CITY OF O’FALLON MISSOURI

AMMONIA & HIGH FLOW DISCHARGE UPGRADES

DRAFT FACILITY PLAN

229868.04
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woodardcurran.com

COMMITMENT & INTEGRITY DRIVE RESULTS
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City of O'Fallon (229868.04)  
Ammonia & High Flow Discharge Draft Facility Plan  
Woodard & Curran  
June 2018
APPENDICES

Appendix A:       MDNR PUB2416 Compliance Table
Appendix B:       MDNR Archeological Site Clearance Letter
Appendix C:       St. Louis Lambert Airport Wind Rose
Appendix D:       Geotechnical Report
Appendix E:       MDNR Water Quality & Antidegradation Review
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EXECUTIVE SUMMARY

The City of O’Fallon (City) is a growing community located within St. Charles County, Missouri. The City encompasses approximately 30 square miles and has a current population of approximately 86,275. The City’s wastewater system serves nearly 16,000 customers and includes the wastewater collection system, 18 existing lift stations (including the new Brookside Forest Lift Station) and the O’Fallon Wastewater Treatment Plant (WWTP).

In 2016 and 2017 the City completed a comprehensive Capital Improvement Plan (CIP) on their wastewater system to support their continued ability to meet existing needs, future needs and permit requirements over the next 20-years. Two key WWTP improvements which were included in the CIP will be discussed in the following Facility Plan due to the following drivers:

- **Ammonia Limits**: More stringent Ammonia-Nitrogen discharge limits were established by the Missouri Department of Natural Resources (MDNR) which will go into effect during the next discharge permit renewal cycle in April 2021. The existing treatment process cannot achieve sufficient Ammonia removal to meet the new more stringent limits and thus the WWTP requires an upgrade to the biological treatment process to meet the new permit limits.

- **High-Flow Discharge**: The WWTP is hydraulically limited by the current capacity of the Effluent Pump Station which does not have adequate capacity to accommodate peak flows, especially when the Mississippi River is under flood conditions. The existing Effluent Pump Station has a capacity of approximately 12.75 Million Gallons Per Day (MGD) when the Mississippi River is under flood conditions. The peak design flow for the O’Fallon WWTP is 16.5 MGD. The capacity limitations have caused surcharging back into the Ultraviolet (UV) Disinfection system upstream of the Effluent Pump Station. A new High-Flow treated effluent discharge into nearby Peruque Creek will be constructed to alleviate capacity limitations of the Effluent Pump Station during peak flow events. A Water Quality & Antidegradation Review (WQAR) which includes the Missouri Department of Natural Resources (MDNR) approval for this discharge has been completed and a copy of the WQAR can be found in Appendix E.

The City is undertaking a WWTP upgrade project to address these needs, consisting of the following main elements. Each of these elements is further described in the following Chapters of this Facility Plan.

- Conversion of the existing biological treatment process at the WWTP from a Bio-Filter Activated Sludge (BF/AS) process to an Activated Sludge with Biological Nutrient Removal (BNR) process to meet the new more stringent Ammonia limits.

- Addition of infrastructure at the WWTP to allow a new high flow treated effluent discharge to Peruque Creek. This cost-effective approach will reduce operational challenges and the risk of surcharging unit processes at the WWTP during high flow events.

- Upgrades to most of the existing electrical systems at the WWTP, which are at or beyond their usable life.

Facility Plan Structure

This report was developed as a Facility Plan and Design Basis Report (DBR) document. A table in Appendix A denotes where the Facility Plan requirements outlined in the MDNR Facility Plan Guidance for Wastewater Treatment Facilities with a Design Flow of 22,500 gallons per day (gpd) or Greater (PUB 2416) are addressed in this report. It is important to note that the City will not be using State funding for this project and thus this Facility Plan was based on requirements in PUB 2416. In addition, this Facility Plan complies with applicable Chapters of the Rules of the Department of Natural Resources, Division 20 – Clean Water Commission, Chapter 8 – Design Guides. Applicable references to compliance with key criteria have been included throughout this Facility Plan.
This Facility Plan includes a summary of the existing conditions, an alternatives analysis, and design criteria used to develop proposed upgrades related to Ammonia removal and the high flow discharge system. Additionally, this report includes a summary (organized by chapter) of the proposed modifications for the major disciplines of work including: Treatment Process, Site Civil, Structural, Architectural, Heating Ventilation & Air Conditioning (HVAC), Plumbing, Electrical, Instrumentation, Controls and Facility Protection Systems. An opinion of probable construction cost, project schedule and proposed sequence of construction are also included.

Opinion of Probable Construction Cost

The opinion of probable construction cost of the project is presented in the table below in 2018 dollars.

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**TOTAL CONSTRUCTION COST** $25,631,000

15% CONSTRUCTION CONTINGENCY $3,845,000

**TOTAL CONSTRUCTION COST (WITH CONTINGENCY)** $29,476,000

* Indeterminate Quantity Used for Bid Comparison

The expected level of accuracy of the cost estimates presented in this Facility Plan is Class 3 in accordance with the Association for the Advancement of Cost Engineering International (AACEI). The expected accuracy for Class 3 estimates and the cost estimate presented in this DBR are within (10-30%) over the estimate to (10-20%) under the estimate. This is appropriate with a Preliminary Design evaluation such as this Facility Plan.
1. INTRODUCTION

1.1 Purpose of Project

The City of O'Fallon (City) is a growing community located within St. Charles County, Missouri. The City encompasses approximately 30 square miles and has a current population of approximately 86,275. The following figure shows the location of the City in the state of Missouri.

![City of O'Fallon Location](image)

The City’s sanitary sewer system serves nearly 16,000 customers and includes the wastewater collection system, 18 existing lift stations (including the new Brookside Forest Lift Station) and the O'Fallon Wastewater Treatment Plant (WWTP).

The City of O'Fallon has completed a comprehensive Capital Improvement Plan (CIP) to support their continued ability to meet existing needs, future needs and permit requirements for their wastewater system over the next 20-years. Two key improvements to the WWTP will be discussed in the following Facility Plan due to the following drivers:

- **Ammonia Limits**: More stringent Ammonia discharge limits were established by the Missouri Department of Natural Resources (MDNR) which will go into effect during the next discharge permit renewal cycle in April 2021. The existing treatment process cannot consistently achieve sufficient Ammonia removal to meet the new more stringent limits and thus the WWTP requires an upgrade to the biological treatment process to meet the new permit limits.

- **High-Flow Discharge**: The WWTP is hydraulically limited by the current capacity of the Effluent Pump Station which does not have adequate capacity to accommodate peak flows, especially when the Mississippi River is under flood conditions. The existing Effluent Pump Station has a capacity of approximately 12.75 million gallons per day (MGD) when the Mississippi River is under flood conditions. The peak design flow for the O'Fallon WWTP is 16.5 MGD. The capacity limitations have caused surcharging back into the Ultraviolet (UV) Disinfection system upstream of the Effluent Pump Station. A new High-Flow treated effluent discharge...
into nearby Peruque Creek will be constructed to alleviate capacity limitations of the Effluent Pump Station during peak flow events. A Water Quality and Antidegradation Review (WQAR) has been completed for this new treated effluent discharge and a copy of the WQAR can be found in Appendix E.

The City is undertaking a WWTP upgrade project to address these needs, consisting of the following main elements. Each of these elements is further described in the following Chapters of this Facility Plan.

1. Conversion of the existing biological treatment process at the WWTP from a Bio-Filter Activated Sludge (BF/AS) process to an Activated Sludge with Biological Nutrient Removal (BNR) process to meet the new more stringent ammonia limits.

2. Addition of infrastructure at the WWTP to allow a new high flow treated effluent discharge to Peruque Creek. This cost-effective approach will reduce operational challenges and the risk of surcharging unit processes at the WWTP during high flow events.

3. Upgrades to the majority of the existing electrical systems at the WWTP, which are at or beyond their usable life.

1.2 MDNR Facility Plan & Design Requirements

This report was developed as a Facility Plan and Design Basis Report (DBR) document. A table in Appendix A denotes where the Facility Plan requirements outlined in the MDNR Facility Plan Guidance for Wastewater Treatment Facilities with a Design Flow of 22,500 gallons per day (gpd) or Greater (PUB 2416) are addressed in this report. It is important to note that the City will not be using State funding for this project and thus this Facility Plan was based on requirements in PUB 2416. In addition, this Facility Plan complies with applicable Chapters of the Rules of the Department of Natural Resources, Division 20 – Clean Water Commission, Chapter 8 – Design Guides. Applicable references to compliance with key criteria have been included throughout this Facility Plan.

This Facility Plan includes a summary of the existing conditions, an alternatives analysis, and design criteria used to develop proposed upgrades related to Ammonia removal and the high flow discharge system. Additionally, this report includes a summary (organized by chapter) of the proposed modifications for the major disciplines of work including: Treatment Process, Site/Civil, Structural, Architectural, Heating Ventilation & Air Conditioning (HVAC), Plumbing, Electrical, Instrumentation, Controls and Facility Protection Systems. An opinion of probable construction cost, project schedule and proposed sequence of construction are also included.

1.3 Report Structure

This Report has been organized in Chapters as indicated in the following listing. In addition, the Rules of the Missouri Department of Natural Resources (MDNR), Division 20-Clean Water Commission, Chapter 8-Design Guides were referenced regarding state required design standards associated with future capital improvements to the WWTP. The “MOP-8 - Design of Municipal Wastewater Treatment Plants” as published by the Water Environment Federation and the American Society of Civil Engineers was also used. A brief description of the chapters contained in this Facility Plan and their content is described below.

- Chapter 1 – Includes background information related to the Facility Plan, defines the project goals, describes the organization of the report, and provides a list of existing data which was reviewed for reference. The Chapter also includes a background of the existing WWTP and a historical timeline of past upgrades.

- Chapter 2 – Establishes the current and future wastewater flows and loads at the WWTP. The projected population growth in the City has also been included. This information is used to estimate the future flows and
loads at the WWTP for the planning period. Current and future discharge permit requirements are also discussed for both treated effluent discharges.

- **Chapter 3** – Includes the treatment alternatives which were evaluated as part of the planning for this project. The WWTP is currently utilizing a Bio-Filter Activated Sludge (BF/AS) treatment system. Upgrades to the existing BF/AS system to meet discharge permit requirements were considered as part of this base project. In addition, two other short-listed alternatives; Membrane Bioreactor (MBR) and Activated Sludge with Biological Nutrient Removal (BNR) are evaluated in detail in this Chapter. The evaluation includes, total life cycle costs and non-cost factors.

- **Chapter 4** – Includes a summary of key considerations for the proposed project. The proposed project includes the conversion of the current WWTP BF/AS treatment process into an Activated Sludge with BNR Treatment Process. The proposed project also includes the elimination of the hydraulic capacity bottleneck at existing Effluent Pump Station via a new high flow discharge to Peruque Creek. The following sections of this Chapter include key consideration and requirements for the project as indicted in PUB 2416.

- **Chapter 5** – Includes the basis of design for the Treatment Process elements which are included in the scope of the project, the existing conditions and design criteria and considerations are discussed and organized by a building and unit process key numbering. The objective of the process design for the WWTP upgrades is to accommodate the treatment performance required to meet the permit requirements while also meeting the City’s budget for construction.

- **Chapter 6** – Includes the basis of design for the Site Civil elements of the project. Elements including the High Flow Discharge outfall, new yard piping systems, zoning, site development requirements, floodplain, grading, storm water management, landscaping, visual barriers, fencing, vehicle access and site utilities are addressed in this Chapter.

- **Chapter 7** – Includes the basis of design for the Structural and Architectural elements related to the project. The criteria and proposed design considerations are discussed for both the existing and proposed components. Building code requirements and geotechnical considerations are also discussed. Upgrades have been organized for each building, unit process, room and space as part of the proposed project.

- **Chapter 8** – Includes the basis of design for the Heating, Ventilation & Air Conditioning (HVAC) elements related to the project. Design criteria, codes, standards and the preliminary design approach for each area of the project have been included. Upgrades have been organized for each building, unit process, room and space as part of the proposed project.

- **Chapter 9** – Includes the basis of design for the Plumbing elements related to the project. Design criteria, codes, standards and the preliminary design approach for each area of the project have been included. Upgrades have been organized for each building, unit process, room and space as part of the proposed project.

- **Chapter 10** – Includes the basis of design for the Electrical elements related to the project. Design criteria and the preliminary design approach for each area of the project have been included. Upgrades have been organized for each building, unit process, room and space as part of the proposed project. A detailed discussion of a proposed electrical sequence of construction and cut-over plan is also included.

- **Chapter 11** – Includes the basis of design for the Instrumentation & Controls elements related to the project. Design criteria and the preliminary design approach for each area of the project have been included. Upgrades have been organized for each building, unit process, room and space as part of the proposed project.
• **Chapter 12** – Includes the basis of design for the Facility Protection elements related to the project. Design criteria and the preliminary design approach for each area of the project have been included. Upgrades have been organized for each building, unit process, room and space as part of the proposed project.

• **Chapter 13** - Includes the 30% design opinion of probable construction cost along with an updated project schedule. A discussion of the anticipated permits required for the project is also included along with recommended next steps in the project.

1.4 **Description of Existing WWTP**

The City owns and operates the O’Fallon WWTP, which has a permitted discharge capacity of 11.25 MGD to the Mississippi River under Missouri State Operating Permit (MO-0028720). The following figure is an orthophotograph showing the WWTP, which is located at 150 Firma Road, O’Fallon, MO 63366.

**Figure 1-2 O’Fallon WWTP General Location Map**

The WWTP was originally constructed in 1971. The original facility was an Oxigest® type treatment facility which included biological treatment, clarification and sludge digestion in a single circular tank. The original treatment facility also included the Blower Building. During subsequent upgrades to the WWTP, the original facility tank was converted to what is now the WAS Holding Tank. The first major upgrade to the WWTP occurred as part of the 1981 WWTP Upgrades Project and gave the WWTP the current treatment process configuration it now uses. The WWTP includes two Influent Equalization Tanks/Basins, Preliminary Treatment including Screening and Grit Removal, four Primary Clarifiers, three Activated Bio-Towers, four Aeration Tanks, four Final Clarifiers, a seasonal UV Disinfection system and an Effluent Pump Station which transports treated effluent to the Mississippi River. The facility also includes a Sludge & Biosolids Processing system which includes Sludge Thickening, Sludge Dewatering and a Thermal Lime Pasteurization process which produces Class-A Biosolids.
Treated effluent from the WWTP is discharged to the Mississippi River. Figure 1-2 is an orthophotograph of the existing WWTP with a key plan showing the location of unit processes and buildings on the site. Figure 1-4 is a block diagram of the existing treatment and solids handling processes at the WWTP.

The plant’s original treated effluent outfall discharged to Peruque Creek which is located directly adjacent to the WWTP site. In 1991 the WWTP underwent an upgrade and an Effluent Pump Station and a 6-mile Effluent Force Main were constructed to discharge all treated effluent to the Mississippi River. The old outfall pipe to Peruque Creek has since been disconnected and plugged.

1.4.1 Existing WWTP Unit Process Summary

All influent flow is pumped to the Headworks of the WWTP. The WWTP has two Influent Equalization Tanks which are setup in an offline configuration. Electrically operated control valves allow influent flow to be diverted to the Equalization Tanks during high flow conditions. The Headworks includes influent flow measurement and Preliminary Treatment via a mechanical bar screen. Grit removal occurs downstream of the Headworks Building via a dedicated Grit Tank. The grit removal system is a proprietary Aeroductor® system. Captured grit is dewatered via a mechanical dewatering screw which is located in the Headworks Building. Influent sampling is conducted just upstream of the Grit Tank on the downstream side of the Influent Screen. Following the Grit Tank, influent flow undergoes Primary Treatment via four 75-foot diameter circular Primary Clarifiers. Primary Sludge is removed via two dedicated below grade Primary Sludge Pump Station vaults. Currently, Primary Sludge is being pumped to the Waste Activated Sludge (WAS) Holding Tank. The design of the WWTP also includes provisions to pump Primary Sludge directly to the Sludge Blend Tank.

The biological treatment system at the WWTP consists of a Bio-Filter/Activated Sludge Process which uses a combination of attached-growth and suspended-growth biological treatment. Primary effluent enters the activated Bio-Tower wet well where it is combined with secondary Return Activated Sludge (RAS). The flow is then pumped to three Activated Bio-Towers via a system of four variable speed submersible pumps. Effluent from the Activated Bio-Towers then flows to four Aeration Tanks which include dedicated fixed floor ultra-fine bubble diffused aeration systems. Low pressure air is delivered via centrifugal turbo blowers located on the third level of the Bio-Filter Complex. The Aeration Tanks also include a Recirculated Sludge Pumping System which is located in the Basement of the Bio-Filter Complex. The pumping system acts as an internal recycle and pulls activated sludge from the four Aeration Tanks and recirculates it continuously to assist with mixing.

Effluent from the Aeration Tanks then flows via gravity to four, 80-foot diameter, center feed, suction header (draft tube) type Final Clarifiers. Settled secondary sludge is removed via the draft tubes and is transported by gravity to the Activated Bio-Filter wet well. Effluent from the Final Clarifiers flows via gravity to an in-channel UV Disinfection System which is required during the recreational season from April 1st to October 30th. Following disinfection, treated effluent flows to the Effluent Pump Station. The Effluent Pump Station transports treated effluent to the Mississippi River for disposal.

Secondary Waste Activated Sludge (WAS) is removed from the treatment process via gravity from a chamber just upstream of the Activated Bio-Filter wet well. Two dedicated waste sludge pumps are located in the Basement of the Bio-Filter Complex and pump WAS to a dedicated WAS Holding Tank.

The facility includes provisions to pump WAS from the WAS Holding Tank to two new Rotary Drum Thickeners (RDTs). The facility design includes provisions for thickened WAS to be pumped to a dedicated Sludge Blend Tank where it can be mixed with Primary Sludge prior to sludge dewatering. Primary Sludge is removed from the four Primary Clarifiers via two below grade Primary Sludge pump station vaults and is then pumped directly into the Sludge Blend Tank. The blended sludge is processed via three new Screw Presses. Dewatered sludge cake is then processed by a proprietary Thermal Lime Pasteurization (RDP) Process which produces Class-A Biosolids.
1.5 Description of Existing Collection System

The City’s collection system serves a portion of O’Fallon along with areas beyond the City limits such as portions of the City of Lake St. Louis. The collection system includes 18 wastewater lift stations, and large capacity interceptor sewers ranging in size from 8-inch up to 48-inches in diameter. The collection system consists of over 200 miles of interceptors and collection sewers with a little over 6,000 manholes. Figure 1-5 shows a map of the existing collection system along with the location of all the lift stations.
FIGURE 1-5
CITY OF O'FALLON, MISSOURI
WWTP FACILITY PLAN
COLLECTION SYSTEM

DATE: June 2018
PROJECT #: 229868.04
DRAWN BY: EWP
SOURCE: ESRI & O'Fallon, MO

Legend
- Lift Stations
- Force Main
- Gravity Sewer
- WWTP
- 70/79
- Brandywine
- Brooksie
- Brooksie Forest
- Daniel Drive
- East
- Gentemann Manor
- Homefield
- Hyland Green
- Mark Twain
- North
- Peruque Creek
- Royal Oaks
- West
- Westchester
- Woodcrest

Map credit: Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community.
1.5.1 Collection System Wet Weather Management Strategies

The City’s collection system does not have any known Combined Sewer Overflows (CSO’s) or Sanitary Sewer Overflows (SSO’s). The City is currently maximizing the ability of the collection system to convey wastewater to the WWTP. Equalization systems are also being used at some collection system pump stations to help mitigate high flows, as necessary.

The City has taken an aggressive and proactive approach to minimize Inflow and Infiltration (I/I) in the collection system. The City has undertaken Capital Improvement projects in the collection system each year to minimize I/I. The City also owns their own grout and seal unit and actively uses this equipment to rehabilitate piping in the older areas of the collection system. These wet weather management efforts have reduced flows to the WWTP but they have not eliminated the need for a high flow discharge to Peruque Creek at the WWTP due to the limiting capacity of the Effluent Pump Station.

1.6 Previous Planning Documents

In May 2016, the City contracted Woodard & Curran (W&C) to develop a Capital Improvement Plan (CIP) for the WWTP and Collection System. An Ammonia Removal Alternatives Evaluation was developed as part of the CIP and additional details are discussed in subsequent Chapters of this Facility Plan. The high flow discharge to Peruque Creek was also recommended in the CIP as an alternative during peak flow events. Following the completion of the CIP in February 2017 the City retained W&C to design the upgrades to the ammonia removal and high flow discharge components of the WWTP. A previous CIP for selected components of the WWTP was also conducted by Gonzalez Companies, LLC in July 2014. Both CIP planning documents included recommendations, estimated projected costs, hydraulic modeling and existing conditions evaluations. These previous planning documents serve as the background for the information contained in this Facility Plan.

1.7 Information Reviewed

Information of record has been reviewed by W&C for development of the CIP and improvements. The following documentation was reviewed in conjunction with site visits and discussions with the City & WWTP operating staff:

- Plans for General Construction – Wastewater Treatment Plant Expansion (1981)
- Flow Equalization Basin Upgrade Drawings (1989)
- Plans for General Construction – Wastewater Treatment Plant Expansion – Contract 1, Section 1 (1991)
- Plans for General Construction – Mississippi River Effluent Force Main – Contract 1, Section 2 (1991)
- Plans for General Construction – Wastewater Treatment Plant Expansion (2001)
- Plans for General Construction – Ultraviolet Disinfection System at the Wastewater Treatment Plant (2004)
- Odor Control System Improvements for the Wastewater Treatment Plant, Drawings, Project 05-009A, (2005)
- Odor Control System Improvements for the Wastewater Treatment Plant, Drawings, Project 05-009B, (2005)
- Wastewater Treatment Plant Bio-Filter Complex Improvements Drawings (2007)
- Wastewater Treatment Plant UV-System Improvements Drawings (2008)
- Contract B – WWTP & Lift Station Improvements Drawings (2009)
- Wastewater Treatment Plant Aeration Improvements Drawings (2011)
- Wastewater Treatment Plant Bio-Tower Pump Station Addition Drawings (2011)
- Missouri State Operating Permit (MO 0028720) for the O’Fallon WWTP
- Plant Operating Data & Discharge Monitoring Reports for the O’Fallon WWTP
- Select Equipment Operation & Maintenance Manuals

1.8 History of WWTP

The O’Fallon WWTP was originally constructed in 1971. The original facility was an Oxigest® type treatment facility which included biological treatment, clarification and sludge digestion in a single circular tank. The original treatment facility also included the Blower Building. During subsequent upgrades to the WWTP, the original facility tank was converted to what is now the WAS Holding Tank. The dates listed in the following plant upgrades were obtained from the Issue for Construction Drawings. The City has indicated that typically, the upgrades were fully completed approximately a year to a year and a half after the initial date of construction listed.

- The first major upgrade to the WWTP occurred as part of the 1981 WWTP Upgrades Project and gave the WWTP the current treatment process configuration it now uses. The upgrade included the addition of a Headworks with two Comminutors, two Primary Clarifiers, the three Bio-Filters and Bio-Filter Complex, two Aeration Tanks, two Final Clarifiers and the Main Office Building. Treated effluent was discharge to Perque Creek which is located to the South of the WWTP site. This upgrade gave the WWTP a capacity of 5.25 MGD.

- In 1990, the WWTP had an upgrade to construct the two offline Influent Equalization Basins. Previously the basins were used as sludge holding lagoons. The 1990 upgrades gave the two Equalization Basins the form and function they currently have today. Several subsequent plant upgrades added additional piping and connections to the Equalization Basins.

- In 1991, the WWTP had a second major upgrade which included the addition of a third Primary Clarifier, third Aeration Tank, third Final Clarifier, a Chlorine Gas Disinfection system and the Effluent Pump Station. The existing effluent force main to the Mississippi River was also constructed during this time frame. This upgrade gave the WWTP a capacity of 7.25 MGD.

- In 1998, the WWTP had its third major upgrade which included the construction of a new Headworks which included the screening and grit removal configuration which is currently at the WWTP site. The upgrade also included the addition of the Class-A Biosolids Processing system and Biosolids Treatment Building which are currently located at the WWTP site. The upgrades included construction of the Sludge Blend Tank, BFP Pump Station, Biosolids Treatment Building and the Biosolids Storage Building currently at the WWTP site.

- In 2001, the WWTP had its fourth major upgrade which included the construction of a fourth Primary Clarifier, fourth Aeration Tank and a Fourth Final Clarifier. This upgrade gave the WWTP a capacity of 10.0 MGD. In 2008, a re-rating study of the WWTP determined the design flow capacity could be increased from 10.0 to 11.25 MGD, which is the current capacity of the WWTP.

- In 2004, the WWTP had an upgrade to its disinfection system and underwent a conversion from Chlorine Gas to UV Disinfection. The UV Disinfection system at that time was a closed channel in-pipe UV disinfection
system. At that time a new building was specifically constructed for the UV disinfection system (Area #49 Old UV Building). The UV Disinfection system was only used for a short time and an open channel UV Disinfection system was constructed in 2008.

- In 2005, the WWTP had a minor upgrade for Odor Control System Improvements at the WAS Holding Tank including the addition of the current geodesic dome cover as well as the addition of an activated carbon odor control system to serve both the Headworks and WAS Holding Tank.

- In 2007, the WWTP Bio-Tower Pump Station was upgraded to include three submersible pumps to replace three of the four original screw pumps. The upgrade also included modifications to the sludge wasting systems from the Bio-Tower Pump Station Wet Well.

- In 2008, the WWTP was upgraded to include the current in-channel UV Disinfection System.

- In 2008, the WWTP underwent a Bio-Tower Complex Media Replacement project.

- In 2009, the WWTP underwent upgrades to the North Lift Station, the influent force mains to the WWTP were modified, Primary Clarifier #1 was upgraded, Primary Clarifier #2 was upgraded, and a fourth pump was added to the Effluent Pump Station. Miscellaneous electrical upgrades were also conducted as part of this project.

- In 2009, a refurbishment and rehabilitation was conducted on the Sludge Blend Tank and related supporting systems including the Sludge Recirculation Pumps, the diffused aeration system in the Sludge Blend Tank and the positive displacement blowers in the BFP Pump Station. The Foam Buster Pump and associated piping was also added as part of this upgrade.

- In 2010, the WWTP underwent an upgrade to the Aeration Tanks. The existing Jet Aeration systems were removed and replaced with new ultra-fine bubble panel diffused aeration systems. The Jet Mix recirculation piping was modified as part of this upgrade. A new centrifugal turbo blower was added as part of the upgrades to supply low pressure air to the Aeration Tanks.

- In 2011, the WWTP underwent an upgrade to add a fourth submersible Bio-Tower feed pump. As part of this upgrade the last remaining screw pump which fed the Bio-Towers was removed.

- In 2016, the WWTP underwent a comprehensive existing conditions evaluation for all trades of work and a 20-year Capital Improvement Plan (CIP) was developed for each area and unit process at the WWTP. This work served as the basis for the upgrades contained in this Facility Plan.

- In 2017, a comprehensive existing conditions analysis and 20-year CIP of the collection system and 17 Lift Stations was conducted.

- In 2018, the WWTP is currently undertaking an upgrade to their Sludge Thickening and Sludge Dewatering unit processes in the Biosolids Treatment Building. The existing Gravity Belt Thickeners (GBTs) are being replaced with two new RDTs and the existing Belt Filter Presses (BFPs) are being replaced with three new Screw Presses.
2. FLOWS & LOADS

The purpose of Chapter 2 is to provide an analysis of current and future flows and loads at the WWTP to establish the design basis flows and loads. Data provided by the City from January 1, 2013 through March 31, 2018 was evaluated to determine the existing flows and loads. Average and peak influent flows and loads were determined, and recycle flows from WWTP unit processes, such as the Filtrate Pump Station, were also quantified in this analysis. Projected future flows and loads from 20-year buildout projections for the sewer service area were combined with the existing flows and were used as the basis of design. Available data was also analyzed for outliers. Additionally, current and future discharge permit requirements are also included to establish the basis for the analysis of alternatives and the preliminary design of the proposed upgrades.

2.1 Existing Flow & Load Data

Influent flow and load data was evaluated to determine the existing flows and pollutant loadings entering the WWTP. Flows and loads were determined using total daily flows, peak daily flows and pollutant loadings, which represent all daily flow coming to the WWTP including increases due to wet weather. The following describes how each of these conditions was derived:

- **Average Day** – The average condition over the entire range of data considered. Per the Missouri Department of Natural Resources (MDNR) 10 CSR 20-8.110, Design Guide: The design average flow is the average of the daily volumes to be received for a continuous twelve (12)-month period expressed as a volume per unit time.

- **Maximum Month** – The maximum month represents conditions that are expected to be exceeded once for each 12 occurrences, or roughly 30 days per year. This is determined by developing a frequency distribution for all the applicable data and selecting the value closest to the 91.7% exceedance value (the value which is exceeded 8.3% of the time).

- **Maximum Week** – The maximum week represents conditions that are expected to be exceeded once for each 52 occurrences, or roughly 1 week per year. This is determined by developing a frequency distribution for all the applicable data and selecting the value closest to the 98.1% exceedance value (the value which is exceeded 1.9% of the time).

- **Maximum Day** – The maximum day represent conditions that are expected to be exceeded once for each 365 occurrences, or once per year. This is determined by developing a frequency distribution for all the data and selecting the value closest to the 99.7% exceedance value (the value which is exceeded 0.3% of the time). Per the MDNR 10 CSR 20-8.110, Design Guide: The design maximum daily flow is the largest volume of flow to be received during a continuous twenty-four (24)-hour period expressed as a volume per unit time. Based on the analysis of the data, the 99.7% exceedance value corresponded to the largest volume of flow received during a continuous 24-hour period. Maximum day flow will be the hydraulic design parameter for most WWTP processes at this facility due to the capability of diversion of peak flows into the offline Equalization Tanks at the WWTP.

- **Peak Hour** – The peak hourly condition was determined by using a frequency distribution for the single highest peak flow experienced by the facility each day. This value corresponds to the peak flow condition that is exceeded the equivalent of a portion of one day each year. Per the MDNR 10 CSR 20-8.110, Design Guide: The design peak hourly flow is the largest volume of flow to be received during a one (1)-hour period expressed as a volume per unit time. Short term peaks at the WWTP are diverted to the offline Equalization Tanks and will not impact most downstream unit processes beyond maximum day conditions. Diversion takes
place automatically in a short time frame; but the Headworks sees momentary peak flows above maximum day and capacity of these unit processes has been evaluated accordingly.

