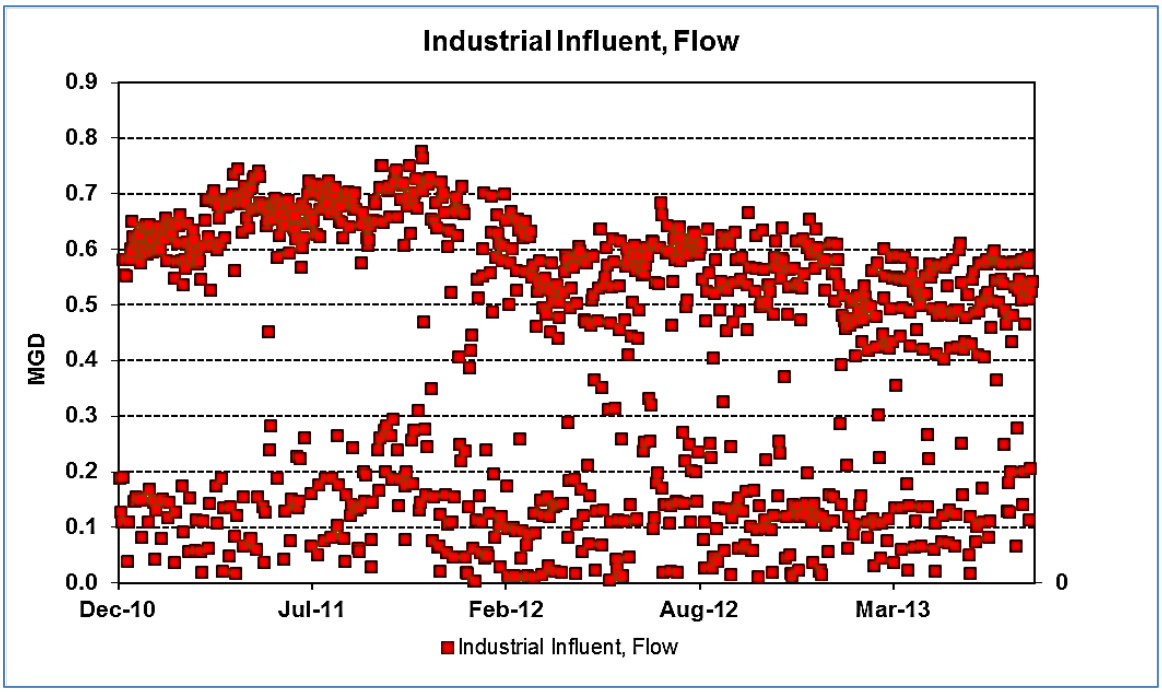


Figure 3-6: SW WWTP - Three Years Historical Industrial Flows

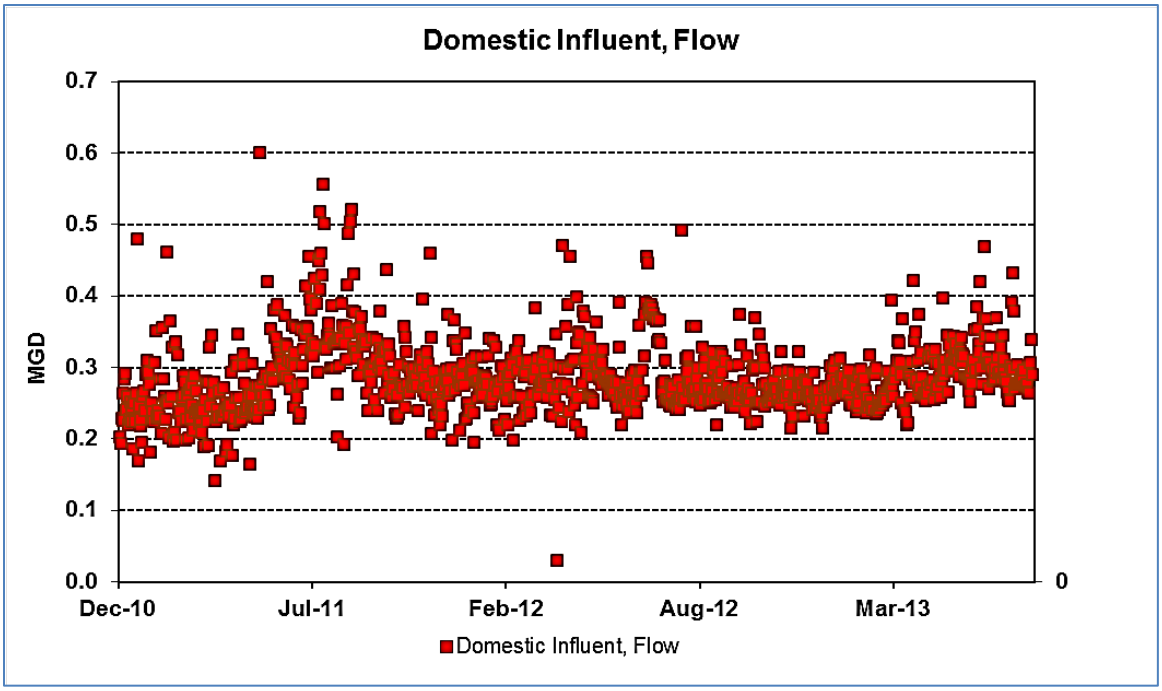


Figure 3-7: SW WWTP - Three Years Historical Domestic Flows

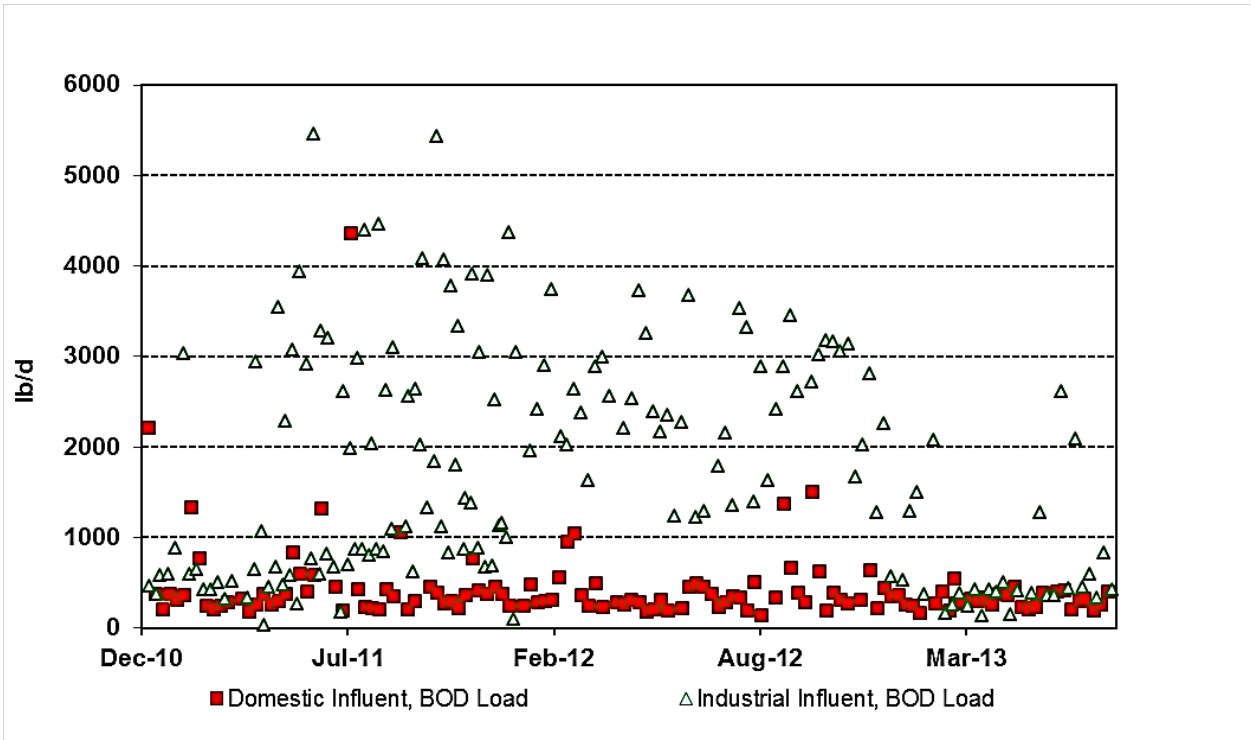


Figure 3-8: SW WWTP - Three Years Historical BOD_5 Loading

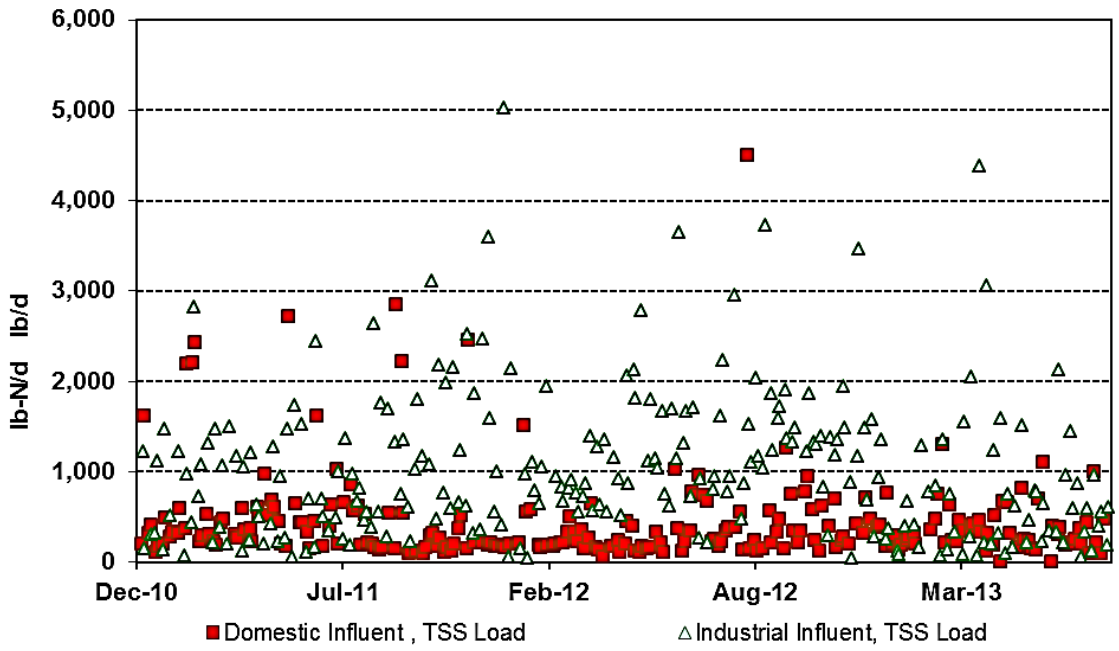


Figure 3-9: SW WWTP - Three Years Historical TSS Loading

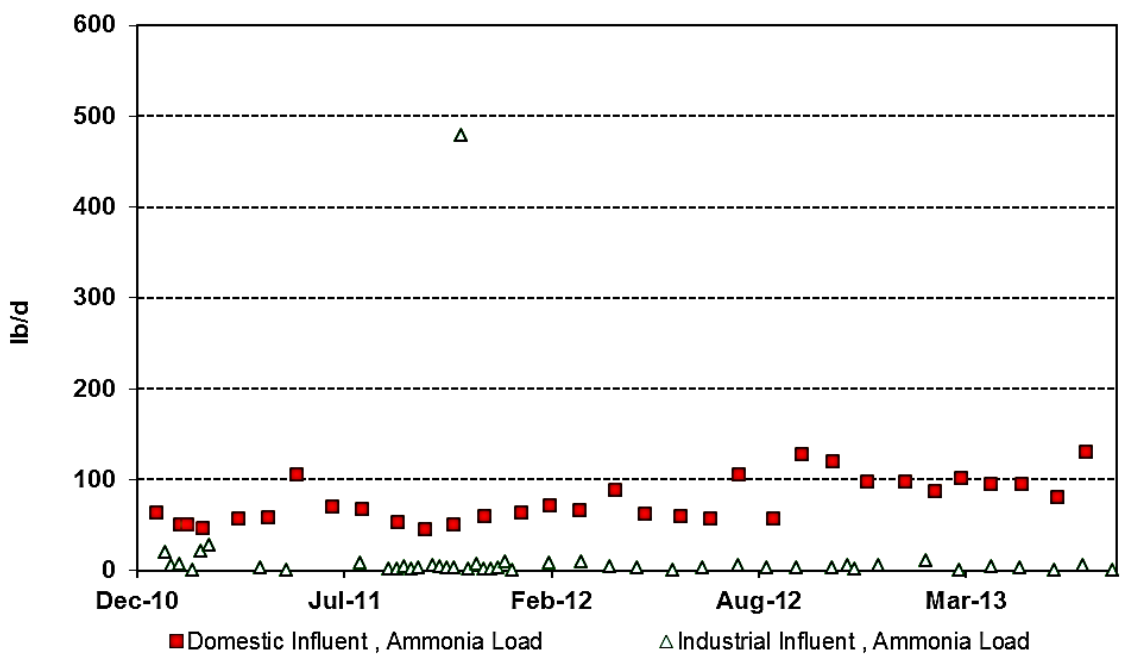


Figure 3-10: SW WWTP - Three Years Historical Ammonia Loading

Table 3-2 presents a summary of influent flows and loads to the Southwest WWTP developed using the statistical approach previously presented. See Appendix A for details of the statistical methodology.

Table 3-2: SW WWTP Summary of Flows and Loads

Southwest WWTP		Average Annual*	Maximum Month**	Maximum Day***	Peaking Factors	
					MM/AA	MD/AA
Domestic	Flow, MGD	0.28	0.36	0.47	1.29	1.68
	BOD, lb/d	300	990	3,320	3.33	11.22
	TSS, lb/d	210	1,350	8,920	6.54	43.38
	NH3, lb/d	70	112	175	1.55	2.42
Industrial	Flow, MGD	0.35	0.74	1.58	2.12	4.51
	BOD, lb/d	1,440	3,510	8,610	2.43	5.96
	TSS, lb/d	810	2,120	5,570	2.61	6.85
	NH3, lb/d	3	37	431	11.36	131.47
Total	Flow, MGD	0.63	1.1	2.05	1.75	3.25
	BOD, lb/d	1,740	4,500	11,930	2.59	6.86
	TSS, lb/d	1,020	3,470	14,490	3.4	14.23
	NH3, lb/d	76	149	606	1.98	8.02

Note: Dataset from December 2010 to July 2013.
*Average annual values based on median statistical value
**Maximum month values based on 91.7th percentile non-exceedance value
***Maximum day values based on 99.7th percentile non-exceedance value

3.3 FLOWS AND LOADS PROJECTIONS – PREVIOUS WORK

Two previous engineering studies conducted for Junction City by Burns and McDonnell Master Plan (July 2008) and Olsson Associates (February 2013) presented design flows and loads for Junction City. Based on discussions with staff, the collection system Option 1 approach presented in the Master Plan represents the appropriate design conditions for both the East and Southwest WWTPs. The previously projected flows and loads for Option 1 are reproduced in Table 3-3 and Table 3-4 of this report for the East and Southwest WWTPs, respectively. These tables project domestic flows and loads based on a design year (2026) population of 33,159. Then, the industrial contribution to the Southwest WWTP is based on maintaining the current contribution from industry. In addition, Table 3-5 shows the projected activated sludge flows and loading after accounting for industrial pretreatment by the DAF process, which is proposed to be improved through this project. The projected flows and loads represent an increase in the domestic contribution that can be attributed to growth. The projected industry flow is consistent with the data. Peaking values are similar except for East WWTP TSS, which relates to solids return streams.

Table 3-3: East WWTP, 2026 Option 1 - Design Flows and Loads
(Burns and McDonnell, 2008)

Parameter	Average Day	Maximum Month	Maximum Day	Peak Hour	Peaking Factors	
					MM/AA	MD/AA
Flow, MGD	2.82	3.44	6.94	7.90	1.22	2.46
BOD_5, lb/d	5,200	8,600	11,700	-	1.65	2.25
TSS, lb/d	5,200	8,800	12,200	-	1.69	2.35
TKN, lb/d	940	1,200	1,400	-	1.28	1.49
TP, lb/d	80	110	130	-	1.38	1.63

Table 3-4: Southwest WWTP, 2026 Option 1 - Design Flows and Loads
(Burns and McDonnell, 2008)

Parameter	Average Day	Maximum Month	Maximum Day	Peak Hour	Peaking Factors	
					MM/AA	MD/AA
Flow, MGD	1.33	1.76	3.04	3.50	1.32	2.29
BOD_5, lb/d	11,600	17,600	23,500	-	1.52	2.03
TSS, lb/d	9,100	13,800	18,600	-	1.52	2.04
TKN, lb/d	780	1,100	1,400	-	1.41	1.79
TP, lb/d	363	527	670	-	1.45	1.84

Table 3-5: Southwest WWTP, 2026 Option 1 - Activated Sludge System Design Flows and Loads
(Burns and McDonnell, 2008)

Parameter	Average Day	Maximum Month	Maximum Day	Peak Hour
Flow, MGD	-	1.76	3.04	-
BOD_5, lb/d	-	13,100	17,500	-
TSS, lb/d	-	8,200	11,100	-
TKN, lb/d	-	1,000	1,300	-
TP, lb/d	-	480	610	-

Table 3-6 shows the design flows and loads for the Southwest WWTP used by Olsson Associates for the nutrient study they conducted. The report focused on average annual values, which were higher for flow, BOD5 loading, TSS loading, and TKN loading than projected in the Wastewater Master Plan. Phosphorus loading, on the other hand, was less than the value in the Wastewater Master Plan.

Table 3-6: Southwest WWTP, Design Flows and Loads (Olsson Associates)

Parameter	Average Day	Maximum Month	Maximum Day	Peak Hour
Flow, MGD	2.50	-	3.05	-
BOD_5, lb/d	13,387	-	-	-
TSS, lb/d	11,370	-	-	-
TKN, lb/d	921	-	-	-
TP, lb/d	250	-	-	-

3.4 POPULATION PROJECTIONS

Population projections have been performed previously as part of the Burns and McDonnell Wastewater Master Plan (July 2008). As shown in Figure 3-11, the past population (blue triangle) and projected population (red square) were projected along a linear growth trend in the Wastewater Master Plan to a 2026 population of 33,159. The population projection was revisited as part of the current work due to an decreasing of growth at Fort Riley. The updated 2026 population project is 26,937 as shown in the figure (purple circle).

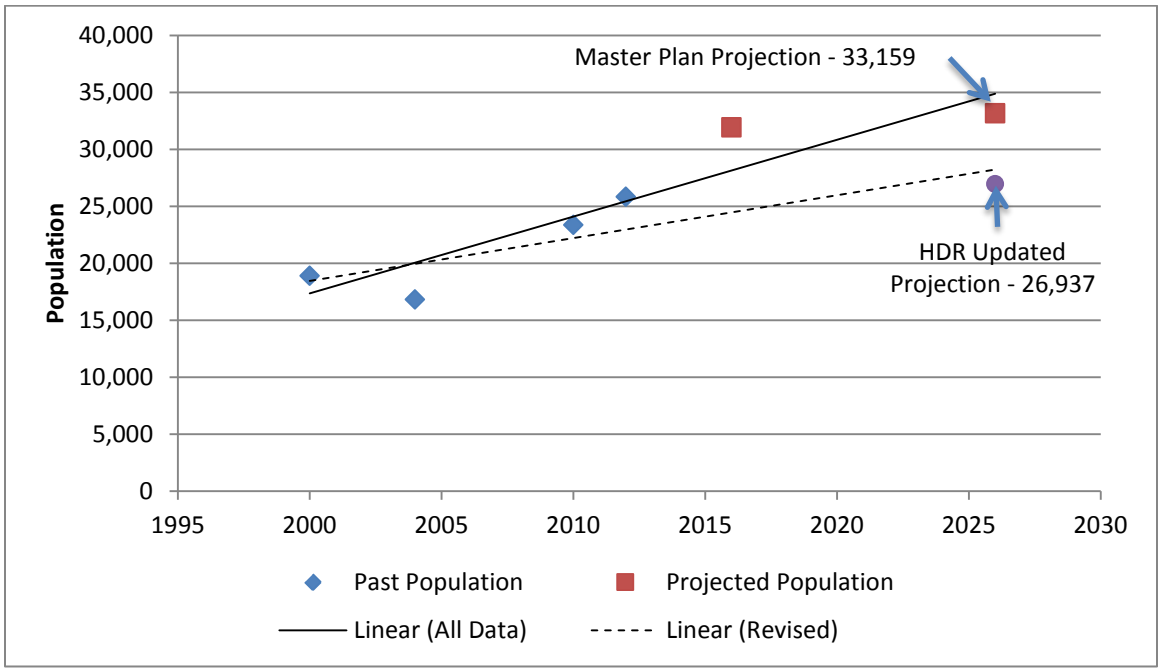


Figure 3-11: Population Projections

3.5 DESIGN FLOWS AND LOADS

3.5.1 East WWTP

Based on the review of historical flows and loads, previous design flows and loads, and after revising the population projection, design flows and loads have been determined as the basis for this project. For the East WWTP, the Option 1 flows and loads from the Wastewater Master Plan were adjusted based on the projected population reduction (Table 3-7). Maximum month, maximum day, and peak hour flows and loads have been developed based on the peaking factors applied in the Master Plan.