- **Peak Instantaneous** – The single highest peak flow condition recorded over the period in question is used to evaluate peak hydraulic capacity requirements (peak instantaneous). Per the MDNR 10 CSR 20-8.110, Design Guide: The design peak instantaneous flow is the instantaneous maximum flow received at the WWTP. In the case of the O’Fallon WWTP, the peak instantaneous flow will be the raw influent total peak flow pumped to the WWTP prior to any diversion to the offline Influent Equalization Tanks. Similar to peak hour flow, instantaneous peaks are diverted to the offline Equalization Tanks and will not impact most unit processes beyond maximum day conditions.

The key influent parameters analyzed include:

- Flow
- Total Suspended Solids (TSS)
- Biochemical Oxygen Demand (BOD)
- pH
- Temperature
- Total Kjehldahl Nitrogen (TKN)
- Total Phosphorous (TP)
- Alkalinity

Influent TKN, TP and Alkalinity are not regularly sampled by the City, however, the City has previously conducted expanded influent sampling for these pollutants.

### 2.2 Existing Flows

A statistical analysis was performed on the influent flow data. The goal of the analysis was to determine existing influent flow conditions and to provide a projection of the potential future flow at the O’Fallon WWTP. The current and future flow and load projections will be used as part of the design to evaluate alternatives and various unit processes at the WWTP.

#### 2.2.1 Influent Flows

The following table provides a summary of the existing influent flow at the WWTP. Peaking factors were calculated by taking the ratio to the average day flow. The historical data was culled to eliminate outliers to ensure a representative analysis. The outlier elimination process was conducted in accordance with recommendations obtained from the Water Environment Federation Manual of Practice No. 8, Design of Municipal Wastewater Treatment Plants – Section 7.1.
Table 2-1  Summary of Existing Flows

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Influent Flow (MGD)</th>
<th>Peaking Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Day</td>
<td>7.3</td>
<td>1.0</td>
</tr>
<tr>
<td>Maximum Month</td>
<td>10.2</td>
<td>1.4</td>
</tr>
<tr>
<td>Maximum Week</td>
<td>12.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Maximum Day</td>
<td>13.8</td>
<td>1.9</td>
</tr>
<tr>
<td>Peak Hourly</td>
<td>17.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Peak Instantaneous</td>
<td>18.3</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Influent flows which are diverted to the offline Equalization Tanks are not measured, however, flows pumped back into the WWTP from the Equalization Tanks are recorded as part of the discharge from the North Lift Station.

2.2.2 Existing In-Plant Recycle Flows

The WWTP staff have indicated that the filtrate recycles have an impact on the hydraulic capacity of the WWTP. During periods when sludge processing is occurring the capacity of the Effluent Pump Station is reduced due to the additional recycle flows which are added to the treatment process. This impact will be lessened following the construction of the upgrades to the Biosolids Processing Systems in 2018 due to the reduction in water use associated with the new thickening and dewatering equipment.

Table 2-2 Existing Filtrate Pump Station Flows

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Flow (MGD)</th>
<th>Peaking Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Day</td>
<td>0.21</td>
<td>----</td>
</tr>
<tr>
<td>Maximum Month</td>
<td>0.37</td>
<td>1.8</td>
</tr>
<tr>
<td>Maximum Week</td>
<td>0.44</td>
<td>2.1</td>
</tr>
<tr>
<td>Maximum Day</td>
<td>0.80</td>
<td>3.8</td>
</tr>
<tr>
<td>Peak Hour</td>
<td>0.86</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Currently, the WWTP staff do not conduct sampling and testing of the recycle flows from the Filtrate Pump Station. The WWTP staff have also indicated that they performed sampling on the recycle flow stream in the past to determine the impacts of loading from this side stream process. Past sampling results did not indicate that this recycle stream was a significant source of loading to the downstream unit processes.

2.3 Existing Loads

Influent and Primary Effluent loads for five-day Biochemical Oxygen Demand (BOD₅) and Total Suspended Solids (TSS) are presented in the following tables. Loads were calculated via historical plant data provided by the City for the pollutants presented. Similar to influent flow, peaking factors for both BOD₅ and TSS were calculated as the ratio to the average day condition.
Table 2-3  Summary of Existing Influent & Primary Effluent BOD Loads

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Flow  (MGD)</th>
<th>Influent BOD5 (lbs/Day)</th>
<th>Influent BOD5 Peaking Factor</th>
<th>Primary Effluent BOD5 (lbs/day)</th>
<th>Primary Effluent BOD5 Peaking Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Day</td>
<td>7.3</td>
<td>9,259</td>
<td>--</td>
<td>5,430</td>
<td>--</td>
</tr>
<tr>
<td>Maximum Month</td>
<td>10.1</td>
<td>13,536</td>
<td>1.5</td>
<td>7,826</td>
<td>1.4</td>
</tr>
<tr>
<td>Maximum Week</td>
<td>12.1</td>
<td>18,793</td>
<td>2.0</td>
<td>11,007</td>
<td>2.0</td>
</tr>
<tr>
<td>Maximum Day</td>
<td>13.8</td>
<td>24,819</td>
<td>2.7</td>
<td>15,015</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Table 2-4  Summary of Existing Influent & Primary Effluent TSS Loads

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Flow  (MGD)</th>
<th>Influent TSS (lbs/day)</th>
<th>Influent TSS Peaking Factor</th>
<th>Primary Effluent TSS (lbs/day)</th>
<th>Primary Effluent TSS Peaking Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Day</td>
<td>7.3</td>
<td>12,638</td>
<td>--</td>
<td>4,484</td>
<td>--</td>
</tr>
<tr>
<td>Maximum Month</td>
<td>10.1</td>
<td>18,512</td>
<td>1.5</td>
<td>6,746</td>
<td>1.5</td>
</tr>
<tr>
<td>Maximum Week</td>
<td>12.1</td>
<td>26,532</td>
<td>2.1</td>
<td>9,750</td>
<td>2.2</td>
</tr>
<tr>
<td>Maximum Day</td>
<td>13.8</td>
<td>37,106</td>
<td>2.9</td>
<td>18,498</td>
<td>4.1</td>
</tr>
</tbody>
</table>

The average BOD₅ and TSS values presented were taken from Influent and Primary Effluent concentration data provided by the City. Influent TKN and TP are currently not sampled by the City regularly. The values presented are based WEF Manual of Practice No. 8, Table 2.12 for typical untreated medium strength domestic wastewater along with additional City sampling results.

Table 2-5  Summary of Existing Influent & Primary Effluent Average Pollutant Concentrations

<table>
<thead>
<tr>
<th>Pollutant(1)(2)</th>
<th>Average Influent Concentration (mg/L)</th>
<th>Primary Treatment Removal Efficiency</th>
<th>Average Primary Effluent Concentration (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD₅</td>
<td>160</td>
<td>42%</td>
<td>93</td>
</tr>
<tr>
<td>TSS</td>
<td>211</td>
<td>61%</td>
<td>73.4</td>
</tr>
<tr>
<td>TKN</td>
<td>40</td>
<td>10%</td>
<td>36</td>
</tr>
<tr>
<td>TP</td>
<td>7</td>
<td>10%</td>
<td>6.3</td>
</tr>
</tbody>
</table>

(1) Primary Clarifier removal efficiency was assumed for TKN and TP
(2) Primary Clarifier removal efficiency for BOD and TSS is based on plant sampling data.

2.3.1 Influent pH and Temperature

Influent pH and Temperature are recorded regularly at the O’Fallon WWTP. The following table shows statistics for pH and temperature of the raw influent. The raw data was obtained from the City.
Table 2-6  Existing Influent pH & Temperature

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average pH</td>
<td>7.6</td>
</tr>
<tr>
<td>Maximum Month pH</td>
<td>7.8</td>
</tr>
<tr>
<td>Minimum Month pH</td>
<td>7.5</td>
</tr>
<tr>
<td>Average Temperature (°C)</td>
<td>17.6</td>
</tr>
<tr>
<td>Maximum Month Temperature (°C)</td>
<td>21.8</td>
</tr>
<tr>
<td>Minimum Month Temperature (°C)</td>
<td>14.6</td>
</tr>
<tr>
<td>(April to September)</td>
<td></td>
</tr>
<tr>
<td>Minimum Month Temperature (°C)</td>
<td>13.4</td>
</tr>
<tr>
<td>(October to March)</td>
<td></td>
</tr>
</tbody>
</table>

According to the data provided by the City, the influent pH at the facility has been consistently neutral over the past several years; which is ideal from a treatment perspective. Currently no supplemental influent alkalinity is being added at the facility. It is important to note the monthly influent temperatures in conjunction with the future seasonal summer and winter permit limits for Ammonia-Nitrogen. The temperatures in conjunction with future effluent Ammonia-Nitrogen limits are a key consideration for designing the biological treatment system to ensure the future effluent ammonia limits can be met.

2.3.2  Major Industrial Users

The City of O’Fallon has the following major industrial users in the collection system:

- Clean Uniform Company: 77,400 gpd
- O’Fallon Casting, LLC: 37,600 gpd
- SunEdison, Inc.: 656,000 gpd
- True Manufacturing: 47,100 gpd

The total flow contribution from industrial users is approximately 818,100 gpd. This represents approximately 11% of the average day influent flow to the WWTP. Available information does not indicate that these industrial users have a significant impact on pollutant loading.

2.4  Population Projection and Planning Period

The future population growth of the City was projected to provide a basis for estimations of future flows and loads to the O’Fallon WWTP over the 20-year planning period. Estimations of future population are contingent on several factors such as the geographic expansion of the City, expansion of user bases outside the City limits such as Lake St. Louis, infrastructure capacity, economic vitality of the housing market, inflation, interest rates and fuel prices. All of these factors have a direct impact on future population growth.

The City’s January 2016 Drinking Water Treatment CIP was used as a reference to determine the expected population growth through the year 2037. The following table shows the projected population of the City of O’Fallon, for the 20-year planning period.
### Table 2-7 Projected Future City Population

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>79,329</td>
</tr>
<tr>
<td>2012</td>
<td>81,979</td>
</tr>
<tr>
<td>2017</td>
<td>88,315</td>
</tr>
<tr>
<td>2022</td>
<td>96,567</td>
</tr>
<tr>
<td>2027</td>
<td>104,030</td>
</tr>
<tr>
<td>2032</td>
<td>112,070</td>
</tr>
<tr>
<td>2035</td>
<td>115,534</td>
</tr>
<tr>
<td>2037</td>
<td>120,731</td>
</tr>
</tbody>
</table>

It is important to note that the water system service area is not the same as the sewer service area within the City. The City indicated that in 2015, there were close to 16,000 customers connected to the sewer system. The majority of the population of O'Fallon is served by the Duckett Creek Sanitary District. As a whole, approximately 95% of the City has sewer and the remaining 5% have septic systems. The City has indicated that the population connected to the O'Fallon WWTP is approximately 35,000 capita which equates to approximately 44.1% of the City’s total population of 79,329 as of the 2010 census.

To project future flows and loads to the O'Fallon WWTP, it was assumed the percentage of the City’s total population that is connected to the O'Fallon WWTP (44.1%) would remain about the same. As shown in the table above, the projected 2037 population in the City is 120,731 capita. The population as of the 2010 census was 79,329 capita. This results in an increase of approximately 41,402 capita in the City as a whole. It was assumed that approximately 44.1% of the additional growth in the City (18,258 capita) would generate additional flow to the O'Fallon WWTP. This projection assumes uniform growth would occur throughout the City and within the service area currently served by the O'Fallon WWTP. It was estimated that a total of approximately 59,258 capita would be connected to the O'Fallon WWTP in 2037.

### 2.5 Projected Flows & Loads

For the purposes of flow and load estimations, the following criteria and assumptions were made regarding flow and load contributions from future growth:

- Per the MDNR Design Requirements 10 CSR 20.8-110, Section (4)(C)4C(I): The sizing of wastewater facilities receiving flows from new wastewater collection systems will be based on an average daily flow of one hundred (100) gallons per capita per day. It is important to note that the upgrades to the O’Fallon WWTP will maintain the current permitted flow capacity of 11.25 MGD. The current flow to the WWTP is approximately 7.3 MGD. This allows for approximately 3.95 MGD of additional growth capacity at the WWTP.

- Per the MDNR Design Requirements 10 CSR 20.8-110, Section (4)(C)5C(1): Domestic wastewater treatment design will be on the basis of at least 0.17 pounds of BOD₅ per capita per day and 0.20 pounds of suspended solids (TSS) per capita per day, unless information is submitted to justify alternate designs.

- Additional Flow: Additional flow was based on MDNR Design Requirements with an additional 18,258 capita at a typical flow generation of 100 gallons per capita per day which totals 1,825,800 gpd of additional flow to the WWTP site by the end of the 20-year planning period. Given the rapid growth currently being experienced in the City as well as the areas outside the St. Louis metropolitan area, this estimation allows an appropriate allowance for future flow. As mentioned, the WWTP will be designed for the permitted flow of 11.25 MGD which allows even more capacity for future growth and development.
• Additional BOD$_5$ & TSS Load: An additional BOD$_5$ load was applied based on 18,258 additional capita at 0.17 lbs BOD$_5$ per capita per day. Additional TSS load was applied based on 0.20 lbs TSS per capita per day as detailed in the MDNR design requirements.

2.5.1 Future Flows

The following table provides a summary of the combined current and future projected flows. The flow projections were calculated based on the future projected flow contributions by additional users through the 20-year planning period.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Flow (MGD)</th>
<th>Peaking Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Average Day</td>
<td>7.3</td>
<td>----</td>
</tr>
<tr>
<td>Permitted Average Day</td>
<td>11.25</td>
<td>----</td>
</tr>
<tr>
<td>Maximum Month</td>
<td>12.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Maximum Week</td>
<td>14.4</td>
<td>2.0</td>
</tr>
<tr>
<td>Maximum Day</td>
<td>16.5</td>
<td>2.3</td>
</tr>
<tr>
<td>Peak Hour (Peak Instantaneous)</td>
<td>19.9</td>
<td>2.7</td>
</tr>
<tr>
<td>Minimum Month</td>
<td>6.8</td>
<td>0.9</td>
</tr>
</tbody>
</table>

The WWTP staff have indicated that the desired sustained maximum day flow for the WWTP to be used in design is 16.5 MGD. Based on historical performance of the WWTP a sustained maximum day capacity of 16.5 MGD along with the existing offline Equalization Tanks will provide an appropriate buffer for treatment and hydraulic capacity. It is important to note that the projected peak flow of 19.9 MGD presented in the table will not occur as a sustained flow to the WWTP and downstream unit processes, as a portion of the flow will be diverted to the offline Equalization Tanks. The Peak Hour (Peak Instantaneous) flow will be examined in conjunction with immediate downstream unit processes such as Influent Screening and Grit Removal. The existing Influent Equalization Tanks have a combined storage capacity of approximately 7.78 Million Gallons (MG). This allows sufficient storage for Peak Hour and Peak instantaneous flows.

2.5.2 Future In-Plant Recycle Flows & Loads

The following table provides a summary of the anticipated flows and loads from the Filtrate Pump Station. It is important to note that these anticipated flows and loads are based on the performance of the new dewatering and thickening equipment which is currently being installed at the WWTP. The Biosolids Processing System Upgrades construction project will be completed before the planned upgrades indicated in this report.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Flow (MGD)</th>
<th>Peaking Factor</th>
<th>TSS (lbs/day)</th>
<th>TSS (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Day</td>
<td>0.30</td>
<td>1.0</td>
<td>719</td>
<td>285</td>
</tr>
<tr>
<td>Maximum Week</td>
<td>0.40</td>
<td>1.3</td>
<td>1,182</td>
<td>349</td>
</tr>
</tbody>
</table>
2.5.3 Future Influent Pollutant Loads

The following table provides a summary of the future projected loads for BOD$_5$ and TSS. The flow projections were calculated based on the future projected flow contributions by additional users through the 20-year planning period as previously presented.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Flow (MGD)</th>
<th>BOD$_5$ (lbs/day)</th>
<th>BOD$_5$ (mg/L)</th>
<th>BOD$_5$ Peak Factors</th>
<th>TSS (lbs/day)</th>
<th>TSS (mg/L)</th>
<th>TSS Peak Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permitted Average Day</td>
<td>11.25</td>
<td>15,293</td>
<td>163</td>
<td>----</td>
<td>20,266</td>
<td>216</td>
<td>----</td>
</tr>
<tr>
<td>Maximum Month</td>
<td>12.3</td>
<td>17,750</td>
<td>173</td>
<td>1.5</td>
<td>23,188</td>
<td>226</td>
<td>1.5</td>
</tr>
<tr>
<td>Maximum Week</td>
<td>14.4</td>
<td>21,887</td>
<td>183</td>
<td>1.8</td>
<td>30,473</td>
<td>254</td>
<td>1.9</td>
</tr>
<tr>
<td>Maximum Day</td>
<td>16.5</td>
<td>26,916</td>
<td>196</td>
<td>2.3</td>
<td>40,293</td>
<td>296</td>
<td>2.6</td>
</tr>
<tr>
<td>Minimum Month</td>
<td>6.8</td>
<td>5,692</td>
<td>100</td>
<td>0.5</td>
<td>10,233</td>
<td>180</td>
<td>0.6</td>
</tr>
</tbody>
</table>

The average BOD$_5$ and TSS values presented below were taken from influent and effluent concentration data provided by the City. As mentioned previously, influent TKN and TP are currently not sampled by the City regularly. The values presented are typical for untreated medium strength domestic wastewater. It was assumed that pollutant concentrations experienced during the permitted average day flow of 11.25 MGD would be the same as those presented below.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Future Average Influent Concentration (mg/L)</th>
<th>Future Average Primary Effluent Concentration (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD$_5$</td>
<td>163</td>
<td>101</td>
</tr>
<tr>
<td>TSS</td>
<td>216</td>
<td>86.4</td>
</tr>
<tr>
<td>TKN</td>
<td>40</td>
<td>36</td>
</tr>
<tr>
<td>TP</td>
<td>7</td>
<td>6.3</td>
</tr>
</tbody>
</table>

2.5.4 Accuracy of Flow & Load Projections

Flow and load projections included in the Facility Plan were updated with all current available data. Existing flow data was obtained via calibrated online flow instruments which are used throughout the facility. The data was analyzed for outliers which were eliminated to further improve accuracy. Existing pollutant data was also obtained via many years of laboratory sampling. The following figure demonstrates a flow probability plot for total flow entering the WWTP.
2.6 Design Flows & Loads Summary

The following provides a listing of key design conditions of note with respect to flows and loads:

- **Design Average Day Flow (ADF):** A design ADF of 11.25 MGD will be used to match the existing permitted discharge to the Mississippi River. The existing permitted discharge capacity will be carried to ensure the City does not lose this existing permitted capacity. The existing WWTP was designed for a capacity of 11.25 MGD. It is important to note that the existing permitted design flow of the WWTP will not be increased or decreased as part of the proposed project.

- **Design Maximum Day Flows & Loads:** The design maximum day flow (16.5 MGD) and loads previously presented will be used for sizing of treatment unit processes such as biological aeration, biological aeration blowers, etc. as part of the design to ensure permit compliance. The design maximum day flow will also be used as the sustained hydraulic capacity of the WWTP as part of the design. This flow will also be used in conjunction with the proposed wet weather discharge to Peruque Creek.

- **Design Peak Hour Flow:** A design Peak Hour (Peak Instantaneous) flow of 19.9 MGD will be used to evaluate the hydraulic capacity of immediate downstream unit processes such as the Influent Screen and Grit Removal System. As mentioned, a portion of the influent flow is automatically diverted to the offline Equalization Tanks. Thus, a sustained hour of peak flow at this condition will not occur at the downstream WWTP unit processes. The existing Influent Equalization Tanks have a capacity of approximately 7.78 MG. This allows sufficient storage for Peak Hour and Peak instantaneous flows.

- **Design Primary Treatment BOD Removal:** The design BOD removal from Primary Treatment will be 38%. This is based on historical plant operating data and primary effluent sampling.
• Design Primary Treatment TSS Removal: The design TSS removal from Primary Treatment will be 60%. This is based on historical plant operating data and primary effluent sampling.

Wet Weather Discharge to Peruque Creek: The design wet weather discharge to Peruque Creek will be based on the Maximum Day Flow of 16.5 MGD. Currently, the capacity of the Effluent Pump Station is approximately 12.75 MGD when the Mississippi River is under flood conditions. The proposed wet weather discharge to Peruque Creek will be the excess influent flow along with the in-plant filtrate recycle flow (approximately 4.53 MGD) which cannot be pumped to the Mississippi River by the existing Effluent Pump Station.

2.6.1 Design Temperatures & pH

The plant is not anticipating any significant changes in influent alkalinity characteristics. No additional supplemental alkalinity is currently utilized, and it is not anticipated that it will be needed in the future to achieve pH compliance with permit requirements. Influent temperature falls in the range of 13.4 °C to 21.8 °C and is not anticipated to change significantly. Plant systems will be designed to accommodate this range of temperatures.

2.6.2 Design In-Plant Recycle Flows & Loads

The major in-plant recycle stream at the WWTP is the Filtrate Pump Station which transports the recycle flows from the Sludge Thickening and Sludge Dewatering process back into the forward flow treatment process. The plant will be designed to accommodate the maximum week in-plant recycle flow with respect to hydraulic capacity. The design flows from the Filtrate Pump Station have been summarized previously.

The filtrate from sludge processing can contain constituents which can affect the downstream biological treatment processes and add to the plants influent loading. The most common constituents found in sludge processing filtrate are BOD, Ammonia-Nitrogen, and Phosphorous. Typically, facilities which utilize biological phosphorous removal and anaerobic digestion can have increased loadings of soluble phosphate in the filtrate recycle streams. This recycle stream can increase phosphate loading to the WWTP as well as create magnesium-based scale (struvite) precipitation in pumping equipment, piping and related systems. The WWTP is not currently configured for Biological Phosphorous removal and sludge processing does not undergo anaerobic digestion, therefore, it is not anticipated that a significant phosphate loading will be present from the dewatering filtrate. The WWTP currently does not utilize anaerobic digestion for sludge stabilization and thus there is not anticipated to be a significant Ammonia-Nitrogen load from this type of unit process.

2.7 Discharge Permit Requirements

The following sections provide a summary of current and future effluent permit requirements at the O’Fallon WWTP.

2.7.1 Existing Mississippi River Discharge Permit Requirements

The following table provides a summary of the existing O’Fallon WWTP Discharge Permit requirements to the Mississippi River under Missouri State Operating Permit (MO-0028720).
Table 2-12 Existing O’Fallon WWTP Discharge Permit Requirements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Final Effluent Limits</th>
<th>Monitoring Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Daily Maximum</td>
<td>Weekly Average</td>
</tr>
<tr>
<td>Flow(^{(1)})</td>
<td>MGD</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>CBOD(_{5})(^{(2)})</td>
<td>mg/L</td>
<td>-----</td>
<td>40</td>
</tr>
<tr>
<td>TSS(^{(3)})</td>
<td>mg/L</td>
<td>-----</td>
<td>45</td>
</tr>
<tr>
<td>pH Units(^{(3)})</td>
<td>SU</td>
<td>6.0-9.0</td>
<td>-----</td>
</tr>
<tr>
<td>E. Coli(^{(4)})</td>
<td>#/100mL</td>
<td>-----</td>
<td>630</td>
</tr>
<tr>
<td>Ammonia-N</td>
<td>mg/L</td>
<td>62.2</td>
<td>-----</td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>mg/L</td>
<td>15</td>
<td>-----</td>
</tr>
<tr>
<td>Total Phosphorous(^{(1)})</td>
<td>mg/L</td>
<td>Monitor</td>
<td>-----</td>
</tr>
<tr>
<td>Total Nitrogen(^{(1)})</td>
<td>mg/L</td>
<td>Monitor</td>
<td>-----</td>
</tr>
<tr>
<td>Copper(^{(1)}) (Total Recoverable)</td>
<td>µg/L</td>
<td>Monitor</td>
<td>-----</td>
</tr>
<tr>
<td>Zinc(^{(1)}) (Total Recoverable)</td>
<td>µg/L</td>
<td>Monitor</td>
<td>-----</td>
</tr>
</tbody>
</table>

1. Monitoring requirement only
2. A 24-hour composite is composed of 48 aliquots (samples) collected at 30-minute intervals by an automatic sampling device.
3. pH is measured in pH units and is not to be averaged.
4. Final limitations and monitoring requirements for E. Coli are only applicable for the recreational season from April 1 through October 31. The Monthly Average Limit for E. Coli is expressed as a geometric mean. The Weekly Average for E. Coli will be expressed as a geometric mean if more than one (1) sample is collected during a calendar week (Sunday through Saturday).

2.7.2 Future Mississippi River Discharge Permit Requirements

The following table provides a summary of future effluent limits at the WWTP site. These effluent limits will be used in conjunction with the analysis of treatment alternatives and supporting systems in the design to ensure permit compliance.
### Table 2-13 O’Fallon WWTP Future Discharge Permit Requirements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Final Effluent Limits</th>
<th>Monitoring Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Daily Maximum</td>
<td>Weekly Average</td>
</tr>
<tr>
<td>Flow(1)</td>
<td>MGD</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>CBOD₅(2)</td>
<td>mg/L</td>
<td>40</td>
<td>25</td>
</tr>
<tr>
<td>TSS(2)</td>
<td>mg/L</td>
<td>45</td>
<td>30</td>
</tr>
<tr>
<td>pH Units(3)</td>
<td>SU</td>
<td>6.0-9.0</td>
<td>6.0-9.0</td>
</tr>
<tr>
<td>E. Coli(4)</td>
<td>#/100mL</td>
<td>630</td>
<td>126</td>
</tr>
<tr>
<td>Ammonia-N (4/1 to 9/30)</td>
<td>mg/L</td>
<td>25.2</td>
<td></td>
</tr>
<tr>
<td>Ammonia-N (10/1 to 3/31)</td>
<td>mg/L</td>
<td>25.2</td>
<td></td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>mg/L</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Total Phosphorous(5)</td>
<td>mg/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Nitrogen(5)</td>
<td>mg/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper(1) (Total Recoverable)</td>
<td>µg/L</td>
<td>Monitor</td>
<td>Monitor</td>
</tr>
<tr>
<td>Zinc(1) (Total Recoverable)</td>
<td>µg/L</td>
<td>Monitor</td>
<td>Monitor</td>
</tr>
</tbody>
</table>

1. Monitoring requirement only
2. A 24-hour composite is composed of 48 aliquots (samples) collected at 30-minute intervals by an automatic sampling device.
3. pH is measured in pH units and is not to be averaged.
4. Final limitations and monitoring requirements for E. Coli are only applicable for the recreational season from April 1 through October 31. The Monthly Average Limit for E. Coli is expressed as a geometric mean. The Weekly Average for E. Coli will be expressed as a geometric mean if more than one (1) sample is collected during a calendar week (Sunday through Saturday).
5. Limit has been shown based on anticipated future limits which MDNR may implement. Sample types and measurement frequencies are unknown for future constituents.

#### 2.7.3 Mississippi River Ammonia Discharge Requirements

The current discharge permit includes effluent ammonia limits year-round. The MDNR has indicated that the Ammonia Nitrogen requirements will become more stringent during the next permitting cycle in April of 2021. If the United States Environmental Protection Agency (EPA) limits are implemented in the future, more stringent ammonia performance will be required. Estimated EPA limits per the fact sheet in the current discharge permit are listed in the table below. These limits are based on EPA water quality criteria for ammonia, based on toxicity studies of mussels and gill breathing snails. Missouri’s current Ammonia criteria are based on toxicity testing of several species but did not include data from mussels and gill breathing snails.

### Table 2-14 Mississippi River Estimated EPA Effluent Ammonia Limits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Daily Maximum (mg/L)</th>
<th>Monthly Average (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer (April-September)</td>
<td>10.2</td>
<td>7.2</td>
</tr>
<tr>
<td>Winter (October-March)</td>
<td>24.7</td>
<td>18.5</td>
</tr>
</tbody>
</table>
2.7.4 Peruque Creek High Flow Discharge Limits

The following table provides a summary of the High Flow Discharge limit requirements to Peruque Creek which were included in the WQAR in Appendix E.

### Table 2-15 Peruque Creek High Flow Discharge Permit Limits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Final Effluent Limits</th>
<th>Monitoring Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Daily Maximum</td>
<td>Weekly Average</td>
</tr>
<tr>
<td>Flow(1)</td>
<td>MGD</td>
<td>(Note #1)</td>
<td></td>
</tr>
<tr>
<td>BOD₅(2)</td>
<td>mg/L</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>TSS(3)</td>
<td>mg/L</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>pH Units(3)</td>
<td>SU</td>
<td>6.5-9.0</td>
<td></td>
</tr>
<tr>
<td>E. Coli(4)</td>
<td>#/100mL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonia-N (4/1 to 9/30)</td>
<td>mg/L</td>
<td>23.8</td>
<td></td>
</tr>
<tr>
<td>Ammonia-N (10/1 to 3/31)</td>
<td>mg/L</td>
<td>23.8</td>
<td></td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>mg/L</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Total Phosphorous(5)</td>
<td>mg/L</td>
<td>Monitor</td>
<td>0.5 to 1</td>
</tr>
<tr>
<td>Total Nitrogen(5)</td>
<td>mg/L</td>
<td>Monitor</td>
<td>8 to 10</td>
</tr>
<tr>
<td>Copper(1) (Total Recoverable)</td>
<td>µg/L</td>
<td>Monitor</td>
<td>Monitor</td>
</tr>
<tr>
<td>Zinc(1) (Total Recoverable)</td>
<td>µg/L</td>
<td>Monitor</td>
<td>Monitor</td>
</tr>
</tbody>
</table>

1. Monitoring requirement only during wet weather discharge events.
2. A 24-hour composite is composed of 48 aliquots (samples) collected at 30-minute intervals by an automatic sampling device.
3. pH is measured in pH units and is not to be averaged.
4. Final limitations and monitoring requirements for E. Coli are only applicable for the recreational season from April 1 through October 31. The Monthly Average Limit for E. Coli is expressed as a geometric mean. The Weekly Average for E. Coli will be expressed as a geometric mean if more than one (1) sample is collected during a calendar week (Sunday through Saturday).
5. Limit has been shown based on anticipated future limits which MDNR may implement. Sample types and measurement frequencies are unknown for future constituents.

2.7.5 Peruque Creek Ammonia Discharge Requirements

The current WQAR includes effluent ammonia limits year-round. If the United States Environmental Protection Agency (EPA) limits are implemented in the future, more stringent ammonia performance will be required. Estimated EPA limits are listed in the table below for the Peruque Creek High Flow Discharge. These limits are based on EPA water quality criteria for ammonia, based on toxicity studies of mussels and gill breathing snails. It is important to note that these limits are preliminary estimations based on the EPA water quality criteria for Ammonia. If implemented, final limits also consider a facilities historical performance regarding Ammonia removal along with other factors.