Table 3-7: East WWTP, 2026 Design Flows and Loads

Parameter	Average Day	Maximum Month	Maximum Day	Peak Hour
Flow, MGD	2.20	2.68	5.41	6.16
BOD, lb/d	3,830	6,330	8,620	-
TSS, lb/d	3,830	6,480	8,990	-
TKN, lb/d	730	930	1,090	-
TP, lb/d	60	80	100	-

For the Southwest WWTP, the flows and loads from the Wastewater Master Plan remain the basis for design (Table 3-4). As indicated in Sections 3.5.2 and 3.5.3, these flows and loads were further broken down into the domestic and industrial components as described in the next two subsections.

3.5.2 Southwest WWTP Domestic Flows and Loads

The domestic component of the average day flows and loads has been determined on the basis of per capita loading values (Table 3-8); as discussed in the Wastewater Master Plan. The per capita values for flow, BOD5 loading, TSS loading, TKN loading, and TP loading are 100 gpd/person, 0.22 lb/d/person, 0.22 lb/d/person, 0.034 lb-N/d/person, and 0.0035 lb-P/d/person, respectively. The maximum month and maximum day flows and loads were then determined based on the peaking factors found from the data analysis in Table 3-2.

Table 3-8: Southwest WWTP, 2026 Design Domestic Flows and Loads

Parameter	Average Day	Maximum Month	Maximum Day
Flow, MGD	0.83	1.01	2.04
BOD, lb/d	1,830	2,940	3,950
TSS, lb/d	1,830	2,890	4,050
TKN, lb/d	280	350	400
TP, lb/d	30	60	70

3.5.3 Southwest WWTP Industry Flows and Loads

In order to size the Southwest WWTPs industrial pretreatment facility properly, the design flows and loads for the industrial component of the overall flows and loads must be developed. In order to do this, the flows and loads in the Wastewater Master Plan were evaluated by subtracting the domestic component from the total flows and loads. The result of the calculation is shown in Table 3-9. Note that a flow of 0.5 MGD represents one shift and a flow of 1.0 MGD represents two shifts at the industry

Table 3-9: Calculated Southwest WWTP, Industrial Flows and Loads

Parameter	Average Day	Maximum Month	Maximum Day
Flow, MGD	0.50	0.75	1.00
BOD, lb/d	9,770	14,660	19,540
TSS, lb/d	7,270	10,910	14,540
TKN, lb/d	500	750	1,000
TP, lb/d	310	450	600

3.5.4 Southwest WWTP Secondary Influent Flows and Loads

An important design flow and load condition to consider is for the influent stream to the secondary, biological process at the Southwest WWTP. In order to determine the secondary design flows and loads, the industrial pretreatment process performance must be estimated. This estimation has been completed as shown in Section 8.1.2.3. The resulting DAF process effluent is shown in Table 3-10. When combined with domestic flow, the two streams sum to the secondary treatment design influent flows and loads (Table 3-11). The secondary design influent flows and loads represent a decreased projected BOD5 and TSS loading compared to the Wastewater Master Plan (Table 3-5) due to a projected improvement in the performance of the DAF process resulting from the replacement of the DAFs with properly sized units.

Table 3-10: Southwest WWTP DAF Effluent*

Parameter	Average Day	Maximum Month	Maximum Day
Flow, MGD	0.47	0.72	0.96
BOD, lb/d	3,440	5,230	6,970
TSS, lb/d	2,410	3,670	4,890
TKN, lb/d	420	650	870
TP, lb/d	280	410	550

* Operation as physical DAF (no chemical addition)

Table 3-11: Southwest WWTP Secondary Influent Design Flows and Loads

Parameter	Average Day	Maximum Month	Maximum Day
Flow, MGD	1.30	1.73	3.00
BOD, lb/d	5,270	8,170	10,920
TSS, lb/d	4,240	6,560	8,940
TKN, lb/d	700	1,000	1,270
TP, lb/d	310	470	610

4 PERMIT LIMITS

4.1 EXISTING PERMIT LIMITS

The existing operating permit for the East WWTP authorizes discharge into the Republican River and was issued effective October 1, 2012, and it expires on December 31, 2016. Table 4-1 summarizes the discharge limits. The BOD5 and TSS limits are technology based limits. The ammonia limit is a water quality based limit meant to protect Republic River water quality for both chronic (monthly) and acute (daily) toxicity. The monthly average limit for August represents the most stringent ammonia target at 2.4 mg-N/L. Finally, E. coli. limits show the need to disinfect year round with more stringent limits in the period from April to October.

Table 4-1: East WWTP NPDES Permit Limit Summary

Parameter	Monthly Average	Weekly Average	Daily Minimum	Daily Maximum
BOD_5, mg/L	30	45	-	-
TSS, mg/L	30	45	-	-
pH, SU	-	-	6.0	9.0
Ammonia, mg-N/L				
January	8.9	-	-	9.5
February	8.9	-	-	9.5
March	5.4	-	-	9.5
April	4.8	-	-	9.5
May	3.8	-	-	9.5
June	2.8	-	-	9.5
July	2.5	-	-	9.5
August	2.4	-	-	9.5
September	4.0	-	-	9.5
October	5.4	-	-	9.5
November	8.2	-	-	9.5
December	8.9	-	-	9.5
E. coli., CFU/100mL				
Nov. - Mar.	2,358	-	-	-
Apr. - Oct.	262	4,348	-	-
Chlorides	250	-	-	-
Sulfates	250	-	-	-

The Southwest WWTP operating permit authorizes discharge into the Smoky Hill River and is effective from January 1, 2010 through August 31, 2014 (Table 4-2). The permit summary shows technology based limits for BOD5 and TSS. Ammonia limits are based on water quality, but the limits are much less stringent than for the East WWTP with a low of 10.7 mg-N/L (monthly) in July and August. As with the East WWTP, year

round disinfection is required. In addition, there is an oil and grease limit listed with industry providing a large contribution of oil and grease to the facility.

Table 4-2: Southwest WWTP NPDES Permit Limit Summary

Parameter	Monthly Average	Weekly Average	Daily Minimum	Daily Maximum
BOD_5, mg/L	30	45	-	-
TSS, mg/L	30	45	-	-
pH, SU	-	-	6.0	9.0
Ammonia, mg-N/L				
January	16.1	-	-	16.1
February	16.1	-	-	16.1
March	16.1	-	-	16.1
April	16.1	-	-	16.1
May	16.1	-	-	16.1
June	13.2	-	-	16.1
July	10.7	-	-	16.1
August	10.7	-	-	16.1
September	14.5	-	-	16.1
October	16.1	-	-	16.1
November	16.1	-	-	16.1
December	16.1	-	-	16.1
E. coli., CFU/100mL				
Nov. - Mar.	2,358	-	-	-
Apr. - Oct.	262	-	-	-
Chlorides	600	-	-	720
Oil and Grease	10	-	-	15

4.2 FUTURE PERMIT REQUIREMENTS

In order to develop the engineering plan, future permit requirements must be considered. The most important permit change anticipated relates to nutrients. Effluent discharge of total phosphorus and total nitrogen are anticipated to be limited to 1.5 mg-P/L and 8 mg-N/L, respectively, at both facilities. Another permit change expected in the next permit is the ammonia limit. Based on new water quality criteria released by the EPA in August 2013, ammonia limits may drop by as much as 50 percent. While this is a significant change, in order to achieve the total nitrogen limit, the target ammonia concentration for design is less than 1 mg-N/L, which should meet future ammonia criterion. No other differences are anticipated in future permits at this time.

5 IMMEDIATE NEEDS

Immediate needs are extremely high priority equipment replacement projects necessary to maintain reliable and/or safe operation of the WWTPs. These projects need to be completed as soon as possible in order to avoid discharge permit violations and to protect operations staff, because of inadequate capacity or no redundancy remaining. Equipment to be replaced as immediate needs should be completed during the current fiscal year, 2013.

This section identifies immediate needs for both facilities. HDR has reviewed the immediate needs with City and Veolia staff, identified data requirements, and refined proposed improvement scopes. Following HDR's review and refinement of equipment supply proposals, Junction City will procure immediate needs equipment for installation by others.

5.1 EAST WWTP

Immediate needs for the East WWTP are shown in Table 5-1.

Table 5-1: Immediate Needs for the East WWTP

Process	Project/Equipment	Reason for Project
Headworks	Replace Gas Detection/Monitoring Equipment	Safety
Secondary Clarification	Replace Clarifier Bearing (1)	Replace failed bearing

5.2 SOUTHWEST WWTP

Immediate needs for the Southwest WWTP are shown in Table 5-2.

Table 5-2: Immediate Needs for the Southwest WWTP

Process	Project/Equipment	Reason for Project
Biosolids	Replace Sludge Stabilization Tank Mixers for Tanks #1 and #2 (2 each, 4 mixers total)	Reliability
Activated Sludge	Replace WAS Pump (1 of 2)	Reliability
Domestic Influent Pump Station	Replace Pumps (2 of 4)	Reliability
DAF	Replace DAF Recycle Pumps for Tanks #1 and #2 (1 each, 2 total)	Reliability
Disinfection	Replace Chlorine Dosing Pumps (3)	Safety/Reliability
Domestic Screening	Replace Gas Detection/Monitoring Equipment Replace room lighting	Safety
Industrial Screening	Improve Room Lighting	Safety
Industrial Screening	Replace Water Boiler – Rotary Screen	Reliability

6 NUTRIENT REMOVAL PLANNING

6.1 INTRODUCTION

The East and Southwest WWTPs have been evaluated to consider the improvements needed to meet the anticipated nutrient criteria indicated by KDHE. The wastewater simulator model Biowin™ has been used as part of the evaluation to aid in sizing of the secondary treatment basins. Biowin™ is a wastewater treatment process simulator that ties together biological, chemical, and physical processes into one model.

It is anticipated that more restrictive effluent limitations for ammonia will be implemented over upcoming NPDES permit cycles for both the East and Southwest WWTPs. There is not currently an effluent limit for nutrients (total nitrogen and/or total phosphorous), however a nutrient limit is anticipated to be included in future permits (Nutrient Removal Study by Olsson Engineering in 2012) and was included for the 2026 design year evaluation. Details of the future effluent limits are presented in Section 4.

Influent flows and loads have been evaluated based on the 2008 Wastewater Master Plan and available plant operating data from January 2011 through July 2013. Design flows and loads have been updated as discussed in Section 3.

Table 6-1 presents a summary of design flows and loads for nutrient removal processes at the East and Southwest WWTP as derived in Section 3 of this report.

Table 6-1: 2026 Design Year Influent Flows and Pollutant Concentrations

	East WWTP		Southwest WWTP*	
	Value	**Conc., mg/L**	**Value**	**Conc., mg/L**
Flow, MGD				
Average Annual	2.20	N/A	1.30	N/A
Maximum Month	2.68	N/A	1.73	N/A
Maximum Day	5.41	N/A	3.00	N/A
BOD_5, lb/d				
Average Annual	3,830	209	5,260	480
Maximum Month	6,340	283	8,170	570
Maximum Day	8,620	191	10,930	440
TSS, lb/d				
Average Annual	3,830	209	4,240	390
Maximum Month	6,480	290	6,560	450
Maximum Day	8,990	199	8,950	360

Table 6-1 cont…

	East WWTP		Southwest WWTP*	
	Value	**Conc., mg/L**	**Value**	**Conc., mg/L**
TKN, lb/d				
Average Annual	730	40	710	65
Maximum Month	930	42	1,000	69
Maximum Day	1,090	24	1,270	51
Total Phosphorous, lb/day				
Average Annual	58	3	314	29
Maximum Month	80	4	464	32
Maximum Day	95	2.1	589	23.5

*Flows and loads to the activated sludge system

6.2 NUTRIENT REMOVAL OVERVIEW

Conventional nitrogen removal is a multiple step process; nitrification converts ammonia nitrogen in the wastewater to nitrate nitrogen and denitrification converts nitrate nitrogen to nitrogen gas which is released into the atmosphere. Nitrification requires a method to accumulate the slow growing nitrifiers, adequate dissolved oxygen, adequate pH, and the absence of significant toxicity. Alkalinity is consumed as part of the biological process. Denitrification requires a large group of facultative, heterotrophic bacteria, an organic "substrate," and the addition of methanol or other carbon source in the absence of an available organic substrate BOD in the wastewater. Alkalinity is produced as a byproduct. Processes capable of removing nitrogen from wastewater are shown in Figure 6-1.

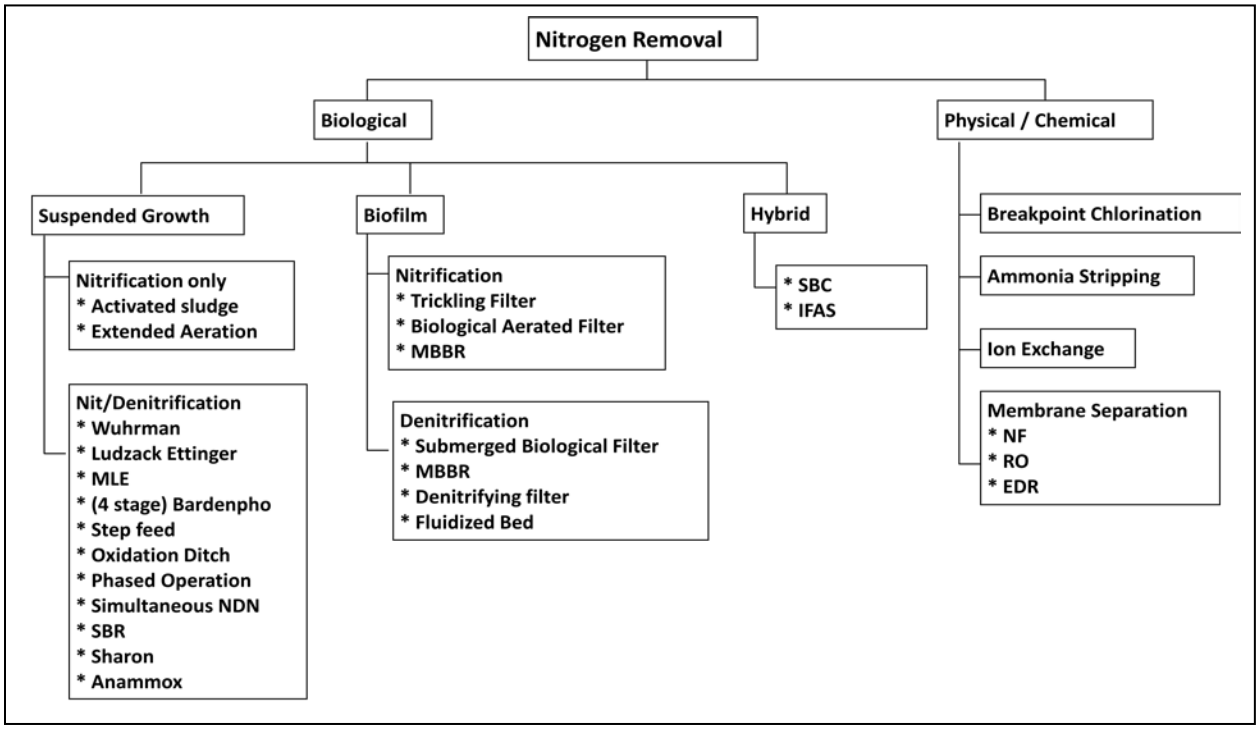


Figure 6-1: Nitrogen Removal Processes

Phosphorus reduction can be accomplished biologically or chemically. Biological phosphorus removal requires 1) an anaerobic then aerobic sequence, 2) an adequate supply of volatile fatty acids (VFAs) in the anaerobic zone, 3) no free oxygen, and no bound oxygen (nitrate). BOD5 and VFA are routinely added to stabilize the operation. If not present in adequate concentrations, VFAs can be added in a variety of forms including fermenter, chemical (acetate, readily biodegradable organics), and / or industrial waste products (cola sugar, glycerin, brewery). Accumulated phosphorous in the bacteria is removed from the treatment plant from biosolids wasted from the system.

Chemical phosphorus removal involves the precipitation of the soluble phosphorus and subsequent removal of the chemical solids. Phosphorus can be precipitated with metal salts such as alum, ferric chloride, or ferrous chloride or with calcium products like lime.

To precipitate phosphorus with calcium or lime, the pH must be increased above 10 to provide the excess hydroxide and carbonate ions needed to tie up the phosphorus. See chemical equation below. The amount of lime addition required is greatly dependent on the alkalinity of the wastewater. When lime is added to raw wastewater or secondary effluent pH adjustment, through recarbonation, is typically required prior to downstream processes. Because of this requirement and high solids production, calcium precipitation is not common and is not investigated as an alternative for this study.

$$10Ca^{2+} + 6PO_4^{3-} + 2OH^- \leftrightarrow Ca_{10}(PO_4)_6(OH)_2$$

Precipitation of phosphorus with aluminum and iron are based on the chemical equations below:

$$Al^{3+} + H_nPO_4^{3-n} \leftrightarrow AlPO_4 + nH^+$$

$$Fe^{3+} + H_nPO_4^{3-n} \leftrightarrow FePO_4 + nH^+$$

In these reactions one molecule of aluminum or iron will precipitate one molecule of phosphorus; however there are several competing reactions that must be considered for chemical dosing requirements. Because of these reactions complex models, like BioWin™ or bench scale tests are required to more accurately define the chemical addition requirements at various effluent targets. Processes capable of removing phosphorus from wastewater are shown in Figure 6-2.

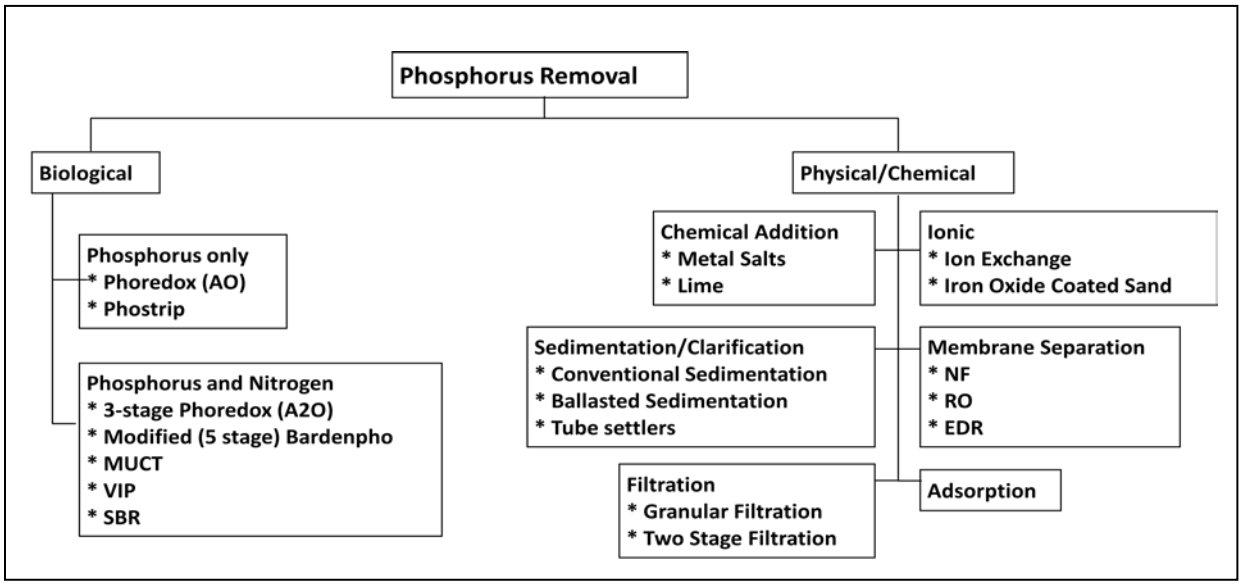


Figure 6-2: Phosphorous Removal Processes

6.3 EAST WWTP ALTERNATIVES ANALYSIS

The 2008 Wastewater Master Plan Report included evaluation of alternatives to provide nutrient removal to meet more stringent effluent limits in the future. The 2008 report included consideration of biological and chemical nutrient removal options. The recommended improvements included additional aeration and anoxic basin volume, recycle pumping and chemical storage and feed system.

The East WWTP uses a lime stabilization process for biosolids treatment that binds phosphorus to the biosolids and removes a portion of phosphorous from the solids treatment recycle stream back to the plant headworks. The anticipated phosphorous removal requirements can be achieved by the activated sludge and biosolids treatment process to meet the projected effluent limits. The data show low effluent phosphorus concentrations at the East WWTP already, which results from the existing waste stream characteristics and the use of lime stabilization for biosolids treatment. As a result of the already low effluent concentrations, it is recommended that chemical phosphorus removal using alum be provided and used as needed as a "polishing" step to meet phosphorus limits. Construction of additional basin volume and associated equipment for biological phosphorus removal would be much higher in cost and is not recommended for further evaluation. Nutrient removal at the East WWTP should be reevaluated if the use of lime stabilization with decant to headworks changes.

It is recommended that chemical phosphorus removal using alum be provided and used, as needed, as a polishing step to meet phosphorus limits.

6.3.1 Biological Nutrient Removal

In order to address total nitrogen limits, a biological process is needed. Upgrades to the existing system have been evaluated with the goal to utilize as much of the existing equipment and basins as practical. Therefore, this alternative uses biological nitrogen removal with chemical phosphorous removal. The system would be operated similar to the current process, with anoxic basins followed by aerobic basins. New post-anoxic and post-aerobic zones are needed to meet the total nitrogen limit. The preliminary model shows that these new zones can be incorporated into the existing aeration basins by installing baffles. The post anoxic zone would have diffusers installed so that it can be operated as a swing zone. The model shows this zone may need to be aerated during design peak day loadings to support ammonia removal. An internal mixed liquor recycle would be provided from the aerobic basin back to the head of the anoxic basin to improve nitrogen removal efficiency. Alum addition to the clarifiers would be used as needed as a polishing step for phosphorous removal.

Figure 6-3 shows the proposed flow schematic for biological nutrient removal.

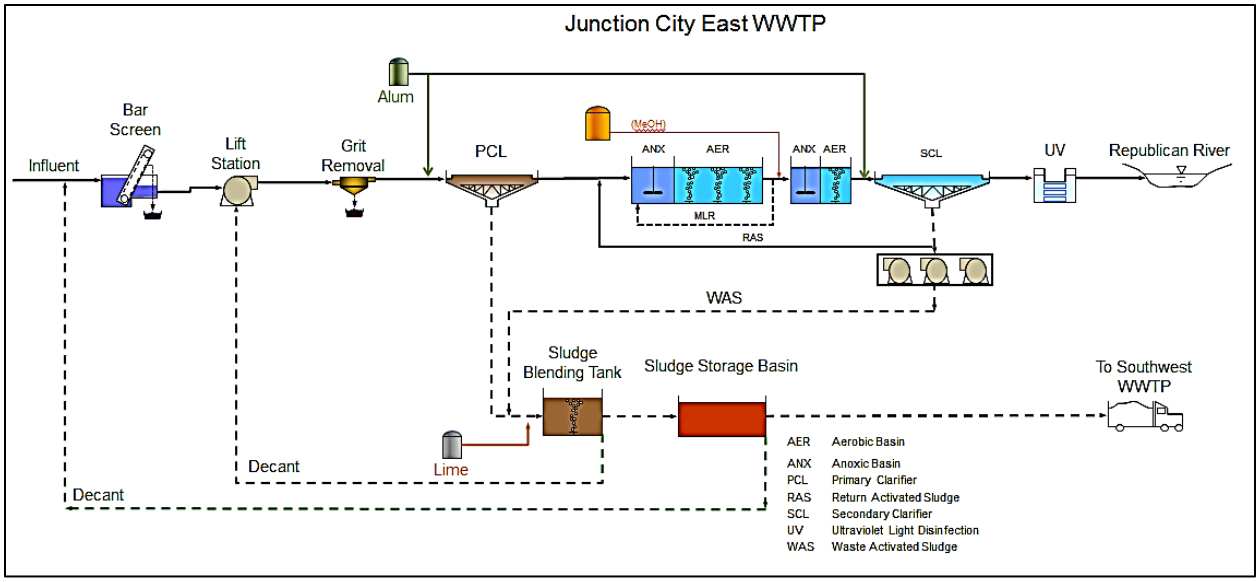


Figure 6-3: East WWTP Flow Schematic

Table 6-3 presents a summary of process design criteria and aeration information for the Biological Nutrient Removal alternative. Note that a conservative alpha value of 0.40 was used for planning purposes. During detailed design, the alpha value may be reevaluated based on operations data.

Table 6-2: East WWTP Biological Nutrient Removal Operating Summary

Description	Value
Influent Condition	Max Month
Temperature, Deg. C	11
Total SRT, days	17.9
Aerobic SRT, days	10
MLSS, mg/L	4,100
MLR, % of Influent	350%
RAS, % of Influent	175%
Sludge Production	
Primary Clarifier Sludge, lb/day	3,940
Primary Clarifier Sludge, gpd	46,000
WAS, lb/day	1,900
WAS, gpd	63,500
Chemical Addition, gal/day	
Alum	0
Basin Volumes, MG	
Existing Anoxic	0.25
Existing Aerobic (reduced)	0.48
Post Anoxic Zone (baffled)	0.30
Post Aerobic Zone (baffled)	0.20
Total	1.23

Table 6-3: East WWTP Biological Nutrient Removal Design Summary

Description	Value
Basin Depth, ft.	18
Alpha Factor, α	0.40
Beta Factor, B	0.95
Oxygen Transfer Efficiency, %/FT of Water Depth	1.5%
Diffuser Floor Coverage, %	10%
Target Dissolved Oxygen Concentration, mg/L	2.0 (Average and Max Month) 1.5 (Peak Day)
Oxygen Uptake Rate, mg/L/hr	
Existing Aeration Basin	31.0 (Average Annual) 44.5 (Max Month) 73.9 (Peak Day)
Post Aerobic Zone	21.4 (Average Annual) 31.0 (Max Month) 55.2 (Peak Day)
Air Flow, scfm	
Existing Aeration Basin	1,250 (Average Annual) 1,800 (Max Month) 2,650 (Peak Day)
Post-Aerobic Basin	360 (Average Annual) 520 (Max Month) 820 (Peak Day)

Facility Modification Summary

The following is a summary of facility modifications that will be completed as part of the BNR alternative:

- Baffling of the aeration basin to create a new 0.15 MG anoxic zone in each aeration basin. A total anoxic zone volume of 0.3 MG.
- Baffling of the aeration basin to create a new 0.1 MG aerobic zone in each aeration basin. A total aerobic zone volume of 0.2 MG.
- MLR pumping improvements
- Alum storage and feed system
- Methanol storage and feed system

Figure 6-4 shows a potential preliminary site layout for biological nutrient removal. Figure 6-5 shows the design flow through for the retrofitted aeration/post-anoxic/post-aerobic basin. The post-anoxic zone of the BNR basin will function as a plug-flow reactor. The post-anoxic zone will have a center baffle to increase flow length and improve plug-flow characteristics.

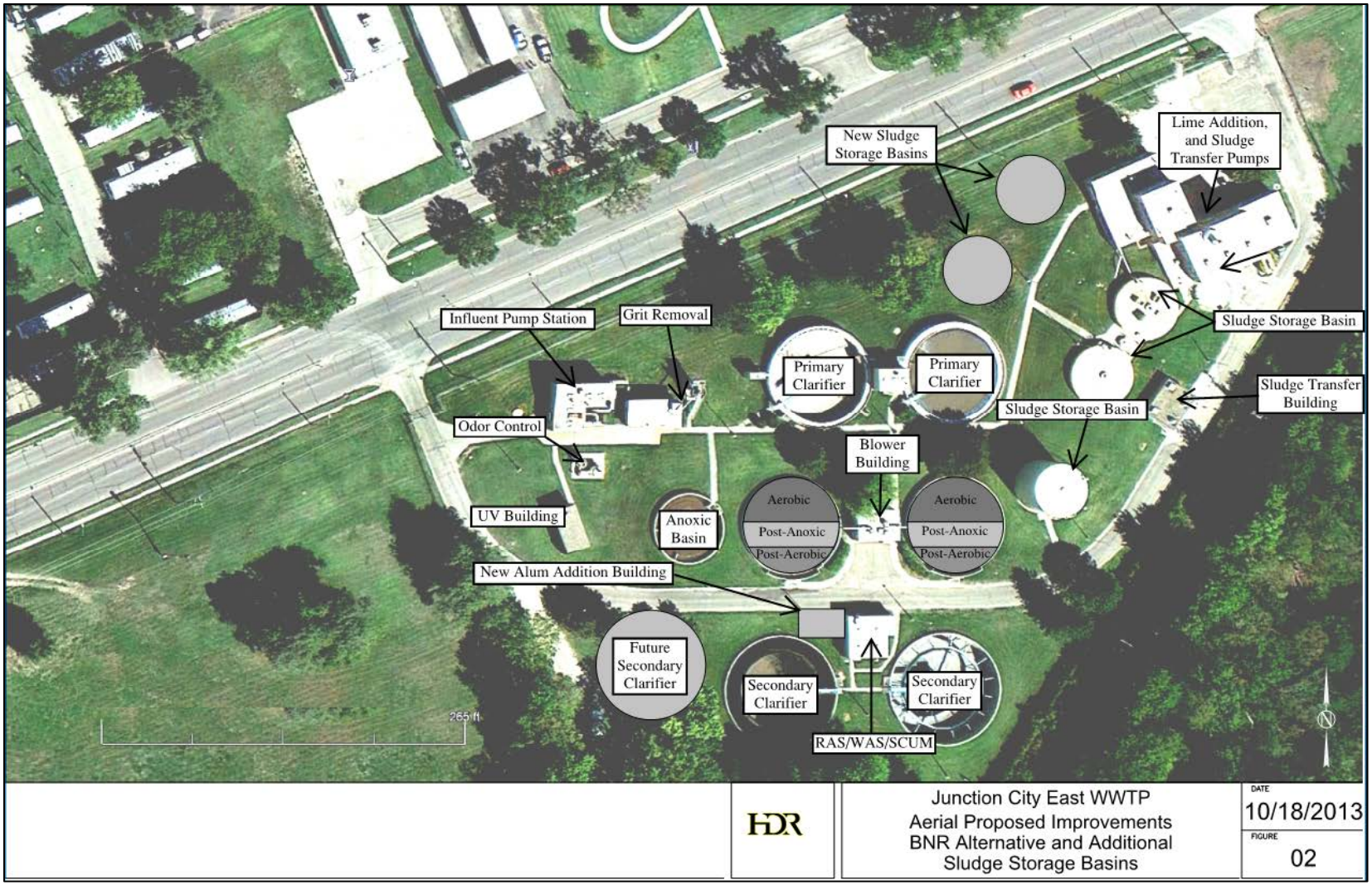


Figure 6-4: East WWTP Biological Nutrient Removal Preliminary Site Layout

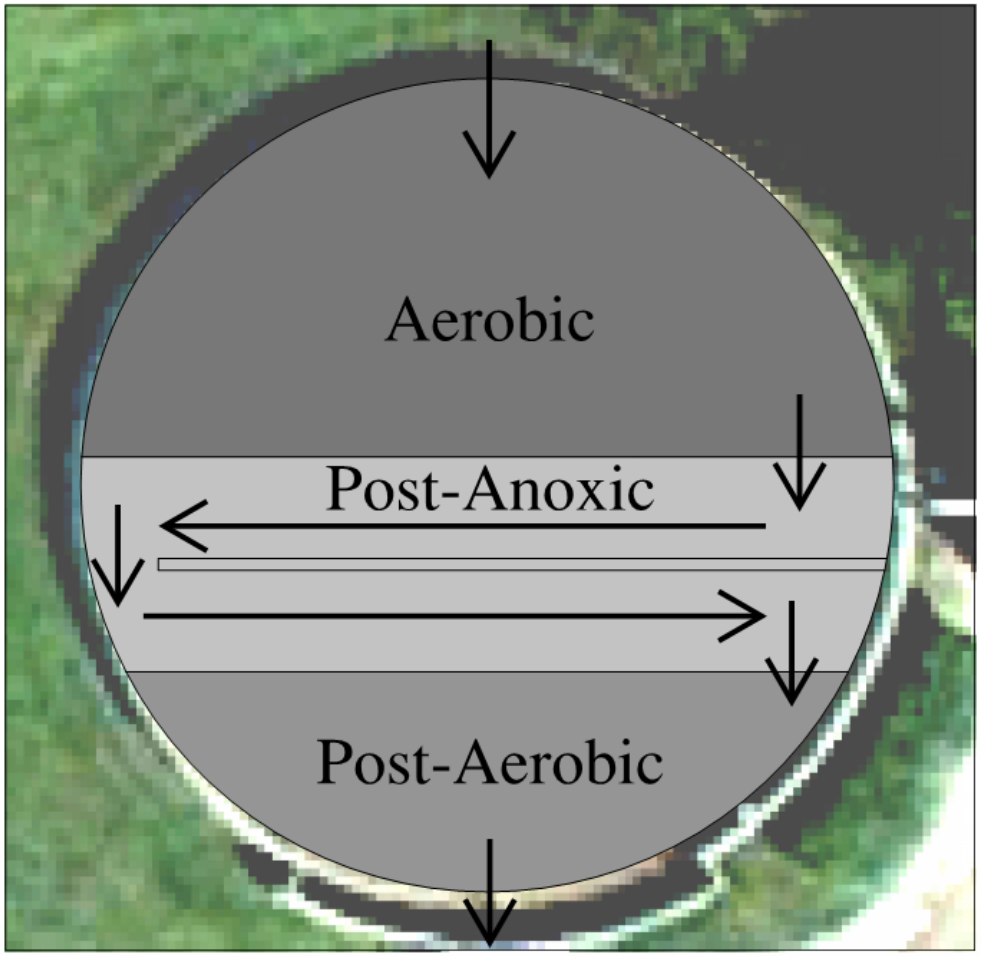


Figure 6-5: BNR Basin Design Flow Through

6.3.1.1 Costs

See Appendix B for a summary of costs for nutrient removal improvements for the East WWTP.

6.4 SOUTHWEST WWTP ALTERNATIVES ANALYSIS

The February 2013 Southwest WWTP Nutrient Removal Study evaluated alternatives to meet three potential future nutrient removal standards with effluent TN ranging from 8 mg/L to 3 mg/L and TP ranging from 1.5 mg/L and 0.3 mg/L. This report updates the findings of the earlier reports with up to date information for flows and loading information.

The Southwest WWTP has a significant industrial wastewater contribution including a high phosphorus loading. Preliminary evaluation of chemical phosphorous removal shows that chemical-only removal is not feasible due to the significant phosphorus load, and therefore, this has not been further evaluated due to the large chemical volume required and high associated costs. The annual chemical cost has been estimated to be $2.75 million, which translates to a 20-year present worth value of roughly $41 million.

6.4.1 Biological Nutrient Removal with Chemical Polish

Due to the high strength influent loadings, biological nutrient removal combined with chemical polishing was selected for further evaluation. Figure 6-6 shows the preliminary flow schematic for biological nutrient removal alternative.

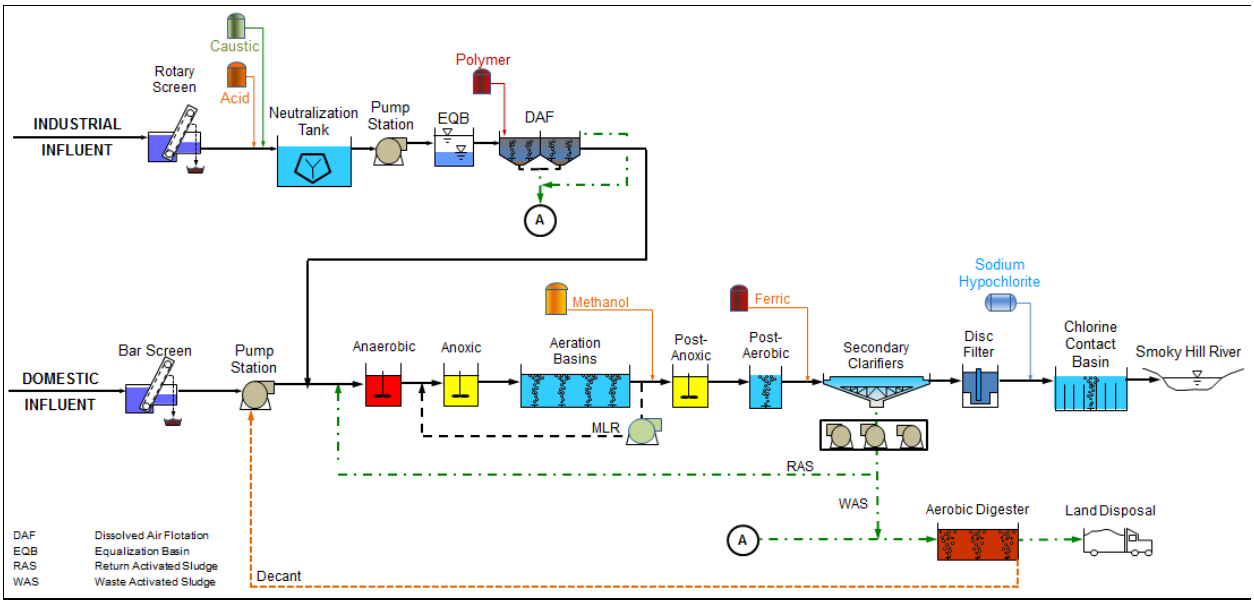


Figure 6-6: Southwest Plant Biological Nutrient Removal Flow Schematic

As part of the evaluation, as much of the existing treatment basins as possible have been incorporated into the nutrient removal system improvements. The existing selector basin would be expanded into an anaerobic basin. The existing circular aeration basins would be retained with upgrades to diffused aeration and new blowers planned to be completed as part of the Phase 1 and Phase II improvements.

The existing final clarifiers are approaching the end of their service lives and have been previously identified for repair/replacement. The existing clarifier tanks are poorly suited to clarification, because the tanks are too shallow and the diameter is too small for future solids loading rates. In lieu of replacing the existing final clarifier mechanisms, new clarifiers are proposed to increase clarification capacity and the existing final clarifiers would be converted into anoxic basins. New post-anoxic and post-aeration basins would be constructed to complete the BNR treatment basins.

To meet the low effluent TN limit, a post anoxic basin is included to provide further denitrification capacity. The bacteria responsible for denitrification rely on a carbon source (typically BOD5 in the wastewater) to drive the process. At the post-anoxic basin, the majority of the BOD5 in the wastewater has already been consumed and a supplemental carbon source is required. Methanol is the most commonly used carbon source for denitrification, and has been assumed for this evaluation however alternative carbon sources can be reviewed during the design phase.

In this application, the biological nutrient removal process is anticipated to remove about 85%-90% of the influent phosphorus on average; however chemical polishing step is needed to meet the final effluent TP requirement. Ferric dosed to the final clarifiers has been included for the polishing step. In addition, a final effluent filter may be needed to support tighter nutrient limits in the future. A final effluent filter is not shown as part of this project (no costs listed), but it is listed as a potential future project. At the time when tighter nutrient limits are required, the hydraulic profile would need to be reviewed during the design phase to evaluate the final effluent filter pumping needs.

Table 6-5 and Table 6-6 present a summary of process design criteria and aeration information for the Biological Nutrient Removal alternative. Note that a conservative alpha value of 0.40 was used for planning purposes. During detailed design, the alpha value may be reevaluated based on operations data.

Table 6-4: Southwest WWTP Biological Nutrient Removal Operating Summary

Description	Value
Influent Condition	Max Month - Winter
Temperature, Deg. C	11
Total SRT, days	19.6
Aerobic SRT, days	10
MLSS, mg/L	3,600
MLR, % of Influent	25%
RAS, % of Influent	200%
Sludge Production	
WAS, lb/day	8,000
WAS, gpd	159,500
Chemical Addition, gal/day	
Methanol	175
Ferric	175
Basin Volumes, MG	
Anaerobic	0.5
Anoxic	0.5
Aerobic	2.48
Post-Anoxic	0.7
Post-Aerobic	0.2
Total	2.38

Table 6-5: Southwest WWTP Biological Nutrient Removal Design Summary

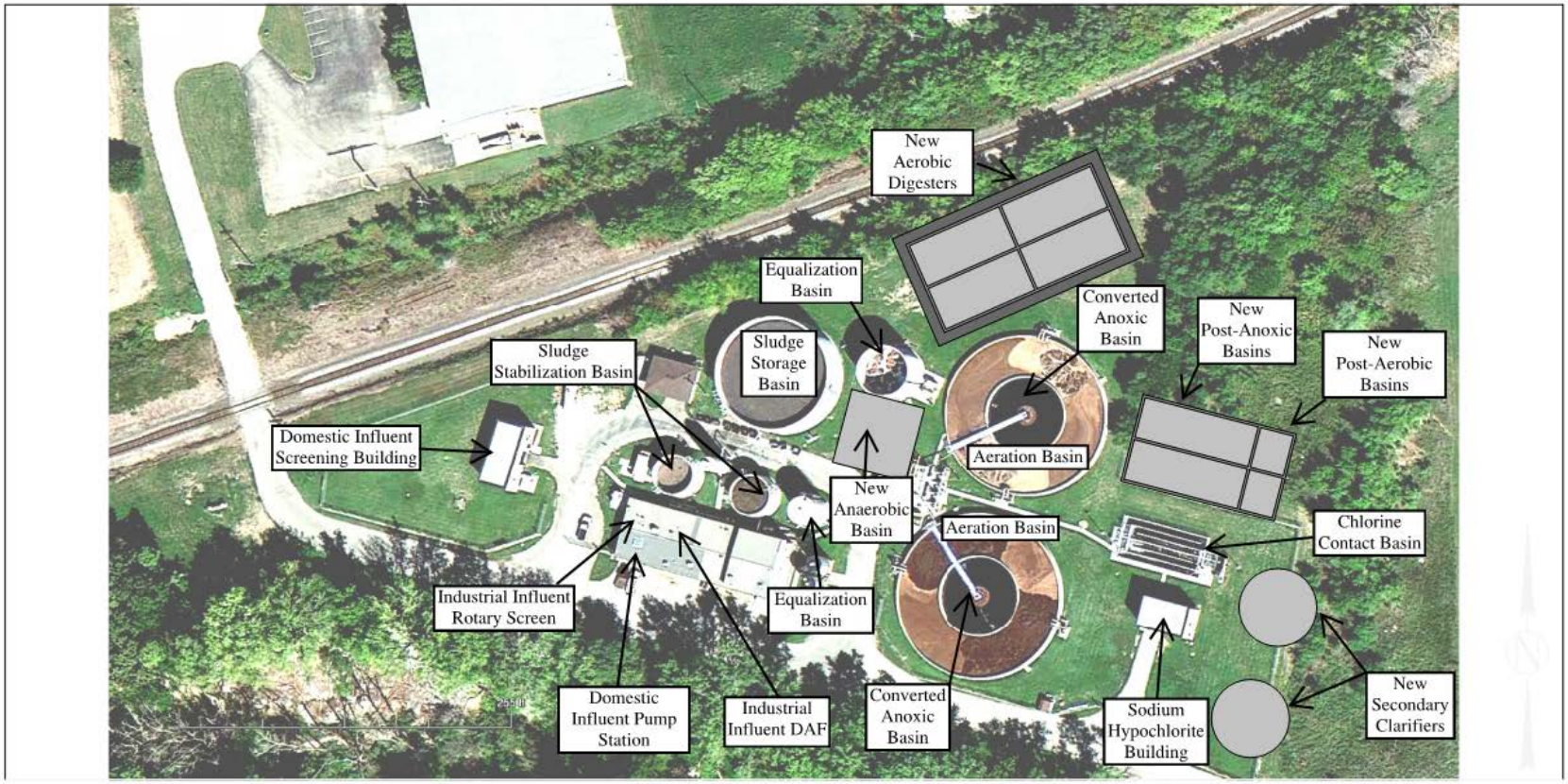
Description	Value
Basin Depth, ft.	18 (Aerobic) 16 (Post Aerobic)
Alpha Factor, α	0.40
Beta Factor, B	0.95
Oxygen Transfer Efficiency, %/FT of Water Depth	1.5%
Diffuser Floor Coverage, %	10%
Target Dissolved Oxygen Concentration, mg/L	2.0 (Average and Max Month) 1.5 (Peak Day)
Oxygen Uptake Rate, mg/L/hr	
Aerobic Basin	12.0 (Average Annual) 18.0 (Max Month) 23.8 (Peak Day)
Post-Aerobic Basin	15.6 (Average Annual) 14.5 (Max Month) 40.9 (Peak Day)
Air Flow, scfm	
Aerobic Basin	(Average Annual) = 2,260 (Max Month) = 3,210 (Peak Day) = 4,130
Post-Aerobic Basin	(Average Annual) = 590 (Max Month) = 860 (Peak Day) = 1,110

Facility Modification Summary

The following is a summary of facility modifications that will need to be completed as part of the BNR alternative:

- Construction of a new 0.5 MG anaerobic basin
- Conversion of the existing final clarifiers to anoxic basins
- New post-anoxic and post-aerobic basins
- Two new final clarifiers
- Methanol and ferric storage and feed systems

Figure 6-7 shows the BNR facility modifications with aerobic digesters (to be discussed in Section 7) for the biosolids treatment process.