### Table 2-16 Peruque Creek Estimated EPA Effluent Ammonia Limits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Daily Maximum (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer (April-September)</td>
<td>14.4</td>
</tr>
<tr>
<td>Winter (October-March)</td>
<td>23.8</td>
</tr>
</tbody>
</table>
2.7.6 Future Total Nitrogen Discharge Requirements

Currently, the facility does not have any Total Nitrogen (TN) effluent requirements for the Mississippi River or Peruque Creek discharges. The MDNR has indicated that that TN limits would likely occur around 2030 to 2035 at the earliest. The MDNR has also indicated that TN limits would follow implementation of TP limits. The MDNR has indicated that the TN limits would likely be in the 10 mg/L to 8 mg/L range. Discussions were also held with the MDNR regarding potential future Nitrogen removal credits and trading between facilities in the State. To date, there have been no real regulatory evaluations of Nitrogen credit trading in the State and this is not currently in progress. Potential for Nitrogen trading is not a driver at this time for potential future sales for the City. The MDNR also indicated that the initial TN limit would likely be a yearly or quarterly average rather than a monthly or weekly limit. The existing discharge permit has a monitoring requirement only for daily maximum and monthly average TN. This requirement is not anticipated to be changed in the next permitting cycle. Provisions in upgrades of the WWTP are provided to allow a streamlined phased upgrade in the future for TN limits as necessary.

2.7.7 Future Total Phosphorous Discharge Requirements

Currently the facility does not have any Total Phosphorous (TP) effluent requirements for the Mississippi River of Peruque Creek discharges. The MDNR has indicated that that TP limits would likely occur around 2025 to 2030 at the earliest. The MDNR has indicated that planning for 1 mg/L to 0.5 mg/L TP would be appropriate. These are reasonable limits which can be met by many approaches including Biological, Chemical or a combination of both. The existing discharge permits have a monitoring requirement only for TP. This requirement is not anticipated to be changed in the next permitting cycle. As will be discussed in subsequent Chapters, provisions in upgrades of the WWTP are provided to allow a streamlined phased upgrade in the future for TP limits.

2.7.8 Mississippi River Discharge & Existing Classified Segments

The Mississippi River is a large receiving water body which allows for a significant dilution of treated effluent from the O’Fallon WWTP. Currently all flow is discharged through the effluent pump station and associated force main to the Mississippi River. The current permitted average day flow from the WWTP is 11.25 MGD (20.9 cfs). This permitted discharge will remain the same as part of this proposed project.

The Mississippi River currently has MDNR EPA approved Total Maximum Daily Loads (TMDLs) for Lead, Zinc, Chlordane and Poly-Chlorinated Biphenyls (PCBs). The TMDLs which have been established for Chlordane and PCBs are applicable to 16 counties in the state of Missouri which border the Mississippi River area including St. Charles County where the City’s WWTP is located. The TMDLs for Lead and Zinc have been established for a 195-mile classified segment in Jefferson County near the City of Herculaneum. The source of the pollutants has been determined to be the Herculaneum Smelter. The length of segment impairment has been established as five miles. This classified segment is located downstream of the discharge from the O’Fallon WWTP.

2.7.9 Sludge Processing Permit Requirements

Sludge disposal practices are currently permitted under the Missouri Clean Water Law and regulation for domestic wastewater. The permit also incorporates applicable EPA federal sludge disposal requirements under 40 CFR 503 for domestic wastewater. The Environmental Protection Agency (EPA) has principal authority for permitting and enforcement of the federal sludge regulations under 40 CFR 503 for domestic wastewater. The permit requirements for land application require Class-A or Class-B Biosolids criteria to be met. As part of this project, the current sludge disposal practices will be continued by the City and the current permitted disposal requirements will remain the same. The requirements for pathogen and vector attraction reductions were also assumed to remain the same. The sludge disposal practices are also further governed under Missouri Water Quality Standard 424 (WQ 424). No upgrades to the Biosolids Processing systems are included as a part of this project.
3. TREATMENT ALTERNATIVES ANALYSIS

The purpose of Chapter 3 is to discuss the treatment alternatives which were evaluated as part of the planning for this project. The WWTP is currently utilizing a Bio-Filter Activated Sludge (BF/AS) treatment system. Upgrades to the existing BF/AS to meet discharge permit requirements were considered as part of the base project. In addition, two other short-listed alternatives were evaluated in detail to determine the basis for the upgrades at the WWTP. An alternatives analysis for the High Flow Discharge to Peruque Creek was previously conducted as part of the Antidegradation Evaluation and is summarized in the WQAR in Appendix E.

3.1 No Action Alternative

The existing WWTP is not capable of achieving the ammonia removal required by the MDNR in the new discharge permit. As such, the change in permit limits requires modifications to the WWTP. Also, the plant is hydraulically limited by the capacity of the existing effluent pump station. No action would continue to limit the plant during high flow conditions and would not allow the City to meet the new discharge permit requirements. The final driver are the proposed upgrades to the electrical systems at the plant. Existing equipment is at the end of its usable life and no action could put WWTP operations and the safety of plant staff at risk. For these reasons the no action alternative is not a viable alternative for the City.

3.2 High Flow Discharge Alternatives Considered

Both no discharge (non-degrading) and less-degrading alternatives were evaluated and compared to the proposed high flow discharge to Peruque Creek. Each of the alternatives was compared regarding their economic viability in comparison to a base project along with their practicability. The base project proposed can protect the existing uses of Peruque Creek and meet the proposed high flow discharge permit limits.

No discharge alternatives were analyzed at a flow up to 4.53 MGD which is the anticipated daily maximum discharge during high flow events to Peruque Creek. In accordance with the MDNR requirements, three less-degrading alternatives were also evaluated in comparison to the base project. Based upon this evaluation of alternatives, the more economically viable and practical alternative was selected for a socioeconomic benefit analysis. To determine the practicability of the identified alternatives, effectiveness, reliability, and potential impacts to the overall natural environment were considered. Effectiveness was measured for each of the less-degrading alternatives by determining their expected level of treatment. The high flow discharge considered the following no discharge and less-degrading alternatives depending on applicability.

1. Land Application with Seasonal Storage
2. Subsurface Disposal with Seasonal Storage
3. Recycling or Reuse
4. Diversion of Flow to a Regional WWTP
5. Alternative Discharge Locations
6. Improved Operation & Maintenance of Existing WWTP
7. Increased Effluent Pump Station Capacity
8. Parallel Effluent Force Main to Increase Effluent Pump Station Capacity
All no discharge alternatives were found to be impractical and/or not economically viable for the City in lieu of a high flow discharge to Peruque Creek. Additional details can be found in the WQAR which is included in Appendix E.

3.2.1 Alternative Discharge Location

The O’Fallon WWTP high flow discharge is to Peruque Creek, the only sizable potential receiving water in the immediate area. The region around the City includes agricultural land, residential housing, development communities, and small losing streams. Peruque Creek is the only river in the area with a significant flow which is maintained year-round. The extreme length of pipe, energy requirements and costs to pump additional effluent to the Mississippi River or run a parallel force main (approximately 6 miles) was found to be cost prohibitive and more disruptive to the environment as compared to the high flow discharge to Peruque Creek. Acquisitions of property easements and disturbance of the natural landscape would likely pose problems associated with the installation of a second effluent transmission pipe line if moved to any other receiving water body. Any relocation of the discharge to a different portion of Peruque Creek would still result in the base project being required to upgrade the O’Fallon WWTP to ensure compliance with current and future regulatory limits. Upgrading the effluent pump station and transmission pipe line would add millions in additional up-front capital cost and operational costs for the City. For these reasons Alternative Discharge Location was considered impractical for the O’Fallon WWTP’s high flow discharge. A detailed evaluation of alternative approaches is included in the WQAR which is included in Appendix E.

3.3 Regionalization

The O’Fallon WWTP is the largest treatment plant in the area. No nearby treatment plants would be able to handle the additional flow from the O’Fallon WWTP. The significant length of large pipe to any other treatment plants as well as excessive pumping costs rendered the regionalization alternative infeasible for the City.

3.4 Decentralized Options

The use of decentralized treatment alternatives was considered as a part of the facility planning process. The use of decentralized alternatives was not found to be feasible or cost effective for the City. Decentralized alternatives do not have the capacity or capabilities to accommodate the City’s treatment requirements and effluent permit limits.

3.5 Treatment Alternatives Evaluated

As part of the CIP, eight (8) initial treatment alternatives were considered. General process descriptions, typical applications, notable advantages and notable disadvantages for each alternative were considered. The eight initial treatment alternatives considered by the City are as follows:

1. Bio-Filter Activated Sludge (BF/AS)
2. Activated Sludge with Biological Nutrient Removal (BNR)
3. Membrane Bioreactor (MBR)
4. Oxidation Ditch (OD)
5. Sequencing Batch Reactor (SBR)
6. Integrated Fixed Film Activated Sludge (IFAS)
7. Moving Bed Biofilm Reactors (MBBR)
8. Enhanced Primary Treatment (EPT)
Of the eight initially evaluated, a refined list of three (3) short-listed alternatives for biological nutrient (Ammonia) removal was generated. The subsequent sections of this report highlight details about each short-listed alternative.

### 3.6 Short-List Alternative #1 – Bio-Filter Activated Sludge

Alternative #1 Bio-Filter Activated Sludge (BF/AS) was recommended for further examination as a short-listed alternative. The following sections provide additional details with respect to capital cost, O&M cost, site layout and the improvements necessary to achieve the future more stringent effluent limits.

#### 3.6.1 BF/AS Alternative – Bio-Filters

In the BF/AS process the Bio-Filters provide the attached growth portion of an Integrated Treatment Process consisting of both attached and suspended growth biological treatment. As is the case in O’Fallon, the Bio-Filters of the BF/AS process are typically designed to remove BOD. The following table provides a summary of the planning level design parameters which were used as part of the evaluation for the Bio-Filter Portion of the BF/AS treatment alternative.

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design BOD Loading</td>
<td>150 lbs/1,000 ft³</td>
<td>Design Loading – Typical Value</td>
</tr>
<tr>
<td>Max BOD Loading</td>
<td>250 lbs/1,000 ft³</td>
<td>Design Loading – Typical Value</td>
</tr>
<tr>
<td>Design Wetting Rate</td>
<td>1 to 4 gpm/ft²</td>
<td>Design Range – Typical Range</td>
</tr>
<tr>
<td>Primary Clarifier BOD Removal</td>
<td>38%</td>
<td>Current Removal Efficiency</td>
</tr>
<tr>
<td>Bio-Filter Towers</td>
<td>4</td>
<td>Three Existing – One New</td>
</tr>
<tr>
<td>Average BOD Loading</td>
<td>135 lbs/1,000 ft³</td>
<td>At Permitted Flow</td>
</tr>
<tr>
<td>Max BOD Loading</td>
<td>224 lbs/1,000 ft³</td>
<td>At Max Flow Conditions</td>
</tr>
<tr>
<td>Average Wetting Rate</td>
<td>2.7 gpm/ft²</td>
<td>At Permitted Flow</td>
</tr>
<tr>
<td>Max Wetting Rate</td>
<td>3.9 gpm/ft²</td>
<td>At Max Flow Conditions</td>
</tr>
</tbody>
</table>

It was determined an additional Bio-Filter would need to be added based on the design flow and load conditions in conjunction with the design BOD loading and wetting rates.

#### 3.6.2 BF/AS Alternative - Aeration Tanks

In the BF/AS process the suspended growth portion of the Integrated Treatment Process occurs in the Aeration Tanks. Typically, this suspended growth portion of the treatment process provides additional BOD removal and can provide Ammonia Removal, Nitrification, Denitrification and Phosphorous removal to meet various treatment limits. For this alternative the purpose of the Aeration Tanks will be to provide additional BOD removal and Ammonia-Nitrogen removal to ensure compliance with the more stringent Ammonia limits proposed in the next discharge permitting cycle.

The aerobic biological treatment tankage will be designed to accommodate the controlling design flows and loads under the controlling design temperature conditions. The following table provides a summary of the planning level design parameters which were used as part of the evaluation for the BF/AS alternative. It should be noted that the design aerobic SRT was calculated based on historical temperatures from plant operating data in conjunction with future more stringent effluent ammonia requirements which will occur in the next permitting cycle. Additional temperature loss was taken into consideration as this typically occurs across the attached growth Bio-Filter portion of the treatment process due to its open-air exposure.
Table 3-2  BF/AS Alternative – Aeration Tanks

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-Filter BOD Removal</td>
<td>50%</td>
<td>Design Removal Efficiency</td>
</tr>
<tr>
<td>Design Aerobic SRT(1)</td>
<td>9 days</td>
<td>Minimum Ammonia Removal</td>
</tr>
<tr>
<td>Design MLSS Concentration</td>
<td>3,000 mg/L</td>
<td>Typical Range 2,000 to 5,000 mg/L</td>
</tr>
<tr>
<td>Influent VSS Fraction</td>
<td>85%</td>
<td>Based on Plant Operating Data</td>
</tr>
<tr>
<td>Influent nbVSS Fraction</td>
<td>30%</td>
<td>Assumed Value</td>
</tr>
<tr>
<td>Septage Waste Addition</td>
<td>0 gpd</td>
<td>Assumed No Septage Waste</td>
</tr>
<tr>
<td>Design Winter Temperature</td>
<td>12 °C</td>
<td>Based Plant Data &amp; Loss Through Bio-Filters</td>
</tr>
<tr>
<td>Design Summer Temperature</td>
<td>21.8 °C</td>
<td>Based On Plant Operating Data</td>
</tr>
<tr>
<td>Total Aerobic Volume</td>
<td>3.36 MG</td>
<td>Aerobic Volume Required</td>
</tr>
<tr>
<td>Aeration Tanks</td>
<td>4</td>
<td>Assume Four Tanks</td>
</tr>
<tr>
<td>Single Tank Volume</td>
<td>0.84 MG</td>
<td>Single Aeration Tank Total Volume</td>
</tr>
<tr>
<td>Aeration Tank SWD</td>
<td>18 feet</td>
<td>Assumed Value (Typical 15 to 25 feet)</td>
</tr>
<tr>
<td>Anoxic Zones</td>
<td>4</td>
<td>One Per Tank – Staged Into 4-Cells</td>
</tr>
<tr>
<td>Anoxic Zone Mixers</td>
<td>16</td>
<td>Four Zones Per Tank - One Mixer Per Zone</td>
</tr>
<tr>
<td>Internal Nitrate Recycle Pumps</td>
<td>4</td>
<td>One Per Aeration Tank</td>
</tr>
<tr>
<td>Aeration Tank Drain Pumps</td>
<td>4</td>
<td>Shared Between All Tanks</td>
</tr>
</tbody>
</table>

1. Suspended growth Aerobic Solids Retention Time (SRT)

As a part of the BF/AS Alternative the aerobic biological tankage was divided into four separate trains to allow for process control flexibility and to facilitate cleaning along with maintenance of equipment as necessary. The sizing criteria also assumes that all tanks will be online to accommodate the design flow and load conditions.

The existing BF/AS process is a high rate process with a high design organic loading rate (150 lbs BOD/1,000 ft³-day). Some Nitrification and Ammonia-Nitrogen removal can be achieved in integrated attached/suspended growth processes. One of the most typical design methods is to provide a total Solids Retention Time (SRT) taking into account both the suspended growth and attached growth treatment systems to provide an equivalent total SRT which is equivalent to a conventional suspended growth process for nitrification and ammonia removal. The current high-rate Bio-Filters do not allow for a reduction in the total SRT of the system with regard to Nitrification. Additionally, previous record documentation indicates that the Bio-Filters were anticipated to only provide a 10% reduction in Ammonia prior to the Aeration Tanks.

Anoxic selector zones were included as part of this alternative to allow for additional process control, control of nitrate loading to the secondary clarifiers and to allow for recovery of alkalinity as part of the treatment process. For the anoxic zones that are used for future TN removal it is important to consider the BOD reduction which occurs in the Bio-Filters. The influent BOD to the WWTP is low to medium strength. The low to medium strength influent BOD combined with additional removal in the Primary Clarifiers (typically 38%) and Bio-Filters (typically an additional 50%) results in low influent BOD loading to the Aeration Tanks as part of the BF/AS alternative. For the anoxic zones to function properly for future TN removal, ample carbon in the form of Primary Effluent, Micro-C or another source would likely be required for this alternative.

3.6.3 BF/AS Alternative – Aeration Systems

The aeration and air delivery systems are critical to treatment performance and permit compliance. Aeration introduces air into the mixed liquor, providing an aerobic environment for microbial degradation of organic matter. Biological aeration has two main purposes as part of the BF/AS alternative in the suspended growth portion of the treatment process.
- Oxygen Supply: Provide the required oxygen to the microorganisms for treatment.
- Mixing: Provide the required mixing so that the microorganisms come into contact with the dissolved and suspended organic matter in the reactor.

Air delivery systems must be designed to accommodate the oxygen demands from BOD as well as Nitrification to meet the more stringent Ammonia-Nitrogen limits in the next permitting cycle. The following table provides a summary of the biological air delivery requirements for the BF/AS Alternative.

### Table 3-3  BF/AS Alternative Biological Aeration

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Condition</td>
<td>Max Day</td>
<td>Designed for Max Day (Summer) Conditions</td>
</tr>
<tr>
<td>BOD Oxidation Required</td>
<td>1.1 lb O$_2$/lb BOD</td>
<td>MDNR Design Requirements</td>
</tr>
<tr>
<td>TKN Oxidation Required</td>
<td>4.6 lb O$_2$/lb TKN</td>
<td>MDNR Design Requirements</td>
</tr>
<tr>
<td>Summer Wastewater Temperature</td>
<td>21.8 °C</td>
<td>Design Temperature Based on Plant Data</td>
</tr>
<tr>
<td>Denitrification Oxygen Credit</td>
<td>2.86 lb O$_2$/lb TKN</td>
<td>O$_2$ Recovery – Reduced Credit @ Peak Flows</td>
</tr>
<tr>
<td>Aeration Tanks</td>
<td>4</td>
<td>Number Of Tanks</td>
</tr>
<tr>
<td>Site Elevation</td>
<td>450 fasl</td>
<td>WWTP Site – Elevation Above Sea Level</td>
</tr>
<tr>
<td>Aeration Tank SWD</td>
<td>18 feet</td>
<td>Assumed Value (Typical 15 to 25 feet)</td>
</tr>
<tr>
<td>Diffuser Depth</td>
<td>17 feet</td>
<td>Assumed 1 Foot Clear Off Tank Bottom</td>
</tr>
<tr>
<td>Alpha Factor</td>
<td>0.5</td>
<td>Assumed Design Value</td>
</tr>
<tr>
<td>Fouling Factor</td>
<td>0.9</td>
<td>Assumed Design Value</td>
</tr>
<tr>
<td>Dissolved Oxygen Target At ADF</td>
<td>2.0 mg/L</td>
<td>Minimum – MDNR Design Requirements</td>
</tr>
<tr>
<td>Dissolved Oxygen Target At MDF</td>
<td>1.0 mg/L</td>
<td>Reduced Target DO at Peak Conditions</td>
</tr>
<tr>
<td>Diffuser Type – Ultra-Fine Bubble</td>
<td>Panel Type</td>
<td>Fixed Floor Panels – Ultra Fine Bubble</td>
</tr>
<tr>
<td>Transfer Efficiency</td>
<td>37.4%</td>
<td>Typical 2.2% Per Foot Depth - Ultra Fine Bubble</td>
</tr>
<tr>
<td>Mixing Requirements</td>
<td>0.12 SCFM/ft$^2$</td>
<td>Mixing Demand Per ft$^2$ Tank Area</td>
</tr>
<tr>
<td>AOR</td>
<td>17,000 lbs O$_2$/day</td>
<td>Max Day Summer Total Air Demand</td>
</tr>
<tr>
<td>SOR</td>
<td>36,200 lbs O$_2$/day</td>
<td>Max Day Summer Total Air Demand</td>
</tr>
</tbody>
</table>

The air requirements in the table include a partial denitrification oxygen recovery credit from the anoxic zones in the Aeration Tanks. The oxygen credit was conservatively estimated due to possible reductions in efficiency of the system under peak flow conditions. The Bio-Filter portion of the treatment process ahead of the suspended growth Aeration Tanks allows for a reduction in the total air demand associated with the suspended growth reactor due to the initial BOD removal provided by the Bio-Filters.

### 3.6.4 BF/AS Alternative – Aeration Blower System

The aeration blower system is a critical component of the BF/AS alternative to ensure aerobic treatment. A dedicated standby blower would be provided with piping and valves to backup any of the lead blowers. The following table provides a summary of the aeration blower system of the BF/AS Alternative.
### Table 3-4 BF/AS Alternative Aeration Blower System

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeration Tanks</td>
<td>4 Total</td>
</tr>
<tr>
<td>Aeration Blowers</td>
<td>5 Total</td>
</tr>
<tr>
<td>Approximate Discharge Pressure</td>
<td>9.0 psig</td>
</tr>
</tbody>
</table>

#### 3.6.5 BF/AS Alternative – Final Clarifier System

The Final Clarifiers are used for solids and liquid separation as a part of the BF/AS alternative. The following table provides a summary of the Final Clarifiers as part of the BF/AS alternative.

### Table 3-5 BF/AS Alternative Final Clarification System

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sludge Volume Index (SVI)(^{(1)})</td>
<td>135 mL/g</td>
<td>Assumed SVI Less Than 150 With Selectors(^{(2)})</td>
</tr>
<tr>
<td>Secondary Clarifiers</td>
<td>4</td>
<td>Four – All Online at Peak Flows</td>
</tr>
<tr>
<td>Design Peak Surface Overflow Rate</td>
<td>1,200 gal/ft(^{2})-day</td>
<td>Max SOR - Per MDNR Design Requirements</td>
</tr>
<tr>
<td>Actual Operating Peak SOR</td>
<td>836 gal/ft(^{2})-day</td>
<td>Less Than MDNR Design Requirements</td>
</tr>
<tr>
<td>Design Peak Solids Loading Rate</td>
<td>40 lbs/ft(^{2})-day</td>
<td>Per MDNR Design Requirements</td>
</tr>
<tr>
<td>Actual Operating SLR</td>
<td>37 lbs/ft(^{2})-day</td>
<td>Less Than MDNR Design Requirements</td>
</tr>
<tr>
<td>Existing Clarifier Diameter</td>
<td>80 feet</td>
<td>Existing Clarifier Diameter</td>
</tr>
<tr>
<td>Existing Clarifier Type</td>
<td>Circular</td>
<td>Circular – Draft Tube Type</td>
</tr>
<tr>
<td>Existing Launder Cover System</td>
<td>Yes</td>
<td>Control of Algal Growth in Lauunders</td>
</tr>
<tr>
<td>Density Current Baffles</td>
<td>Yes</td>
<td>Added - For Settling Assistance &amp; Control</td>
</tr>
<tr>
<td>Existing Feed Type</td>
<td>Center</td>
<td>Center Feed – Energy Dissipating Inlet</td>
</tr>
</tbody>
</table>

1. The SVI of 135 mL/g was selected based on max month SVI values from plant data provided by the City staff.
2. With selectors typical SVI values are less than 150 mL/g and typically can range from 80 to 120 mL/g. For the purposes of comparing alternatives the max month existing plant SVI was selected.

As part of the Final Clarifier sizing, it was assumed all clarifiers would be online to accommodate peak flow conditions. It is also recommended that the Final Clarifiers include the addition of Density Current Baffles as part of this alternative to provide improved settling. As shown in the table above, the existing Final Clarifiers are appropriately sized and can accommodate the MDNR design criteria for Surface Overflow Rate (SOR) and Solids Loading Rate (SLR).

#### 3.6.6 BF/AS Alternative - Return Sludge System

The Return Activated Sludge (RAS) system is a critical component of the BF/AS alternative. The RAS system controls the settled sludge blanket elevation in the Final Clarifiers and returns activated sludge biomass back to the biological treatment system for use in treatment of primary effluent. As part of the BF/AS alternative the existing RAS piping system from each of the four Final Clarifiers will be reused. The RAS will be directed to the Bio-Filter Feed Pump wet well as is currently the case and it will be pumped up to the Bio-Towers.

#### 3.6.7 BF/AS Alternative - Recirculated Sludge System

As part of the BF/AS alternative the existing Recirculated Sludge Pumping System will no longer be required to function in its current capacity. The pumping system can potentially be reused as an internal nitrate recycle pumping system for one Aeration Tank. The pumps could also be potentially repurposed for use as Aeration Tank Drain Pumps.
3.6.8 BF/AS Alternative - Waste Sludge System

The Waste Activated Sludge (WAS) system allows for control of the solids inventory of the system and provide a means to remove solids from the process to direct them to the Sludge Processing facilities. For the purposes of the BF/AS alternative it was assumed that the existing gravity sludge wasting system including the WAS Valve Vault (Area #21) would be reused along with the two WAS pumps in the Basement of the Bio-Filter Complex.

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Sludge Pumps</td>
<td>2</td>
<td>Reuse Existing Progressive Cavity Pumps</td>
</tr>
<tr>
<td>Waste Sludge Flow</td>
<td>140,000 gpd</td>
<td>Estimated WAS Flow</td>
</tr>
</tbody>
</table>

3.6.9 BF/AS Alternative - Summary of Key Upgrades

The following provides a summary of the key components of the BF/AS Alternative:

- Bio-Filter Feed Pump Station: As part of the BF/AS Alternative it was assumed that the existing Bio-Filter Pump Station Wet Well and Bio-Filter Feed Pumps would be reused and refurbished.
- Bio-Towers: As part of this alternative a fourth Bio-Tower is proposed to be added. New influent slide gates and weir plates are also proposed for the Upper Level wet well in the Bio-Filter Complex. The existing Bio-Filter Towers are also proposed to be refurbished and the exteriors will be repainted. Areas of limiting hydraulics and freeboard will be modified to accommodate changes in flow.
- Aeration Influent Splitter Box: A new dedicated Aeration Influent Splitter Box with top overflow weirs to ensure an even flow split between all treatment trains is also proposed.
- Anoxic Selector Zones: Anoxic selector zones and/or staged zones to allow process control of organisms to provide a selection effect to maximize an environment to favor well settling organisms will be included. Each anoxic zone will require dedicated mixing provisions. Internal Nitrate recycle pumping will also be included to transport Nitrate to the Anoxic zones for Denitrification to allow for oxygen recovery and recovery of Alkalinity.
- De-Oxygenation Zone: A dedicated De-oxygenation Zone to allow removal of elevated residual dissolved oxygen from internal nitrate recycle pumping at the back end of each aeration train will be included.
- Distribution Box #3 Upgrades: Distribution Box #3 will be upgraded with new self-contained manual slide gates. In addition, the hydraulics of the Distribution Box would be modified to allow for a top overflow weir to ensure even flow split between all four Final Clarifiers. The hydraulic modifications would alleviate any chance of Final Clarifier #3 experiencing more flow due to its elevation being several inches lower than the other three Final Clarifiers.
- Final Clarifiers: Each of the Final Clarifiers would be upgraded with density current baffle systems to improve settling performance. Final Clarifier #4 would be upgraded completely due to its age.
- RAS Pumping System: The existing RAS piping system would be reused. RAS pumping to the Bio-Filters would be accomplished by the existing Bio-Filter Feed Pumps as is currently the case at the WWTP. The existing RAS pump which is located in the RAS Box adjacent to the Bio-Filter Feed Pump wet well could potentially be reused and modified transport Primary Effluent to the Anoxic Zones as needed for an additional carbon source.
- Tank Drain Pumps: A tank drain pump system is proposed to allow draining of the Aeration Tanks and also to allow provisions to transfer MLSS to different tanks.

- Electrical & Controls Upgrades: The existing Electrical Distribution System, MCC, Transformers, Panelboards and Control Panels in the Bio-Filter Complex are also all proposed to be upgraded as a part of this alternative. These upgrades are necessary to accommodate the new process equipment and electrical loads which are required for the alternative.

### 3.7 Short-List Alternative #2 – Membrane Bioreactor

Alternative #2 – Membrane Bioreactor (MBR) was recommended for further examination as a short-listed alternative due to its ability to produce consistent high-quality effluent and its ability to be incorporated into existing tankage at the WWTP site. The following sections will provide additional details with respect to capital cost, O&M cost, site layout and the improvements necessary to achieve the future more stringent effluent limits. For the purposes of this alternatives evaluation, flat plate type membranes are considered as part of the alternatives analysis. It is important to note that hollow fiber type membrane systems would also be applicable for this technology and the final determination of membrane technology is recommended for more detailed consideration as part of Preliminary Design for any future upgrades.

There are many ways to convert and reuse the existing treatment tankage at the WWTP site as part of the MBR alternative. For the purposes of this alternatives analysis, the existing Final Clarifiers were chosen to be repurposed into Aeration and Membrane Tanks and the existing Aeration Tanks were chosen to be repurposed into Anoxic Tanks/Zones.

#### 3.7.1 MBR Alternative – Fine Screening System

Robust fine screening is critical to the MBR Alternative to protect the membranes from damage and to maximize their available service life. Fine screening reduces the need for membrane maintenance and cleaning. As part of the MBR Alternative a new dedicated fine screening system will be included to screen Primary Effluent Prior to the downstream biological treatment system and membrane filtration processes. The following table provides a summary of the new fine screening system.

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine Screens(1)</td>
<td>2 Total – Lead/Standby – Full Redundancy</td>
</tr>
<tr>
<td>Single Screen Hydraulic Capacity</td>
<td>16.5 MGD + Peak Filtrate Flow</td>
</tr>
<tr>
<td>Location</td>
<td>Indoors – New Fine Screening Building</td>
</tr>
<tr>
<td>Screen Aperture Opening</td>
<td>2 mm – Perforated Plate</td>
</tr>
<tr>
<td>Screen Mounting Location</td>
<td>In - Channel</td>
</tr>
<tr>
<td>Screen Type</td>
<td>Inclined Rotary Drum Type</td>
</tr>
</tbody>
</table>

1. Fine Screens include an integral washing, dewatering and compaction system which functions as a wash press for captured screenings

As part of the MBR Alternative the two new fine screens were assumed to be located in a new building adjacent to the Bio-Filter Complex. Primary Effluent flow would be pumped to a dedicated influent channel. Dedicated slide gates would also be provided to allow screen channel isolation. Screened Primary Effluent would then flow by gravity to the downstream biological treatment system.
3.7.2 MBR Alternative – Biological Treatment Tankage

The aerobic biological treatment tankage (combination of Aeration Tanks and Membrane Tanks located in repurposed Final Clarifiers) will be designed to accommodate the controlling design flows and loads under the controlling design temperature conditions. Due to the high volume of air scour, aerobic treatment is performed in the Membrane Tanks along with the membrane filtration process. Additionally, the air scour provides additional oxygen delivery, which results in a credit (reduction) of the total required air delivery to the aerobic treatment process.

For the MBR Alternative, Anoxic zones will also be included to provide additional process control. Anoxic zones and/or staged zones allow process control of organisms to provide a selection effect to maximize an environment to favor organisms which can be filtered well by the MBR process which in turn reduces fouling. Each anoxic zone will require dedicated mixing provisions. Nitrate recycle pumping will also be included to transport Nitrate to the Anoxic zones for Denitrification to allow for oxygen recovery and recovery of Alkalinity. For the MBR Alternative the RAS pumping system will also function as a Nitrate recycle. The following table provides a summary of the aerobic tankage as part of the MBR Alternative.

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Aerobic SRT</td>
<td>8 days</td>
<td>Minimum - Ammonia Removal</td>
</tr>
<tr>
<td>Design MLSS Concentration</td>
<td>8,000 mg/L</td>
<td>Typical Range 8,000 to 10,000 mg/L</td>
</tr>
<tr>
<td>Influent VSS Fraction</td>
<td>85%</td>
<td>Based On Plant Data</td>
</tr>
<tr>
<td>Influent nbVSS Fraction</td>
<td>30%</td>
<td>Assumed Value</td>
</tr>
<tr>
<td>Septage Waste Addition</td>
<td>0 gpd</td>
<td>Assumed No Septage Waste</td>
</tr>
<tr>
<td>Design Winter Temperature</td>
<td>13.4 °C</td>
<td>Design Temperature - Based On Plant Data</td>
</tr>
<tr>
<td>Design Summer Temperature</td>
<td>21.8 °C</td>
<td>Design Temperature - Based On Plant Data</td>
</tr>
<tr>
<td>Membrane Tank Volume Credit</td>
<td>Yes</td>
<td>Tanks Operate With Aerobic MLSS</td>
</tr>
<tr>
<td>Membrane Tanks Online</td>
<td>3</td>
<td>3 of 4 Tanks Online – Allowance for Cleaning</td>
</tr>
<tr>
<td>Total Aerobic Volume</td>
<td>1.43 MG</td>
<td>Minimum Total Aerobic Volume Required</td>
</tr>
<tr>
<td>Membrane Tank Aerobic Volume</td>
<td>1.57 MG</td>
<td>Three Tanks Online-Repurposed Clarifiers</td>
</tr>
<tr>
<td>Existing Aeration Tank Volume</td>
<td>0.62 MG</td>
<td>Total Existing Aeration Tank Total Volume</td>
</tr>
<tr>
<td>Existing Final Clarifier Volume</td>
<td>2.1 MG</td>
<td>Total Final Clarifier Volume – 4 Tanks Online</td>
</tr>
</tbody>
</table>

As a part of the MBR Alternative the aerobic biological tankage represents the sum of the online combined Membrane Tanks and the Aeration Tanks. Due to the high volume of air scour, aerobic treatment is performed in the Membrane Tanks along with the filtration process. Three of the four membrane tanks were assumed to be online to allow for membrane cleaning or tank maintenance. As shown in the table above, with three membrane tanks online the WWTP has sufficient aerobic tankage to accommodate the design aerobic SRT requirements for treatment and Ammonia-Nitrogen removal.

3.7.3 MBR Alternative – Membrane Tanks

For the MBR Alternative, the goal of the membrane filtration system is to provide sufficient surface area for filtration at a target design flux. Typical design fluxes at average day flow conditions range from 10 to 20 gallons per day per square foot (gpd/ft²). Typical design fluxes for peak flow conditions range from 20 to 30 gpd/ft². It is typically desirable to operate membrane facilities under low flux rates when possible as this improves filtration performance, minimizes fouling, reduces recovery-cleaning requirements and maximizes the useful life of the membranes.
For the MBR Alternative, having redundant filtration capacity is critical especially under peak flow conditions to allow for sufficient filtration capacity in the event a membrane tank is offline for physical maintenance, maintenance cleaning or recovery cleaning. A recommended robust design practice is to provide sufficient filtration capacity to accommodate the design Maximum Day Flow (MDF) with one Membrane Tank offline for a period of at least 48 hours. Peak Hour and instantaneous flows are recommended to be accommodated by the offline Influent Equalization Tanks at the WWTP. The following table provides a summary of the Membrane Tanks which would be included as part of the MBR Alternative.

Table 3-9 Membrane Filtration Summary

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Day Flow</td>
<td>16.5 MGD</td>
</tr>
<tr>
<td>Average Day Permitted Flow</td>
<td>11.25 MGD</td>
</tr>
<tr>
<td>Peak Dewatering Filtrate Flow</td>
<td>0.4 MGD</td>
</tr>
<tr>
<td>Design MDF Flux</td>
<td>22 gpd/ft²</td>
</tr>
<tr>
<td>Surface Area Required at MDF</td>
<td>787,273 ft²</td>
</tr>
<tr>
<td>Design ADF Flux</td>
<td>14 gpd/ft²</td>
</tr>
<tr>
<td>Surface Area Required at ADF</td>
<td>803,571 ft²</td>
</tr>
<tr>
<td>Surface Area Per SMU</td>
<td>5,166 ft²</td>
</tr>
<tr>
<td>Total SMU's Required at MDF</td>
<td>152</td>
</tr>
<tr>
<td>Total SMU's Required at ADF</td>
<td>156</td>
</tr>
</tbody>
</table>

Several viable alternatives are available at the WWTP to accommodate the membrane filtration equipment. For the purposes of this alternatives analysis it was assumed that the membrane equipment would be retrofitted into the existing Final Clarifiers. The following table provides a summary of the Membrane Tanks as part of the MBR Alternative.

Table 3-10 Membrane Tank Summary

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Membrane Tanks</td>
<td>4</td>
<td>3 Online &amp; 1 Standby Tank</td>
</tr>
<tr>
<td>Tank Diameter</td>
<td>80 feet</td>
<td>Match Existing Diameter</td>
</tr>
<tr>
<td>Tank Operating Depth</td>
<td>14 feet</td>
<td>Minimum Operating Depth</td>
</tr>
<tr>
<td>Single Membrane Tank Volume</td>
<td>526,380 gallons</td>
<td>Single Tank Volume (14 feet Depth)</td>
</tr>
<tr>
<td>Total Membrane Tank Volume</td>
<td>2.1 MG</td>
<td>Total Volume-Four Tanks Online</td>
</tr>
<tr>
<td>Air Scour Requirements</td>
<td>76 SCFM/SMU</td>
<td>Air Scour Requirements</td>
</tr>
<tr>
<td>Membrane Units Per Tank</td>
<td>52 SMU</td>
<td>Total Cassettes Per Tank</td>
</tr>
<tr>
<td>Total Air Scour Required Per Tank</td>
<td>3,952 SCFM</td>
<td>Air Scour Requirements Per Tank</td>
</tr>
<tr>
<td>Air Scour Blowers</td>
<td>9</td>
<td>Two Per Tank &amp; Shared Standby</td>
</tr>
<tr>
<td>Air Scour Blower Type</td>
<td>PD</td>
<td>Positive Displacement – Tri-Lobe</td>
</tr>
</tbody>
</table>

3.7.4 MBR Alternative – Aeration Systems

The aeration and air delivery systems are critical to treatment performance and permit compliance. Aeration introduces air into the mixed liquor, providing an aerobic environment for microbial degradation of organic matter. Biological aeration has two main purposes in the MBR Alternative.

- Oxygen Supply: Provide the required oxygen to the microorganisms for treatment.
- Mixing: Provide the required mixing so that the microorganisms come into contact with the dissolved and suspended organic matter in the reactor.

Air delivery systems must be designed to accommodate the oxygen demands from BOD as well as Nitrification. The following table provides a summary of the biological air delivery requirements for the MBR Alternative.

### Table 3-11 MBR Alternative Biological Aeration

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Condition</td>
<td>Max Day</td>
<td>Designed for Max Day (Summer) Conditions</td>
</tr>
<tr>
<td>BOD Oxidation Required</td>
<td>1.1 lb O(_2)/lb BOD</td>
<td>MDNR Design Requirements</td>
</tr>
<tr>
<td>TKN Oxidation Required</td>
<td>4.6 lb O(_2)/lb TKN</td>
<td>MDNR Design Requirements</td>
</tr>
<tr>
<td>Summer Wastewater Temperature</td>
<td>21.8 °C</td>
<td>Design Temperature Based on Plant Data</td>
</tr>
<tr>
<td>Denitrification Oxygen Credit</td>
<td>2.86 lb O(_2)/lb TKN</td>
<td>O(_2) Recovery – Reduced Credit @ Peak Flows</td>
</tr>
<tr>
<td>Aeration/Membrane Tanks</td>
<td>4</td>
<td>Reuse Existing Four Final Clarifiers</td>
</tr>
<tr>
<td>Site Elevation</td>
<td>450 fasl</td>
<td>WWTP Site – Elevation Above Sea Level</td>
</tr>
<tr>
<td>Membrane Tank SWD</td>
<td>14 feet</td>
<td>Existing Final Clarifier SWD</td>
</tr>
<tr>
<td>Diffuser Depth</td>
<td>13 feet</td>
<td>Assumed 1 Foot Clear Off Tank Bottom</td>
</tr>
<tr>
<td>Alpha Factor</td>
<td>0.5</td>
<td>WEF MOP 8 Figure 14.77 @ MLSS = 8,000 mg/L</td>
</tr>
<tr>
<td>Fouling Factor</td>
<td>0.9</td>
<td>Assumed Design Value</td>
</tr>
<tr>
<td>Dissolved Oxygen Target At ADF</td>
<td>2.0 mg/L</td>
<td>Minimum – MDNR Design Requirements</td>
</tr>
<tr>
<td>Dissolved Oxygen Target At MDF</td>
<td>1.0 mg/L</td>
<td>Reduced Target DO At Peak Conditions</td>
</tr>
<tr>
<td>Aeration Diffuser Type-Fine Bubble</td>
<td>Panel Type</td>
<td>Fixed Floor Grid Pattern</td>
</tr>
<tr>
<td>Transfer Efficiency</td>
<td>28.6%</td>
<td>Typical 2.2% Per Foot Depth-Ultra Fine Bubble</td>
</tr>
<tr>
<td>Mixing Requirements</td>
<td>0.12 SCFM/ft(^2)</td>
<td>Mixing Demand Per ft(^2) Tank Area</td>
</tr>
<tr>
<td>Total Plant AOR</td>
<td>30,270 lbs O(_2)/day</td>
<td>Max Day Summer Total Air Demand</td>
</tr>
<tr>
<td>Air Scour AOR Reduction</td>
<td>14,000 lbs O(_2)/day</td>
<td>AOR Reduction Due To Air Scour Input</td>
</tr>
<tr>
<td>Additional AOR Required</td>
<td>16,270 lbs O(_2)/day</td>
<td>Additional Aerobic AOR Requirements</td>
</tr>
<tr>
<td>SOR With Air Scour Credit</td>
<td>33,250 lbs O(_2)/day</td>
<td>Max Day Summer Total Air Demand</td>
</tr>
</tbody>
</table>

The MBR Alternative will allow for an oxygen delivery credit from the air scour system. The air scour system for some membrane systems operates intermittently, typically in 10-minute cycles with 9 minutes of air scour and 1 minute of relaxation with no air scour or permeate flow. Typically, membranes use coarse bubble aeration for air scour. Some newer membranes operate with continuous air scour and use a finer bubble diffused aeration system for air scouring. It should be noted that the diffusers are not typically configured to provide a true fine bubble and thus they have similar oxygen transfer characteristics as compared to diffused coarse bubble systems. Overall, the air scour system is not intended for biological treatment with most membrane systems, but it does allow for an oxygen delivery credit, which subsequently reduces the size of the Aeration Blower system which is the case for the MBR Alternative in this application.

### 3.7.5 MBR Alternative – Aeration Blower System

The aeration blower system is a critical component of the MBR Alternative to ensure aerobic treatment. The WWTP has sufficient aerobic tankage via reuse of the existing Final Clarifiers as Membrane Tanks. As part of this retrofit, a portion of each tank is dedicated to aerobic volume with diffused aeration without membrane cassettes. As part of the alternative, it was assumed that a dedicated blower would be provided for the aerobic portion of each Membrane Tank to simplify the operation and control. This approach would eliminate the need for modulating air control valves and it allows the air scour blowers to be de-coupled from the Aeration Blowers. A dedicated standby blower would be provided...
with piping and valves to backup any of the lead blowers. The following table provides a summary of the aeration blowers for the MBR alternative.

### Table 3-12 MBR Alternative Aeration Blower System

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membrane/Aeration Tanks</td>
<td>4 Total</td>
</tr>
<tr>
<td>Aeration Blowers</td>
<td>5 Total – 4 Lead/1 Standby</td>
</tr>
<tr>
<td>Approximate Discharge Pressure</td>
<td>6.5 to 7.0 psig</td>
</tr>
</tbody>
</table>

Positive displacement blowers are recommended for this application due to the varying water depths and associated discharge pressures in the Membrane Tanks.

#### 3.7.6 MBR Alternative – Air Scour Blower System

The air scour blower system is a critical component of the MBR Alternative to properly clean (agitate) the surfaces of the membranes to maintain optimum filtration performance and prevent fouling. As part of the alternative it was assumed that two dedicated blowers would be provided for each Membrane Tank to simplify the operation and control. This approach would eliminate the need for modulating air control valves. A dedicated standby blower would be provided with piping and valves to backup any of the lead blowers. The following table provides a summary of the Air Scour Blowers as part of the MBR Alternative.

### Table 3-13 MBR Alternative Air Scour Blower System

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membrane Tanks</td>
<td>4 Total</td>
</tr>
<tr>
<td>Air Scour Blowers</td>
<td>8 Total</td>
</tr>
<tr>
<td>Approximate Discharge Pressure</td>
<td>6.5 to 7.0 psig</td>
</tr>
</tbody>
</table>

#### 3.7.7 MBR Alternative – Permeate System

The permeate system is a critical component of the MBR Alternative to pull clean water (permeate) through the membrane filters. Two alternatives were considered for the permeate system; pumped permeate and gravity permeate. For the comparison of alternatives in this report, a pumped permeate system was considered. Gravity permeate systems require a large differential head in the WWTP hydraulic profile (often as much as 15 feet) between the Membrane Tanks and associated downstream unit processes. Without making significant and costly modifications the existing WWTP does not have a sufficient hydraulic profile drop to accommodate a gravity permeate system. The following table provides a summary of the Permeate Pumping system.

### Table 3-14 MBR Alternative Permeate Pumping System

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membrane Tanks</td>
<td>4 Total</td>
</tr>
<tr>
<td>Permeate Pumps</td>
<td>5 Total</td>
</tr>
</tbody>
</table>

As part of the MBR Alternative it was assumed that a dedicated permeate pump would be provided for each membrane tank with a common standby unit for redundancy.
3.7.8 MBR Alternative – Return Sludge System

The Return Activated Sludge (RAS) system is a critical component of the MBR Alternative to transport filtered MLSS out of the membrane tanks back to the Anoxic Zones or Aeration Tanks to allow treatment of Primary Effluent. The following table provides a summary of the return sludge systems as part of the MBR Alternative.

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membrane Tanks</td>
<td>4</td>
</tr>
<tr>
<td>Return Sludge Pumps</td>
<td>4 Lead &amp; 1 Standby</td>
</tr>
<tr>
<td>RAS Rate</td>
<td>200 to 400% – Typical</td>
</tr>
</tbody>
</table>

Each Membrane Tank would include a dedicated RAS pump. The pumps would pull directly from each membrane tank and transport RAS and nitrate back to a dedicated De-Oxygenation Zone. The De-Oxygenation Zone would allow for removal of excess dissolved oxygen in the RAS flow, thus eliminating a high dissolved oxygen recycle flow into the anoxic zone. Typical RAS dissolved concentrations in membrane systems can be as high as 6 mg/L. The configuration also improves process control and allows monitoring of RAS flows from each Membrane Tank independently. Some membrane systems can be configured with a gravity return sludge configuration where recycled mixed liquor is returned to the anoxic or aerobic zones by gravity via telescoping valves or other control flow control schemes. This configuration provides limited control over the recycle flows and is not recommended for this application.

3.7.9 MBR Alternative – Waste Sludge System

The Waste Activated Sludge (WAS) system allows for control of the solids inventory of the system and provide a means to remove solids from the process to direct them to the Sludge Processing facilities. For the purposes of the MBR Alternative it was assumed that the existing sludge wasting system including the WAS Valve Vault (Area #21) would be reused along with the two WAS pumps in the Basement of the Bio-Filter Complex.

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Sludge Pumps</td>
<td>2</td>
<td>Reuse Existing Progressive Cavity Pumps</td>
</tr>
<tr>
<td>Waste Sludge Flow</td>
<td>142,800 gpd</td>
<td>Estimated Waste Sludge Flow</td>
</tr>
</tbody>
</table>

Also, it was assumed that the piping connecting the WAS Valve Vault (Area #21) would be connected to the common RAS force main from the Membrane Tanks or directly to the De-Ox Zone to allow controlled wasting.

3.7.10 MBR Alternative – Summary of Key Upgrades

The following provides a summary of the proposed upgrades as part of the MBR Alternative:

- Fine Screening: A new dedicated fine screening system would be included to allow fine screening of Primary Effluent Prior to the biological treatment system and the Membrane Tanks. The system would include two, 2 mm perforated plate fine screens with full redundancy at all flow conditions to provide protection for the membrane filtration equipment.
• **Bio-Filter Feed Pump Wet Well**: The existing Bio-Filter Feed Pump Wet Well and pumping system will be reused, refurbished and converted into a Primary Effluent Pump Station to transport flow to the new Fine Screening Building and system.

• **Anoxic Zones**: Staged anoxic zones would be provided to allow process control of organisms to provide a selection effect to minimize foaming. The anoxic zones would include dedicated mechanical mixing equipment. A dedicated De-Oxygenation Zone would be included to allow removal of residual DO in the combined RAS and Nitrate Recycle flow prior to the anoxic zones. The existing Aeration Tanks would be repurposed as Anoxic Zones.

• **Traditional Solids Recycle (RAS)**: The process would include a traditional pumped recycle system to transport RAS and Nitrate out of the membrane tanks back to the Anoxic Zones. RAS pumps would be installed in new pump galleries adjacent to the Membrane Tanks (Final Clarifiers).

• **Flow Splitting**: Distribution Box #3 would be refurbished and upgraded to allow flow split between the Membrane/Aeration Tanks. This would allow different Membrane Tanks to be run online with various Anoxic Zones as needed.

• **Foam Wasting & Control**: The system would include a dedicated means to remove foam from system and waste it to the Sludge Storage facilities to remove it from building up in the Membrane Tanks.

• **Air Scour**: Dedicated Blowers would be provided for each Membrane Tank. Blowers would be equipped with variable speed control based on level thus eliminating the need for control valves.

• **Aeration**: Dedicated Blowers would be provided for the aerobic portion of each Membrane Tank. Blowers would be equipped with variable speed control based on level thus eliminating the need for control valves.

• **Permeate**: Dedicated permeate pumps for control of permeate flows, especially during high flow events would be provided. Permeate Pumps would be installed in new pump galleries adjacent to the Membrane Tanks (Final Clarifiers).

• **Blower Building**: A new dedicated blower building would be included to house all the Air Sour and Aeration Blowers for the MBR Alternative. The Blower building would be located adjacent to the Membrane Tanks (Final Clarifiers).

• **Electrical & Controls Upgrades**: The existing Electrical Distribution System, MCC, Transformers, Panelboards and Control Panels in the Bio-Filter Complex are also all proposed to be upgraded as a part of this alternative. These upgrades are necessary to accommodate the new process equipment and electrical loads which are required for the alternative. Additionally, a new electrical building, MCC, etc. is proposed to be located adjacent to the Membrane Tanks (Final Clarifiers) to power and control electrical loads in this area as a part of this alternative.

### 3.8 Short-List Alternative #3 – Activated Sludge with BNR

Alternative #3—Activated Sludge with provisions for Biological Nutrient Removal (BNR) in a Modified Ludzack-Ettinger (MLE) type configuration (Anoxic/Aerobic) was recommended for further examination as a short-listed alternative due to its robust characteristics, proven track record, ability to handle high flows and its potential to accommodate future permit requirements. The following sections provide additional details with respect to capital cost, O&M cost, site layout and the improvements necessary to achieve the future more stringent effluent limits.
3.8.1 Activated Sludge with BNR Alternative - Biological Treatment Tankage

The aerobic biological treatment tankage will be designed to accommodate the design flows and loads under the controlling design temperature conditions. The following table provides a summary of the planning level design parameters which were used as part of the evaluation for the Activated Sludge with BNR alternative. It should be noted that the design aerobic solids retention time (SRT) was calculated based on historical temperatures from plant operating data in conjunction with future more stringent effluent ammonia requirements which will occur in the next permitting cycle.

### Table 3-17 Activated Sludge with BNR Alternative Biological Treatment Tankage

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Aerobic SRT</td>
<td>9 days</td>
<td>Minimum – Ammonia Removal</td>
</tr>
<tr>
<td>Design MLSS Concentration</td>
<td>3,000 mg/L</td>
<td>Typical Range 2,000 to 5,000 mg/L</td>
</tr>
<tr>
<td>Influent VSS Fraction</td>
<td>85%</td>
<td>Based On Plant Operating Data</td>
</tr>
<tr>
<td>Influent nbVSS Fraction</td>
<td>30%</td>
<td>Assumed Value</td>
</tr>
<tr>
<td>Septage Waste Addition</td>
<td>0 gpd</td>
<td>Assumed No Septage Waste</td>
</tr>
<tr>
<td>Design Winter Temperature</td>
<td>13.4 °C</td>
<td>Based On Plant Operating Data</td>
</tr>
<tr>
<td>Design Summer Temperature</td>
<td>21.8 °C</td>
<td>Based On Plant Operating Data</td>
</tr>
<tr>
<td>Total Aerobic Volume</td>
<td>3.82 MG</td>
<td>Aerobic Volume Required</td>
</tr>
<tr>
<td>Aeration Tanks</td>
<td>4</td>
<td>Assume Four Tanks</td>
</tr>
<tr>
<td>Single Tank Volume</td>
<td>0.96 MG</td>
<td>Single Aeration Tank Total Volume</td>
</tr>
<tr>
<td>Aeration Tank SWD</td>
<td>18 feet</td>
<td>Assumed Value (Typical 15 to 25 feet)</td>
</tr>
<tr>
<td>Anoxic Zones</td>
<td>4</td>
<td>One Per Tank</td>
</tr>
<tr>
<td>Anoxic Zone Mixers</td>
<td>16</td>
<td>Four Zones Per Tank - One Mixer Per Zone</td>
</tr>
<tr>
<td>Nitrate Recycle Pumps</td>
<td>4</td>
<td>One Per Aeration Tank</td>
</tr>
<tr>
<td>Aeration Tank Drain Pumps</td>
<td>4</td>
<td>Shared Between All Tanks</td>
</tr>
<tr>
<td>Organic Loading Rate</td>
<td>40 lbs BOD/1,000 ft³-day</td>
<td>MDNR Design Requirement</td>
</tr>
<tr>
<td>Operating Loading Rate</td>
<td>17 lbs BOD/1,000 ft³-day</td>
<td>Actual Operating Organic Loading Rate</td>
</tr>
<tr>
<td>Food to Microorganism Ratio</td>
<td>0.2-0.5 lbs BOD/lbs MLVSS-day</td>
<td>MDNR Design Requirement</td>
</tr>
<tr>
<td>Operating F:M Ratio</td>
<td>0.2 lbs BOD/lbs MLVSS-day</td>
<td>Actual Operating F:M Ratio</td>
</tr>
</tbody>
</table>

As a part of the Activated Sludge with BNR Alternative the aerobic biological tankage was divided into four new separate trains to allow for process control flexibility and to facilitate cleaning along with maintenance of equipment as necessary. The sizing criteria also assumes that all tanks will be online to accommodate the design flow and load conditions.

3.8.2 Activated Sludge with BNR Alternative - Aeration Systems

The aeration and air delivery systems are critical to treatment performance and permit compliance. Aeration introduces air into the mixed liquor, providing an aerobic environment for microbial degradation of organic matter. Biological aeration has two main purposes as part of the Activated Sludge with BNR alternative.

- **Oxygen Supply**: Provide the required oxygen to the microorganisms for treatment.
- **Mixing**: Provide the required mixing so that the microorganisms come into contact with the dissolved and suspended organic matter in the reactor.
Air delivery systems must be designed to accommodate the oxygen demands from BOD as well as Nitrification to meet the more stringent Ammonia-Nitrogen limits in the next permitting cycle. The following table provides a summary of the biological air delivery requirements for the Activated Sludge with BNR Alternative.

**Table 3-18 Activated Sludge with BNR - Biological Aeration**

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Condition</td>
<td>Max Day</td>
<td>Designed for Max Day (Summer) Conditions</td>
</tr>
<tr>
<td>BOD Oxidation Required</td>
<td>1.1 lb O&lt;sub&gt;2&lt;/sub&gt;/lb BOD</td>
<td>MDNR Design Requirements</td>
</tr>
<tr>
<td>TKN Oxidation Required</td>
<td>4.6 lb O&lt;sub&gt;2&lt;/sub&gt;/lb TKN</td>
<td>MDNR Design Requirements</td>
</tr>
<tr>
<td>Summer Wastewater Temperature</td>
<td>21.8 °C</td>
<td>Design Temperature Based on Plant Data</td>
</tr>
<tr>
<td>Denitrification Oxygen Credit</td>
<td>2.86 lb O&lt;sub&gt;2&lt;/sub&gt;/lb TKN</td>
<td>O&lt;sub&gt;2&lt;/sub&gt; Recovery – Reduced Credit @ Peak Flows</td>
</tr>
<tr>
<td>Aeration Tanks</td>
<td>4</td>
<td>Number Of Tanks</td>
</tr>
<tr>
<td>Site Elevation</td>
<td>450 fasl</td>
<td>WWTP Site – Elevation Above Sea Level</td>
</tr>
<tr>
<td>Aeration Tank SWD</td>
<td>18 feet</td>
<td>Assumed Value (Typical 15 to 25 feet)</td>
</tr>
<tr>
<td>Diffuser Depth</td>
<td>17 feet</td>
<td>Assumed 1 Foot Clear Off Tank Bottom</td>
</tr>
<tr>
<td>Alpha Factor</td>
<td>0.5</td>
<td>Assumed Design Value</td>
</tr>
<tr>
<td>Fouling Factor</td>
<td>0.9</td>
<td>Assumed Design Value</td>
</tr>
<tr>
<td>Dissolved Oxygen Target At ADF</td>
<td>2.0 mg/L</td>
<td>Minimum – MDNR Design Requirements</td>
</tr>
<tr>
<td>Dissolved Oxygen Target At MDF</td>
<td>1.0 mg/L</td>
<td>Reduced Target DO At Peak Conditions</td>
</tr>
<tr>
<td>Diffuser Type – Ultra-Fine Bubble</td>
<td>Panel Type</td>
<td>Fixed Floor Panels</td>
</tr>
<tr>
<td>Transfer Efficiency</td>
<td>37.4%</td>
<td>Typical 2.2% Per Foot Depth - Ultra Fine Bubble</td>
</tr>
<tr>
<td>Mixing Requirements</td>
<td>0.12 SCFM/ft&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Mixing Demand Per ft&lt;sup&gt;2&lt;/sup&gt; Tank Area</td>
</tr>
<tr>
<td>AOR</td>
<td>25,760 lbs O&lt;sub&gt;2&lt;/sub&gt;/day</td>
<td>Max Day Summer Total Air Demand</td>
</tr>
<tr>
<td>SOR</td>
<td>54,690 lbs O&lt;sub&gt;2&lt;/sub&gt;/day</td>
<td>Max Day Summer Total Air Demand</td>
</tr>
</tbody>
</table>

The air requirements in the table include a partial denitrification oxygen recovery credit from the anoxic zones in the Aeration Tanks. The oxygen credit was conservatively estimated due to possible reductions in efficiency of the system under peak flow conditions.

### 3.8.3 Activated Sludge with BNR Alternative - Aeration Blower System

The aeration blower system is a critical component of the Activated Sludge with BNR alternative to ensure aerobic treatment. A dedicated standby blower would be provided with piping and valves to backup any of the lead blowers. Detailed examination of blower turndown to accommodate current flow and load conditions is recommended as part of future Preliminary Designs to ensure efficiency in conjunction with current conditions. The following table provides a summary of the aeration blower system of the Activated Sludge with BNR Alternative.
As part of the Activated Sludge with BNR Alternative it was assumed that the existing two centrifugal turbo blowers would be removed from service to the Aeration Tanks. The manufacturer also confirmed that the blowers cannot be upgraded with new cores to meet the new flow and pressure requirements. Based on the manufacturer’s performance curves it was determined that re-using existing blowers would not be feasible.

3.8.4 Activated Sludge with BNR Alternative - Final Clarifier System

The Final Clarifiers are used for solids and liquid separation as a part of the Activated Sludge with BNR alternative. The existing four Final Clarifiers are appropriately sized to accommodate the design flows and loads. The following table provides a summary of the Final Clarifiers as part of the Activated Sludge with BNR alternative.

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sludge Volume Index (SVI)</td>
<td>135 mL/g</td>
<td>Assumed SVI Less Than 150 With Selectors</td>
</tr>
<tr>
<td>Secondary Clarifiers</td>
<td>4</td>
<td>Four Minimum – All Online at Peak Flows</td>
</tr>
<tr>
<td>Design Peak Surface Overflow Rate</td>
<td>1,200 gal/ft²-day</td>
<td>Per MDNR Design Requirements</td>
</tr>
<tr>
<td>Actual Operating Peak SOR</td>
<td>836 gal/ft²-day</td>
<td>Less Than MDNR Design Requirements</td>
</tr>
<tr>
<td>Design Peak Solids Loading Rate</td>
<td>50 lbs/ft²-day</td>
<td>Per MDNR Design Requirements</td>
</tr>
<tr>
<td>Actual Operating SLR</td>
<td>37 lbs/ft²-day</td>
<td>Less Than MDNR Design Requirements</td>
</tr>
<tr>
<td>Existing Clarifier Diameter</td>
<td>80 feet</td>
<td>Existing Clarifier Diameter</td>
</tr>
<tr>
<td>Existing Clarifier Type</td>
<td>Circular</td>
<td>Circular – Suction Heater (Draft Tube) Type</td>
</tr>
<tr>
<td>Existing Launder Cover System</td>
<td>Yes</td>
<td>Control of Algal Growth in Launder</td>
</tr>
<tr>
<td>Density Current Baffles</td>
<td>Yes</td>
<td>Added for Settling Assistance &amp; Control</td>
</tr>
<tr>
<td>Existing Feed Type</td>
<td>Center</td>
<td>Center Feed – Energy Dissipating Inlet</td>
</tr>
</tbody>
</table>

1. The SVI of 135 mL/g was selected based on max month SVI values from plant data provided by the City staff.
2. With selectors typical SVI values are less than 150 mL/g and typically can range from 80 to 120 mL/g. For the purposes of comparing alternatives the max month existing plant SVI was selected.