HDR

Junction City Southwest WWTP
Aerial Proposed Improvements
BNR Improvements and Aerobic Digesters

DATE 9/10/2013

FIGURE 03

Figure 6-7: Proposed BNR Alternative and Aerobic Digestion for Biosolids Treatment

6.4.1.1 Costs

Table 6-6 presents the preliminary opinion of probable project cost for the Southwest WWTP biological nutrient removal alternative. Present value costs were developed based on a 20 year period at 3% inflation factor.

Table 6-6: Opinion of Probable Cost for Southwest Plant Biological Nutrient Removal

Description	**Cost**
Anaerobic Basin	$790,000
Conversion of Final Clarifiers to Anoxic Basins	$100,000
Post-Anoxic	$854,000
Post-Aerobic	$887,000
New Final Clarifiers	$5,329,000
Chemical Feed	$683,000
Subtotal	**$8,643,000**
Mobilization (5%)	$432,000
Overhead (10%)	$864,000
Engineering and Administration (20%)	$1,729,000
Contingency (25%)	$2,161,000
Opinion of Probable Project Cost	**$13,829,000**
Annual Operation and Maintenance	**$550,000**
Present Worth Value O&M	$8,180,000
Present Worth Value (Capital and O&M)	**$22,009,000**

6.4.2 Integrated Fixed Film Activated Sludge

Due to the relatively limited available footprint at the Southwest WWTP, the integrated fixed-film activated sludge (IFAS) treatment processes was evaluated as an alternative with potentially lower footprint requirements. IFAS incorporates submerged fixed-film media with an activated sludge system. The purpose of the media is to provide a carrier to grow additional biomass in a suspended-growth basin. The IFAS process offers several advantages:

- Additional biomass without increasing solids loading to secondary clarifier
- Smaller treatment basins
- Reduced sludge production and improved settling characteristics
- Improved resistance to shock loadings

- Potential for some simultaneous nitrification-denitrification

The media can be either free floating in the basin or fixed in place. Free floating media includes sponges and plastic carriers of various shapes. Fixed media includes fabric or ropes arranged in various configurations secured in frames to the basin floor or walls. The media can also be designed to grow thicker biomass to promote simultaneous nitrification-denitrification. For the Southwest WWTP, the IFAS media would be installed in a portion of the existing circular aeration basin.

As noted in the previous option, the existing final clarifiers are approaching the end of their service lives and have been previously identified for repair/replacement. Since new anoxic basins would be needed for this option, and the existing clarifier tanks are poorly suited to clarification, new clarifiers are proposed to increase clarification capacity and the existing final clarifiers would be converted into anoxic basins.

Figure 6-8 shows the flow schematic for the IFAS alternative.

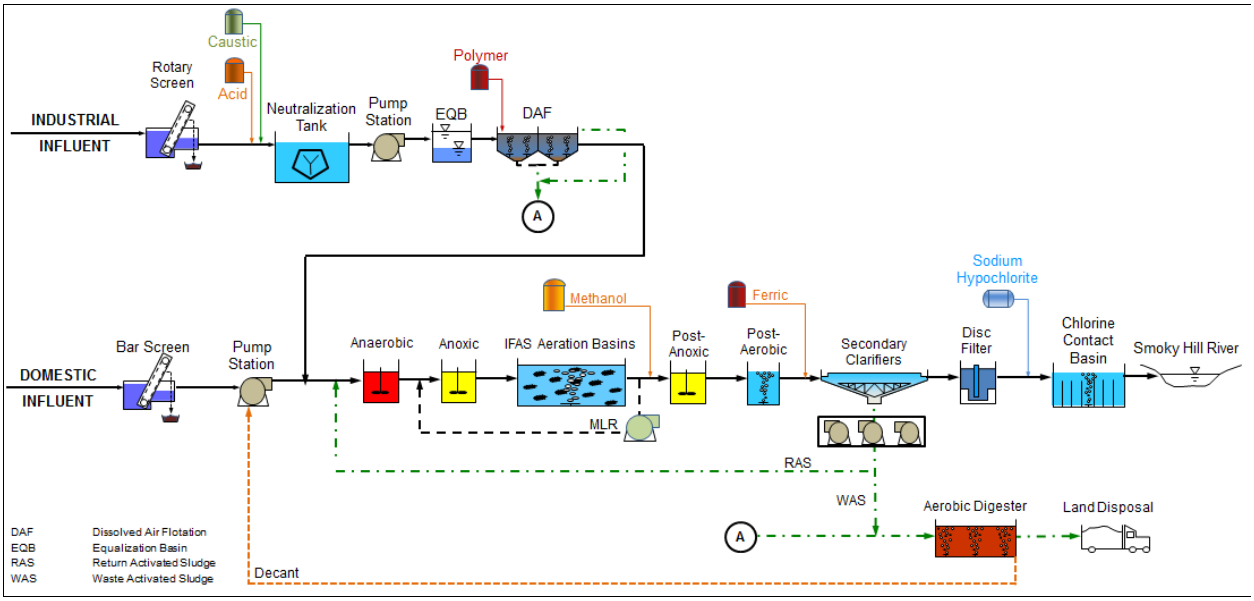


Figure 6-8: Southwest Plant IFAS Flow Schematic

Table 6-7 and Table 6-8 present a summary of process design criteria and aeration information for the Biological Nutrient Removal alternative.

Table 6-7: Southwest Plant IFAS Operating Summary

Description	Value
Influent Condition	Max Month - Winter
Temperature, Deg. C	11
Total SRT, days	22.6
Aerobic SRT, days	10
MLSS, mg/L	3,800 (Bulk)
MLR, % of Influent	50%
RAS, % of Influent	200%
Sludge Production	
WAS, lb/day	5,700
WAS, gpd	145,800
Chemical Addition, gal/day	
Methanol	200
Ferric	310
Basin Volumes, MG	
Anaerobic	0.5
Anoxic	0.5
Aerobic-IFAS	1.58
Post-Anoxic	0.9
Post-Aerobic	0.5
Total	3.81

Table 6-8: Southwest Plant IFAS Design Summary

Description	Value
Basin Depth, ft.	18
Alpha Factor, α	0.45
Beta Factor, B	0.95
Oxygen Transfer Efficiency, %/FT of Water Depth	1.5%
Diffuser Floor Coverage, %	10%
Target Dissolved Oxygen Concentration, mg/L	2.0 (Average and Max Month) 1.5 (Peak Day)
Oxygen Uptake Rate, mg/L/hr	
Aerobic Basin	17.0 (Average Annual) 24.1 (Max Month) 31.0 (Peak Day)
Post-Aerobic Basin	13.9 (Average Annual) 20.3 (Max Month) 26.4 (Peak Day)
Air Flow, scfm	
Aerobic Basin	Average Annual = 1,725 Max Month = 2,437 Peak Day = 3,135
Post-Aerobic Basin	Average Annual = 429 Max Month = 650 Peak Day = 845

Facility Modification Summary

The following facility modifications will be completed as part of the IFAS alternative:

- Construction of a new 0.5 MG anaerobic basin
- Conversion of the existing final clarifiers to anoxic basins
- Installation of IFAS media in portion of existing aeration basins
- Conversion of portion of existing aeration basins to anoxic basins
- Conversion of portion of existing aeration basins to post aeration basins
- Two new final clarifiers
- Methanol and ferric storage and feed systems

6.4.2.1 Costs

Table 6-9 shows the opinion of probable construction cost for the IFAS alternative. The IFAS media will be dropped into the current aeration basins. The cost for existing blower replacement and fine bubble diffusers is not considered in this opinion of probable cost because they have already been replaced as part of the Phase I Southwest WWTP construction project. The cost of additional blowers to meet the increase capacity of IFAS was included.

Table 6-9: Opinion of Probable Cost for Southwest Plant IFAS Biological Nutrient Removal

Description	**Cost**
New Anaerobic Basin	$790,000
Conversion of Final Clarifiers to Anoxic Basins	$100,000
Aeration Basin Modification and IFAS Media	$5,550,000
Post-Anoxic Conversion of Portion of Existing Aeration Basin	$96,000
New Final Clarifiers	$5,330,000
New Post-Aerobic Basin Conversion	$1,407,000
Chemical Storage and Feed	$683,000
Subtotal	**$13,956,000**
Mobilization (5%)	$698,000
Overhead (10%)	$1,396,000
Engineering and Administration (20%)	$2,79,000
Contingency (25%)	$3,489,000
Opinion of Probable Construction Cost	**$22,330,000**
Annual Operation and Maintenance	$508,000
Present Worth Value O&M	$7,560,000
Present Worth Value (Capital and O&M)	**$29,890,000**

6.4.3 Recommended Nutrient Removal System

As discussed in Section 4.2, the effluent discharge of total phosphorus and total nitrogen are anticipated to be limited to 1.5 mg-P/L and 8 mg-N/L, respectively, at both facilities. Another permit change expected in the next permit is the ammonia limit. Based on new water quality criteria released by the EPA in August 2013, ammonia limits may drop by as much as 50 percent. While this is a significant change, in order to achieve the total nitrogen limit, the target ammonia concentration for design is less than 1 mg-N/L, which should meet future ammonia criterion.

Table 6-10 shows a comparison of the capital, annual operation and maintenance and present value life cycle costs for the two nutrient removal alternatives. The present worth costs were based on a 20 year period at 3%.

Table 6-10: Cost Comparison of Nutrient Removal Alternatives

Cost Component	BNR Activated Sludge Alternative	BNR IFAS Alternative
Capital Cost	$13,829,000	$22,330,000
Present Worth O&M Costs	$8,180,00	$7,560,000
Total Present Worth Life Cycle Costs	**$22,009,000**	**$29,890,000**

The BNR activated sludge alternative has the lowest life cycle costs and is recommended to meet the future nutrient removal requirements.

7 BIOSOLIDS PLANNING

7.1 EAST WWTP – BIOSOLIDS TREATMENT

7.1.1 General

The current biosolids processing facilities for the East WWTP consists of a sludge mixing tank, lime stabilization, and three lime storage tanks. See Section 2.2.4 for existing East WWTP biosolids treatment system description. The current lime stabilization process is operated to meet the requirements for Class B biosolids for pathogen reduction per EPA Part 503 requirements. The plant currently uses a 15 to 18 percent lime slurry to raise the pH of the sludge to 12 or greater for two hours in the sludge mixing tank. The biosolids are then transferred to one of the sludge storage tanks prior to withdrawal and transport to the Southwest WWTP and mixed with Southwest WWTP biosolids. The combined biosolids are further stabilized and stored before being land applied. The sludge storage tank pH is maintained at 11.5 for minimum 22 hours to meet EPA 503 vector attraction requirements.

The Kansas Department of Health and Environment (KDHE) and EPA 503 regulations require that biosolids must be land applied at agronomic rates. With the increase in projected biosolids production, additional land may be required for land application.

The East WWTP biosolids process is being evaluated to continue using the same stabilization process; note that the biosolids design basis focuses on independent stabilization and storage without combining with biosolids from the Southwest WWTP. Additional biosolids storage is required to meet the KDHE 60-day sludge storage requirement for land applied biosolids. Significant equipment replacement and repair is also proposed to improve process reliability and redundancy.

7.1.2 Biosolids Production

The biosolids production rate has been projected to represent future population growth and the addition of biological nutrient removal to meet nutrient standards. The projected design loadings are shown in Table 7-1 below.

Table 7-1: Junction City East WWTP Solids Production

Condition	Primary Solids, lb/day	% Solids Conc.	WAS Solids, lb/day	% Solids Conc.	Total	
					Volume[1], gallons/day	% Solids Conc.*
Max Month	3,940	@ 3.0%	1,920	@ 1.0%	23,170	@ 3.0%
Average Annual	2,520	@ 3.0%	840	@ 1.0%	17,407	@ 3.0%

[1] Density = 8.34 lb/gallon

*Decant to thicken and achieve target solids concentration

7.1.3 Process Upgrades Needed

As indicated, the East WWTP is expected to continue using the same biosolids treatment process that they are currently using. The current system requires significant repairs and replacements that are planned to be spread out over the next three to five years. Many of the equipment replacements are recommended for the Phase 1 construction project taking place during the fiscal years 2014 and 2015 as described in Section 8.1. This project addresses replacing equipment that has reached the end of its design life and updating the tanks, pumps, and lime feed system so they operate properly and offer appropriate reliability. Additional equipment replacement should occur in a Phase II construction project taking place during fiscal years 2015, 2016, and 2017 as described in Section 8.2.

Additional sludge storage is needed to meet KDHE requirements at the projected design solids production. The projected design maximum month sludge volume produced in a max 60-day period is 1.4 MG at a thickened solids content (3 percent). The East WWTP would need an additional 0.72 MG of storage along with the existing 0.69 MG to meet this requirement. This translates to either one, 0.72 MG tank, or two 0.36 MG tanks.

7.2 SOUTHWEST WWTP – BIOSOLIDS TREATMENT

7.2.1 General

The current biosolids processing facilities at the Southwest WWTP consists of two sludge stabilization basins, a lime feed system (not currently in use or operational), and a sludge storage basin. The lime feed system has not been operational since 2001. Since 2005, the waste activated sludge has been rerouted by pumping into the southern aeration basin, where it is aerated and thickened prior to being pumped into storage. The staff at KDHE approved this approach as a temporary procedure, but it is not considered a permanent solution, because the second oxidation ditch is needed for liquid treatment. In addition, at this time, all of the East WWTP biosolids are shipped to the Southwest WWTP where the biosolids from both facilities are combined. As discussed in the previous section, the East WWTP biosolids have been lime stabilized prior to being combined with the Southwest biosolids. This results in a combined biosolids that consists of East WWTP biosolids, East WWTP lime additive, and Southwest WWTP biosolids.

Currently, the combined biosolids meet the EPA 503 and KDHE regulation pathogen reduction requirement by testing to prove the reduction in pathogens. The biosolids meet vector attracting reduction requirements via specific oxygen uptake rate (SOUR) testing. While the combined biosolids meet the requirements for land application, the Southwest WWTP biosolids system is not currently adequate to provide full independent treatment at design capacity. Therefore, in order to provide adequate biosolids stabilization to support the Southwest WWTP's needs, biosolids upgrades are required for the Southwest plant biosolids treatment process.

Under the EPA 503 and KDHE regulations, the biosolids must be applied on land at agronomic rates, i.e., at rates at which available nitrogen in the biosolids applied does not exceed the anticipated crop uptake. In this report, specific areas have not been identified for land application of the biosolids but increased future loading may require additional land purchase.

To upgrade the Southwest WWTP biosolids treatment system so that it can meet the EPA part 503 and KDHE requirements for pathogen and vector attraction reduction three alternatives were considered.

1. Rehabilitate the existing lime stabilization process to raise the pH of the biosolids to a minimum of 12 for 2 hours of contact time for pathogen reduction and then maintain a pH of 11.5 for 22 hours to meet vector attraction reduction.
2. Install a Reed Bed System. Reed Beds meet the air drying pathogen reduction requirement. Reed Beds can meet the vector attraction requirement via the following methods:
    a. Meet 38 percent reduction in volatile solids content
    b. Demonstrate vector attraction reduction with additional anaerobic digestion in a bench-scale unit
    c. Demonstrate vector attraction reduction with additional aerobic digestion in a bench-scale unit
    d. Meet an SOUR for aerobically digested biosolids
    e. Alkali addition to raise the pH of the biosolids to 12 or higher for 2 hours and above 11.5 for 22 hours
    f. Inject biosolids beneath the soil surface
    g. Incorporate biosolids into the soil within 6 hours of application to or placement on the land
3. Install aerobic digesters that maintain the solids in an aerobic condition for a minimum 60 days at 15ºC or 40 days at 20ºC for pathogen reduction. To meet vector attraction reduction the aerobic digesters will meet the 38 percent reduction in volatile solids content.

Biosolids application on frozen and snow covered ground is discouraged due to concerns that biosolids applied will eventually be washed into receiving waters such as lakes and streams. The regulations state that “bulk sewage biosolids shall not be applied to flooded, frozen or snow-covered ground so that the biosolids enters wetlands or other waters of the U.S. unless authorized by the permitting authority”. This statement has been interpreted by regulatory agencies as saying that biosolids application on frozen and snow-covered ground can be permitted if the applier can demonstrate to the satisfaction of regulatory agencies that the biosolids will not be subject to entering waters of the United States.

As with the East WWTP, the biosolids facilities plan needs sufficient storage to meet KDHE minimum 60 days storage requirement for land applied biosolids.

7.2.2 Biosolids Production

Sludge production from the DAF and WAS production for the Junction City Southwest WWTP have been evaluated to reflect plant improvements to meet nutrient removal requirements for the design year 2026. Table 7-2 shows a summary of the solids production.

Table 7-2: Junction City Southwest WWTP Solids Production 2026 Design Year

Condition	WAS Solids, lb/day	% Solids Conc.	DAF Solids, lb/day	% Solids Conc.	Total	
					Volume[1], gallons/day	% Solids Conc.*
Max 60-day	6,400	@ 1.5%	5,445	@ 1.00%	63,123	@ 2.25%
Average Annual	5,300	@ 1.5%	4,847	@ 1.00%	54,073	@ 2.25%
[1] Density =	8.34	lb/gallon				

*Decant to thicken and achieve target solids concentration

7.2.3 Alternative 1 – Rebuilding Existing Process, Lime Stabilization and Decant

7.2.3.1 Description

This alternative would rehabilitate or replace the current lime feed system. Lime would be added to sludge stabilization basins to raise the pH to minimum of 12 for 2 hours of contact time to meet the EPA part 503 and KDHE pathogen reduction requirements. The lime stabilized solids would be transferred to the sludge storage basins for a minimum 22 hours at minimum pH of 11.5 to meet vector attraction reduction requirements. An additional 2.6 MG of storage is needed included to provide a minimum 60 days of storage per KDHE requirements.

The current lime feed system has not been operational since 2001, and was beyond its useful life expectancy at that time, therefore complete replacement of the major equipment was assumed. The lime system will supply a 15 percent lime solution to the stabilization tanks with a dose of approximately 0.3 lb. Ca(OH)2 / lb. of dry solids (Metcalf and Eddy, 2003). During average conditions, total lime addition would be approximately 2,300 gal/day. Lime stabilization can improve phosphorous removal by binding phosphorous to solids in the solids treatment system and reducing phosphorous returned to the headworks in the decant/recycle stream.