As part of the Final Clarifier sizing, it was assumed all clarifiers would be online to accommodate peak flow conditions. It is also recommended that the Final Clarifiers include the addition of Density Current Baffles as part of this alternative to provide improved settling.

3.8.5 Activated Sludge With BNR Alternative - Return Sludge System

The Return Activated Sludge (RAS) system is a critical component of the Activated Sludge with BNR alternative. The RAS pumping system controls the settled sludge blanket elevation in the Final Clarifiers and returns activated sludge biomass back to the biological treatment system for use in treatment of primary effluent. As part of the RAS system the existing RAS piping system from each of the four Final Clarifiers will be reused. A dedicated RAS wet well is recommended to allow additional control of RAS flows in conjunction with the draft tubes which are located in the Final Clarifiers. The separate RAS wet well also allows provisions for multiple modes of operation including Step Feed and
Contact Stabilization. It was assumed that the RAS wet well would be located in one of the existing Aeration Tanks. The following table provides a summary of the anticipated RAS pumping system.

### Table 3-21 Activated Sludge with BNR Alternative RAS Pumping System

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return Sludge Pumps</td>
<td>3</td>
<td>Assumed 3 Minimum – 2-Lead &amp; Standby</td>
</tr>
<tr>
<td>RAS Rate (% of ADF)</td>
<td>50 to 100%</td>
<td>MDNR &amp; Typical Design Requirements</td>
</tr>
<tr>
<td>RAS Flow</td>
<td>5.6 to 11.25 MGD</td>
<td>Based On Current Permitted Flow</td>
</tr>
</tbody>
</table>

It was assumed that at a minimum a three-pump system would be used to allow capabilities to meet high flow RAS rate requirements while also allowing for appropriate turndown to accommodate current average day RAS flow requirements. Several potential alternatives considered for RAS pumping systems as follows:

- Reuse/Refurbishment of Existing Recirculated Sludge Pumps in the Basement of the Bio-Filter Complex for use as new RAS Pumps. This alternative involves the conversion of a portion of one of the existing Aeration Tanks into a new RAS Wet Well.
- New dedicated RAS Pumps in one of the empty Aeration Tanks and conversion of a portion of one other tank into a RAS Wet Well.
- New dedicated submersible RAS pumps in a new RAS wet well in one of the Aeration Tanks.

As part of the RAS wet well a dedicated influent box with a weir gate would also be included to allow for additional flow control and backpressure on the entire RAS system. For the purposes of this alternatives comparison, reuse of the existing recirculation pumps was chosen. The existing pumps were evaluated, and it was confirmed with the manufacturer that they can be reused with an upsize of the motor from the existing 50 hp motor to a 60 hp motor.

#### 3.8.6 Activated Sludge with BNR Alternative – Waste Sludge System

The Waste Activated Sludge (WAS) system allows for control of the solids inventory of the system and provide a means to remove solids from the process to direct them to the Sludge Processing facilities. For the purposes of the Activated Sludge with BNR alternative it was assumed that the existing gravity sludge wasting system including the WAS Valve Vault (Area #21) would be reused along with the two WAS pumps in the Basement of the Bio-Filter Complex. An addition of a WAS/RAS wet-well was also considered in this alternative.

### Table 3-22 Activated Sludge with BNR Alternative WAS Pumping System

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Sludge Pumps</td>
<td>2</td>
<td>Reuse Existing Progressive Cavity Pumps</td>
</tr>
<tr>
<td>Waste Sludge Flow</td>
<td>178,560 gpd</td>
<td>Estimated Waste Sludge Flow</td>
</tr>
</tbody>
</table>

#### 3.8.7 Activated Sludge with BNR Alternative – Summary of Key Upgrades

The following provides a summary of the key components of the Activated Sludge with BNR Alternative:

- **Bio-Filter Feed Pump Station:** As part of the Activated Sludge with BNR Alternative the existing Bio-Filter Feed Pump Wet Well and Bio-Filter Feed Pumps would be repurposed as a Primary Effluent Pump Station. As mentioned previously, a separate wet well and pumping system is recommended for RAS to allow
provisions for multiple modes of operation including Step Feed and Contact Stabilization. These provisions provide an added benefit for treatment performance under high flow conditions. This configuration also allows improved control of RAS flows and allows RAS flow pacing to be conducted in conjunction with influent flows to the WWTP.

- **Aeration Influent Splitter Box**: A new dedicated Aeration Influent Splitter Box with top overflow weirs to ensure an even flow split between all treatment trains will be included. The splitter box would also include the hydraulic provisions to allow for Step Feed or Contact Stabilization modes of operation.

- **Aeration Tanks**: The Aeration Tanks would include fixed floor diffused ultra-fine bubble diffusers. The effluent box from each Aeration Tank would include provisions for foam and scum wasting along with a foam control spray header to mitigate foam prior to the Final Clarifiers.

- **Anoxic Selector Zones**: Anoxic selector zones and/or staged zones to allow process control of organisms to provide a selection effect to maximize an environment to favor well settling organisms will be included. Each anoxic zone will require dedicated mixing provisions. Internal Nitrate recycle pumping will also be included to transport Nitrate to the Anoxic zones for Denitrification to allow for oxygen recovery and recovery of Alkalinity.

- **De-Oxygenation Zone**: A dedicated De-Oxygenation Zone to allow removal of elevated residual dissolved oxygen from internal nitrate recycle pumping at the back end of each aeration train will be included.

- **Distribution Box #3 Upgrades (Area #27)**: Distribution Box #3 will be upgraded with new self-contained manual slide gates. In addition, the hydraulics of the Distribution Box would be modified to allow for a top overflow weir to ensure even flow split between all four Final Clarifiers. The hydraulic modifications would alleviate any chance of Final Clarifier #3 experiencing more flow due to its elevation being several inches lower than the other three Final Clarifiers.

- **Final Clarifiers**: Each of the Final Clarifiers would be upgraded with Density Current baffle systems to improve settling performance. Final Clarifier #4 would be upgraded completely due to its age.

- **RAS Pumping System**: A new dedicated RAS wet well and RAS Pumping System would be implemented. Provisions would be included to allow for chlorination of the RAS flow for process control as needed.

- **Tank Drain Pumps**: A tank drain pump system is proposed to allow draining of the Aeration Tanks and also to allow provisions to transfer MLSS to different tanks.

### 3.9 Electrical & Controls Upgrades

The existing Electrical Distribution System, MCC, Transformers, Panelboards and Control Panels in the Bio-Filter Complex are also all proposed to be upgraded as a part of this alternative. These upgrades are necessary to accommodate the new process equipment and electrical loads which are required for the alternative.

### 3.10 Short-Listed Alternatives Summary Comparison

All three of the short-listed treatment alternatives have both “common” and unique systems and components. These systems are listed in the following sections of this report. The unique components of each alternative have been discussed in previous sections of this report. The following sections also outline process equipment and systems in a direct comparison between the three short-listed alternatives. A capital and life cycle cost analysis was also conducted to screen the three alternatives from a cost perspective.
### Table 3-23 Short-Listed Alternatives Summary Comparison

<table>
<thead>
<tr>
<th>Alternatives Evaluation Criteria</th>
<th>Biological Treatment Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MBR</td>
</tr>
<tr>
<td>Aerobic Solids Retention Time (SRT)</td>
<td>8</td>
</tr>
<tr>
<td>Mixed Liquor Concentration (mg/L)</td>
<td>8,000</td>
</tr>
<tr>
<td>Aerobic Treatment Reactors</td>
<td>4</td>
</tr>
<tr>
<td>Anoxic Treatment Zones Per Tank</td>
<td>4</td>
</tr>
<tr>
<td>Winter Design Temperature (°C)</td>
<td>13.4</td>
</tr>
<tr>
<td>Summer Design Temperature (°C)</td>
<td>21.8</td>
</tr>
<tr>
<td>Final Clarifiers</td>
<td>Not Used</td>
</tr>
<tr>
<td>Return Sludge Pumps</td>
<td>5</td>
</tr>
<tr>
<td>Waste Sludge Pumps</td>
<td>2</td>
</tr>
<tr>
<td>Aerobic Reactor Blowers</td>
<td>5</td>
</tr>
<tr>
<td>Air Scour Blowers</td>
<td>9</td>
</tr>
<tr>
<td>Aerobic/Anoxic Tank Drain Pumps</td>
<td>4</td>
</tr>
<tr>
<td>Biological Aeration Type</td>
<td>Fine Bubble</td>
</tr>
<tr>
<td>Anoxic Zone Mixers</td>
<td>6</td>
</tr>
<tr>
<td>Internal Nitrate Recycle Pumps (1)</td>
<td>Not Used</td>
</tr>
<tr>
<td>Waste Sludge (% Solids)</td>
<td>1.0%</td>
</tr>
<tr>
<td>Aeration Diffuser Depth (feet)</td>
<td>13</td>
</tr>
</tbody>
</table>

1. For the MBR Alternative, the RAS Pumps will provide both RAS and Nitrate recycle pumping.

### 3.11 Non-Monetary Comparison Of Alternatives

Each of the short-listed alternatives includes advantages and disadvantages associated with the treatment process along with the day-to-day operation and maintenance considerations. Discharge permit requirements are often a leading criterion in the selection of a treatment alternative however, each of the three short-listed alternatives are applicable for upgrades to the WWTP and all are capable of meeting the anticipated discharge permit requirements. Subsequent sections provide a Life Cycle Cost comparison of the three alternatives. The following table compares non-monetary factors for each of the three short listed alternatives. The following legend applies to the comparison of the three alternatives:

- (+1) = Positive Comparison Item
- (0) = Neutral Comparison Item
- (-1) = Negative Comparison Item
### Table 3-24 Non-Monetary Alternatives Comparison

<table>
<thead>
<tr>
<th>Non-Monetary Evaluation Criteria</th>
<th>Biological Treatment Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MBR</td>
</tr>
<tr>
<td>Process Complexity</td>
<td>-1</td>
</tr>
<tr>
<td>Process Upset Recovery</td>
<td>+1</td>
</tr>
<tr>
<td>Staff Operational Experience</td>
<td>-1</td>
</tr>
<tr>
<td>Energy Input</td>
<td>-1</td>
</tr>
<tr>
<td>Maintenance Requirements</td>
<td>-1</td>
</tr>
<tr>
<td>Requires Well-Settling Organisms</td>
<td>+1</td>
</tr>
<tr>
<td>May Require Future Tertiary Filtration&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>+1</td>
</tr>
<tr>
<td>Requires Final Clarifiers</td>
<td>+1</td>
</tr>
<tr>
<td>Construction &amp; Maintaining Operation of Plant</td>
<td>-1</td>
</tr>
<tr>
<td>Required Tank Construction &amp; Complexity</td>
<td>+1</td>
</tr>
<tr>
<td>Process Reliability</td>
<td>+1</td>
</tr>
<tr>
<td>Ability to Thicken Waste Sludge</td>
<td>-1</td>
</tr>
<tr>
<td>Sludge Settling</td>
<td>+1</td>
</tr>
<tr>
<td>Sludge Stability &amp; Low Production</td>
<td>+1</td>
</tr>
<tr>
<td>Footprint &amp; Tankage Required</td>
<td>+1</td>
</tr>
<tr>
<td>Amount of Mechanical Process Equipment</td>
<td>-1</td>
</tr>
<tr>
<td>Requires Influent Equalization</td>
<td>-1</td>
</tr>
<tr>
<td>Established Design &amp; Operating Parameters</td>
<td>+1</td>
</tr>
<tr>
<td>Flexibility For Future Nutrient Removal</td>
<td>+1</td>
</tr>
<tr>
<td>Historical Process Performance</td>
<td>+1</td>
</tr>
<tr>
<td>Sampling &amp; Process Control Requirements</td>
<td>+1</td>
</tr>
<tr>
<td>Level of Automation Required</td>
<td>-1</td>
</tr>
<tr>
<td>Biological Aeration Energy Requirements</td>
<td>+1</td>
</tr>
<tr>
<td>Performance Under Load Fluctuations</td>
<td>-1</td>
</tr>
<tr>
<td>Sensitivity To Preliminary Treatment</td>
<td>-1</td>
</tr>
<tr>
<td>Chemical Use Requirements</td>
<td>-1</td>
</tr>
<tr>
<td>Odor Generation Potential</td>
<td>+1</td>
</tr>
</tbody>
</table>

1. This evaluation criterion denotes if future Tertiary Filtration is likely to be required for future Total Phosphorous (TP) Removal if the TP effluent limits are lower than what is achievable utilizing enhanced biological phosphorous removal for treatment alone.

As shown in the table, the Activated Sludge with BNR alternative has a comparative advantage over the MBR and BF/AS alternatives when analyzed based on non-monetary factors.

### 3.12 Short-Listed Alternatives Life Cycle Cost Comparison

The alternatives which were previously analyzed have been considered in a systematic manner in order to identify the alternative which best meets the needs of the City in the most economical way. Consideration of both life cycle costs (LCC) and non-monetary factors such as financial, social and environmental factors have also been considered.
The LCC evaluations take into account capital costs as well as the operational costs over the design life for each alternative. Capital costs following the initial investment are also considered by accounting for the cost of replacement of short-lived assets with a design life that is shorter than the overall project basis of 20 years. In addition, the salvage value of the remaining assets at the end of the project’s 20-year period were subtracted from the initial investment and replacement cost. The net present value (NPV) of operational and maintenance costs were then added to the capital investment to arrive at a total ‘life cycle cost’. The following table provides a summary of the common factors used for evaluation of all the alternatives considered. The “real” federal discount rate has been used as noted in the table. The discount rate is the Real Federal Discount Rate as obtained from the United States Office of Management and Budget Circular A-94, Appendix C.

Construction capital cost estimates were developed by obtaining equipment component budget prices from vendors, developing cost estimates for concrete and structures directly associated with the various treatment alternatives, and via estimating cost components such as yard piping, or other supporting systems that are unique to that respective alternative. The treatment alternative cost estimates, evaluation and comparisons were conducted by sizing each process for design flows and loadings as well as the anticipated effluent limitations. Capital as well as operation and maintenance (O&M) and replacement costs for short-lived components of the alternatives were also developed for each alternative.

Table 3-25 Common Life Cycle Cost Analysis Criteria

<table>
<thead>
<tr>
<th>Common Life Cycle Cost Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity Cost ($/kWh)</td>
<td>$0.07</td>
</tr>
<tr>
<td>Discount Rate</td>
<td>1.2%</td>
</tr>
<tr>
<td>Life Cycle Period (Years)</td>
<td>20</td>
</tr>
</tbody>
</table>

All costs have been converted to present day dollars. The following formulas were used in all LCC calculations:

- \[ LCC = I + O&M - S \]

The terms in the LCC formula are defined as follows:

- \( I \): Initial Capital Investment (Construction & Non-Construction Costs)
- \( O&M \): Present Value of Annual Operation & Maintenance Costs Including Costs for Replacements Such as Membrane Plates.
- \( S \): Present Value of Salvage Costs at End of Planning Period

Annual costs were converted to present day dollars using the following formula.

- \[ P = A \left(\frac{(1+i)^n - 1}{i(1+i)^n}\right) \] or \[ P = A^*(17.69) \]

Variables in the formula are defined as follows:

- \( A \): Annual Costs (Short Lived Assets & O&M)
- \( i \): Real Federal Discount Rate
- \( n \): Planning Period (Years)
The following table provides a LCC summary of the short-listed treatment alternatives for upgrades to the WWTP. Following the initial review of the detailed short-lived alternatives analysis presented above, the City requested an additional analysis for the IFAS Treatment Alternative. It is important to note that, the initial capital costs presented in the following table represent upgrades associated with the treatment alternatives only. The costs do not reflect all of the upgrade costs at the WWTP. Total project costs are presented in subsequent sections of this Facility Plan. The initial capital costs presented include direct costs associated with the three short-listed treatment alternatives. A total project summary along with an implementation schedule is provided in subsequent chapters of this report.

Table 3-26 Treatment Alternatives Life Cycle Cost Comparison

<table>
<thead>
<tr>
<th>LCC Cost Item(4)</th>
<th>Biological Treatment Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BF/AS</td>
</tr>
<tr>
<td>Initial Capital Cost (I)(3)(5)</td>
<td>$26,004,000</td>
</tr>
<tr>
<td>Present Value of O&amp;M Costs (O&amp;M)(1)(2)</td>
<td>$8,915,000</td>
</tr>
<tr>
<td>Salvage Value (S)</td>
<td>$(2,027,000)</td>
</tr>
<tr>
<td>Total Life Cycle Cost (LCC)</td>
<td>$32,900,000</td>
</tr>
</tbody>
</table>

1. O&M Costs for the MBR alternative assumed complete replacement of membrane cartridges after years 12-15 with 20% replacement each year. This is a typical replacement interval for systems with robust fine screening and regular chemical cleaning.
2. O&M Costs for power and chemical use were based on typical future average day flow and load conditions.
3. Initial capital costs are total project costs for this portion of the upgrades only and include Construction, General Conditions, Contingency and Engineering.
4. The costs presented in the table have been rounded up to the nearest thousand for presentation purposes.

The initial capital costs for the BF/AS and CAS alternatives are comparable. This is to be expected as several of the biological components for both alternatives are essentially identical. These include the Secondary Clarifiers, RAS pumping system, WAS pumping system, Aeration Systems and Anoxic Zones. The BF/AS alternative has more building construction costs associated with the Bio-Filter towers as compared to the CAS alternative. The IFAS initial capital cost is also comparable to the BF/AS and CAS alternatives. While the IFAS alternative allows for less concrete tank construction due to reductions in aerobic tank volume, this savings is nullified by the expense of the proprietary media and other associated supporting equipment. As part of the IFAS alternative, it is highly recommended that fine screening be added to the WWTP to prevent the IFAS media retention screens from blinding or clogging. In addition, the existing ultra-fine bubble aeration system would need to be replaced for use with an IFAS system. Conversely, the CAS alternative has slightly more concrete work due to the larger tank volume requirements. The initial capital costs for the MBR alternative are the highest due to the high cost of the membrane equipment, the additional associated supporting equipment along with the supporting electrical and controls which are required.

As shown in the table the operation and maintenance costs for the MBR alternative are considerably higher than the BF/AS, CAS and IFAS alternatives. This is due to the higher annual electricity use along with added costs for membrane replacement and other short-lived assets. The MBR alternative also has a higher annual chemical usage cost when compared to the BF/AS and CAS alternatives. The O&M costs for the IFAS alternative are higher than those for BF/AS and CAS also due to higher annual electricity use, high chemical use for foam control and annual replacement of a portion of the IFAS media. The IFAS alternative aeration requirements are much higher as compared to the CAS alternative aeration requirements, resulting in larger aeration blowers and higher annual power use. The O&M costs for the BF/AS alternative are slightly higher than the CAS alternative mainly due to the increased annual energy use associated with Primary Effluent/RAS pumping to the Bio-Filter Towers as well and the annual reserve assets for replacement of the Bio-Filter media.

With regard to salvage value the BF/AS and CAS alternatives have higher residual salvage values as compared to the MBR and IFAS alternatives. This is due to the concrete tankage, splitter structures and yard piping as these
components have a usable life which exceeds the 20-year planning period. The MBR and IFAS alternatives are more equipment intensive and the associated equipment has a usable life which is closer to the 20-year planning period. The equipment components of the MBR and IFAS alternatives will have no residual salvage value at the end of the 20-year planning period.

The MBR and IFAS alternatives have the highest O&M, Capital & total LCC and are thus not recommended for further consideration. The BF/AS and CAS alternatives are comparable. Consequently, the more-subtle differences between the two processes as well as the non-monetary factors were analyzed as part of the alternative technology selection process.

3.12.1 Non-Monetary Comparison

The non-monetary factors for each of the three alternatives were previously compared and the Activated Sludge with BNR alternative was scored with (+8) while the BF/AS alternative was scored at (+3). Based on a non-monetary comparison the Activated Sludge with BNR alternative has the comparative advantage.

3.12.2 Cost of Ownership

With respect to cost of ownership for the City the Activated Sludge with BNR alternative has a lower anticipated annual O&M cost and thus also holds the comparative advantage in this regard.

3.12.3 Future Discharge Permit Requirements

As mentioned previously in this Chapter, the influent BOD loading to the WWTP is low. The existing Primary Treatment system historically removes 38% of the influent BOD. The low to medium strength influent BOD combined with additional removal in the Bio-Filters (typically an additional 50%) results in low influent BOD loading to the Aeration Tanks as part of the BF/AS alternative. In order for the anoxic zones to function properly for future TN removal, ample carbon in the form of Primary Effluent, Micro-C or another source would likely be required for this alternative. The BF/AS alternative does not provide any significant benefit for future Ammonia-Nitrogen, Total Nitrogen or Total Phosphorous Removal. With regard to future nutrient removal, the Activated Sludge with BNR alternative holds the comparative advantage.

3.12.4 Treatment Alternative Construction

The BF/AS and Activated Sludge with BNR alternatives are equivalent in many aspects of the future construction. The Activated Sludge with BNR alternative reactor consists of square and rectangular tankage with cells separated by FRP baffle walls. The BF/AS alternative includes similar concrete tankage work but also includes more complex and costly construction and upgrades to the Bio-Filter Towers and Bio-Filter Complex. The vast majority of construction for the Activated Sludge with BNR Alternative will occur adjacent to the existing treatment process without the need for significant temporary facilities. The Activated Sludge with BNR alternative has the comparative advantage with regard to construction as well as maintenance of plant operations during construction.

3.12.5 Provisions for Dual Modes of Operation

The Activated Sludge with BNR alternative can be configured to be run in several modes of operation including Step Feed and/or Contact Stabilization. These modes of operation further enhance the already strong high flow management capabilities of the Activated Sludge with BNR alternative. With regard to provisions for multiple modes of operation the Activated Sludge with BNR alternative has the comparative advantage.
3.12.6 Odors

Odor mitigation at the WWTP is a key consideration for the City. The Activated Sludge with BNR alternative consists entirely of suspended growth biological treatment which historically does not tend to generate odors. The BF/AS alternative includes the spraying of RAS and Primary Effluent into the air over the Bio-Filter Towers. Historically, these systems have a higher potential for odor and aerosol generation as compared to suspended growth treatment. With regard to odor generation the Activated Sludge with BNR alternative has the comparative advantage.

3.12.7 Future Total Phosphorous Removal

As indicated in previous sections of this report, the MDNR has indicated that Total Phosphorous removal will likely occur in the near future as an effluent limit. If the limits are very stringent, both the BF/AS and Activated Sludge with BNR alternatives may require Tertiary Filtration in conjunction with chemical and/or biological phosphorous removal to meet the anticipated permit limits. If the limits are reasonable in the 0.5 to 1 mg/L range (as is currently anticipated based on conversations with the MDNR) the Activated Sludge with BNR alternative can be converted from an MLE (Anoxic/Aerobic) process to an A²O process (Anaerobic/Anoxic/Aerobic) with relatively minor modifications related to establishment of zones with baffle walls and the delivery location of internal nitrate recycle flows. The Activated Sludge with BNR alternative holds a comparative advantage with regard to a streamlined upgrade for future TP removal. It is important to note that the TP limits which are established by the MDNR will dictate the type of treatment that is required for TP removal. If the limits are less-stringent (as is anticipated), tertiary filtration may not be required to achieve permit compliance.

It is important to note that the initial tankage volume for an A²O process could be constructed initially in conjunction with the tankage volume for the Activated Sludge with BNR process as the volume required for the anaerobic zone of the process is typically small in relation to the volume required for the anoxic or aerobic zones which are included as part of the process. With the total required tank volume in place initially, future upgrades for TP removal would likely be less intensive.

3.12.8 Future Total Nitrogen Removal

As indicated in previous sections of this report, the MDNR has indicated that Total Nitrogen removal will likely occur as a future effluent limit. The MDNR has indicated that they anticipate the limits will be reasonable and in the 10 mg/L range for TN removal. The MDNR has also indicated that TP removal will occur before TN removal. The Activated Sludge with BNR alternative with an A²O configuration previously described can provide TN removal to concentrations as low as 8 mg/L. The BF/AS alternative can’t provide future TN removal to these limits. With regard to streamlined upgrades for future TN removal the Activated Sludge with BNR alternative holds the comparative advantage.

3.13 Recommended Treatment Alternative

The BF/AS and Activated Sludge with BNR alternatives are comparable in many ways, including life cycle cost. However, the Activated Sludge with BNR alternative in an MLE configuration provides several advantages with respect to up-front capital cost, cost of ownership, facility layout, future expansion, provisions for future biological phosphorous removal, provisions for future TN removal, wet weather flexibility, constructability and odors. Therefore, the Activated Sludge with BNR alternative; with nitrogen management provisions (MLE), provisions for step feed or contact stabilization modes of operation, and a future conversion to an A²O process is the recommended treatment alternative.
3.14 Streamlining Future Nutrient Removal Upgrades

As mentioned, the Activated Sludge with BNR alternative in an MLE configuration for Ammonia-Nitrogen removal can be converted in a streamlined manner to an A²O treatment process to achieve Enhanced Biological Phosphorous Removal (EBPR) and TN removal. To achieve EBPR an Anaerobic Zone is needed ahead of the Anoxic Zone which was previously presented in the Activated Sludge with BNR alternative in an MLE configuration. The Anaerobic Zone volume is typically small as compared to the overall biological treatment tankage volume as it is typically designed for a Hydraulic Retention Time (HRT) of 0.5 to 1 hour. This results in an Anaerobic Zone volume of approximately 0.21 MG. In total the Anaerobic Zone represents approximately 4 to 7% of the total volume required for the A²O treatment process.

To streamline for future TP and TN removal it is recommended that the initial tank construction include the required volume for the addition of a future Anaerobic Zone. Including this initial tankage construction as part of the upgrades for Ammonia-Nitrogen removal will allow for a far more streamlined plant upgrade in the future for TP and TN removal. The additional tankage construction is anticipated to add approximately 1 to 2% to the additional up-front construction cost above what is required for Ammonia-Nitrogen removal only. It is recommended that this tankage be constructed initially as part of the upgrades for Ammonia-Nitrogen Removal. The volume which will be dedicated to the Anaerobic Zone in the future can be used for additional Anoxic or Aerobic zone volume initially.

3.14.1 Future A²O Treatment Process Upgrades

The following provides a listing of recommended upgrades for the future conversion to an A²O treatment process. The recommended upgrades and the associated costs assume that the required treatment tankage volume for the Anaerobic Treatment zones is built into the Activated Sludge with BNR with MLE alternative for Ammonia-Nitrogen removal.

- **Baffle Walls:** New and modified baffle wall configuration to allow for an Anaerobic Zone and an Anoxic Zone prior to the Aerobic Zone.
- **Anaerobic Zone Mixer:** Dedicated mixers for the Anaerobic Zones.
- **Anaerobic Zone Carbon Source:** Dedicated supplemental carbon source for Anaerobic Zone (e.g. Acetic Acid) storage tanks, secondary spill containment, metering pumps, piping, valves, a small heated building and related appurtenances. As part of future Preliminary Design it is recommended that consideration also be given to construction of an off-line sludge fermentation tank to provide a readily biodegradable carbon source (Volatile Fatty Acids) in lieu of a chemical carbon source. The final determination of the carbon source is recommended to be determined as part of a future Preliminary Design.
- **Anoxic Zone Carbon Source:** Dedicated supplemental carbon source for Anoxic Zone, storage tanks, secondary spill containment, metering pumps, piping, valves, a small heated building and related appurtenances. It was assumed that the building would be shared with the storage area for supplemental anaerobic zone carbon chemical.
- **Chemical Coagulant System:** Provisions for chemical coagulant addition as needed to supplement and backup the biological phosphorous removal system with a chemical phosphorous removal system. The system would include dedicated chemical storage tanks, secondary spill containment, metering pumps, piping, valves, a small heated building and related appurtenances. It was assumed that the building would be shared with the storage area for supplemental carbon chemical.
- Fire Protection System: It was assumed that a fire protection system would be required for the chemical storage and feed building due to the volume of stored chemical. The final fire protection requirements are recommended to be determined as part of future Preliminary Design.

- Internal Nitrate Recycle Modifications: Modifications to the delivery piping for the Internal Nitrate Recycle Pump and piping systems.
4. PROPOSED PROJECT

Chapter 4 includes a summary of key considerations for the Proposed Project as a whole. The proposed project includes the conversion of the current WWTP BF/AS treatment process into an Activated Sludge with BNR Treatment Process. The proposed project also includes the elimination of the hydraulic capacity bottleneck of the existing effluent pumping system via a new high flow discharge to Peruque Creek. The following sections of this Chapter include key consideration and requirements for the project as indicted in the MDNR PUB 2416.

4.1 Project Scope & Organization

For the treatment process and other elements included in the scope of the project, the existing conditions and design criteria are discussed and organized by the building and unit process key numbering shown in Figure 4-1.

4.2 Flow Diagram

Figure 4-2 shows the proposed project flow diagram with the planned upgrades and conversion to an Activated Sludge with BNR Treatment Process. In addition, a proposed piping layout is included in Figure 4-3.

4.3 Preliminary Hydraulic Profile

Preliminary design drawings, including a preliminary hydraulic profile are included in Appendix G.

4.4 Existing Conditions

An Existing Conditions Report which discusses current equipment condition and operation throughout the entire WWTP can be found in Appendix I. Additional details of specifics surrounding unit processes and other supporting trade work which are part of the proposed project are discussed in subsequent chapters of this report.

4.5 Site Evaluation

The proposed upgrades are located on land that is already owned by the city. The expansion will not take place in the location of any other present or future land use. No significant additional noise is expected as part of the upgrades. New construction includes new biological treatment tanks and high-flow treated effluent infrastructure, neither of which is typically of high generation potential for odors. Existing sludge disposal and infrastructure will be reused and is not included in this project. Non-aerated lagoons are not included in this project. Zoning restrictions are not anticipated, and existing land use will remain the same and is all City owned land.

4.6 Noise

The proposed project will not have any appreciable noise generation. The expansion site already includes an existing WWTP and the existing site/land use will not be changed as part of the proposed project. The WWTP will be designed with noise mitigation and sound attenuating enclosures on all equipment as necessary depending upon the final design of the facilities. If blasting is required during construction, notice of when blasting activities will occur will be given to local residents prior to the commencement of work. It is currently not anticipated that any significant blasting will be required as part of the proposed project. The completed project will not have any noticeable adverse effects on noise levels in the area.
BUILDING & UNIT PROCESS KEY
1: Equalization Tank #1
2: Equalization Tank #2
3: North Lift Station
4: Headworks Building
5: Grit Tank
6: Old Headworks
7: Distribution Box # 1
8: Primary Clarifier # 1
9: Primary Clarifier # 2
10: Primary Clarifier # 3
11: Primary Clarifier # 4
12: Junction Box # 4
13: Junction Box # 1
14: Primary Sludge Pump Station # 1
15: Primary Sludge Pump Station # 2
16: Bio-Filter Complex
17: RAS/WAS Wet Well
18: RAS/WAS Dry Pit (Alternative)
19: Aeration Blower Building
20: Aeration Splitter Box
21: WAS Valve Vault
22: BNR Tank # 1
23: BNR Tank # 2
24: BNR Tank # 3
25: BNR Tank # 4
26: UV Disinfection System
27: Distribution Box # 3
28: Final Clarifier # 1
29: Final Clarifier # 2
30: Final Clarifier # 3
31: Final Clarifier # 4
32: Junction Box # 3
33: Effluent Control Structure
34: Effluent Pump Station
35: Gravity Bypass Valve Vault
36: Old Chlorine Building
37: Process Water Pump Station
38: Septage Receiving Station
39: Parshall Flume
40: WAS Holding Tank
41: Sludge Blend Tank
42: Bio-Solids Treatment Building
43: Bio-Solids Storage Building
44: BFP Feed Pump Station
45: GBT Feed Pump Station
46: Sludge Blower Building
47: Garage
48: Main Office Building
49: Old UV Building
50: Odor Control Carbon Filter
51: High Flow Discharge Pump Station
52: Re-aeration System
53: High Flow Discharge Outfall

FIGURE 4-1
CITY OF O'FALLON, MISSOURI
WWTP FACILITY PLAN
PROPOSED UPGRADES - LOCATION KEY

SCALE: 1" = 100'
DATE: June 2018
SOURCE: ESRI & O’Fallon, MO
PROJECT #: 228868.04
4.7 Air Quality

Temporary dust and vehicle emissions may result from construction activities associated with the proposed project. Any disturbances due to construction activities will be short in duration, and the ambient air quality will return to preconstruction quality once the project is complete. Provisions for dust control to minimize any impacts to air quality will be included in the project’s construction Contract Documents. Contractors will be required to perform pavement sweeping and use water, calcium chloride, or other methods to control dust during construction of the proposed project. No permanent air quality impacts are anticipated as part of the proposed project.

4.8 Sludge Processing & Disposal

The existing permitted sludge disposal practice will continue to be conducted by the City. The proposed project will continue to meet compliance with the City’s current permitting requirements for Class A biosolids.

4.9 Site Separation to Abutters

The existing WWTP site is located on a dedicated lot in an area which is separated from dense areas of habitation in the City. The existing site location provides a buffer to residences on all sides. The existing site separation and buffers will not be reduced by the proposed project. None of the proposed treatment alternatives will have a negative effect or reduction in the site separation to abutters. The proposed alternative requires additional tankage that will be constructed on City-owned land.

4.10 Zoning & Land Use

The existing site currently contains a WWTP, and the land use will not change as a part of the proposed project. Construction of the new equipment does not impact any wetlands or geological features. A previously identified archaeological site in the area of the proposed biological treatment system upgrades has been mitigated and a Clearance Letter from the MDNR can be found in the Appendix B.

4.11 Site Accessibility & Topography

The existing WWTP site has existing all weather road to allow access to the WWTP. The road will be reused as part of the proposed project. The existing road is in good condition and is suitable for all the proposed upgrades. The existing topography of the WWTP site is well suited for the proposed project. The site consists of relatively flat land with even topography. The site does not contain a large forested area and significant clearing and grubbing is not anticipated as part of the proposed project. The following figure shows the general topographical and feature map of the site.

4.12 Technology Not Included in 10 CSR 20-8

The proposed project does not include any new treatment technologies which have not been previously established or used in the State of Missouri.
4.13 Future Expansion Area

Areas for future WWTP expansion have been identified for the proposed design. The existing WWTP site has ample land area to allow provisions for future facility expansion. Possible future expansions of the treatment plant include expanded aeration tanks and tertiary filtration are identified in the figure below. Additional provisions for future expansion will be included as part of the detailed design process.
4.14 **Direction of Prevailing Wind**

The direction of the prevailing wind in the project area of the State of Missouri is predominantly blowing from the South and heading towards the North. This information was obtained from the University of Missouri Extension Commercial Agriculture Program including a wind rose for St. Louis Lambert International Airport which can be found in Appendix C.

4.15 **Geologic Information**

Previous geotechnical information from record drawings of the existing WWTP site was reviewed in conjunction with the geologic considerations of the facility planning process. In addition, a geotechnical investigation was conducted as part of the planning for this project. A geotechnical evaluation of the site was conducted by Geotechnology, Inc.

Based on the conducted geotechnical report, soil stratigraphy generally consists of alluvial deposits of lean clay and clay underlain by sand. The consistency of cohesive materials varies from soft to very stiff and the density of the sand varies from loose to very dense. Auger refusal was not encountered in 25-foot deep borings. Refusal was encountered in one Cone Penetrometer (CPT) sounding at a depth of 77 feet below grade. Groundwater was observed between 19 and 27 feet below grade. Additional details of the geotechnical report including mitigation recommendations can be found in Appendix D of this report. No earthen basin structures are included as part of this project. A new tanks and liquid containment structures will be reinforced concrete.

As indicated in the Geotechnical Report. The existing site contains soils which are susceptible to consolidation and settlement. An additional challenge is the liquefaction potential of the existing soils during a seismic event. Mitigation measures such as stone columns (aggregate piers) and earthquake drains are currently being evaluated for incorporation into the design to mitigate these site conditions for all new tanks and structures which are proposed for this project.
4.16 Groundwater Protection

The proposed project will protect groundwater including public and private wells. No public or private wells are known to be on the land which will be used as a part of the proposed project. The proposed project will also reuse the existing O’Fallon WWTP site, and the project work will not encroach on any drinking water sources or water facilities. Peruque Creek is not a Drinking Water Supply source.

All the wastewater treatment unit processes will be conducted in water-tight tanks and piping systems. Pipes and tanks will be operated with test water prior to full operation with wastewater. No contamination of the existing groundwater is anticipated from the proposed project.

Best Management Practices (BMPs), including temporary sedimentation and erosion control methods, will be used to minimize potential impacts to ground water and surface water quality during construction. Proper excavation and dewatering procedures (if required) will also be implemented. The proposed facilities will be designed to improve the overall water quality in the area by treating municipal wastewater prior to discharge into the Mississippi River or Peruque Creek.

4.17 Field Tile

No existing field tile is known to be on the proposed project site location.

4.18 Outfall Access

Outfall access to Peruque Creek has been shown on the following figure. An existing access road is adjacent to the outfall and will allow access to the outfall location. The existing Mississippi River outfall will continue to be reused as part of the proposed project and the existing access provisions will continue to be reused.

Figure 4-6 Outfall Access
4.19 Floodplain

The WWTP is located adjacent to Peruque Creek. Base Flood Elevations were obtained from FEMA Map 29183C0230G, Panel 230 of 525, dated January 20, 2016. The base flood elevations are referenced from North American Vertical Datum (NAVD) 1988. Construction of Aeration Tanks, the Aeration Splitter Box and the High Flow Discharge system to Peruque Creek will take place in the floodplain. The new structures within the floodplain have been approved by the City's Floodplain Administrator and all process and electrical equipment will be designed accordingly and will be located at least 3-feet above the base flood elevation. All structures will be designed for associated flood forces and provisions will be included to ensure anti-floatation as well. The facility will remain operational and accessible during a 25-year flood and new structures, electrical, and mechanical equipment will be protected from damage during a 100-year flood.
1% Annual Chance Flood Hazard
Regulatory Floodway
Special Floodway
Area of Undetermined Flood Hazard
0.2% Annual Chance Flood Hazard

FEMA's National Flood Hazard Layer (Official)
Data from Flood Insurance Rate Maps (FIRMs) where available digitally. New NFHL FIRMette Print app available: http://tinurl.com/j4xwp5e

CITY OF O'FALLON, MISSOURI
FEMA FLOODPLAIN MAP
WWTP FACILITY PLAN

APPROXIMATE ELEVATION: 443 ft.
APPROXIMATE ELEVATION: 446 ft.
4.21 Geohydrologic Evaluation

A Geohydrologic Evaluation was conducted as part of the Antidegradation Evaluation for the discharge to Peruque Creek. Peruque Creek is a Class P gaining stream. A copy of the full MDNR WQAR and the MDNR Geohydrologic Evaluation can be found in Appendix E and Appendix F respectively.

4.22 208B Plans

The City of O’Fallon does not have a water quality management plan under Section 208b.

4.23 Environmental Review

The proposed project is intended to improve environmental impact through improved wastewater treatment. As previously stated, the WQAR can be found in Appendix E of this document. New unit processes will be constructed on land already owned by the WWTP and will not be constructed in wetlands or other environmentally sensitive areas. Potential environmental impacts from construction activities and any impacts that cannot be avoided will be mitigated. A previously identified archeological site is located in the proposed area of construction. This area has been mitigated and reviewed and cleared by the Missouri State Historic Preservation Office. The clearance letter can be found in the Appendix B of this document. A National Heritage Review was also conducted as part of the Antidegradation Evaluation and a copy of the findings is included in Appendix E.
5. TREATMENT PROCESS

The purpose of Chapter 5 is to document Treatment Process elements which are included in the scope of the project, the existing conditions and design criteria and considerations are discussed and organized by the building and unit process key numbering previously described in Chapter 4. Preliminary design drawings are included in Appendix H. The objective of the process design for the WWTP upgrades is to accommodate the treatment performance required to meet the permit requirements while also meeting the City’s budget for construction.

5.1 Area #1 – Influent Equalization Tank #1

Equalization Tank #1 is a large, open-topped, oval-shaped, concrete basin. The structure consists of a flat concrete slab-on-grade floor with flatly sloped slab-on-grade sidewalls creating a trapezoidal cross section in any direction. There are multiple pipe penetrations through the sloped sidewalls at various locations. The outlet of the tank is located in the center sump and consists of a 16-inch drain line which runs to the Effluent Flow Control Manhole at the South edge bank of the Tank. The Tank has a 36-inch plant effluent overflow pipe at the Northwest corner which connects to the Effluent Control Structure (Area #33). The West side of the tank includes three overflow pipes which are connected to the influent force mains which deliver flow to the WWTP Headworks (Area #4). Valve vaults are located just to the West of the Equalization Tank and include electrically operated control valves which can divert a portion of the influent flow to the Equalization Tank. The Northeast end of the tank has a 12-inch filtrate return pipe which can be used to equalize dewatering filtrate if desired. Equalization Tank #1 has a volume of approximately 3.13 MG. The following figure provides a photo of Equalization Tank #1.

Figure 5-1 Influent Equalization Tank #1

5.1.1 Influent Equalization Tank #1 Upgrades Summary

No Treatment Process related upgrades are included in this project for Equalization Tank #1. The capacity of the existing tank (3.13 MG) combined with the capacity of Equalization Tank #2 (4.65 MG) are sufficient to accommodate the design peak hour flows to the WWTP which are included as part of this project.
5.2  Area #2 – Influent Equalization Tank #2

Equalization Tank #2 a large, open-topped, oval-shaped, earthen basin. The structure consists of an earthen basin with a flat center and flatly sloped sidewalls creating a trapezoidal cross section in any direction. This tank has a continuous membrane liner with welded seams. There are multiple pipe penetrations through the sloped sidewalls at various locations, which are wrapped and sealed with the membrane. The piping to the West side of the tank is the overflow from Equalization Tank #1. The piping in the center sump is a 16-inch drain line which runs to Effluent Flow Control Manhole #2 at the South edge of the Tank. Equalization Tank #2 has a volume of approximately 4.65 MG. The following figure provides a photo of Equalization Tank #2.

![Equalization Tank #2](image)

5.2.1 Equalization Tank #2 – Upgrades Summary

No Treatment Process related upgrades are included in this project for Equalization Tank #2. The capacity of Equalization Tank #1 (3.13 MG) combined with the capacity of Equalization Tank #2 (4.65 MG) are sufficient to accommodate the design peak hour flows to the WWTP which are included as part of this project.

5.3  Area #4 – Headworks Building

The Headworks Building and associated unit processes provide preliminary treatment of the influent flow at the O'Fallon WWTP. The Headworks Building was constructed in 1998 in conjunction with upgrades to the Biosolids processing facilities at the WWTP and has remained largely unchanged since its initial construction. The Headworks Building includes the is the Meter Room, Screen Room, Grit Room, and Electrical Room. The Headworks building is shown in the figure below. Specific upgrades are discussed for each room within the existing building in the following sections:
5.3.1 Screen Room

The existing influent screen and wash press located in the Screen Room are in good condition and have adequate hydraulic capacity to accommodate the peak design flow of 16.5 MGD and the peak instantaneous flow of 19.9 MGD. The table below summarizes the design criteria for the existing screening equipment.

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influent Screen Quantity</td>
<td>1</td>
</tr>
<tr>
<td>Screen Bypass Channel</td>
<td>Yes – With Bar Rack</td>
</tr>
<tr>
<td>Type</td>
<td>Mechanical Bar Screen</td>
</tr>
<tr>
<td>Rated Hydraulic Capacity</td>
<td>25 MGD</td>
</tr>
<tr>
<td>Screen Bar Spacing</td>
<td>¼-Inch</td>
</tr>
<tr>
<td>Screen Motor</td>
<td>1 hp</td>
</tr>
<tr>
<td>Wash Press Quantity</td>
<td>1</td>
</tr>
<tr>
<td>Wash Press Motor</td>
<td>¾ hp</td>
</tr>
<tr>
<td>Wash Press Discharge</td>
<td>Wheeled 4 CY Dumpster</td>
</tr>
</tbody>
</table>

Odors, moisture and corrosive sewer gasses are a problem in the Screen Room. In colder months the screen room develops frosting on the equipment due to the current setup and ventilation. An odor control connection is currently in place in the existing screen room, but this system is currently ineffective in mitigating sewer gasses as the connection is to the entire room and fights with the room’s HVAC system.

5.3.2 Screen Room Upgrades Summary

The following upgrades are proposed for the Screen Room:

- Selective Demolition of existing grating, safety rails, covers and supports on both influent channels
- Installation of new sealed aluminum cover system specifically designed for odor control
- Extend the existing FRP odor control duct to direct connections to the covers and the influent screen
- Work in partnership with the existing influent screen and wash-press manufacturer to provide a bagging attachment on the wash-press discharge to mitigate odors.

5.3.3 Meter Room Upgrades Summary

The Meter Room includes three influent force mains, each with an in-line magnetic flow meter that measures the total flow to the WWTP. All flow is pumped to the WWTP from the North Lift Station, West Lift Station and New East Lift Station. The existing force mains and flow meters will be reused as part of the proposed project and all have sufficient capacity for the proposed upgrades. No process upgrades in the Meter Room are included as part of this project.

5.3.4 Grit Room Upgrades Summary

The Grit Room includes a Grit Washer and Grit Blower and allows access to the Electrical Room. Grit separated from the wastewater stream is collected in a dumpster and removed for offsite disposal. No process upgrades in the Grit Room are included as part of this project.

5.4 Area #5 – Grit Tank

Screened influent flow exits the Headworks Building and flows by gravity to the grit removal process. The grit removal process consists of an influent channel, an uncovered, aerated Grit Tank, and a bypass channel. The grit tank is a separate structure located adjacent to the Headworks Building and is shown in the figure below.

![Figure 5-4 Grit Tank](image)

The bypass channel includes a dedicated isolation slide gate. Influent composite sampling is also conducted in the grit tank influent channel downstream of the Headworks Building. The following table provides a summary of the existing Grit Tank and equipment.
Table 5-2  Existing Grit Processing Equipment Design Criteria

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grit Tank Volume</td>
<td>81,800 gallons</td>
</tr>
<tr>
<td>Rated Hydraulic Capacity</td>
<td>20 MGD</td>
</tr>
<tr>
<td>Grit Tank Blower Quantity</td>
<td>1</td>
</tr>
<tr>
<td>Grit Tank Blower Motor</td>
<td>20 hp</td>
</tr>
<tr>
<td>Grit Dewatering Screws</td>
<td>1</td>
</tr>
<tr>
<td>Type</td>
<td>Dewatering Screw</td>
</tr>
<tr>
<td>Screw Diameter</td>
<td>9-Inch</td>
</tr>
<tr>
<td>Operating Speed</td>
<td>20 rpm</td>
</tr>
<tr>
<td>Grit Dewatering Screw Motor</td>
<td>¾ hp</td>
</tr>
</tbody>
</table>

The existing grit removal system has sufficient hydraulic capacity to accommodate the peak design flow of 16.5 MGD, and the maximum peak instantaneous flow of 19.9 MGD.

5.4.1 Grit Tank Upgrades Summary

No upgrades to the Grit Tank process are included in the scope of this project. The existing Influent Sampler will also be reused as part of this project.

5.5 Area #6 – Old Headworks

The Old Headworks (Screen Chamber) is located downstream of the Grit Tank and includes a below grade vault and channels containing equipment and related appurtenances, all of which are out of service. Currently, flow from the Grit Tank enters the northeast side of the Old Headworks on the downstream side of the channels. Effluent from the Old Headworks then flows via gravity through a 36-inch pipe to Distribution Box #1. The following figure shows the Old Headworks.

Figure 5-5  Old Headworks
The existing flow structures in the Old Headworks can accommodate the peak design flow.

5.5.1 Old Headworks Upgrades Summary

The following Treatment Process related upgrades will be included:

- Demolition of the existing influent screen, bar rack and comminutor
- Demolish wood shed and odor control fan
- Demolish piping, valves and supports in existing valve vault
- Demolish sunken concrete sidewalk sections and replace with new sections
- Provide blind flanges on all abandoned piping segments
- New Aluminum flat panel covers for odor control will be added for use with a future odor control system

5.6 Area #7 – Distribution Box #1

Distribution Box #1 is a concrete structure used to split the flow to the Primary Clarifiers. Flow enters Distribution Box #1 in the center via a 36-inch pipe and flow is distributed peripherally outward to the four Primary Clarifiers via effluent boxes. Each of the four effluent boxes contains a manual isolation slide gate to allow flow control to the Primary Clarifiers. Distribution Box #1 is shown in the following figure.

![Figure 5-6 Distribution Box #1](image)

5.6.1 Distribution Box #1 Upgrades Summary

The following upgrades are proposed for Distribution Box #1:

- Existing manual slide gates will be demolished, and new mill aluminum gates will be installed
• New Aluminum weir plates will be added to ensure an even flow split between all four Primary Clarifiers
• New flat panel aluminum covers for odor control
• Structural modifications as indicated in subsequent chapters

5.7 Areas #8-11 – Primary Clarifiers 1-4

Four Primary Clarifiers provide separation of suspended solids and floatables including scum, grease and oils at the WWTP. The Primary Clarifiers reduce the influent BOD and TSS prior to the downstream biological treatment processes. Flow from Distribution Box #1 is transported to each of the four Primary Clarifiers via four separate dedicated pipes. The Primary Clarifiers are center feed type with a 75-foot diameter and an outboard launder as shown in the following figure.

Figure 5-7 Primary Clarifiers

Settled primary sludge is collected and transported to a center sump via scraper blades on the clarifier mechanism arms. Primary sludge is withdrawn via dedicated 8-inch pipes from each clarifier. Primary scum is withdrawn through a rotating full radius scum trough that includes an electric actuator mounted to the full-radius access bridge of each Primary Clarifier. Each Primary Clarifier includes a trip counter for scum trough operation. The rake arms of each Primary Clarifier include a ducking skimmer. The following table provides a summary of the existing characteristics of the Primary Clarifiers at the WWTP:
### Table 5-3  Existing Primary Clarifier Design Criteria

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Clarifiers</td>
<td>4</td>
</tr>
<tr>
<td>Type</td>
<td>Circular</td>
</tr>
<tr>
<td>Feed</td>
<td>Center Feed</td>
</tr>
<tr>
<td>Launder</td>
<td>Outboard</td>
</tr>
<tr>
<td>Diameter</td>
<td>75-feet</td>
</tr>
<tr>
<td>Units Operating</td>
<td>All-4</td>
</tr>
<tr>
<td>Scum Beach Type</td>
<td>Full Radius</td>
</tr>
<tr>
<td>Skimmer Type</td>
<td>Ducking</td>
</tr>
<tr>
<td>Access Bridge</td>
<td>Radius</td>
</tr>
<tr>
<td>Primary Clarifier Drive Motor</td>
<td>1 hp</td>
</tr>
<tr>
<td>Scum Collector Motor</td>
<td>½ hp</td>
</tr>
<tr>
<td>Total Primary Clarifier Volume</td>
<td>132,200 gallons</td>
</tr>
<tr>
<td>Total Primary Clarifier Surface Area</td>
<td>17,668 ft²</td>
</tr>
<tr>
<td>Total Primary Clarifier Weir Length</td>
<td>944-linear feet</td>
</tr>
<tr>
<td>MDNR Average Design SOR</td>
<td>1,000 gpd/ft²</td>
</tr>
<tr>
<td>Operating Average Day SOR</td>
<td>637 gpd/ft²</td>
</tr>
<tr>
<td>MDNR Design Peak SOR</td>
<td>1,500 gpd/ft²</td>
</tr>
<tr>
<td>Operating Peak SOR</td>
<td>934 gpd/ft²</td>
</tr>
</tbody>
</table>

The Primary Clarifiers currently have adequate capacity for the design peak flow and existing permitted flow. The average day and peak MDNR SOR requirements are met as part of this project.

#### 5.7.1 Primary Clarifiers Upgrades Summary

No treatment process upgrades are included to the Primary Clarifiers in this project.

#### 5.8  Area #12 – Junction Box 4

Primary effluent from Primary Clarifiers #3 and #4 flows by gravity to Junction Box #4, which is a rectangular concrete structure. The following figure shows Junction Box #4.
5.8.1 Junction Box #4 Upgrades Summary

No treatment process related upgrades will occur to Junction Box #4 as part of this project.

5.9 Area #13 – Junction Box 1

Junction Box #1, shown in the following figure, is a rectangular concrete structure which accepts primary effluent flow from Junction Box #4, Primary Clarifier #1 and Primary Clarifier #2. Primary Effluent composite sampling also occurs from Junction Box #1.

5.9.1 Junction Box #1 Upgrades Summary

No treatment process related upgrades will occur to Junction Box #1 as part of this project. The existing Primary Effluent Sampler will be reused as part of the project.
5.10 Area #16 – Bio-Filter Complex

Primary effluent from Junction Box #1 flows by gravity to a wet well located at the top of the Bio-Filter Complex. The Bio-Filter Complex is comprised of multiple components discussed in the following sections, including the Primary Effluent Wet Well, Bio-Filter Towers, and Bio-Filter Building. In addition to housing process equipment, power is distributed from the Bio-Filter Complex to a significant portion of the WWTP. The following is a photo of the existing Bio-Filter Complex.

Figure 5-10 Existing Bio-Filter Complex

The biological treatment process will be converted to an activated sludge process with biological nutrient removal, and the project includes decommissioning and selective demolition of some Bio-Filter Complex components. The Bio-Filters and related equipment will no longer be used. Primary effluent will be pumped from the existing wet-well directly to the new Aeration Tank Splitter Box using the existing Bio-Filter Feed Pumps. From this point forward in this Facility Plan these pumps will be referred to as Primary Effluent Pumps. Electrical systems within the complex will be upgraded. Bio-Filter Complex structures, equipment, and related appurtenances will be altered as described in the following sections.

5.10.1 Primary Effluent Wet Well

Primary Effluent from Distribution Box #1 mixes with Return Activated Sludge (RAS) from the Final Clarifiers in the Primary Effluent Wet Well (old Bio-Filter Feed Pump Wet Well). The following piping systems are currently connected to the wet well.

- 36-inch ductile iron primary effluent pipe from the Primary Clarifiers
- Four 16-inch ductile iron RAS pipes from each Final Clarifier
- 18-inch ductile iron Bio-Filter effluent recycle from Distribution Box #2. The pipe is currently not used regularly by the City.
- 14-inch RAS line to the Bio-Filter common effluent channel
- 8-Inch WAS from the RAS Box.
Four submersible Bio-Filter Feed pumps with variable speed control are in the Bio-Filter Feed Pump Wet Well and pump the mixed flow to an upper level wet well located at the top of the Bio-Filters. These pumps replaced the original screw pumps as part of two past upgrade projects. The following is a photo of the Bio-Filter Feed Pump Wet Well.

![Bio-Filter Feed Pump Wet Well](image)

In addition, a submersible centrifugal RAS pump is in the RAS influent chamber upstream of the Wet Well seen at the far end in this photograph by the access stairs. The RAS pump discharges to the common effluent channel below Bio-Filter #1. This pump allows for RAS to by-pass the Bio-Filters and the wet well if desired.

### 5.10.2 Primary Effluent Wet Well Upgrades Summary

The existing wet-well will be re-purposed to pump primary effluent to the new Aeration Tank Splitter Box; RAS and Bio-Filter Effluent will no longer be recycled to the same wet well. The four (4) submersible centrifugal Bio-Filter feed pumps will be re-purposed to supply flow directly to a new Aeration Tank Splitter Box. New isolation valves and check valves will be added to the four existing discharge lines, which will connect into one new force main with an in-line magnetic flow meter. A portion of the new force main will be located above grade, following the wall of the Bio-Filter Complex to avoid underground piping and electrical ducts that must remain in place. The piping will then be routed underground through the yard before entering the new Aeration Tank Splitter Box. Design criteria for the existing Bio-Filter feed pumps that will be repurposed as Primary Effluent Pumps are summarized in the table below.

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Effluent Pumps</td>
<td>4-Total</td>
</tr>
<tr>
<td>Redundancy Provided</td>
<td>100% - 3-Duty &amp; 1 Standby</td>
</tr>
<tr>
<td>Pump Type</td>
<td>Submersible Centrifugal Non-Clog</td>
</tr>
<tr>
<td>Motor Size</td>
<td>85 hp</td>
</tr>
<tr>
<td>Motor Type</td>
<td>Variable Speed</td>
</tr>
<tr>
<td>Pump Capacity (Each)</td>
<td>5,400 gpm</td>
</tr>
<tr>
<td>Existing Discharge Head</td>
<td>48.5 ft H₂O</td>
</tr>
<tr>
<td>New Discharge Head</td>
<td>23 ft H₂O-Approximate</td>
</tr>
<tr>
<td>Total Peak Pumping Capacity</td>
<td>23.3 MGD</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Xylem - Flygt</td>
</tr>
</tbody>
</table>
The new design flow and head conditions have been reviewed in conjunction with existing pump performance curves and the existing pumps can be reused to pump Primary Effluent to the new Aeration Splitter Box instead of their current discharge to the Bio-Filter towers. The following table provides a summary of the existing RAS pump located in the RAS box just upstream of the Primary Effluent Wet Well.

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAS Pumps</td>
<td>1</td>
</tr>
<tr>
<td>RAS Pump Type</td>
<td>Submersible Centrifugal Non-Clog</td>
</tr>
<tr>
<td>RAS Pump Motor</td>
<td>25 hp</td>
</tr>
</tbody>
</table>

The existing RAS pump will be removed, salvaged and turned over to the City as part of the proposed project. The pump will also be evaluated for possible reuse as an Aeration Tank Drain Pump, a low flow Primary Effluent Pump or other use in partnership with the City during subsequent design phases. The following upgrades are proposed:

- Demolish and cap existing Bio-Filter Recycle Pipe and all unused piping with solid ductile iron end caps or blind flanges with 304 stainless steel hardware
- Add 18-Inch Check Valves & Plug Valves to the discharge of each Primary Effluent Pump
- Add new 24-Inch common discharge force main to new Aeration Splitter Box
- New rigid grooved end ductile iron pipe and fittings with 316 stainless steel hardware
- Partially demolish existing force mains to Bio-Filter Feed Pump Wet Well
- Provide new pipe supports constructed of 304 stainless steel
- New In-Line Magnetic Flow Meter to measure Primary Effluent Pump Flow
- Prep and paint all new and existing piping
- Add foam spray system to mitigate foam and scum which may accumulate in wet well

### 5.10.3 Upper Level Feed Well

The Upper Level Wet Well is located at the top level of the Bio-Filter Complex. The structure includes four outlet boxes: one for each Bio-Tower (3-total) and one overflow box, which bypasses flow around the Bio-Filters. The following figure provides a photo of the Upper Level Feed Well.
5.10.4 Upper Level Feed Well Upgrades Summary

The following upgrades are proposed:

- Demolish existing grating and ferrous metal covers
- Add new sealed and removable aluminum cover panels
- Demolish existing stop plates
- Demolish existing odor control fan and related appurtenances

5.10.5 Bio-Filter Towers

The footprint of each of the three existing Bio-Filter Towers is approximately 48-feet by 24-feet. The towers sit on top of concrete platforms with rooms in the garage underneath. Each tower is filled with plastic media to a depth of approximately 21 feet. The flow pumped to the feed well at the top of the Bio-Towers is transported to a pipe distribution system at the top the Bio-Towers via three separate 16-inch pipes. Flow is sprayed through nozzles onto the media and flows downward through the towers where it is collected at the bottom of each tower and flows by gravity to the existing Aeration Basins through a series of junction and distribution boxes. The following figure is a photo of an existing Bio-Filter distribution and media system.
5.10.6 Bio-Filter Towers Upgrades Summary

The following upgrades are proposed:

- Existing towers, media, distribution piping, supports and related appurtenances will be completely demolished.

5.10.7 Basement

The Bio-Filter Complex Basement includes the waste activated sludge (WAS) wet well and a dry pit pump gallery consisting of three vertical centrifugal Sludge Recirculation Pumps and two progressive-cavity WAS Pumps. The three Sludge Recirculation Pumps currently recycle mixed liquor within the four Aeration Tanks via a common 30-inch suction header and a 24-inch force main back to the aeration tanks. The WAS Pumps pump flow from the WAS Wet Well through a common force main to the WAS Holding Tank. Primary Sludge from Primary Clarifier #1 and #2 can be directed to the WAS Wet Well via a valve manifold located in the Basement if desired. An existing flume with an ultrasonic level sensor located outdoors adjacent to the building measures WAS. This flume will remain as part of the project for WAS flow measurement. The following figure is a photo of the existing Sludge Recirculation Pumps located in the Basement area of the Bio-Filter Complex.
5.10.8 Basement Upgrades Summary

The three existing recirculation pumps will remain and can be reused with a larger motor to serve as RAS pumps in the new BNR activated sludge process. The new proposed design conditions have been reviewed with the pump manufacturer and they have determined that the pumps can be reused and refurbished to function as RAS Pumps. The RAS pumps will recycle return activated sludge from the Secondary Clarifiers to the new Aeration Splitter Box. The two existing WAS pumps will remain and continue to operate as WAS pumps. They will pump WAS and scum from the Secondary Clarifiers to the existing Sludge Holding Tank (Area #40). Existing piping, valves, and appurtenances will be reused for both the RAS and WAS pumps. The following tables summarizes the design criteria for the existing RAS and WAS Pumps.