7.2.3.2 Sizing

The current lime stabilization and sludge storage basins will continue to be used. A total of 3.9 MG of storage basin capacity (2.6 MG new construction) would be required to meet the 60 day storage requirements per KDHE based on the maximum 60-day loading condition. This volume is based on in-basin decanting to thicken the solids from about 1.9 to approximately 2.25 percent. Mechanical mixing has been assumed for all of the storage basins. Two 80-ft diameter tanks with liquid depths of 35-ft have been assumed for the preliminary site layout. Figure 7-1 shows a preliminary site layout for the Southwest WWTP biosolids treatment improvements.

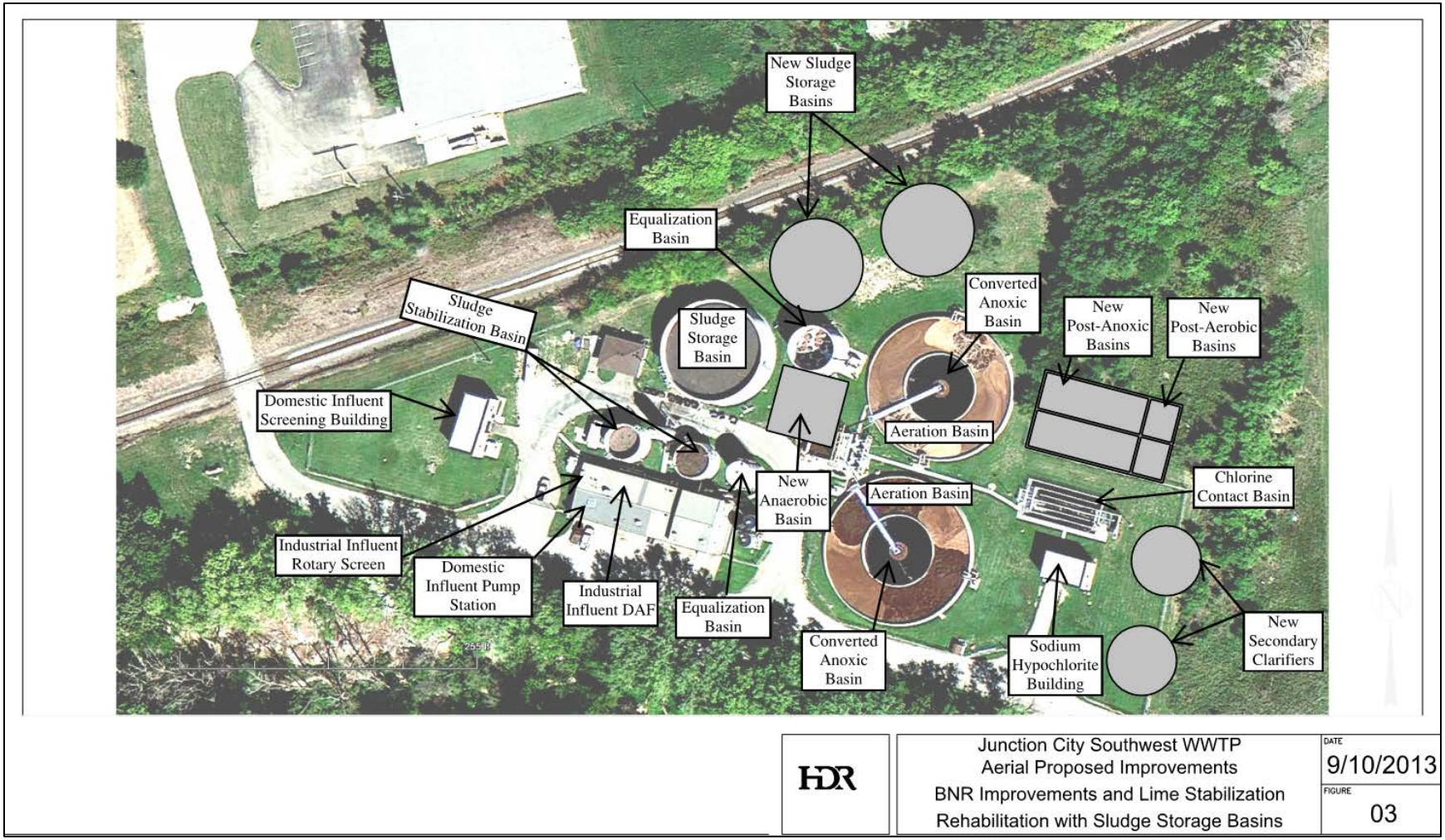


Figure 7-1: Proposed Sludge Storage Tanks with BNR Alternative

7.2.3.3 Cost

Table 7-3 shows the capital, operations and maintenance and present worth life cycle costs for lime stabilization. The present worth values are based on a 20 year period and 3 percent interest rate.

Table 7-3: Opinion of Probable Cost for Rehabilitation of the Lime Stabilization System Alternative

Description	Cost	
Lime Stabilization Rehabilitation	$422,000	
New Sludge Storage Tanks	$2,483,000	
Subtotal	**$2,905,000**	
Mobilization (5%)	$145,000	
Overhead (10%)	$291,000	
Engineering and Administration (20%)	$581,000	
Contingency (25%)	$726,250	
Opinion of Probable Project Cost	**$4,648,000**	
Operation and Maintenance Cost		
Maintenance, 20% of equipment cost	$32,000	/ yr
Labor	$42,000	/ yr
Energy Cost	$65,000	/ yr
Chemical - Lime Addition, $110/ton	$62,000	/ yr
Solids Disposal Cost, $0.05/gallon	$823,000	/ yr
Annual O&M Cost	$1,024,000	/ yr
Present Worth Value O&M, 20 yr, 3.0%	**$15,235,000**	
Present Worth Value (Capital and O&M)	**$19,883,000**	

7.2.4 Alternative 2 – Reed Beds

7.2.4.1 Description

For this alternative, a ten-cell reed bed system is proposed to store, dewater and stabilize the solids with a storage volume of approximately 10 years. According to "Natural Systems for Waste Management and Treatment", Reed et al., reed beds are similar in concept to constructed wetland processes. Each of ten beds would have dimensions of 200-ft x 200-ft and a surface area of approximately 40,000 ft2. Each reed bed provides a storage depth of 3 feet, including freeboard. The reed beds consist of earthen construction, sealed with a clay or synthetic liner with a layer of gravel overlain by a layer of filter sand. The underdrain

system would include piping in the gravel layer for drainage of the system. The collected water would be directed to the head end of the treatment plant. The reeds will be planted in the gravel layer and be allowed to become well established before the first biosolids are applied, see Figure 7-2 below.

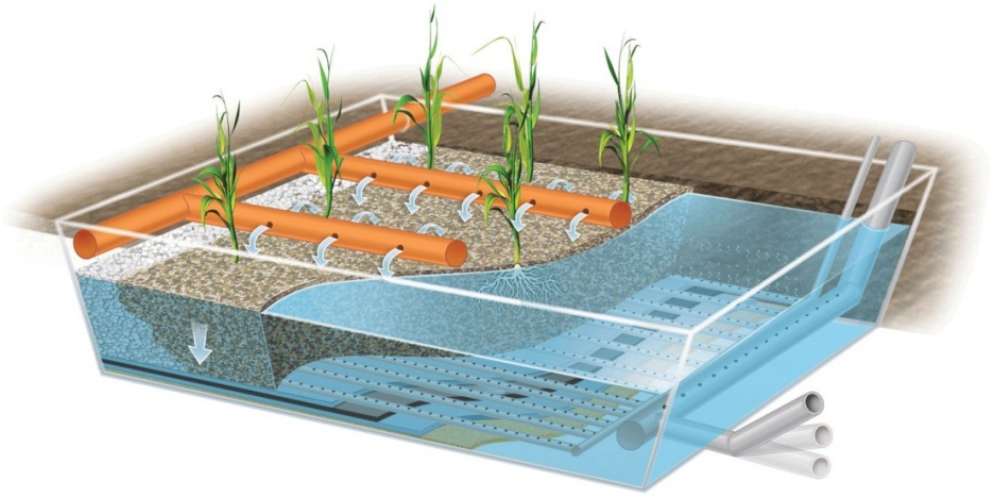


Figure 7-2: Reed Bed System

(Source: WEF.Org http://wef.org/publications/page_archives.aspx?id=9474&page=features)

According to Reed et al., the root system of the reeds function to absorb water from the solids. The water is then lost to the atmosphere via evapotranspiration. The penetration of the plant stems and root system also provides a pathway for continuous drainage of water from the solids layer. During the winter when there is no active reed growth, the solids will continue to be dewatered with the normal freeze-thaw cycles similar to a sand drying bed system.

Biosolids from the treatment plant will first be directed to an aerobic holding tank system, where biosolids digestion would occur. Two options have been considered for the aerobic storage system. The first option would be to construct two new aerated basins with a total storage capacity of 30 days. The second option would be to modify the existing secondary treatment basin, which would result in savings compared to constructing a new storage basin.

Prior to application on the reed beds, the biosolids are thickened to approximately two percent solids by repeated decanting cycles from the aerobic tanks. The aerobically digested solids will be applied sequentially to each of the reed beds in 3 to 5-inch layers. The beds will receive solids at a rate of approximately 45 gallons/ft2/year. The beds are projected to be cleaned once every ten years. However, the reeds need to be harvested annually from each of the cells after freezing of the bed surface.

7.2.4.2 Sizing

A reed bed system is sized based on the solids loading rate that it can receive. The reed bed alternative sizing is based on a loading rate of 45 gallons/ft2/year and the average projected solids production volume of 48,666 gallons/day at 2.5 percent solids content. The projected loading is modeled to reflect improvements to the industrial DAF pretreatment and biological nutrient removal Under these criteria a reed bed system would require 9.1 acres of land to meet the projected solids production, see Table 7-4.

Table 7-4: Reed Beds Sizing - Land Required

Solids Volume, gal/day	Solids Volume, gal/year	Reed Bed Area Required, ft^2	Reed Bed Area Required, acres
48,666	17,762,921	394,732	9.1
Solids Loading Rate =	45	Gal/ft^2/year	
Percent Solids =	2.50	From Sludge Storage Basin Decant	

The Southwest WWTP is footprint limited and the required 9.1 acres of land for the reed bed alternative would not be feasible for the projected biosolids production. This disqualifies the reed bed alternative as a practical option for biosolids treatment and was not further considered.

7.2.5 Alternative 3 – Aerobic Digestion

7.2.5.1 Description

Aerobic digestion is considered as an alternative, because it yields effective stabilization in a relatively small treatment volume, and the Southwest WWTP is footprint limited.

7.2.5.2 Sizing

The aerobic digesters considered in this alternative were sized based on several criteria. One criterion was the EPA part 503 and KDHE requirement of 60 days of storage at 15ºC to meet pathogen reduction. Another criterion considered was achieving a minimum 38 percent reduction in volatile solids to meet the vector attraction reduction requirement. The final criterion used in sizing was using the maximum 60-day projected solids production which was developed to reflect improvements to the industrial DAF pretreatment and future biological nutrient removal plant improvements.

The aerobic digesters would be decanted to thicken the sludge to approximately 2.5 percent and reduce digester volume requirements. An additional 25 percent of aerobic digestion volume was included to account for in-tank decant. The existing sludge storage tank would be retrofitted into an aerobic digester operated at a water depth of 20 feet. A 1.52 MG new aerobic digester, partitioned into four units, is proposed to meet the balance of the aerobic digestion requirement. See Table 7-5 for required area and the volume of new tankage.

Table 7-5: Aerobic Digestion Sizing - Land Required

Final Digested Solids[1,2], lbs/day	Final Digested Volume[3], gallons/day	Total Volume Req'd for Aerobic Digestion[4], MG	Volume of New Tanks Required[5], MG
8,244	39,540	2.97	2.0

[1] - Assume Volatile Solids are 80% of Total Solids

[2] - Assume 38% Volatile Solids Destruction

[3] - Assume a 2.5% in digester thickening via decant from 1.21%

[4] - 60 days was used for required storage time to meet KDHEs pathogen reduction requirement and minimum storage for land application

[6] - The current sludge storage tank will be retrofitted for aerobic digestion and will only be operated at a depth of 20 FT, thus reducing the required volume

Figure 6-7 in the previous section shows a preliminary site layout of the aerobic digestion system.

7.2.5.3 Cost

The cost for the new aerobic digester basins, retrofitting the current sludge storage basin, and blower equipment were evaluated to find the capital and operation and maintenance costs for aerobic digestion. Table 7-6 below shows the opinion of probable cost for aerobic digesters.

Table 7-6: Opinion of Probable Cost for Aerobic Digester Alternative

Description	Cost	
Aerobic Digesters	$5,702,000	
Retrofit Sludge Storage Tank to Aeration Basin	$30,000	
Subtotal	$5,732,000	
Mobilization (5%)	$287,000	
Overhead (10%)	$573,000	
Engineering and Administration (20%)	$1,146,000	
Contingency (25%)	$1,433,000	
Opinion of Probable Project Cost	**$9,171,000**	
Operation and Maintenance Cost		
Maintenance, 5% of equipment cost	$55,000	/ yr
Labor	$20,000	/ yr
Energy Cost	$120,000	/ yr
Solids Disposal Cost, $0.05/gallon	$515,000	/ yr
Annual O&M Cost	$710,000	/ yr
Present Worth Value O&M, 20 yr, 3.0%	**$10,564,000**	
Present Worth Value (Capital and O&M)	**$19,735,000**	

7.2.6 Recommendations

Table 7-7 shows a comparison of capital, operations and maintenance and present values costs for the biosolids treatment alternatives. As previously presented, there is insufficient footprint available for the reed bed alternative and costs were not developed.

Table 7-7: Comparison of Estimated Costs of Biosolids Processing Alternatives

Alternatives	Project Cost	Annual O&M Cost	Present Worth Value O&M*	Total Present Worth Value (Capital + O&M)
Lime Stabilization	$4,648,000	$1,024,000	$15,235,000	$19,883,000
Aerobic Digestion	$9,171,000	$710,000	$10,564,000	$19,735,000
* 20 years interest at 3.0%				

Based on the preliminary cost comparison lime stabilization and aerobic digestion are similar in price and required footprint. Aerobic digestion is recommended due to several benefits including no chemical handling requirements, ease of operation, and lower maintenance for plant staff.

8 PROJECT PRIORITIZATION AND CONSTRUCTION PHASING

8.1 PHASE I

The Phase I projects is high priority work important to provide reliable and safe operation. While there is not an immediate concern for permit violations or staff safety with these projects, these projects address infrastructure at or near the end of its useful life. Work conducted as part of the Phase I project is expected to maintain or improve overall treatment process efficiency with minimal capacity increase, and the Phase I work should be completed over the 2014 and 2015 fiscal years. This section identifies immediate needs for both facilities.

8.1.1 East WWTP

In order to ensure continued safe and reliable operation of the East WWTP, a number of process replacements, upgrades, and/or enhancements are recommended as part of the Phase I project.

Table 8-1: Phase I Recommended Projects for the East WWTP

WWTP	Process	Project/Equipment	Reason for project	Phase
East	Headworks, Primary Clarifiers	Repair/Rehabilitate Odor Control Systems	Safety, Public	Phase I
East	Influent Pump Station	Replace Wet well Cover (FRP)	Safety	Phase I
East	Headworks	Replace Doors Repair/Replace HVAC Repair/Replace Electrical	Safety, Reliability, Operational Cost	Phase I
East	Grit Removal	Replace Doors Replace Air Lift Pump Repair/Replace HVAC Repair/Replace Electrical	Safety, Reliability, Operational Cost	Phase I
East	Primary Clarification	Replace Primary Sludge Pumps (3), Install Grinders (2)	Reliability	Phase I
East	Primary Clarification	Replace Primary Sludge Piping	Reliability	Phase I
East	Primary Clarification	Rehabilitate Primary Clarifier & PC Splitter	Reliability, Efficiency, Capacity	Phase I
East	Activated Sludge	Install Blower VFDs Install Aeration Instrumentation	Reliability, Efficiency, Capacity	Phase I

Table 8-1 cont…

WWTP	Process	Project/Equipment	Reason for project	Phase
East	Secondary Clarification	Rehabilitate Clarifiers (2) Install Algae Cleaning System	End of Design Life, Reliability, Safety, Efficiency	Phase I
East	Biosolids	Rehabilitate Biosolids Replace Volumetric Lime Feeder (2) Replace Lime Feed Pumps/Mixers (2) Replace Lime Slurry Pumps (2) Replace Air Compressor Blending Tank Rehabilitation Replace Sludge Transfer (2) Replace WAS In-line Grinder (2) Replace Sludge Storage Tank Blower #2 Replace Lime Room HVAC	Reliability, Operational Cost	Phase I
East	Site	Install SCADA System (New)	Safety, Reliability	Phase I

8.1.1.1 Headworks

The headworks at the East WWTP is in poor condition due to corrosive gases caused by insufficient ventilation, and the poor condition contributes to reliability and safety issues. As a result, work needs to be done on the headworks to address the corrosive gases and to repair and replace infrastructure affected by the gases. This means fixing the ventilation and gas detection system and repairing doors, flow control gates, and miscellaneous electrical.

In addition, the wet well cover, located within the headworks structure, has failed in several places. This should be repaired to help control release of gases. An odor and gas control system that supports the headworks is in disrepair and is not considered functional. This system should be repaired and restored to normal operation to both control odors and to pull and neutralize corrosive gases from the structure.

8.1.1.2 Grit Removal Equipment and Housing

While the grit removal unit process itself is in good condition, the supporting ancillary equipment is in poor condition. As with the headworks, it appears that poor ventilation may have contributed to deterioration of equipment and building systems. As a result, repairs are needed to replace doors, electrical and HVAC. In addition, the grit pump, located within the grit building, is at the end of its useful life and needs to be replaced.

8.1.1.3 Wastewater Treatment Needs

The primary clarifiers at the East WWTP are in poor condition having been extended past the end of the useful life for much of the equipment. As a result, rehabilitation is needed to restore the clarifiers to good operating condition. For Phase I, primary clarifier rehabilitation focuses sludge pumps and piping. In

addition, the flow splitter to the primary clarifiers is poorly designed and modifications are needed to provide improved flow splitting.

One of the most important needs of the secondary treatment process is proper aeration. The existing aeration system gives inconsistent dissolved oxygen concentrations in the aeration basins. As a result, instrumentation and VFD upgrades are proposed to support blower operation that results in consistent aeration.

The secondary clarifiers have reached the end of their useful lives and require rehabilitation. This includes replacement of the mechanisms, upgrade of the weirs and weir launders, and tank inspection and repair as needed. Clarifier algae control is critical for future nutrient removal and should be included with the rehabilitation.

8.1.1.4 Solids Handling Needs

The biosolids system achieves satisfactory stabilization; however, many of the components have reached the end of their useful lives. As a result, an equipment replacement is recommended for much of the biosolids system as shown in Table 8-1.

8.1.2 Southwest WWTP

In order to ensure continued safe and reliable operation of the Southwest WWTP, a number of process replacements, upgrades, and/or enhancements are recommended as part of the Phase I project.

Table 8-2: Phase I Recommended Projects for the Southwest WWTP

WWTP	Process	Project/Equipment	Reason for Project	Phase
Southwest	Industrial Screen	Install Industrial Influent Emergency Diversion	Reliability	Phase I
Southwest	Industrial Screen	Rebuild Rotary Screen	Reliability	Phase I
Southwest	Domestic Influent Pumps	Replace Domestic Influent Pumps (2)	Reliability	Phase I
Southwest	Activated Sludge	Install Fine Bubble Diffuser System	Reliability	Phase I
Southwest	Activated Sludge	Replace Blowers and Controls, Add Enclosure	Reliability, Efficiency	Phase I
Southwest	Activated Sludge	Replace DO, ORP, and pH Probes	Reliability, Efficiency	Phase I
Southwest	Activated Sludge	Replace RAS Pumps (2), WAS Pump (1)	Reliability	Phase I
Southwest	Biosolids	Rebuild Sludge Transfer Pumps (3)	Reliability	Phase I
Southwest	Industrial DAF	Repair/Replace HVAC Repair/Replace Lighting Repair/Replace Roof and Structural As Required Replace DAF Units	Reliability, Safety, Efficiency	Phase I
Southwest	Industrial pH Control	Install and Relocate a New pH Stabilization System – Acid/Base Feed	Reliability	Phase I

8.1.2.1 Industrial Emergency Screen Diversion

An emergency overflow diversion is needed to divert industrial influent flow from the rotary screen to the domestic lift station in order to maintain process continuity and reliability. Due to occasional slug discharges and equipment failures of the system, the rotary screen may be blinded resulting in flooding of the screen room/building. A new overflow to the domestic lift station would eliminate flooding in the industrial screen room if equipment fails. The rotary screen is due to be rebuilt and the overflow diversion should be installed as part of the rebuild work.

8.1.2.2 Industrial Rotary Screen

The Southwest WWTP uses a rotary screen as a first treatment step for industrial waste. The existing screen is built by Dontech Industries and has an effective size of 0.015 inches with a peak flow capacity of 1.0 MGD. It uses an external flow configuration along with a hot water spray to prevent blinding with oil and grease. In general, external flow screens are a poor fit for applications with oil and grease due to severe blinding issues associated with the oil and grease. On the other hand, internal screens maintain the oil and grease on the water surface better; therefore allowing the oil and grease to flow out with the solids.

As experienced by the operations staff, the existing screen experiences challenges in operation due to inadequate peak flow capacity, due to the inefficient external flow configuration, and due to intermittent blinding problems, and this screen is not considered a good fit in the application. As a result, rather than rebuilding the operations intensive screen, it is recommended to replace this screen with an internal flow rotary screen with an effective size of 0.03 inches to reduce problems with blinding, and a peak flow capacity of 1,500 gpm in order to better handle daily flow spikes. The heating costs for an internal flow screen should be lower as well.

8.1.2.3 Industrial Dissolved Air Flotation Pretreatment

The DAF system provides a critical pretreatment function for the industrial waste stream. The existing DAF uses pressurized recirculation resulting in the physical separation process. This DAF typically relies on coagulant and polymer dosing to provide chemical enhancement of the separation process. The DAFs are overloaded by approximately 50 percent, and due to costs, no chemical addition is currently used with the DAFs at the Southwest WWTP. This system has neared the end of its useful life; thus it requires either a rebuild or replacement.

Due to the condition of the existing DAF and due to the fact that the existing DAF is overloaded, it is recommended that two new DAF units be installed. The new DAF will improve treatment efficiency (due to proper sizing) and will be less operations and maintenance intensive (due to the use of proper materials and newer condition). The improved treatment efficiency is important to support the future secondary treatment process (nutrient removal). Therefore, two new 150 ft2 DAFs are recommended for installation at the Southwest WWTP.

For evaluation of DAF performance, two scenarios have been evaluated. The first scenario is operation of the DAF without chemical support. For this condition, removals have been estimated as shown in Table 8-3. The second scenario tested is operation of the DAF with chemical dosing (coagulant and/or polymer). For this condition, removals have been estimated as shown in Table 8-4.

Table 8-3: DAF Performance without Chemical Addition

Parameter	Removal Efficiency
BOD5	63
TSS	65
FOG	75
TN	10
TP	10

Table 8-4: DAF Performance with Chemical Addition

Parameter	Removal Efficiency
BOD5	66
TSS	70
FOG	90
TN	10
TP	10

In addition, operation of the EQ basin to give a constant output flow gives the best DAF operation with the most compact footprint. Therefore, a modulating valve and flow meter should be installed to support operation of the EQ basin to provide flow equalization.

Based on the evaluation, it is recommended that the existing DAFs be replaced as part of the Phase I project with two 150 ft2 DAFs, and the EQ basin effluent piping be modified with a modulating valve and flow meter for control of flow to the DAF(s). The DAF system may be operated as a physical DAF, but chemical addition will enhance performance.

Due to high humidity in the DAF room, severe deterioration of structural and electrical components has occurred. As a result, rehabilitation has been included as part of this work including HVAC improvements, structural repairs and replacement, and lighting replacement. As part of the HVAC work, it is proposed that hoods be installed above the DAF open water surface to pull humidity directly out of the room.

With the significant rehabilitation work required for the DAF room, the DAF replacement and room repairs need to be coordinated.

8.1.2.4 Aeration System

The aeration blowers have become unreliable due to age and maintenance challenges. As a result, the aeration blowers need to be replaced. These blowers should be replaced with blowers that are fully

enclosed to protect the blowers from the weather and to control sound. Blower capacity the existing process is adequate to support the upgraded nutrient removal system.

In addition, as part of this project and in order to prepare for future process needs, it is recommended to remove the jet aeration pumps and install a fine bubble diffuser system to improve efficiency of the transfer of oxygen in the process.

8.2 PHASE II

The Phase II project includes medium priority work necessary to address capacity needs and prepare the WWTPs for existing and upcoming increased regulatory requirements. Work conducted as part of the Phase II project is expected to improve overall treatment process efficiency (consistent with future process needs) with appropriate capacity increase, and Phase II work should be completed over the 2015, 2016, and 2017 fiscal years. This section identifies needs for both facilities.

8.2.1 East WWTP

In order to improve process performance and meet future capacity needs of the East WWTP, a number of process replacements, upgrades, and/or enhancements are recommended as part of the Phase II project.

Table 8-5: Phase II Recommended Projects for the East WWTP

WWTP	Process	Project/Equipment	Reason for Project	Phase
East	Headworks	Install Fine Screens (2) Install Washer, Compactor, Bagger (2) Replace Handrail, Grating	Safety, Reliability, Operational Cost	Phase II
East	Activated Sludge	Replace Anoxic Mixer	Reliability	Phase II
East	Activated Sludge	Replace Aeration Diffuser System	Reliability, Efficiency	Phase II
East	Activated Sludge	Replace RAS Pumps (3)	End of Design Life	Phase II
East	Activated Sludge	Replace WAS Pumps (2)	End of Design Life	Phase II
East	Activated Sludge	Replace Scum Pump (1)	End of Design Life	Phase II
East	Biosolids	Rehabilitate/Recoat Blending Tank Exterior Rehabilitate/Recoat Sludge Storage Tank Exterior Replace Sludge Transfer Pumps (2) Replace Blend Tank Blower (1) Replace Sludge Storage Tank Blower (2) New Sludge Storage Tanks – 1.6 MG Needed	Reliability, Operational Cost	Phase II
East	Site	Remodel Laboratory/Locker room	Safety	Phase II

8.2.1.1 Headworks

As the second step in updating and upgrading the headworks building, it is recommended that the coarse screens be replaced with fine screens and a washer, compacter, bagging system be installed. The East WWTP experiences substantial problems with pass through screenings throughout the treatment process and in the biosolids handling system, and replacing the existing screens with more efficient and finer screens is expected to improve the entire process.

8.2.1.2 Activated Sludge System

The activated sludge system requires some maintenance replacements and some preliminary upgrades to support additional capacity and more stringent ammonia and nitrogen standards. Maintenance items include a new anoxic mixer, RAS pumps, WAS pumps, and Scum pumps. In addition, the aeration system should be upgraded to a fine bubble diffuser system to support the treatment process.

8.2.1.3 Biosolids

Additional upgrades are required to maintain the existing biosolids process at the East WWTP. These include tank restorations, pump replacement, and replacement of blowers. In addition, in order to provide the minimum KDHE storage requirements, additional storage tanks are recommended to be constructed.

8.2.2 Southwest WWTP

In order to improve process performance and meet existing and future capacity needs of the Southwest WWTP, a number of process replacements, upgrades, and/or enhancements are recommended as part of the Phase II project.

Table 8-6: Phase II Recommended Projects for the Southwest WWTP

WWTP	Process	Project/Equipment	Reason for Project	Phase
Southwest	Domestic Influent	Rebuild or Replace Domestic Influent Screen	Reliability, Life	Phase II
Southwest	Equalization	Rebuild EQ Tank 2 Blowers	Reliability, Life	Phase II
Southwest	Equalization	Replace EQ Tank 1 Mixers	Reliability, Life	Phase II
Southwest	Equalization	Rehabilitate EQ Tank 1	Reliability, Life	Phase II
Southwest	Activated Sludge	Replace Anoxic Zone Mixers	End of Design Life	Phase II
Southwest	Activated Sludge	Replace Scum Pump (1)	End of Design life	Phase II
Southwest	Biosolids	Retrofit existing Sludge Storage Tank into an Aerobic Digester and construct a new 1.52 MG Aerobic Digester	Capacity, Future Regulatory	Phase II

8.2.2.1 Industrial Pretreatment

The equalization basins require some maintenance to be conducted including rehabilitation of Tank 1, new mixers for Tank 1, and new blowers for Tank 2.

8.2.2.2 Domestic Screening

As part of the Phase II project, the domestic screens should undergo a rebuild as a maintenance item to provide reliability.

8.2.2.3 Activated Sludge

Several maintenance items for the activated sludge system should be addressed as part of Phase II improvements including the anoxic zone mixers, WAS pumps, and the scum pump.

The HVAC in the operations building may need to be replaced to provide a safe working environment; however, HVAC improvements are planned for the DAF room, and these improvements may correct the operations room issues.

8.2.2.4 Biosolids

In order to provide an independent, fully functional biosolids system, biosolids treatment improvements are needed for Phase II as discussed in Section 7.2.6.

8.3 PHASE III

The Phase III project includes lower priority work meant to address anticipated future regulatory requirements; in particular, nutrient removal. The work conducted as part of the Phase III project is planned to provide a treatment process that reduces wastewater total nitrogen and total phosphorus concentrations in the discharge to levels that meet KDHE tier 1 nutrient requirements. Phase III work should be completed when required by the NPDES discharge permit. It is anticipated that Phase III projects should be completed during the 2017, 2018, and 2019 fiscal year or beyond. This section identifies lower priority work for both facilities.

8.3.1 East WWTP

Alternatives have been evaluated to support nutrient removal at the East WWTP as detailed in Section 6.3. Based on the analysis, denitrification with chemical phosphorus removal has been recommended as the preferred approach to meeting nutrient requirements. The evaluation identified installation of the following:

- Baffling of the aeration basin to create a new 0.3 MG anoxic zone
- Baffling of the aeration basin to create a new 0.2 MG aerobic zone
- MLR pumping improvements
- Alum storage and feed system
- Methanol storage and feed system

8.3.2 Southwest WWTP

Alternatives have been evaluated to support nutrient removal at the Southwest WWTP as detailed in Section 6.4. Based on the analysis, the recommended approach to meeting nutrient requirements is a suspended growth, biological nutrient removal system with chemical polishing as needed. The evaluation identified installation of the following:

- Construction of a new 0.5 MG anaerobic basin
- Conversion of the existing final clarifiers to anoxic basins
- New post-anoxic and post-aerobic basins
- Two new final clarifiers
- Methanol and ferric storage and feed systems

Due to inadequate depth and diameter of the existing clarifiers to support operating the activated sludge process at elevated capacity, it is recommended that new secondary clarifiers are constructed. Once the new secondary clarifiers are constructed and in operation, the existing secondary clarifiers may be converted to bioreactor tankage.

9 COST ESTIMATE

This section presents a preliminary capital improvements plan based on estimates of construction costs[1]. It includes order of magnitude costs and anticipated timing for each item. Costs have been evaluated for all treatment projects including those for rehabilitation, capacity upgrades, and upgrades to address future nutrient requirements and have been evaluated using the most appropriate means available including budgetary quotes from vendors, unit costs from comparable projects, and cost curves from the HDR WaterCost Tool; derived from an extensive library of projects. The costs for recommended projects only are shown in this section; i.e. alternatives evaluations have been conducted in previous sections.

Costs shown in this section have been split between Phase I, Phase II, and Phase III projects. Projects that need to be completed in order to address safety and reliability have been prioritized as Phase I costs to protect plant operations. Projects related to capacity and continued reliability have been assigned to Phase II costs. Nutrient focused project work has been assigned to Phase III costs. Note: costs shown in Phase II have been adjusted with a two-year escalation factor at three percent interest while costs shown for Phase III have received a five-year escalation.

9.1 EAST WWTP IMPROVEMENTS CAPITAL COSTS

As described in detail in Section 8, projects for the East WWTP are split into the phases shown. In addition to nutrient costs, the Phase III costs include additional sludge storage. Currently, the facility does not have storage matching the 60-day KDHE requirement.

The anoxic and aeration basin improvements' costs include work on the existing system to replace and rehabilitate the system for reliability, to give the appropriate capacity for future growth, and to support the nutrient removal scheme.

The nutrient removal system costs have been estimated for the entire system including tanks, equipment, chemical feed, site piping, etc. These costs are considered accurate within a range of -20 to +40 percent. Cost details may be found in Appendix B.

[1] *Any opinions of probable construction cost or cost estimates provided by HDR, Inc. are made on the basis of information available to HDR, Inc. and on the basis of cost estimator's experience and qualifications, and represents its judgment as an experienced and qualified professional engineer. However, since HDR, Inc. has no control over the cost of labor, materials, equipment or services furnished by others, or over the contractor(s') methods of determining prices, or over competitive bidding or market conditions, HDR, Inc. does not guarantee that proposals, bids or actual project or construction cost will not vary from opinions of probable cost or cost estimates prepared by HDR, Inc."*

Table 9-1: East WWTP Proposed Capital Improvements - Phase I, II, and III Projects

		PHASE		
FACILITIES		**1 (2014 - 2015)**	**2 (2015 - 2017)**	**3 (2019 - 2021)**
INFLUENT PUMP STATION		$41,000	$0	$0
HEADWORKS BUILDING		$130,000	$706,000	$0
GRIT BUILDING		$45,000	$0	$0
PRIMARY CLARIFIERS		$420,000	$0	$0
PRIMARY SLUDGE PUMP STATION		$282,000	$0	$0
ANOXIC BASIN		$0	$47,000	$0
AERATION BASINS		$185,000	$266,000	$0
SECONDARY CLARIFIERS		$502,000	$0	$0
RAS/WAS PUMP STATION		$0	$235,000	$0
SLUDGE SYSTEM		$298,000	$344,000	$1,681,000
SITE		$475,000	$483,000	$0
BNR IMPROVEMENTS		$0	$0	$1,029,000
SUBTOTAL		$2,378,000	$2,081,000	$2,710,000
Mobilization, Bonding and General Requirements	5.0%	$119,000	$104,000	$136,000
Overhead and Profit	10.0%	$238,000	$208,000	$271,000
SUBTOTAL		$2,735,000	$2,393,000	$3,117,000
Contingency	25.0%	$684,000	$598,000	$779,000
CONSTRUCTION		$3,419,000	$2,991,000	$3,896,000
Engineering, Legal, Administrative	20.0%	$684,000	$598,000	$779,000
TOTAL		$4,103,000	$3,589,000	$4,675,000

9.2 SOUTHWEST WWTP IMPROVEMENTS CAPITAL COSTS

As described in detail in Section 8, projects for the Southwest WWTP are split into the phases shown. In addition to nutrient costs, the Phase III costs include new secondary clarifiers as part of the overall biological nutrient removal system.

The screening process repairs are planned for Phases I and II with the industrial screen being replaced in Phase I and the domestic screens being rebuilt during Phase II. For the DAF room ceiling and roof repairs, the costs have been estimated assuming full replacement; however, a structural evaluation is needed to determine whether replacement is needed or if sandblasting and recoating is adequate.

The biological nutrient removal system costs have been estimated for the entire system including tanks, equipment, chemical polishing, site piping, etc. These costs are considered accurate within a range of -20 to +40 percent. Cost details may be found in Appendix B.

Table 9-2: Southwest WWTP Proposed Capital Improvements - Phase I, II, and III Projects

		Phase		
FACILITIES		**1 (2014 - 2015)**	**2 (2015 - 2017)**	**3 (2019 - 2021)**
FLOW DIVERSION STRUCTURE		$41,000	$0	$0
SCREENING - INDUSTRIAL AND DOMESTIC		$163,000	$153,000	$0
ACID FEED SYSTEM		$20,000	$0	$0
EQUALIZATION BASINS		$0	$169,000	$0
DISSOLVED AIR FLOTATION		$557,000	$0	$0
BNR BASIN(S) (NEW)		$0	$0	$3,843,000
SELECTOR BASIN (EXISTING)		$0	$46,000	$0
AERATION SYSTEM		$899,000	$0	$0
SECONDARY CLARIFIERS		$3,083,000	$0	$0
WAS/RAS/SCUM HANDLING		$41,000	$16,000	$0
BIOSOLIDS SYSTEM		$0	$6,175,000	$0
SUBTOTAL		**$4,804,000**	**$6,559,000**	**$3,843,000**
Mobilization, Bonding and General Requirements	5.0%	$240,000	$328,000	$192,000
Overhead and Profit	10.0%	$480,000	$656,000	$384,000
SUBTOTAL		$5,542,000	$7,543,000	$4,419,000
Contingency	25.0%	$1,381,000	$1,886,000	$1,105,000
CONSTRUCTION		$6,905,000	$9,429,000	$5,524,000
Engineering, Legal, Administrative	20.0%	$1,381,000	$1,886,000	$1,105,000
TOTAL		$8,286,000	$11,315,000	$6,629,000

Appendix A

FLOWS AND LOADS ANALYSIS
PROBABILISTIC ANALYSIS OF HISTORICAL DATA

The figures below contain log-normal probability distributions for Junction City influent flow, BOD_5, TSS, and NH_3 loads used to project annual average, maximum month and maximum day loadings. These distributions were generated from three years of data as provided by operations staff. The values were arranged in order of increasing magnitude (non-exceedance probability) and corresponding plotting positions were determined according to the following equation:

$$\text{Plotting position (\%)} = (m/(n+1))*100$$

m = order number
n = number of observations

A regression analysis was performed to determine if the data was normally or log-normally distributed. Most of the data sets were found to fit a log-normal distribution well; however, Southwest WWTP industrial flow and East WWTP TSS loads do not appear to fit a normal distribution as well. Southwest WWTP industrial flow appears to be capped at the maximum by the limit of production at industry. East TSS loads appears to be skewed by the solids decant stream.

From the probability plots, average day and maximum day flows and mass loads were determined based on the normalized distribution. The average day values represent a 50 percent probability of occurrence. Maximum Month values represent a 91.7 percent (11/12) probability of occurrence. Maximum day values represent a 99.7 percent (364/365) probability of occurrence.