Table 5-6  Existing RAS/Recirculation Pump Design Criteria

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAS Pumps</td>
<td>3</td>
</tr>
<tr>
<td>RAS Pump Redundancy Provided</td>
<td>100% - 2 Duty &amp; 1 Standby</td>
</tr>
<tr>
<td>RAS Pump Manufacturer</td>
<td>Aurora Pumps (Pentair)</td>
</tr>
<tr>
<td>RAS Pump Type</td>
<td>Vertical Centrifugal Non-Clog</td>
</tr>
<tr>
<td>RAS Pump Motors (Existing)</td>
<td>50 hp</td>
</tr>
<tr>
<td>RAS Pump Motor Type (Existing)</td>
<td>Constant Speed</td>
</tr>
<tr>
<td>RAS Pump Capacity (Existing) - Each</td>
<td>3,900 gpm (5.6 MGD)</td>
</tr>
<tr>
<td>RAS Pump Design TDH (Existing)</td>
<td>41 ft H₂O</td>
</tr>
<tr>
<td>RAS Pump Motors (New)</td>
<td>60 hp</td>
</tr>
<tr>
<td>RAS Pump Motor Type (New)</td>
<td>Variable Speed</td>
</tr>
<tr>
<td>RAS Pump Capacity (New) - Each</td>
<td>4,400 gpm (6.3 MGD)</td>
</tr>
<tr>
<td>RAS Pump Design TDH (New)</td>
<td>36 ft H₂O - Approximate</td>
</tr>
<tr>
<td>RAS Capacity Provided</td>
<td>112% of Design Flow</td>
</tr>
</tbody>
</table>
Table 5-7 Existing WAS Pump Design Criteria

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAS Pumps</td>
<td>2</td>
</tr>
<tr>
<td>WAS Pump Type</td>
<td>Progressive Cavity</td>
</tr>
<tr>
<td>WAS Pump Manufacturer</td>
<td>Moyno</td>
</tr>
<tr>
<td>WAS Pump Motor</td>
<td>20 hp &amp; 40 hp</td>
</tr>
<tr>
<td>WAS Pump Motor Type</td>
<td>Constant Speed</td>
</tr>
</tbody>
</table>

The following upgrades are proposed:

- Refurbish and reuse existing Recirculation Pumps for new RAS Pumps with larger motors
- New in-line magnetic flow meter and flow meter vault in yard for RAS flow measurement
- New pressure gauges for pumps

5.10.9 Blower Room

The Blower Room is located on the third level of the Bio-Filter Complex and currently contains two existing 75-hp centrifugal turbo blowers. The blowers each have dedicated outside air intake pipes with exterior filters and supply process air to the Aeration Tanks through a common 12-inch air header. The following figure is a photo of the blowers located in the Bio-Filter Complex Blower Room.

Figure 5-15 Bio-Filter Complex – Blower Room

The following table provides a summary of the existing Turbo Blowers:
Table 5-8  Existing Aeration Turbo Blowers

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeration Blowers</td>
<td>2</td>
</tr>
<tr>
<td>Aeration Blower Type</td>
<td>Centrifugal Turbo</td>
</tr>
<tr>
<td>Aeration Blower Manufacturer #1</td>
<td>Aerzen</td>
</tr>
<tr>
<td>Aerzen Blower Capacity</td>
<td>1,350 SCFM</td>
</tr>
<tr>
<td>Aerzen Blower Discharge Pressure</td>
<td>8.6 psig</td>
</tr>
<tr>
<td>Aerzen Blower Motor Horsepower</td>
<td>75 hp</td>
</tr>
<tr>
<td>Aerzen Blower Motor Type</td>
<td>Variable Speed</td>
</tr>
<tr>
<td>Aeration Blower Manufacturer #2</td>
<td>Siemens</td>
</tr>
<tr>
<td>Siemens Blower Capacity</td>
<td>1,350 SCFM</td>
</tr>
<tr>
<td>Siemens Blower Discharge Pressure</td>
<td>8.8 psig</td>
</tr>
</tbody>
</table>

5.10.10 Blower Room Upgrades Summary

The following upgrades are proposed for the Blower Room:

- Existing Blowers including two turbo blowers and one multi-stage centrifugal blower will be removed from the room, salvaged and delivered to the City for resale.

- The existing Siemens turbo blower is not anticipated to be reused as part of the project. The City has reported issues with the communications and controls programming associated with that blower. The support from the manufacturer has also been lacking. Due to these factors and the limited number of installations and support for this model of blower, reuse is not recommended.

- The existing Aerzen Turbo Blower was evaluated for possible reuse at low air demand periods. The blower manufacturer was consulted, and the existing unit and frame cannot be upgraded with a larger core or motor for increased capacity and discharge pressure. The new Aeration Tanks will have a depth of 18-feet. Depending on the model, the new diffused aeration system will have a top of drop leg pressure of approximately 7.7 to 8.9 psig. Depending on the City’s selected model for diffused aeration, the existing Aerzen turbo blower could be reused to provide low pressure air delivery at lower flow and load conditions, possible alone or in partnership with one of the new Aeration Blowers. Min day aerobic and mixing demands range from approximately 1,100 to 1,700 SCFM and depending on the selected diffuser pressure loss the existing Aerzen Turbo blower could be a good fit to accommodate these lower air flow conditions. The manufacturer has also been consulted and this older model turbo blower can be implemented into a control system with newer centrifugal turbo blowers without issue. The final determination of the reuse of this blower will be determined during subsequent project phases as it is dependent on design basis selection for the Aeration Blower and diffused Aeration equipment.

- Existing aeration piping will be demolished in the room and outside and capped or provided with blind flanges at all wall and roof penetrations.

- Existing pipe insulation and jacket will be demolished along with piping

- Existing pipe supports will be demolished
5.10.11 Sludge Pump Room

A pumping system consisting of two, progressive-cavity, digested-sludge pumps is located in the ground level garage area below Bio-Filter #3. The piping system includes 6-inch suction and 6-inch discharge piping with a 6-inch line flush connected to the discharge piping with an electrically operated control valve. The pumps are used in emergency situations to pump sludge to an off-site storage lagoon in the event of an emergency and/or issue with the Class-A biosolids processing system. The storage lagoon and piping system are still connected, and the staff have indicated the lagoons can still be used in the event of an emergency or shut down associated with the Class-A Biosolids Processing System. The following figure is a photo of the Sludge Pump Room.

**Figure 5-16 Bio-Filter Complex Sludge Pump Room**

The following table provides a summary of the design criteria for the existing Digested Sludge Pumps.

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sludge Pumps</td>
<td>2</td>
</tr>
<tr>
<td>Pump Type</td>
<td>Progressive Cavity</td>
</tr>
<tr>
<td>Pump Motor</td>
<td>60 hp</td>
</tr>
<tr>
<td>Pump Motor Type</td>
<td>Constant Speed</td>
</tr>
</tbody>
</table>

5.10.12 Sludge Pump Room Upgrades Summary

No treatment process upgrades in the sludge pump room are included in this project, and the existing sludge pumps will remain in service for use in emergency situations.
5.10.13 Garage

The Bio-Filter Complex Garage is located at the ground level between Bio-Tower #1 and #2. The garage area includes the main electrical service entrance to the building, an electrical room, storage room and workshop areas. The following figure is a photo of the Bio-Filter Garage Area.

![Figure 5-17 Bio-Filter Complex Garage](image)

5.10.14 Garage Upgrades Summary

No treatment process upgrades to the Garage are included in this project. The garage will continue to be used for storage and maintenance. Additional upgrades in this area are further discussed in subsequent chapters of this report.

5.10.15 Electrical Room

The Bio-Filter Complex Electrical Room is located on the second level and is accessed via the Garage. The room also provides access to other areas of the building through stairways and hatches including:

- Open stairway to the Basement
- Access hatch to the Basement located in the center of the room
- Access door to a Storage Room which contains controls
- Stairway to the upstairs Blower Room with an access hatch to the WAS wet well
- Access door to a hallway and administrative office spaces and restrooms

The following figure provides a photo of the Electrical Room.
5.10.16 Electrical Room Upgrades Summary

The electrical distribution and motor control center in this room powers a significant number of treatment processes at the WWTP. No process equipment upgrades are included in the Bio-Filter Complex Electrical Room. As will be discussed in subsequent Chapters, selective demolition and upgrades to the electrical distribution gear including the MCC, transformer, control panels, and related appurtenances are included in this upgrade project.

5.11 Existing Area #17 – Junction Box #2

Junction Box #2 is located downstream of the Bio-Filters and routes flow to Distribution Box #2 and Aeration Junction Box #5. Junction Box #2 will be demolished as part of this project. Junction Box #2 is shown on the Existing Location Key in Figure 1-3.

5.12 Existing Area #18 – Aeration Junction Box #5

Aeration Junction Box #5 is located downstream of Junction Box #2 and directs flow to Aeration Distribution Box #4. Aeration Junction Box #5 will be demolished as part of this project. Aeration Junction Box #5 is shown on the Existing Location Key in Figure 1-3.

5.13 Existing Area #19 – Distribution Box #2

Distribution Box #2 is located downstream of the Junction Box #2 and directs flow to Aeration Tank #1 and Aeration Tank #2. Distribution Box #2 will be demolished as part of this project. Distribution Box #2 is shown on the Existing Location Key in Figure 1-3.

5.14 Existing Area #20 – Aeration Distribution Box #4

Aeration Distribution Box #4 is located downstream of Aeration Junction Box #5 and directs flow to Aeration Tank #3 and Aeration Tank #4. Aeration Distribution Box #4 will be demolished as part of this project. Aeration Distribution Box #4 is shown on the Existing Location Key in Figure 1-3.
5.15 Area #17 – New RAS & WAS Wet Well

As discussed previously, the existing Recirculation Pumps and WAS pumps located in the Basement will be repurposed for use as RAS and WAS pumps. The current base design concept includes the following:

- Keeping the RAS pumps (old Recirculation Pumps) in their current location in the Basement of the Bio-Filter Complex but with refurbishments for increased capacity, a larger motor and variable speed control.
- Retrofitting a portion of Existing Aeration Tank #2 into a new RAS and WAS Wet Well
- Connecting each of the four existing 16-inch RAS lines from the Final Clarifiers into this new Wet Well
- Connecting a new pipe from the existing gravity WAS line to the new Wet Well.
- Using the existing aeration tank recirculation suction line for the RAS pumps in the Basement. Connections of this suction line to the other Aeration Tanks will be capped.
- Installing a new RAS force main to the new splitter box and BNR tanks. A connection point for chlorine addition will be furnished for intermittent use to control filamentous bacteria growth in the mixed liquor.
- Installing a new RAS Flow Meter Vault in the yard to measure real time RAS flow. This will allow RAS to be paced directly off of the Primary Effluent Flow as measured by the Primary Effluent Flow Meter.
- Continue using the WAS pumping system, including the existing suction line with the automatically-actuated valve, parshall flume, pumps and pipeline to the WAS Holding Tank.
- Reuse the existing WAS Pumps in the Basement of the Bio-Filter Complex

The following figure shows the location of the proposed RAS/WAS System located in the old Aeration Tanks. The base project costs presented in Chapter 13 include costs associated with this base project alternative.

Figure 5-19 Proposed RAS/WAS System Location
5.15.1 RAS & WAS Pumping System Alternatives

Several alternative configurations are possible for the RAS and WAS Pumping Systems. Each of the Alternatives has been described in the following sections:

- **Alternative #1:** Eliminate the new RAS wet well to be located in existing Aeration Tank #2 and install a new yard piping connection between the RAS box at the Primary Effluent Wet Well and the existing recirculation suction line from the aeration tanks to the RAS pumps in the basement. The following listing provides a summary of the advantages and disadvantages of this alternative:

  **Advantages**
  - Lowest Cost due to less construction and concrete work in Aeration Tank #2 to construct a wet well compartment. Due to the size and volume of the existing tank, use of the entire Aeration Tank for a wet well is not recommended.
  - Eliminates the need to extend the existing four, 16-inch RAS lines from the yard to the existing Aeration Tank
  - Eliminates the need for isolation gates or yard valves on these RAS Lines
  - Entire WAS system can be reused with minor modifications

  **Disadvantages**
  - Small wet well volume for pump control and pump cycling. Careful consideration will be needed with regard to pump speed control set points to prevent short cycling of pumps due to the small draw down volume.
  - Challenging yard piping installation to connect to existing sludge recirculation piping
  - No way to isolate individual RAS lines without adding buried isolation valves
  - Relies of refurbishment of the existing Recirculation Pumps and only three pumps can fit in the current location in the Basement of the Bio-Filter Complex

  Due to the small wet well volume this alternative is not recommended for detailed consideration.

- **Alternative #2:** Convert a portion of Aeration Tank #2 into a new RAS/WAS wet well and install new submersible pumps in the wet well. The following listing provides a summary of the advantages and disadvantages of this alternative:

  **Advantages**
  - Allows more room for multiple pumps as needed to best suit the RAS flow requirements. A system of small and large pumps can be used. Additionally, for separate RAS cells could be used depending on pump turndown to allow independent control of RAS from each Final Clarifier.
  - Allows ease of access by City staff with their boom truck for removal
  - Does not require HVAC upgrades to the Bio-Filter Complex Basement
Isolation valves, check valves and flow meter can be located in an adjacent Aeration Tank dry pit or vault. As this flow is constant the vault could be a non-conditioned space.

WAS Pumps can be relocated to Dry Pit or existing system can be reused entirely with minor modifications.

Disadvantages

- Higher cost due to new pumps, piping and valves
- Requires submersible pumps instead of dry pit pumps
- Requires re-routing of the existing four, 16-inch RAS lines from each Final Clarifier to Aeration Tank #2
- Requires longer wiring from either the new Blower Building or Bio-Filter Complex

Alternative #3: Convert a portion of Aeration Tank #2 into a new RAS wet well and convert Aeration Tank #1 into a below grade dry pit RAS pump gallery. The following listing provides a summary of the advantages and disadvantages of this alternative:

Advantages

- Allows more room for multiple pumps as needed to best suit the RAS flow requirements.
- Pumps, flow meter and valves are all accessible for maintenance by City staff in Dry Pit
- Pumping system can be configured such that a single pump is dedicated to each Final Clarifier. This allows for the best process and RAS control as each pump can be connected to an individual wet well cell from each Final Clarifier. This allows independent RAS flow control from each clarifier.
- Existing WAS system can be reused, or WAS pumps can be relocated to dry pit next to RAS pumps
- Pumping system can be any type of pump, horizontal centrifugal, vertical centrifugal, dry pit submersible to best suit the design conditions and the City's preferences. Existing Recirculation pumps could also be relocated to this area to provide cost savings.

Disadvantages

- Highest cost due to new pumps, piping and valves as well as HVAC equipment, access stairs and associated roof structure to make Aeration Tank #1 a dry pit.
- Requires re-routing of the existing four, 16-inch RAS lines from each Final Clarifier
- Requires longer wiring from either the new Blower Building or Bio-Filter Complex
- Requires reconnection of the existing WAS piping or new WAS piping

The following table provides a summary of up-front capital costs associated with each of the three alternatives. The costs presented in the following table are incremental costs above the base project which is to reuse the existing Recirculation Pumps as new RAS Pumps:
Table 5-10  RAS Pumping Alternative Cost Comparison

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Cost (Compared To Base Project)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative #1 – Use Existing RAS Box</td>
<td>Not Recommended</td>
</tr>
<tr>
<td>Alternative #2 – New RAS Wet Well &amp; Submersible Pumps</td>
<td>+$ 844,000</td>
</tr>
<tr>
<td>Alternative #3 – New RAS Wet Well &amp; Dry Pit Pumps</td>
<td>+$ 917,000</td>
</tr>
</tbody>
</table>

5.16  Area #19 – New Aeration Blower Building

New blowers will provide oxygen for the BNR activated sludge process. Five blowers are included in the proposed design at this time to be able to cover the range of airflows needed to deliver at peak conditions and not over-aerate during low demand periods. With the addition of BNR to the process, over-aeration not only results in expenditure of unnecessary power, but it also could interfere with treatment system performance. The blowers will be installed in a new building adjacent to the new BNR tanks as shown in the following figure.

Figure 5-20 Proposed Aeration Blower Building Location

The following table summarizes design criteria for the new BNR Aeration Blower System.

Table 5-11  New Aeration Blower Building and Equipment

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Piping</td>
<td>304L Stainless Steel</td>
</tr>
<tr>
<td>Air Main Size</td>
<td>28-Inch</td>
</tr>
<tr>
<td>Blowers</td>
<td>5</td>
</tr>
<tr>
<td>Redundancy Provided</td>
<td>100% - 4-Lead &amp; 1 Standby</td>
</tr>
<tr>
<td>Blower Type</td>
<td>See Alternatives Discussion</td>
</tr>
<tr>
<td>Air Flow Rate - Each</td>
<td>2,200 to 2,400 SCFM</td>
</tr>
<tr>
<td>Air Flow Rate – Total Peak</td>
<td>8,800 SCFM</td>
</tr>
<tr>
<td>Discharge Pressure</td>
<td>9 psig</td>
</tr>
<tr>
<td>Blower Motor hp (Each)</td>
<td>150 hp</td>
</tr>
<tr>
<td>Motor Type</td>
<td>Variable Speed</td>
</tr>
</tbody>
</table>
5.17 Aeration Blower Alternatives

Five types of aeration blowers were evaluated for this project, including:

- Multi-stage centrifugal blowers
- Single-stage centrifugal blowers with variable guide vanes
- High-speed, single stage centrifugal blowers – Turbo blowers
- Rotary lobe positive displacement blowers
- Screw compressor positive displacement blowers – Hybrid blowers

Information about each blower type is included in the following sections.

5.17.1 Alternative #1 – Multi-Stage Centrifugal Blowers

Like centrifugal pumps, centrifugal blowers move air via a spinning impeller that is directly coupled to a motor. The air is compressed as it moves through the blower, and characteristics of the impeller and motor speed determine the airflow and discharge pressure. Often, a single impeller cannot meet the pressure conditions in typical aeration tanks, so multiple impellers are used in series to supply air to the process tanks. Most multi-stage blowers have a vertically-split housing, and the footprint of multistage centrifugal blowers is comparatively large. When operating, these blowers generate high noise levels which can be mitigated by sound attenuation in rooms. The following figure shows an example of an existing Multi-Stage Centrifugal Blower at the WWTP. The O’Fallon WWTP originally had Multi-Stage Centrifugal blowers as part of the original Bio-Filter Complex Construction.

Figure 5-21 Multi-Stage Centrifugal Blower

Prior to the use of variable frequency drives (VFDs) for control, airflow through these blowers was varied using an inlet throttling valve. It is more energy efficient to use VFD to vary the speed of the blower motor to modulate the airflow,
and new installations of multistage blowers are typically installed with VFDs rather than automatically-actuated inlet throttling valves. Blower instrumentation typically includes bearing temperature and vibration monitoring.

This style of blower has been in service at wastewater treatment plants for decades and have a proven track record of dependable operation. Blower manufacturing companies have merged over time, and now Gardner Denver, which owns Hoffman and Lamson blowers, has the largest market share of multistage centrifugal blowers in the United States.

Typical O&M requirements for the blowers include bearing lubrication and air filter changes. Typical turndown of multistage centrifugal blowers is limited to approximately 50%.

### 5.17.2 Alternative #2 – Single Stage Centrifugal Blowlers-Variable Guide Vanes

Single-stage centrifugal blowers with variable guide vanes are centrifugal blowers with a single impeller. The blowers operate at a constant speed, and airflow is modulated using an integral gear reducer. Mechanically-operated inlet guide vanes and outlet diffusors change the characteristic blower curve to maintain operation at or near its best efficiency point over the range of speeds, resulting in high energy efficiency over a range of operating conditions. The guide vanes are controlled by and are mechanically connected to an automatic actuator. Like multi-stage centrifugal blowers, these machines generate enough noise to warrant isolation in either an indoor room with sound-attenuating insulation or dedicated enclosure. The following figure provides a photo of a typically installation.

**Figure 5-22 Single Stage Centrifugal Blowlers (Turblex)**

![Single Stage Centrifugal Blowlers (Turblex)](Photo: Howden 2017 – Turblex Blower Installation)

The advantage of these blowers over current day alternatives is that a VFD is not required to modulate the airflow of these blowers, and they are comparatively an energy efficient option. The controls for this type of blower are relatively more complex than other blowers. Blower monitoring typically includes vibration, temperature, pressure and power. Turndown of airflow is approximately 45% to 50% of capacity.

These blowers have been in service for over 25 years in the United States. Turblex was the original leading supplier of these machines. When Turblex was acquired by Siemens several years ago, the company experienced some customer service challenges but have been recently acquired by Roots-Howden, another company with a long history in the blower market. A new company Next-Turbo has been gaining market share in the United States recently.
Typical O&M requirements for the blowers include lubrication for the bearings and air filter changes. Manufacturers typically offer a service contract for preventive maintenance. Blower disassembly for inspection and repairs is recommended every 18,000 hours and can take several days.

Single-stage centrifugal blowers with variable guide vanes are relatively more expensive on a capital cost basis than multi-stage centrifugal blowers and rotary lobe blowers. However, they are more energy efficient and can be a lower-cost alternative on a life-cycle cost basis for medium to large-sized installation.

5.17.3 Alternative #3 – High Speed Centrifugal Turbo Blowers

Turbo blowers are high-speed centrifugal blowers that operate at rotation speeds greater than 20,000 Revolutions Per Minute (RPM). The impeller uses either magnetic or air bearings, reducing friction at high speeds. Of the alternatives evaluated, turbo blowers are the newest centrifugal-style blower on the market. They gained rapid popularity about a decade ago due to the opportunity to save energy as compared to more traditional multi-stage centrifugal or rotary lobe blowers. The O’Fallon WWTP has two existing turbo blowers which are manufactured by Aerzen and Siemens.

The turbo blowers are typically supplied as a package with the blower, motor, VFD, and local control system enclosed in a sound-attenuating enclosure. When running, the noise levels near the enclosures are typically less than 85 decibels, which is attractive to many owners. However, during startup and shutdown, a blow off valve may be opened, and the rush of air is quite loud. The following figure shows a typical example of a turbo blower.

![Figure 5-23 Centrifugal Turbo Blower (APG Neuros)](image)

Turbo blowers are typically installed indoors with an upstream air filter. Particulates, including dust and pollen, can damage the blower core. Because the VFD and local PLC are integral to the blower package, adequate temperature control in the room is required. For larger units, an auxiliary cooling system may also be supplied with the blowers.

Like other centrifugal-style blowers, a characteristic minimum flow must be exceeded to remain above surge conditions, which is a condition in which airflow surges through the distribution system and can result in damage to the blower. This characteristic of the turbo blower results in lower turndown capabilities as compared to equivalent positive displacement alternatives. Typical turndown is 50% but can be even less if the blower is operating at the upper end of its discharge pressure range.
Airflow is modulated by the VFD, which typically requires a harmonic filter. The motors are permanent magnet type. While no oil lubrication is required, the blower package is supplied with instrumentation to monitor pressure, speed, and vibration, temperature and to protect the blower core.

Several companies have entered the turbo blower market. Some of the original manufacturers were acquired by existing blower companies. APG Neuros has the majority of the market share in the United States for air bearing turbo blowers. Other air bearing companies with over 100 installations include Aerzen (formerly K-turbo) and Atlas Copco (formerly HSI). Companies with more than thirty installations that manufacture turbo blowers with magnetic bearings include ABS and Atlas Copco. There are several other companies with small but growing lists of installations that manufacture turbo blowers.

Turbo blowers are advantageous from an energy efficiency standpoint, require minimal day-to-day maintenance, are quiet, and typically have a smaller footprint than other blower types. However, the when major service is required, the repairs cannot typically be done by WWTP staff or local contractors. Often, a representative from the manufacturer is required for service, and parts may need to be shipped back to the factory. Turbo blowers are typically relatively expensive from a capital cost standpoint but can be very competitive when life cycle energy costs are considered. However, because they have only been in operation for just over a decade, the long-term reliability of turbo blowers is still unknown, and it is more difficult to quantify replacement and significant repair costs in life cycle cost analysis.

5.17.4 Alternative #5 – Positive Displacement Rotary Lobe Blowers

A rotary lobe blower is a positive displacement type machine that uses lobe rotors with close tolerances to move air through the machine. As the rotors turn, air is moved out of the blower, through the air supply piping, and out of the diffusers at the bottom of the process tanks. For aeration applications at WWTPs, tri-lobe blowers are often utilized because they have a higher efficiency than the older-style dual lobe blowers. The following figure depicts typical tri-lobes.

![Figure 5-24 Rotary Tri-Lobes](image)

Like centrifugal blowers, rotary lobe blowers create enough noise to warrant isolation in a separate interior room or a dedicated sound enclosure. They are often supplied with relatively large silencers on the intake and discharge. The blowers can be located inside or outside, and it is becoming more common to house rotary lobe blowers with the motor, belt drive and related accessories and instrumentation within a sound-attenuating enclosure, even if they are being installed inside a building. The following figure shows several positive displacement blowers installed within a conditioned room with individual sound attenuating enclosures.
Each revolution of the lobes displaces an equal amount of air, and VFDs are used control airflow for these blowers. The VFDs are typically not included within the blower enclosures. The blowers can operate over a relatively wide range of system pressures. Instrumentation typically includes temperature and pressure gages. Rotary lobe blowers offer a relatively large turndown to 40%.

Rotary lobe blowers are a very mature technology and have been in service for decades in the United States. There are many manufacturers of rotary lobe blowers, several with hundreds and thousands of blowers in operation, including Howden-Roots, Aerzen, and Kaiser.

Typical O&M requirements for the blowers include belt replacements, annual oil changes, and air filter changes. Bearing and seals may require replacement after 15-20 years of operation. In addition, regular inspection for hot spots, vibration changes and operating temperatures and pressures are recommended.

Rotary lobe blowers are typically an economical choice from a capital cost standpoint. However, they are one of the least energy efficient blower alternatives. They are commonly selected for small to medium sized systems with capacities less than 15,000-cfm and pressure up to 15-psig (and higher is some cases).

5.17.5 Hybrid Blowers

Screw compressors are positive displacement-type blowers. The hybrid blower evaluated for this project is a hybrid between the rotary lobe blower and a screw compressor. Unlike the rotary lobe blower, the rotors in a hybrid blower are twisted and the air is compressed as it passes along the axis of the rotors. This offers the benefits of lower energy consumption and a higher operating pressure range than available with a rotary lobe blower. The following figure depicts the lobes.
Hybrid blowers are typically supplied with a sound-attenuating enclosure that contains the blower, motor, belt drive, inlet silencer, and related accessories and instrumentation. The blowers can be located inside or outside. The following figure provides an example of a sound enclosure.

Similar to the more traditional rotary lobe blowers, the hybrid blowers offer a relatively large turndown to 40%. O&M requirements are also similar to rotary lobe blowers. Hybrid blowers for WWTPs have been on the market for about a decade but are based on very mature technology. The leading manufacturer for hybrid blowers is Aerzen, but others, including Atlas Copco, also make energy-efficient screw compressors. The development of hybrid blowers was driven by the need to improve energy efficiency, and hybrid blowers are being installed in an increasing number of WWTPs across the United States.

5.17.6 Aeration Blower Design Criteria

Because of operator familiarity with Turbo blowers at the O’Fallon WWTP and the energy efficiency benefits, the preliminary blower design concept and current project cost estimate is based on turbo blowers. Five blowers are included in the proposed design to be able to cover the range of airflows needed to deliver at peak conditions and not...
over-aerate during low demand periods. With the addition of BNR to the process, over-aeration could interfere with treatment system performance. Based on anticipated input from the City staff on diffuser and blower preferences, the selected blower type and design criteria will be modified, and the size and number of blowers in the system will be optimized as part of a follow up Technical Memo in partnership with City staff and their specific preferences for these equipment selections.

5.18 Area #20 – New Aeration Splitter Box

A new Aeration Splitter Box will be constructed adjacent to the new aeration tanks for the BNR activated sludge process as shown on the following figure. The Aeration Splitter Box will be partially below grade and largely above grade and accessed from grade via access stairs. Pumped Primary Effluent and RAS will mix in the box. Overflow weirs and manually-operated mill aluminum isolation gates will be provided to distribute the flow evenly as it exits the splitter box. Pipes from each effluent chamber of the splitter box will carry the flow by gravity from the Aeration Tank Splitter Box to the new Activated Sludge with BNR treatment process. All flow from the new Aeration Splitter box to the existing Effluent Pump Station will flow by gravity as part of the proposed project. Design criteria are summarized in the following table along with a figure showing the proposed location.

![Figure 5-28 Aeration Splitter Box Proposed Location](image)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Weirs-RAS &amp; Primary Influent</td>
<td>4</td>
</tr>
<tr>
<td>Number of Weirs-RAS Influent Alone</td>
<td>4 – Used for High Flow Mode</td>
</tr>
<tr>
<td>Number of Weirs-Step Feed-Primary Influent</td>
<td>4 - Used for High Flow Mode</td>
</tr>
<tr>
<td>Weir Type</td>
<td>Rectangular With End Contractions</td>
</tr>
<tr>
<td>Weir Length</td>
<td>5-feet</td>
</tr>
<tr>
<td>Number of Gates</td>
<td>12-Total</td>
</tr>
<tr>
<td>Gate Type</td>
<td>Self-Contained Aluminum Slide Gates</td>
</tr>
<tr>
<td>Gate Operator Type</td>
<td>Manual Hand Crank</td>
</tr>
</tbody>
</table>
As shown in the table above, the splitter box will include multiple gates and flow paths to allow combined or independent delivery of RAS and Primary Effluent to the biological treatment system. This splitter box configuration allows provisions for dual mode of operation and a chance to Step Feed or Contact Stabilization as desired by the City during high flow conditions. The manual gates include provisions to attach a drill driver to open and close the gates.

5.19 Area #21 – WAS Valve Vault

The existing WAS Valve Vault is located to the West of the Bio-Filter Complex and it is a below-grade concrete structure. The valve vault contains an 8-Inch electrically operated plug valve which allows wasting of secondary WAS. Sludge currently flows via gravity from the RAS box of the Primary Effluent Wet Well through the vault to a WAS wet well in the Basement of the Bio-Filter Complex. The electrically operated control valve actuator is located above grade outside the valve vault and controls the WAS flow rate to the WAS wet well. The flow rate is set by operators and the valve adjusts position based on the flow rate through an existing dedicated parshall flume downstream of this structure. The following shows a photo of the WAS Valve Vault area.