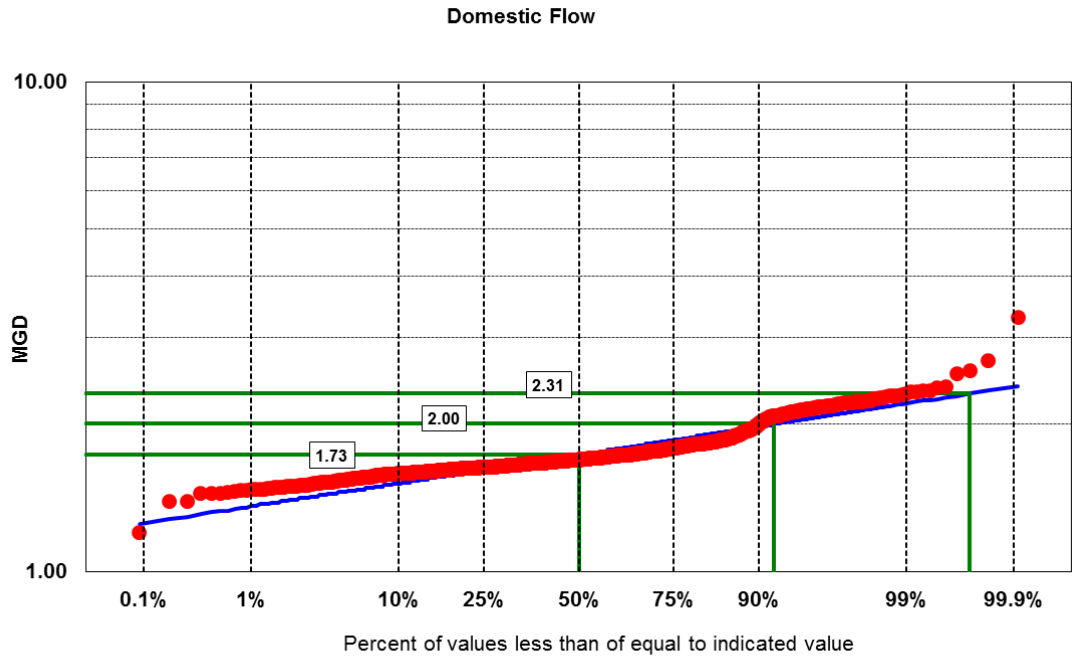


Figure A-1: East WWTP Cumulative Distribution of Flows

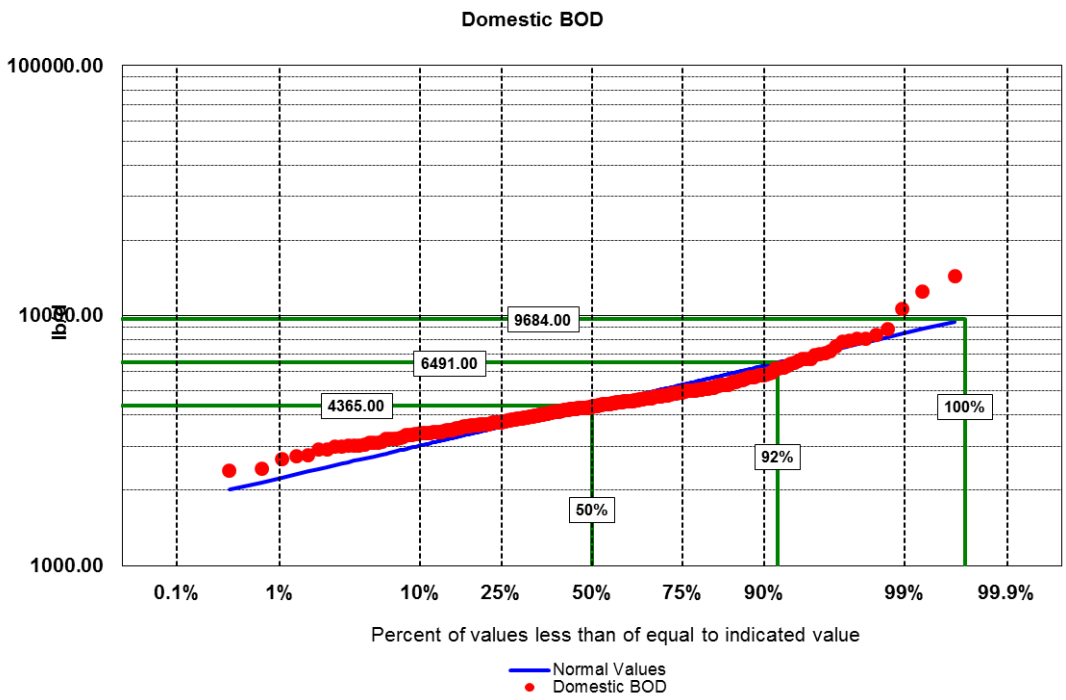


Figure A-2: East WWTP Cumulative Distribution of BOD_5 Loading

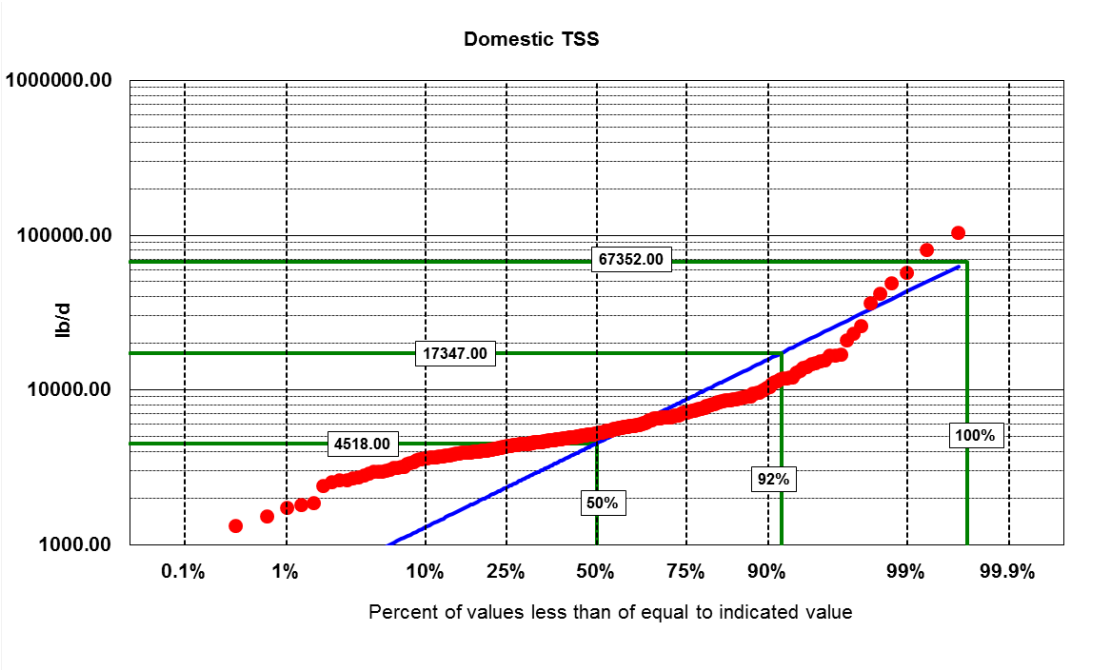


Figure A-3: East WWTP Cumulative Distribution of TSS Loading

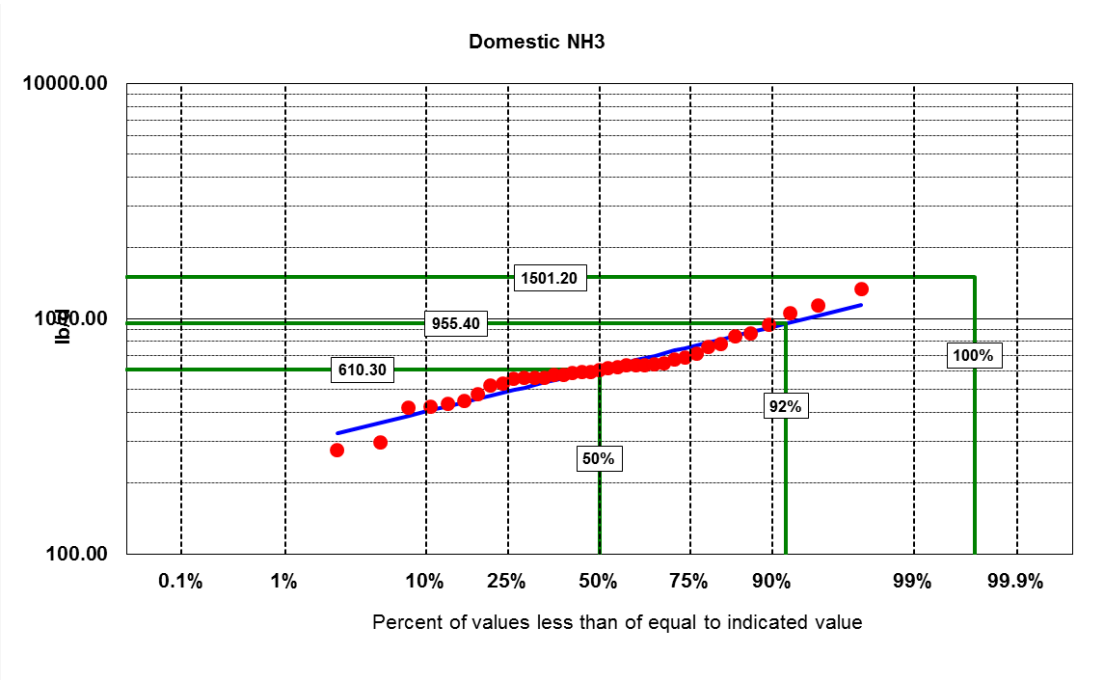


Figure A-4: East WWTP Cumulative Distribution of Ammonia Loading

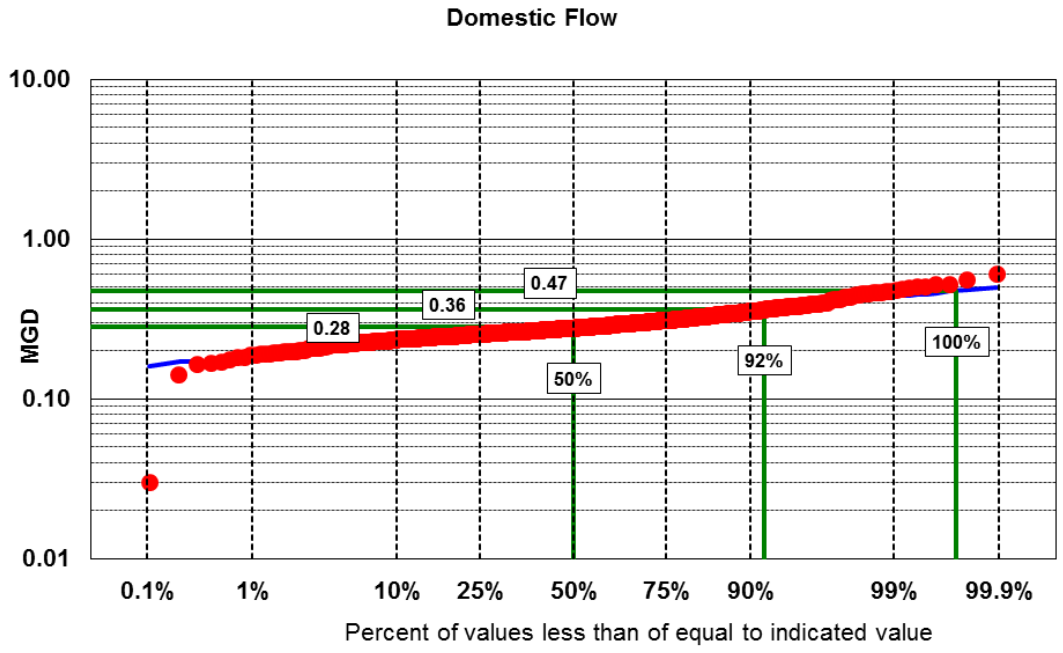


Figure A-5: Southwest WWTP Cumulative Distribution of Domestic Flow

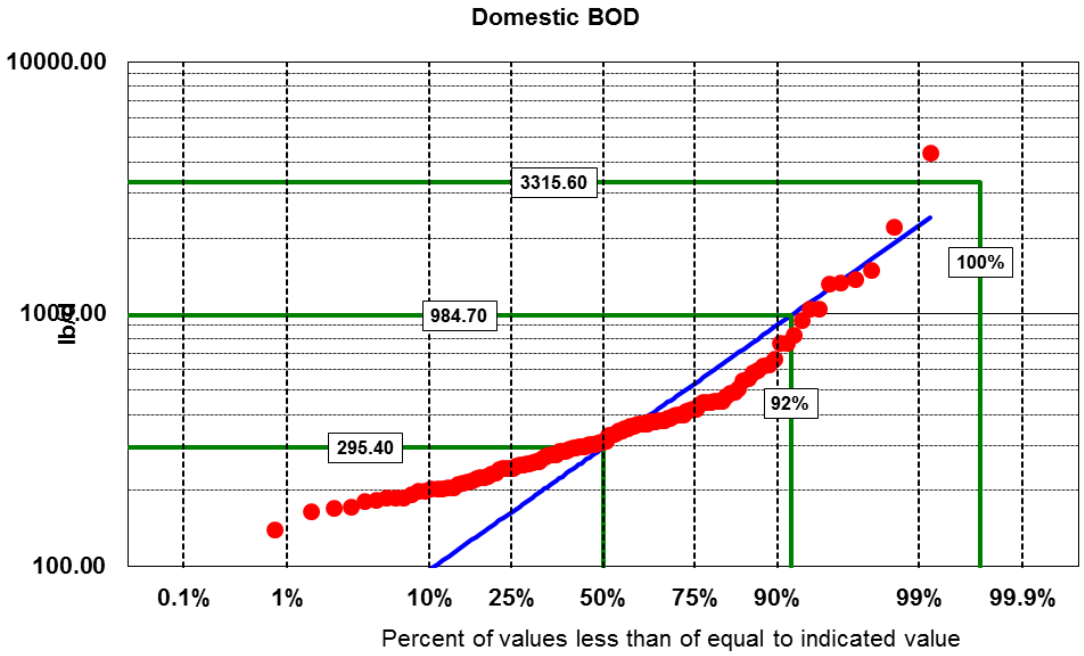


Figure A-6: Southwest WWTP Cumulative Distribution of Domestic BOD_5 Loading

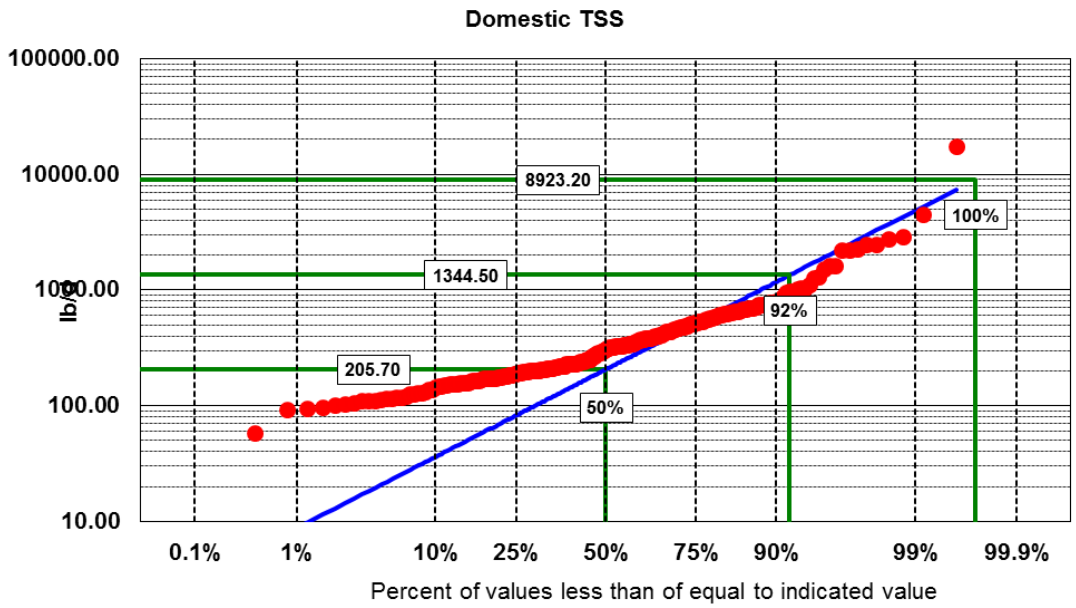


Figure A-7: Southwest WWTP Cumulative Distribution of Domestic TSS Loading

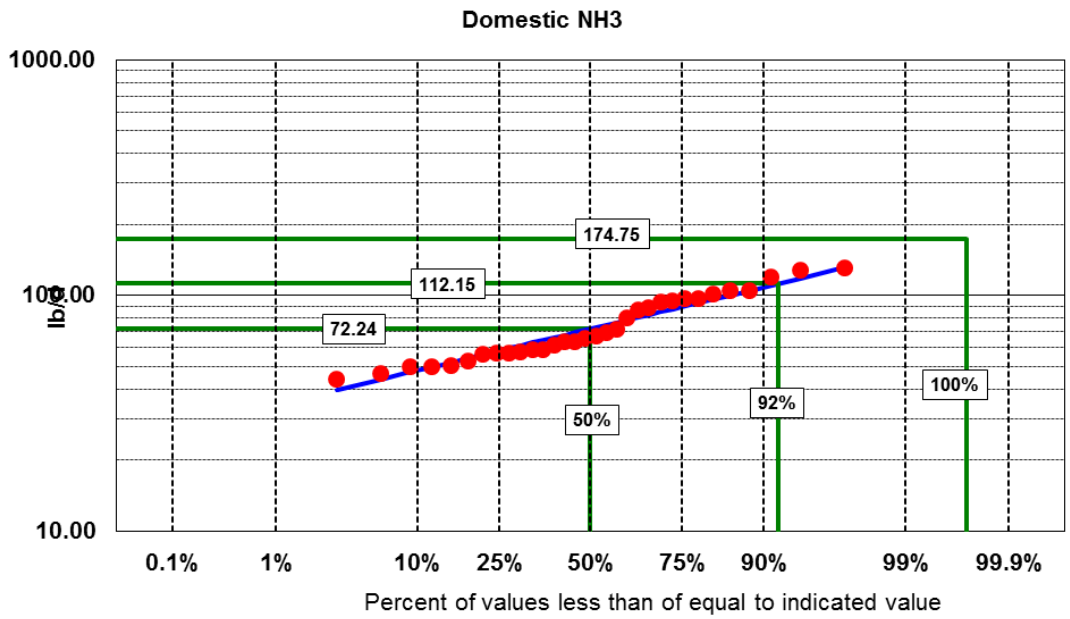


Figure A-8: Southwest WWTP Cumulative Distribution of Domestic Ammonia Loading

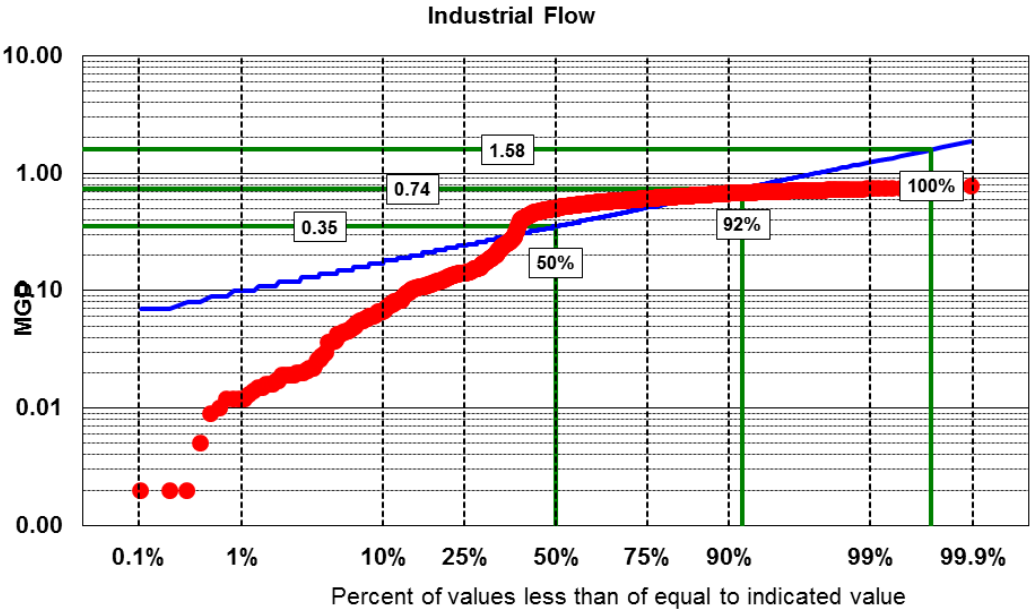


Figure A-9: Southwest WWTP Cumulative Distribution of Industrial Flow

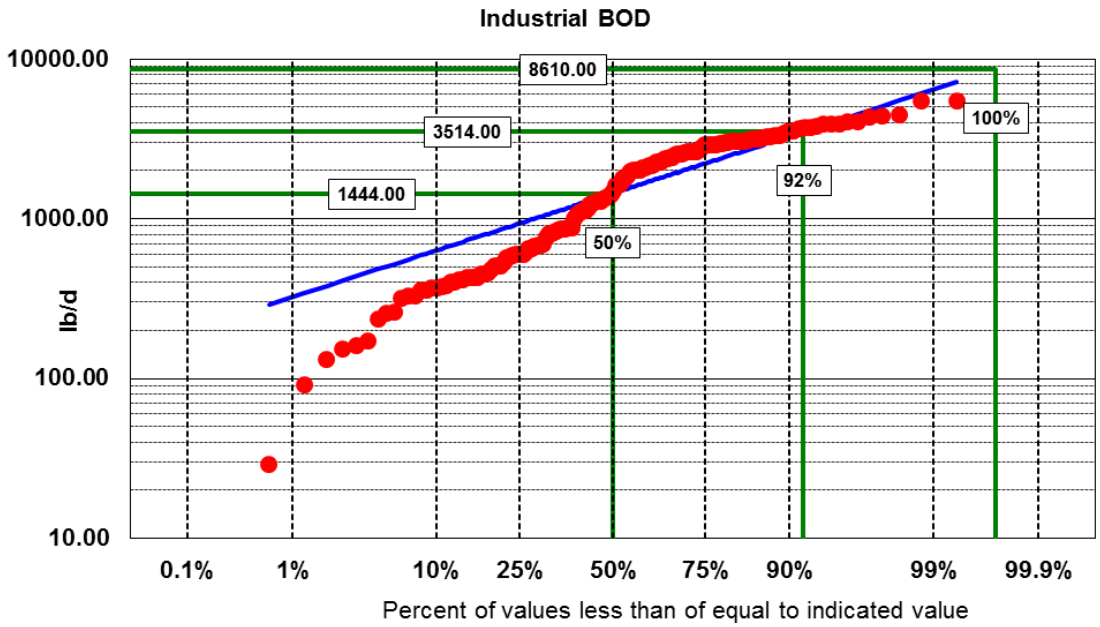


Figure A-10: Southwest WWTP Cumulative Distribution of Industrial BOD_5 Loading

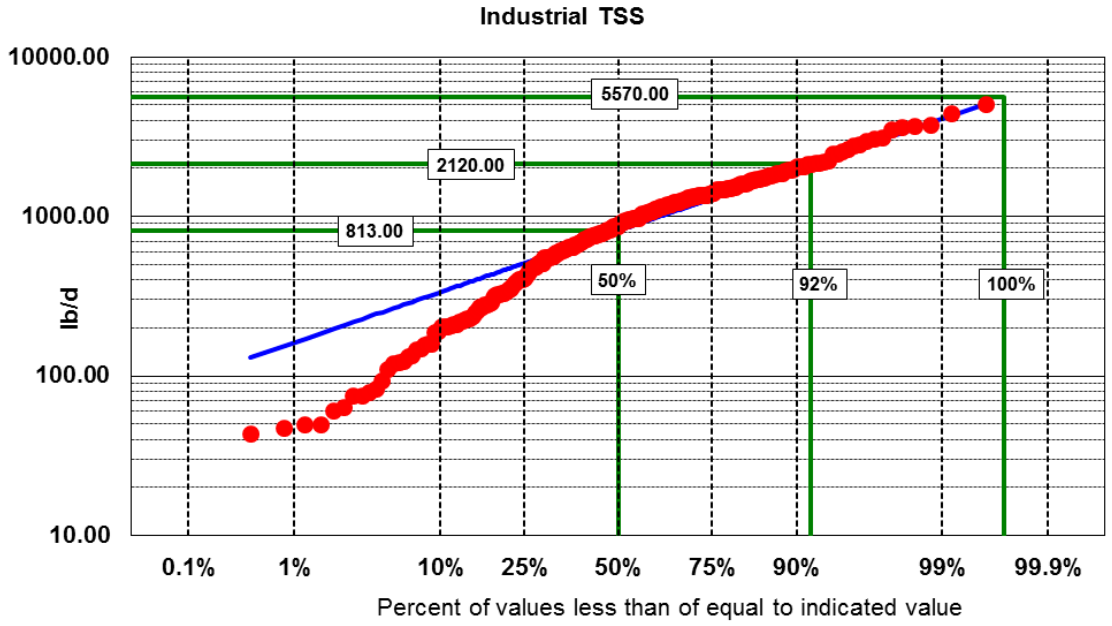


Figure A-11: Southwest WWTP Cumulative Distribution of Industrial TSS Loading

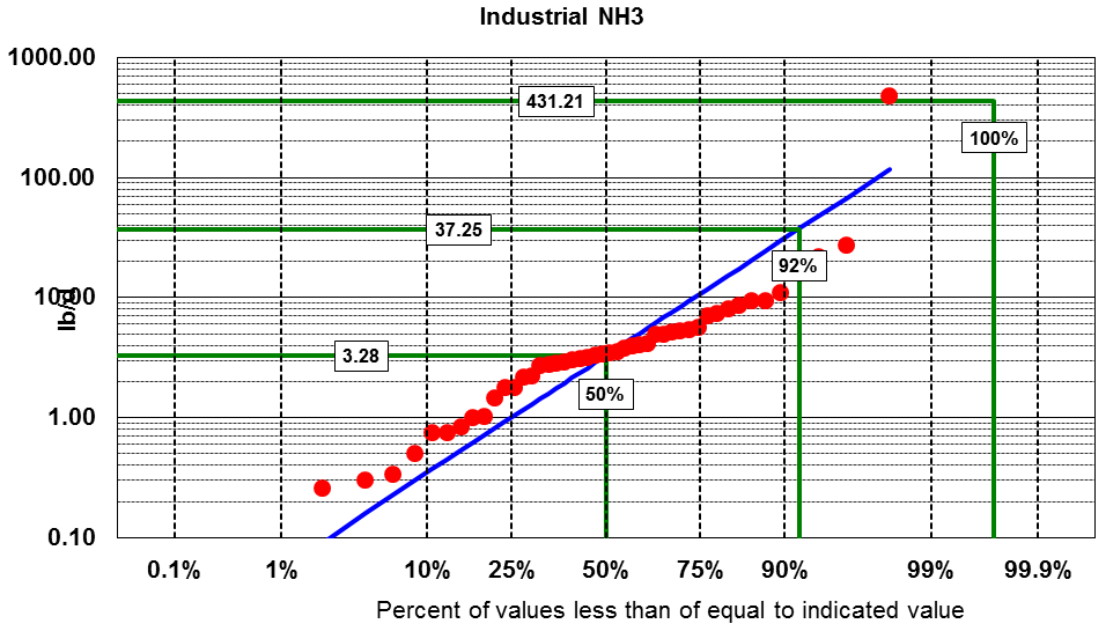


Figure A-12: Southwest WWTP Cumulative Distribution of Industrial Ammonia Loading

Appendix B

APPENDIX B – COST DETAILS

EAST WWTP PLANNING LEVEL COST ESTIMATE DETAILS

INFLUENT PUMP STATION							
ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 13							
Wet well Enclosure - FRP Cover	330	ft^2	$100	$33,000	$33,000		
Installation	25%	% ls		$8,250	$8,250		
SUBTOTAL				$41,000	$41,000	$0	$0

HEADWORKS BUILDING							
ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 03							
Channel Modifications	1	ls	$15,000	$15,000		$15,000	
DIVISION 05							
Handrail	1	ls	$1,500	$1,500		$1,500	
Grating	1	ls	$1,000	$1,000		$1,000	
DIVISION 08							
Single Exterior Door	1	ea	$1,500	$1,500	$1,500		
Double Exterior Door	1	ea	$4,000	$4,000	$4,000		
DIVISION 09							
Paint (Interior Screen Room)	1	ls	$7,500	$7,500		$7,500	
DIVISION 11							
Perforated Plate Fine Screen (1/4")	2	ea	$200,000	$400,000		$400,000	
Washer/Compactor with Bagging System	2	ea	$55,000	$110,000		$110,000	
Installation	25%	% ls		$127,500		$127,500	
DIVISION 15							
Sluice Gate	2	ls	$30,000	$60,000	$60,000		
NPW Modifications	1	ls	$2,500	$2,500		$2,500	
Ventilation	1	% ls	$5,000	$5,000	$5,000		
DIVISION 16							
Lighting and Receptacles	1	ls	$7,500	$7,500	$7,500		
Electrical Installation	10%	% ls		$51,500	$51,500		
SUBTOTAL				$795,000	$130,000	$665,000	$0

GRIT BUILDING							
ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 05							
Misc Metals	1	ls	$2,500	$2,500	$2,500		
DIVISION 08							
Double Exterior Door	1	ea	$4,000	$4,000	$4,000		
DIVISION 11							
Grit Blower (Includes Demo of Existing Unit)	1	ea	$20,000	$20,000	$20,000		
Installation	25%	% ls		$5,000	$5,000		
DIVISION 15							
Ventilation	1	% ls	$5,000	$5,000	$5,000		
DIVISION 16							
Lighting and Receptacles	1	ls	$6,000	$6,000	$6,000		
Electrical Installation	10%	% ls		$2,000	$2,000		
SUBTOTAL				$45,000	$45,000	$0	$0

PRIMARY CLARIFIERS							
ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 02							
Equipment and Metals Demolition	2	ea	$15,000	$30,000	$30,000		
DIVISION 03							
Splitter Structure Modifications	1	ls	$15,000	$15,000	$15,000		
DIVISION 05							
Misc. Metals for Splitter Structure	1	ls	$10,000	$10,000	$10,000		
DIVISION 11							
Clarifier Mechanisms (Excludes Bridges)	2	ea	$135,000	$270,000	$270,000		
Installation	25%	% ls		$67,500	$67,500		
DIVISION 16							
Electrical Installation	10%	% ls		$27,000	$27,000		
SUBTOTAL				$420,000	$420,000	$0	$0

PRIMARY SLUDGE PUMP STATION							
ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 02							
Equipment Demolition	3	ea	$5,000	$15,000	$15,000		
DIVISION 08							
Double Exterior Door	1	ea	$4,000	$4,000	$4,000		
DIVISION 11							
Primary Sludge Pumps	3	ea	$30,000	$90,000	$90,000		
Primary Sludge Grinder	2	ea	$40,000	$80,000	$80,000		
Installation	25%	% ls		$42,500	$42,500		
DIVISION 15							
Piping and Valves (Interior)	1	ls	$20,000	$20,000	$20,000		
Ventilation	1	% ls	$5,000	$5,000	$5,000		
DIVISION 16							
Lighting and Receptacles	1	ls	$7,500	$7,500	$7,500		
Electrical Installation	10%	% ls		$17,500	$17,500		
SUBTOTAL				$282,000	$282,000	$0	$0

ANOXIC BASIN							
ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 11							
Anoxic Mixer	1	ea	$35,000	$35,000		$35,000	
Installation	25%	% ls		$8,750		$8,750	
SUBTOTAL				$44,000	$0	$44,000	$0

AERATION BASINS							
ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 04							
Building Addition Required for Blower VFDs	300	sf	$300	$90,000	$90,000		
DIVISION 11							
Fine Bubble Diffusers	2	ea	$100,000	$200,000		$200,000	
Installation	25%	% ls		$50,000		$50,000	
DIVISION 13							
I&C (DO Probes, Air Flow Meters, PLC)	1	ls	$5,000	$5,000	$5,000		
DIVISION 16							
Blower VFDs	3	ea	$25,000	$75,000	$75,000		
Electrical Installation (Includes Controls)	20%	% ls		$15,000	$15,000		
SUBTOTAL				$435,000	$185,000	$250,000	$0

SECONDARY CLARIFIERS							
ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DEMOLITION							
Equipment and Metals Demolition	2	ea	$15,000	$30,000	$30,000		
DIVISION 03							
Concrete Weirs	68	cy	$1,250	$84,648	$84,648		
DIVISION 11							
Clarifier Mechanisms (Excludes Bridges)	2	ea	$135,000	$270,000	$270,000		
Algae Brush Cleaning System	2	ea	$20,000	$40,000	$40,000		
Installation	25%	% ls		$77,500	$77,500		
SUBTOTAL				$502,000	$502,000	$0	$0

RAS/WAS PUMP STATION							
ITEM	**QUANTITY**	**UNIT**	**UNIT PRICE**	**EXTENSION**	PHASE 1	PHASE 2	PHASE 3
DIVISION 11							
RAS Pumps	3	ea	$22,500	$67,500		$67,500	
WAS Pumps	2	ea	$10,000	$20,000		$20,000	
Scum Pump	1	ea	$7,500	$7,500		$7,500	
Installation	25%	% ls		$23,750		$23,750	
DIVISION 13							
I&C (RAS and WAS Flow Meters)	1	ls	$20,000	$50,000		$50,000	
Installation	25%	% ls		$12,500		$12,500	
DIVISION 15							
Piping and Valves (Interior)	1	ls	$30,000	$30,000		$30,000	
DIVISION 16							
Electrical Installation	10%	% ls		$9,500		$9,500	
SUBTOTAL				$221,000	$0	$221,000	$0

SLUDGE SYSTEM

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 09							
Blending Tank Coating - Interior	2,200	ft^2	$35	$77,000	$77,000		
Blending Tank Painting - Exterior	320	ft^2	$15	$4,800		$4,800	
Sludge Storage Tank Painting - Exterior	4,200	ft^2	$15	$63,000		$63,000	
DIVISION 11							
Lime Slurry Feed Pump - (15 gpm @ 20 psi, 120 gpm @ 100 psi)	2	ea	$12,500	$25,000	$25,000		
Lime Slurry Mixers	2	ea	$7,500	$15,000	$15,000		
Air Compressor	1	ea	$3,500	$3,500	$3,500		
Volumetric Lime Feeder	2	ea	$5,000	$10,000	$10,000		
Sludge Tansfer Pump	2	ea	$35,000	$70,000		$70,000	
TWAS Grinder	2	ea	$40,000	$80,000	$80,000		
Blend Tank Blower	1	ea	$20,000	$20,000		$20,000	
Sludge Storage Tank #1 Blower	1	ea	$35,000	$35,000		$35,000	
Sludge Storage Tank #2 Blower	1	ea	$35,000	$35,000	$35,000		
Sludge Storage Tank #3 Blower	1	ea	$40,000	$40,000		$40,000	
Installation	25%	% ls		$83,375	$42,125	$41,250	$0
New Sludge Storage Basins	2	ea	$724,877	$1,449,754.00			$1,449,754
DIVISION 15							
Lime Mixing Room Ventilation	1	% ls	$10,000	$10,000	$10,000		
DIVISION 16							
MCC Relocation	1	ls	$50,000	$50,000		$50,000	
SUBTOTAL				$2,071,000	$298,000	$324,000	$1,450,000

SITE

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 02							
Site Pavement Demolition	3,900	yd^2	$10	$39,000		$39,000	
Site Pavement Resurface	3,900	yd^2	$55	$214,500		$214,500	
Pavement Curbing	3,200	lf	$20	$64,000		$64,000	
DIVISION 12							
Laboratory / Locker-room Remodel	375	sf	$100	$37,500		$37,500	
DIVISION 13							
SCADA	1	ls	$275,000	$275,000	$275,000		
DIVISION 15							
Odor Control	1	ls	$100,000	$100,000	$100,000		
DIVISION 16							
Site Electrical	1	ls	$100,000	$100,000	$100,000	$100,000	
TOTAL				$830,000	$475,000	$455,000	$0

BNR Improvements

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 11							
Post Aerobic Basin Conversion	1	ea	$100,000	$100,000			$100,000
Post Anoxic Basin Conversion	1	ea	$150,000	$150,000			$150,000
MLR Pump Station Improvements	1	ea	$150,000	$150,000			$150,000
Alum Storage and Feed	1	ea	$330,000	$330,000			$287,000
Methanol Feed System	1	ea	$200,000	$200,000			$200,000
SUBTOTAL				**$930,000**	**$0**	**$0**	**$887,000**

SOUTHWEST WWTP PLANNING LEVEL COSTS

FLOW DIVERSION STRUCTURE

Construct influent valve vault for industrial wastewater screening building bypass

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 02							
Excavation	2417	ft^3	$5	$12,087	$12,087		
Base Rock	21	ft^3	$14	$294	$294		
Base Rock Stabilization	84	ft^3	$14	$1,176	$1,176		
					$0		
DIVISION 03					$0		
5' x 4' Precast Valve Vault	14	yd^3	$700	$9,981	$9,981		
					$0		
DIVISION 04					$0		
Masonry	0	yd^3	$0	$0	$0		
					$0		
DIVISION 05					$0		
Metals	0	yd^3	$0	$0	$0		
					$0		
DIVISION 06					$0		
Wood and Plastics	131	yd^3	$0	$0	$0		
					$0		
DIVISION 07					$0		
Thermal and Moisture Protection	0	yd^3	$0	$0	$0		
					$0		
DIVISION 08					$0		
Doors and Windows	0	ea	$0	$0	$0		
					$0		
DIVISION 09					$0		
Finishes	0	ft^2	$0	$0	$0		
					$0		
DIVISION 10					$0		
Specialties	0	ea	$0	$0	$0		
					$0		
DIVISION 11					$0		
Air Compressor	1	ea	$3,000	$3,000	$3,000		
Installation	25%	% ls		$750	$750		
					$0		
DIVISION 12					$0		
Furnishings	0	ea	$0	$0	$0		
					$0		
DIVISION 13					$0		
					$0		
DIVISION 14					$0		
Conveying Systems	0	ea	$0	$0	$0		
					$0		
DIVISION 15					$0		
12" Pinch Valve with fail-safe air system	1	ea	$4,500	$4,500	$4,500		
Flanged Coupling Adaptor	1	ea	$1,500	$1,500	$1,500		
Air Line	20	LF	$40	$800	$800		
HVAC	10%	% ls		$0	$0		
Installation	25%	% ls		$1,700	$1,700		
					$0		
DIVISION 16					$0		
Electrical Modifications to power compressor	1	ls	$5,000	$5,000	$5,000		
Lighting	10%	% ls		$0	$0		
Instrumentation and Controls	25%	% ls		$0	$0		
SUBTOTAL				**$41,000**	**$41,000**	**$0**	**$0**

SCREENING - INDUSTRIAL AND DOMESTIC
Rebuild industrial rotary screens, Replace domestic influent pumps

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 02							
Site Work	0	ea	$0	$0			
DIVISION 03							
Concrete	0	lf	$0	$0			
DIVISION 04							
Masonry	0	yd^3	$0	$0			
DIVISION 05							
Metals	0	yd^3	$0	$0			
DIVISION 06							
Wood and Plastics	0	yd^3	$0	$0			
DIVISION 07							
Thermal and Moisture Protection	0	yd^3	$0	$0			
DIVISION 08							
Doors and Windows	0	ea	$0	$0			
DIVISION 09							
Finishes	0	sf	$0	$0			
DIVISION 10							
Specialties	0	ea	$0	$0			
DIVISION 11							
Replace Industrial Rotary Screen	1	ls	$90,000	$90,000	$90,000		
Replace Ind. Rotary Screen Service Water Boiler	1	ea	$40,000	$40,000	$40,000		
Replace Domestic Influent Pumps	4	ea	$17,500	$70,000		$70,000	
Installation	25%	% ls		$32,500	$32,500		
Rebuild Domestic Influent Screen	1	ls	$45,000	$45,000		$45,000	
Installation	25%			$28,750		$28,750	
DIVISION 12							
Furnishings	0	ea	$0	$0			
DIVISION 13							
Special Construction	0	ea	$0	$0			
Installation	25%	% ls		$0			
DIVISION 14							
Conveying Systems	0	ea	$0	$0			
DIVISION 15							
Replace Domestic Screen Room Exhaust Fans		ea		$0			
DIVISION 16							
Electrical	0	ea	$0	$0			
SUBTOTAL				**$306,000**	**$163,000**	**$144,000**	**$0**

ACID FEED SYSTEM
Replace pH stabilization acid feed pumps

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 11							
Replace Acid Feed Pumps	2	ea	$8,000	$16,000	$16,000		
Installation	25%	% ls		$4,000	$4,000		
SUBTOTAL				**$20,000**	**$20,000**	**$0**	**$0**

EQUALIZATION BASINS

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 05							
Metals - EQ Tank 1 Patches	2	ea	$5,000	$10,000		$10,000	
DIVISION 09							
Coating - EQ Tank 1 - Interior (Surface Prep and Coating)	2450	sf	$15	$36,750		$36,750	
Coating - EQ Tank 1 - Exterior (Surface Prep and Coating)	2475	sf	$10	$24,750		$24,750	
DIVISION 10							
Specialties	0	ea	$0	$0			
DIVISION 11							
EQ Tank 2 Blowers	2	ea	$20,000	$40,000		$40,000	
EQ Tank 1 Mixers	2	ea	$15,000	$30,000		$30,000	
Installation	25%	% ls		$17,500		**$17,500**	
SUBTOTAL				**$159,000**	**$0**	**$159,000**	**$0**

DISSOLVED AIR FLOTATION
DAF Improvements

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 05					$0		
DAF Roof Replacement	500	sf	$80	$40,000	$40,000		
DAF Room Repainting	0	sf	$20	$0	$0		
					$0		
DIVISION 09					$0		
DAF Exterior Painting	750	sf	$0	$0	$0		
					$0		
					$0		
DIVISION 11					$0		
Replace DAF System	2	ea	$150,000	$300,000	$300,000		
Replace DAF Water Boilers	1	ea	$40,000	$40,000	$40,000		
Installation	25%	% ls		$85,000	$85,000		
					$0		
DIVISION 15					$0		
Rebuild DAF Area Heating (Outside)	1	ls	$3,000	$3,000	$3,000		
Replace DAF Exhaust Fans	1	ls	$1,500	$1,500	$1,500		
Ventilation Hoods over DAF Units	2	ea	$18,148	$36,295.38	$36,295		
Electrical Installation	15%	% ls		$46,914.69	$46,915		
DIVISION 16					$0		
Replace DAF and Walkway Lighting	1	ls	$4,300	$4,300	$4,300		
SUBTOTAL				**$557,000**	**$557,000**	**$0**	**$0**

SELECTOR BASIN

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
						$0	
DIVISION 11						$0	
Anoxic Selector Mixer	2	ea	$17,000	$34,000		$34,000	
Installation	25%	% ls		$8,500		$8,500	
						$0	
SUBTOTAL				**$43,000**		$43,000	

BNR BASINS

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 11							
New Anaerobic Basin and equipment	1	ea	$790,000	$790,000			$790,000
New Post-Anoxic Basin and equipment	1	ea	$854,000	$854,000			$854,000
New Post-Aerobic Basin and equipment	1	ea	$887,000	$887,000			$887,000
Convert Final Clarifiers to Anoxic Basins	1	ea	$100,000	$100,000			$100,000
Final Effluent Filter	0	ea	$1,150,000	$0			$0
Methanol Storage and Feed System	1	ea	$300,000	$300,000			$300,000
Ferric Storage and Feed System	1	ea	$383,213	$383,213			$384,000
SUBTOTAL				**$3,315,000**	**$0**	**$0**	**$3,315,000**

AERATION SYSTEM

Oxidation recirculation impellors, Blowers/controls weather protection, and DO, ORP and pH Probes

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 11							
Replace Oxidation Recirculation Pumps	4	ea	$70,000	$280,000	$280,000		
Replace/Add DO, ORP & pH Probes	1	ls	$30,000	$30,000	$30,000		
Installation	10%	% ls		$31,000	$31,000		
Fine Bubble Diffusers	1	ls	$126,000	$126,000	$126,000		
Installation of Diffusers	25%	ls		$31,500	$31,500		
Replacement of Aeration Blowers with Covered Blowers	4	ea	$80,000	$320,000	$320,000		
Installation of Blowers	25%	% ls		$80,000	$80,000		
SUBTOTAL				**$899,000**	**$899,000**	**$0**	**$0**

SECONDARY CLARIFIERS

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
WATER COST TOOL ESTIMATE						$0	
New Secondary Clarifiers	2	ls	$3,082,913	$3,082,913	**$3,083,000**	$0	$0
						$0	
SUBTOTAL				**$3,083,000**	$3,083,000	$0	$0

RAS/WAS/SCUM PUMPING

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
						$0	
DIVISION 11						$0	
Replace RAS Pumps	2	ea	$12,500.00	$25,000.00	$25,000.00		
Installation	25%	% ls		$6,250.00	$6,250.00		
Replace WAS Pumps	1	ea	$9,500	$9,500	$9,500		
Replace Scum Pump	1	ea	$9,500	$9,500		$9,500	
Installation	25%	% ls		$4,750		$7,125	
SUBTOTAL				**$55,000**	$40,750	$14,250	$0

SLUDGE SYSTEM

Replace Sludge Pumps

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
DIVISION 11							
Rebuild Sludge Chopper Transfer Pumps	3	ea	$10,000	$30,000		$30,000	
New Aerobic Digester Basins	1	ls	$5,702,447	$5,703,000		$5,703,000	
Sludge Stabilization Tank Mixers	4	ea	$10,000	$40,000		$40,000	
Installation	25%	% ls		$17,500		$17,500	
Convert sludge storage basin to aerobic digester	1	ls	$30,000	$30,000		$30,000	
SUBTOTAL				**$5,821,000**	$0	$5,821,000	$0

LIME FEED SYSTEM
Replace lime silo feed pumps and mixer

ITEM	QUANTITY	UNIT	UNIT PRICE	EXTENSION	PHASE 1	PHASE 2	PHASE 3
						$0	
DIVISION 11						$0	
Replace Lime Stabilization Feed System	1	ls	$420,000	$420,000		$420,000	
						$0	
SUBTOTAL				**$420,000**		**$0**	

HDR
3741 NE Troon Drive
Lee's Summit, MO 64064
816-347-1100 Ph
816-347-1197 Fx

www.hdrinc.com