Figure 5-29 WAS Valve Vault

5.19.1 WAS Valve Vault Upgrades Summary

No process upgrades are included as part of this project and the WAS Valve Vault system will be reused. Miscellaneous structural upgrades to allow for improved access and safety are discussed in subsequent Chapters.

5.20 Existing Area #22-25 – Aeration Tanks

The WWTP has four existing Aeration Tanks. Currently influent enters each Aeration Tank from Distribution Box #2 or via Aeration Distribution Box #4 at the North end of the tank and exits from the South end. The North end of each tank includes a recirculated sludge suction line and a recirculated sludge discharge line. The recirculated sludge suction and discharge lines each connect to a common 24-inch recirculated sludge suction line and discharge line which both run to the Basement of the Bio-Filter Complex to the existing Recirculation Pumps (repurposed as RAS Pumps as part of this project).

Low pressure air is delivered to the tank at the South end via a shared 12-inch line for all tanks. All existing Aeration tanks operate with ultra-fine bubble panel-type diffused aeration systems. The Sludge Recirculation Piping also provides seven horizontal diffuser ports for mixing and mixed liquor distribution in each tank. The following figure provides a photo of the Aeration Tanks.
Figure 5-30 Existing Aeration Tanks

5.20.1 Existing Aeration Tanks Upgrades Summary

The following upgrades are proposed for the existing Aeration Tanks:

- All existing piping supports and valves that are not reused will be demolished and capped at walls with ductile iron blind flanges.

- Existing Dissolved Oxygen probes, transmitter and related appurtenances will be removed, salvaged and reused in the new BNR treatment system.

- Existing ultra-fine bubble panel diffuser systems and associated appurtenances will be demolished. The City conducted a recent investigation into the condition of the existing panel diffusers and several have been found to be torn. Given the current condition these existing panels are not being reused as part of the proposed project.

5.21 Area #22-25 – New BNR Tanks

This project will include four BNR tanks, as shown in the following figure. The activated sludge system with BNR is designed to operate in a Modified Ludzak-Ettinger (MLE) type configuration with flexibility for future process modifications to treat for Total Nitrogen and Total Phosphorous. Each tank will have four staged anoxic selector zones with mechanical mixing and aerobic zones with ultra-fine bubble fixed floor diffused aeration. Each tank will also include high flow modes of operation such as step-feed for peak wet weather management. The back end of each tank will also include nitrate recycle from the aerobic zone to the anoxic zone. The Nitrate recycle will assist to manage the Nitrate loading on the Final Clarifiers while also allowing for oxygen and alkalinity recovery as part of the day-to-day treatment process.
5.22 Preliminary Aeration Tank Drawings

A preliminary rendering and 3D model of the new BNR Tanks has been included in Appendix H. The rendering is taken from Highway 79 and shows the anticipated tank wall height above grade as viewed from the road.

5.23 New BNR Tank Anoxic Zones

Anoxic Zones will be constructed to promote the growth of microorganisms with good settling characteristics via selection and to allow for Denitrification. In each BNR Tank, the anoxic treatment volume will be subdivided into four zones separated with fiberglass baffles, each with its own dedicated mixer. During typical operation, flow from the Aeration Tank Splitter Box will proceed sequentially through the anoxic zones. Nitrate recycle flow from the end of the aerobic zone will be mixed with the flow from the Splitter Box as it enters the first zone of the anoxic stage. Design criteria for the anoxic zones and mixing equipment are summarized in the following table.
### Table 5-13 Anoxic Zone Design Criteria

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Anoxic Treatment Trains</td>
<td>4</td>
</tr>
<tr>
<td>Number of Anoxic Zones per Train</td>
<td>4</td>
</tr>
<tr>
<td>Total Anoxic Zone Dimension per Train</td>
<td>30-feet Wide x 128-feet Long x 18-feet Deep</td>
</tr>
<tr>
<td>Total Anoxic Volume – All Trains</td>
<td>2 MG</td>
</tr>
<tr>
<td>Total Anoxic Volume per Train</td>
<td>0.53 MG</td>
</tr>
<tr>
<td>Anoxic Zone #1 - Dimensions per Train</td>
<td>30-feet Wide x 11.5-feet Long x 18-feet Deep</td>
</tr>
<tr>
<td>Anoxic Zone #1 - Volume per Train</td>
<td>46,450 gallons</td>
</tr>
<tr>
<td>Anoxic Zone #1 – Total Volume All Trains</td>
<td>185,800 gallons</td>
</tr>
<tr>
<td>Anoxic Zone #1 – Mixer</td>
<td>3 hp</td>
</tr>
<tr>
<td>Anoxic Zone #1 – Mixer Type</td>
<td>Floating</td>
</tr>
<tr>
<td>Anoxic Zone #2 - Dimensions per Train</td>
<td>30-feet Wide x 23-feet Long x 18-feet Deep</td>
</tr>
<tr>
<td>Anoxic Zone #2 - Volume per Train</td>
<td>92,900 gallons</td>
</tr>
<tr>
<td>Anoxic Zone #2 – Total Volume All Trains</td>
<td>0.37 MG</td>
</tr>
<tr>
<td>Anoxic Zone #2 – Mixer</td>
<td>5 hp</td>
</tr>
<tr>
<td>Anoxic Zone #2 – Mixer Type</td>
<td>Floating</td>
</tr>
<tr>
<td>Anoxic Zone #3 - Dimensions per Train</td>
<td>30-feet Wide x 45-feet Long x 18-feet Deep</td>
</tr>
<tr>
<td>Anoxic Zone #3 - Volume per Train</td>
<td>0.18 MG</td>
</tr>
<tr>
<td>Anoxic Zone #3 – Total Volume All Trains</td>
<td>0.72 MG</td>
</tr>
<tr>
<td>Anoxic Zone #3 – Mixer</td>
<td>7.5 hp</td>
</tr>
<tr>
<td>Anoxic Zone #3 – Mixer Type</td>
<td>Floating</td>
</tr>
<tr>
<td>Anoxic Zone #4 - Dimensions per Train</td>
<td>30-feet Wide x 49-feet Long x 18-feet Deep</td>
</tr>
<tr>
<td>Anoxic Zone #4 - Volume per Train</td>
<td>0.19 MG</td>
</tr>
<tr>
<td>Anoxic Zone #4 – Total Volume All Trains</td>
<td>0.76 MG</td>
</tr>
<tr>
<td>Anoxic Zone #4 – Mixer</td>
<td>7.5 hp</td>
</tr>
<tr>
<td>Anoxic Zone #4 – Mixer Type</td>
<td>Floating</td>
</tr>
<tr>
<td>Hydraulic Retention Time</td>
<td>4 to 4.5 hr @ 11.25 MGD Design Flow</td>
</tr>
<tr>
<td>Number of Mixers, per Train</td>
<td>4</td>
</tr>
<tr>
<td>Number of Mixers, Total</td>
<td>16</td>
</tr>
<tr>
<td>Mixer Manufacturers</td>
<td>Aqua-Aerobic Systems, Inc. &amp; Siemens (Evoqua)</td>
</tr>
</tbody>
</table>

The Anoxic Zones in each treatment train have been oversized intentionally to allow for future addition of an Anaerobic Zone to facilitate Enhanced Biological Phosphorous Removal (EBPR).

### 5.24 New BNR Tank Aerobic Zones

The Aerobic Zones will provide oxidation of organic material (BOD removal) and Ammonia removal through nitrification to meet the more stringent effluent limits. In each train, the aerobic stage will have four aerobic aeration zones, each with its own dedicated air drop leg from the main header pipe for that respective BNR Tank. Design criteria for the aerobic zones are summarized in the following table.
**Table 5-14 Aerobic Zone Design Criteria**

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Design Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Aerobic SRT</td>
<td>9 days</td>
<td>Minimum – Ammonia Removal</td>
</tr>
<tr>
<td>Design MLSS Concentration</td>
<td>3,000 mg/L</td>
<td>Typical Range 2,000 to 5,000 mg/L</td>
</tr>
<tr>
<td>Influent VSS Fraction</td>
<td>85%</td>
<td>Based on Plant Operating Data</td>
</tr>
<tr>
<td>Influent nbVSS Fraction</td>
<td>30%</td>
<td>Assumed Value</td>
</tr>
<tr>
<td>Septage Waste Addition</td>
<td>0 gpd</td>
<td>Assumed No Septage Waste</td>
</tr>
<tr>
<td>Design Winter Temperature</td>
<td>13.4 °C</td>
<td>Based on Plant Operating Data</td>
</tr>
<tr>
<td>Design Summer Temperature</td>
<td>21.8 °C</td>
<td>Based on Plant Operating Data</td>
</tr>
<tr>
<td>Total Aerobic Volume</td>
<td>3.82 MG</td>
<td>Aerobic Volume Required</td>
</tr>
<tr>
<td>Aeration Tanks</td>
<td>4</td>
<td>Four Tanks Total</td>
</tr>
<tr>
<td>Single Tank Volume</td>
<td>0.96 MG</td>
<td>Single Aeration Tank Total Volume</td>
</tr>
<tr>
<td>Aeration Tank SWD</td>
<td>18 feet</td>
<td>Assumed Value (Typical 15 to 25 feet)</td>
</tr>
<tr>
<td>Nitrate Recycle Pumps</td>
<td>4</td>
<td>One Per Aeration Tank</td>
</tr>
<tr>
<td>Aeration Tank Drain Pumps</td>
<td>4</td>
<td>One Per Tank</td>
</tr>
<tr>
<td>Organic Loading Rate</td>
<td>40 lbs BOD$_5$/1,000 ft$^3$-day</td>
<td>MDNR Design Requirement</td>
</tr>
<tr>
<td>Operating Loading Rate</td>
<td>17 lbs BOD$_5$/1,000 ft$^3$-day</td>
<td>Actual Operating Organic Loading Rate</td>
</tr>
<tr>
<td>Food to Microorganism Ratio</td>
<td>0.2-0.5 lbs BOD$_5$/lbs MLVSS-day</td>
<td>MDNR Design Requirement</td>
</tr>
<tr>
<td>Operating F:M Ratio</td>
<td>0.2 lbs BOD$_5$/lbs MLVSS-day</td>
<td>Actual Operating F:M Ratio</td>
</tr>
<tr>
<td>Aerobic Zone Level</td>
<td>Yes</td>
<td>Pressure Transducer in Each Tank</td>
</tr>
<tr>
<td>Aerobic Zone DO</td>
<td>Yes</td>
<td>4 Probes Per Tank – One Per Zone</td>
</tr>
<tr>
<td>Aerobic Zone pH</td>
<td>Yes</td>
<td>1 Probe Per Aerobic Zone</td>
</tr>
<tr>
<td>Anoxic Zone ORP</td>
<td>To Be Determined with City</td>
<td>1 Probe Per Anoxic Zone</td>
</tr>
<tr>
<td>Aerobic Zone Ammonia</td>
<td>To Be Determined with City</td>
<td>1 Probe Per Aerobic Zone</td>
</tr>
<tr>
<td>Air Flow Measurement</td>
<td>Yes</td>
<td>1 Probe Per Aerobic Zone</td>
</tr>
<tr>
<td>Air Drop Legs</td>
<td>4 Per Tank – 6-Inch Each</td>
<td>4 Per Each Aerobic Zone</td>
</tr>
<tr>
<td>Air Drop Leg Control Valves</td>
<td>4 – Per Tank</td>
<td>Electrically Operated IRIS Valves</td>
</tr>
<tr>
<td>Aeration Control Scheme</td>
<td>Most Open Valve</td>
<td>Control Scheme – Blower Control</td>
</tr>
</tbody>
</table>

As shown in the table above the new BNR Tanks meet MDNR design requirements for Organic Loading Rate and F:M Ratio.

### 5.25 BNR Tanks - High Flow Operation

The design of the secondary treatment process incorporates flexibility to modify the operation of the system during wet weather flows to minimize the risk of overloading the secondary clarifiers with solids and causing the solids to wash out with the effluent. During normal flow conditions, primary effluent and RAS will enter the anoxic zone of the BNR tanks through a single pipe. During high flow conditions, the entry point for the primary effluent into the BNR tanks can be changed to allow all or a portion of the primary effluent to enter the tank through three (3) discharge ports in aerobic zones 1, 2, and 3. The RAS will have the ability to be delivered independently of Primary Effluent directly into the Anoxic zone to facilitate the ability to run the system in contact stabilization mode during high flow events. Additional details regarding the final configuration; either Step-Feed or Contact Stabilization will be determined in partnership with the City in subsequent phases of design in partnership with the City.
5.26 New Nitrate Recycle System

Each tank will be outfitted with a Nitrate Recycle System. The Nitrate Recycle System will include a submersible axial flow pump in a dedicated de-oxygenation zone at the end of each Aerobic Zone in each tank. The de-oxygenation zone will be separated from the Aerobic Zones via a Fiberglass Baffle Wall to prevent dissolved oxygen from being transported back to the Anoxic Zones. The Nitrate Recycle System is designed to transport Nitrate (NO$_3^-$) back to the Anoxic Zones to facilitate Denitrification and Nitrogen management in the BNR Tanks. The combination of the Nitrate Recycle System and the Anoxic Zones provides several benefits in the BNR Tanks:

- **Nitrate Load Management:** The recycle system manages the Nitrate loading on the Final Clarifiers to prevent unwanted Denitrification and sludge blanket rise in the Final Clarifiers.

- **Alkalinity Recovery:** The new BNR tanks are designed to achieve full Nitrification for Ammonia removal to meet discharge permit requirements. This process consumes Alkalinity. Denitrification (the conversion of Nitrate to Nitrogen Gas) in the Anoxic Zones recovers Alkalinity naturally without the need for supplemental chemical addition.

- **Oxygen Recovery:** The new BNR tanks are designed to achieve full Nitrification for Ammonia removal to meet discharge permit requirements. This process consumes oxygen. Denitrification (the conversion of Nitrate to Nitrogen Gas) in the Anoxic Zones recovers oxygen naturally which leads to a more efficient aeration and air delivery system for the City.

The following table provides a summary of the Nitrate Recycle System. The tank and electrical system will be designed to accommodate a second nitrate recycle pump in each tank for use as needed for future total Nitrogen removal requirements.

**Table 5-15 Nitrate Recycle Pump Design Criteria**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrate Recycle Pumps</td>
<td>4 Total &amp; 1 Per Tank</td>
</tr>
<tr>
<td>Type</td>
<td>Submersible Propeller (Axial Flow)</td>
</tr>
<tr>
<td>Pump Capacity (Each)</td>
<td>5,250 gpm (7.56 MGD)</td>
</tr>
<tr>
<td>Design TDH</td>
<td>4.3 ft H$_2$O</td>
</tr>
<tr>
<td>Pump Motor</td>
<td>20 hp</td>
</tr>
<tr>
<td>Pump Motor Type</td>
<td>Variable Speed</td>
</tr>
<tr>
<td>Pump Intake</td>
<td>End of Aerobic Zone</td>
</tr>
<tr>
<td>Outlet</td>
<td>Anoxic Selector Zone #1</td>
</tr>
<tr>
<td>Discharge Check Valve</td>
<td>Elastomer Sleeve (Duck Bill)</td>
</tr>
<tr>
<td>Nitrate Recycle Rate</td>
<td>250% of Design Flow</td>
</tr>
<tr>
<td>Pump Manufacturers</td>
<td>Flygt, ABS, Wilo</td>
</tr>
</tbody>
</table>

5.27 New Diffused Aeration System

The aerobic zones of the BNR tanks will be aerated using a fixed floor diffused aeration system to maximize energy efficiency and oxygen transfer. Several different alternatives are viable for this new system. Each of the alternatives are discussed in the following sections. The alternatives have been organized by type and a typical manufacturer to allow for a basis of comparison. The comparison includes the industry standard 9-inch membrane disc diffusers as well as newer ultra-fine bubble diffusers.
Diffused air systems are used to introduce air into the aerobic zones of the BNR process to provide oxygen for BOD oxidation and Nitrification for Ammonia removal. The systems typically introduce air bubbles into the bottom of the process tank through small orifices known as diffusers. The size of the air bubble affects the oxygen transfer efficiency of the system; the smaller the bubble, the more efficiently oxygen is transferred, resulting in lower total air requirements. Efficiency is important because the air supplied for BNR processes can account for 50% of the energy at a wastewater treatment plant.

5.27.1 Aquarius Technologies, LLC – Quantaer™ Membrane Disc Diffusers

Standard 9-inch membrane disc diffusers are widely used at wastewater treatment facilities and are currently used in the Sludge Blend Tank at the WWTP. The diffuser membranes for applications like this project are typically constructed of EPDM (Ethylene Propylene Diene Monomer) rubber and installed on PVC air supply pipe laterals as shown in the figure below. These aeration diffuser laterals are typically fixed floor systems installed at the bottom of the tanks with a center line elevation of approximately 1-foot above the tank floor.

The membranes have small slits through which the air passes, creating small bubbles (1-3 mm). Over time, these membranes become fouled by organic and inorganic deposits and the oxygen transfer efficiency decreases. The membranes then typically need to be cleaned or replaced. Replacement of the membranes requires each diffuser holder to be unscrewed, the membrane removed and replace, and the holder to be reinstalled. Standard 9-inch membrane disc diffusers are not as efficient at transferring oxygen as ultra-fine bubble diffusers. This equates to a larger air flow requirement for the Aeration Blowers and a larger energy draw. These systems are typically used at facilities of all sizes with the most being at small to mid-sized facilities.

5.27.2 Parkson Corporation – HiOX® Messner® Aeration Panels

The existing Aeration Tanks currently utilize this diffused aeration system. As mentioned in previous sections of this Chapter, the existing panels are damaged and cannot be reused. The Parkson HiOx® Messner® diffused aeration system is a proprietary panel design and an older model is currently in use at the O'Fallon WWTP. The oxygen transfer efficiency is high and the air supply to each panel can be individually isolated for maintenance or replacement. The membrane life of these panels is typically longer than standard 9-inch membrane disc diffusers and can range from 10 to 15 years. The newer design panel frames are constructed of stainless steel for durability.

The HiOX® diffused aeration system is an Ultra-Fine bubble fixed floor diffused aeration system. The system uses a frame and support base of 316 stainless steel to support a polyurethane membrane. The diffused aeration panel produces an ultra-fine bubble to efficiently transfer oxygen from compressed atmospheric air into activated sludge. The
large surface and rectangular shape provide the capability to maximize diffuser area, enhancing bubble contact and oxygen transfer efficiency. This system requires individual polyethylene air drop-leg piping to each panel.

The City currently has an older model of the Parkson panels. The newer model is 3.28-feet by 6.56-feet, roughly half the size of the older model. The smaller panels allow for more flexibility in placement and more evenly distributed aeration. The new design is also made up of strips of stainless steel that are banded together to make these panels. This allows for the membrane to stay better connected to the panel to eliminate possible tearing of the membranes as has occurred to several of the City’s existing panels. The following figure provides a photo of the HiOX® panels.

**Figure 5-33 Parkson HiOX® Aeration Panels**

5.27.3 Xylem, Inc. Sanitaire® – Gold Series Membrane Diffusers

The Sanitaire® Gold Series Membrane Diffusers are an ultra-fine bubble diffused aeration system that have a unique diffuser geometry with an advanced micro-punched membrane system. The Gold Series Diffusers are also referred to as strip type diffusers. These diffusers are designed to provide a high-density basin floor coverage and low air flux, which together provide high oxygen transfer efficiency with low energy consumptions from the Aeration Blowers. The Gold Series diffusers typically have a long service life before replacement is required. Unlike some of the larger panels these diffusers are compact and easy to install. The following figure provides a photo of a Gold Series diffuser.
5.27.4 Environmental Dynamics, Inc. – FlexAir™ MiniPanel

The Environmental Dynamics, Inc. (EDI) FlexAir™ MiniPanels are an ultra-fine bubble rounded, curvilinear fixed floor panel strip diffused aeration system. The diffuser features an exclusive top-half only perforation design. The geometry of the diffuser supports high diffuser density applications over 65% floor coverage when the highest oxygen transfer efficiency is desired. An integral triple-check valve feature prevents the backflow of liquid into the diffuser and piping. The diffuser is suited for On/Off applications and requires minimal maintenance for long-term performance. This diffuser is constructed of PVC or ABS for maximum chemical resistance and mechanical durability. The following figure provides a photo of the FlexAir™ MiniPanel.

![Figure 5-35 EDI FlexAir™ MiniPanel Diffusers](image)

5.27.5 Ovivo USA, LLC – Aerostrip® Aerators

The Aerostrip® fine pore diffuser systems are fixed floor ultra-fine bubble strip type diffused aeration systems. The diffusers are manufactured with a proprietary polyurethane membrane using a check valve perforation technique. When air is turned off pores close, and no air is released, and no backflow of mixed liquor occurs. As air is turned on, pores open simultaneously along the length of the diffuser, allowing for small bubble formation at very low air flux rates.

Conventional stainless steel drops to Schedule 40 PVC or stainless steel manifolds may be used for installation. Alternatively, high temperature-rated HDPE drops may be connected from the main air header down to a group of 4-6 diffusers in a configuration which is like the Parkson HiOX® panels. This option allows flexibility to operate (or not
operate) small groups of individual diffusers by adjusting valves at the top of the tank. The following figure provides a photo of the Aerostrip® diffusers.

Figure 5-36 Ovivo Aerostrip® Diffusers

5.27.6 Aeration Diffusers Summary Comparison

The following table provides a summary comparison of the key components of the diffused aeration systems previously discussed.

Table 5-16 Aeration Diffuser Summary Comparison

<table>
<thead>
<tr>
<th>Comparison Criteria</th>
<th>Aquarius Quantaer™</th>
<th>Parkson HiOx® Messner®</th>
<th>Sanitaire® Gold Series</th>
<th>EDI FlexAir™ MiniPanel</th>
<th>Ovivo Aerostrip®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuser Type</td>
<td>Disc</td>
<td>Panel</td>
<td>Strip</td>
<td>Strip</td>
<td>Strip</td>
</tr>
<tr>
<td>Geometry</td>
<td>Circular - Flat</td>
<td>Rectangular - Flat</td>
<td>Tubular – Flat</td>
<td>Tubular – Curved</td>
<td>Tubular -Flat</td>
</tr>
<tr>
<td>Materials</td>
<td>EPDM</td>
<td>TPU Polyurethane</td>
<td>Polyurethane</td>
<td>EPDM</td>
<td>Polyurethane</td>
</tr>
<tr>
<td>Piping &amp; Supports</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PVC lower drop leg &amp; distribution laterals</td>
<td>Stainless steel frames, isolation ball valve, and hardware</td>
<td>PVC distribution laterals</td>
<td>PVC distribution laterals</td>
<td>PVC diffuser frame &amp; manifold piping</td>
</tr>
<tr>
<td></td>
<td>Stainless steel upper drop leg, supports &amp; hardware</td>
<td>HDPE air supply hose</td>
<td>Stainless steel drop leg, supports &amp; hardware</td>
<td>Stainless steel drop leg, supports &amp; hardware</td>
<td></td>
</tr>
<tr>
<td>Total Number of</td>
<td>6,272</td>
<td>336</td>
<td>1,568</td>
<td>2,600</td>
<td>792</td>
</tr>
<tr>
<td>Diffusers¹</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOTE (%)¹</td>
<td>34%</td>
<td>37.4 - 48.13% (41-43% average)</td>
<td>40.9% - Current 38.3% - Design</td>
<td>42.5% - Current 39.1% - Design</td>
<td>44.7-46.9% Current 41.4-42.7% Design</td>
</tr>
<tr>
<td>Diffuser Submergence¹</td>
<td>17</td>
<td>17.85</td>
<td>17</td>
<td>17</td>
<td>17.75</td>
</tr>
<tr>
<td>Air Rate (SCFM)¹</td>
<td>4,800-Current 7,400-Design</td>
<td>3,800-Current 6,100-Design</td>
<td>4,000-Current 6,600-Design</td>
<td>3,800-Current 6,400-Design</td>
<td>3,700-Current 6,100-Design</td>
</tr>
<tr>
<td>Comparison Criteria</td>
<td>Aquarius Quantaer&lt;sup&gt;TM&lt;/sup&gt;</td>
<td>Parkson HiOx&lt;sup&gt;®&lt;/sup&gt; Messner&lt;sup&gt;®&lt;/sup&gt;</td>
<td>Sanitaire&lt;sup&gt;®&lt;/sup&gt; Gold Series</td>
<td>EDI FlexAir&lt;sup&gt;™&lt;/sup&gt; MiniPanel</td>
<td>Ovivo Aerostrip&lt;sup&gt;®&lt;/sup&gt;</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------------------------------</td>
<td>---------------------------------</td>
<td>------------------</td>
<td>-------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Diffuser Flux (SCFM/Diffuser)&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1.0 current 1.6 design (3-Tanks)</td>
<td>0.7 SCFM/SF Current 1.1 SCFM/SF Design</td>
<td>0.9 SCFM/SF Current 1.5 SCFM/SF Design</td>
<td>0.6 SCFM/SF Current 0.9 SCFM/SF Design</td>
<td>0.9 SCFM/SF Current 1.5 SCFM/SF Design</td>
</tr>
<tr>
<td>Max Pressure at Top of Dropleg (psig)&lt;sup&gt;1&lt;/sup&gt;</td>
<td>7.9</td>
<td>8.5</td>
<td>7.78</td>
<td>8.6</td>
<td>8.95</td>
</tr>
<tr>
<td>Typical Membrane Service Life (Years)</td>
<td>7 – 10 years</td>
<td>15 years</td>
<td>20+ years</td>
<td>7 – 10 years</td>
<td>15 – 20 years</td>
</tr>
<tr>
<td>Existing Installations</td>
<td>Industry Standard &amp; Used For Decades</td>
<td>Over 15 Years of Continuous Operation</td>
<td>Relatively New Diffuser With Installations Since 2010</td>
<td>Common With Over A Decade of Experience</td>
<td>Over 20 Years of Experience with over 1,800 Installations Worldwide &amp; 75 in USA</td>
</tr>
<tr>
<td>Installation Considerations</td>
<td>• Diffuser grids require anchor bolts to tank floor and leveling&lt;br&gt;• Fastest installation due to smaller number of diffusers and fewer anchors needed&lt;br&gt;• Requires drop pipe and valve for each panel</td>
<td>• Similar piping and support system to 9-inch fine bubble membrane&lt;br&gt;• Can be integrated with disc system (can use discs at back end of plug flow tanks where more mixing and less air is required)</td>
<td>• Similar piping and support system to 9-inch fine bubble membrane diffusers</td>
<td>• Similar piping and support system 9-inch fine bubble membrane diffusers&lt;br&gt;• Can be equipped with drop pipe &amp; valve for a group of panels if desired</td>
<td></td>
</tr>
</tbody>
</table>
### O&M Considerations

<table>
<thead>
<tr>
<th>Comparison Criteria</th>
<th>Aquarius Quantaer™</th>
<th>Parkson HiOx® Messner®</th>
<th>Sanitaire® Gold Series</th>
<th>EDI FlexAir™ MiniPanel</th>
<th>Ovivo Aerostrip®</th>
</tr>
</thead>
</table>
| ● O'Fallon staff are familiar with the technology  
● Membrane replacement effort will be significant due to number of diffusers in system  
● Purge system in drop legs to remove water entrained into distribution laterals  
● Very little space for maintenance work  
● Membrane may be damaged by UV light and freezing and should be kept covered by several inches of water when tanks are out of service | ● O'Fallon staff familiar with technology – currently in use  
● Automatically-controlled periodic flexing of panels recommended to reduce fouling  
● Have not provided satisfactory service in the past  
● Individual air feed shut-off valves provide ease of single panel isolation or airflow adjustments  
● Membrane may be damaged by UV light and freezing and should be kept covered by several inches of water when tanks are out of service | ● Frequent air bumping not needed  
● Multiple orifices from supply piping along length of diffuser which results in uniform stress and less fouling and head loss  
● Less space for maintenance work  
● Membrane may be damaged by UV light and freezing and should be kept covered by several inches of water when tanks are out of service | ● Curved membrane surface is designed to minimize solids accumulation and associated fouling  
● Membrane replacement is faster than disc diffusers  
● Membrane may be damaged by UV light and freezing and should be kept covered by several inches of water when tanks are out of service | ● Track record of minimal maintenance  
● Membrane may be damaged by UV light and freezing and should be kept covered by several inches of water when tanks are out of service |

1. The data in this table is based on design calculations and preliminary design proposals from the vendors and may change as the design concept is refined. The information presented herein is for comparative purposes.

#### 5.27.7 Aeration System Life Cycle Cost Comparison

The table below compares the present worth estimates for the diffuser alternatives, including initial capital cost, present value O&M costs, replacement cost, and salvage value. It is important to note that the capital cost presented in the following table represents aeration equipment only.
## Table 5-17 Diffuser Life Cycle Cost Comparison

<table>
<thead>
<tr>
<th>LCC Cost Item</th>
<th>Aquarius Quantaer&lt;sup&gt;TM&lt;/sup&gt;</th>
<th>Parkson HiOx&lt;sup&gt;®&lt;/sup&gt; Messner&lt;sup&gt;®&lt;/sup&gt;</th>
<th>ITT Sanitaire Gold</th>
<th>EDI FlexAir&lt;sup&gt;™&lt;/sup&gt; MiniPanel</th>
<th>Ovivo Aerostrip&lt;sup&gt;®&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Capital Cost&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>$330,000</td>
<td>$670,000</td>
<td>$680,000</td>
<td>$600,000</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Annual O&amp;M Costs&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>$160,000</td>
<td>$140,000</td>
<td>$140,000</td>
<td>$150,000</td>
<td>$150,000</td>
</tr>
<tr>
<td>Replacement Cost&lt;sup&gt;(3)&lt;/sup&gt;</td>
<td>$190,000</td>
<td>$330,000</td>
<td>-</td>
<td>$450,000</td>
<td>$ -</td>
</tr>
<tr>
<td>Salvage Value&lt;sup&gt;(4)&lt;/sup&gt;</td>
<td>$ -</td>
<td>$ (160,000)</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
</tr>
<tr>
<td>NPV LCC&lt;sup&gt;(5)&lt;/sup&gt;</td>
<td>$2.7 M</td>
<td>$2.8 M</td>
<td>$2.6 M</td>
<td>$3.1 M</td>
<td>$3.0 M</td>
</tr>
</tbody>
</table>

1. Initial Capital Cost include equipment costs based on vendor quotations received in Spring 2018, estimated installation costs, and 30% markup for contractor overhead, profit and contingency.
2. Annual O&M Costs include estimates for labor at $40/hour, estimated parts cost, and electricity at $0.07/kWh. The electrical costs include the energy anticipated to be consumed by the blowers assuming 23-25 scfm/kW and average annual conditions. An average of the estimated energy use at current and design conditions was utilized for the analysis.
3. Replacement Costs include membrane for the Aquarius Quantaer<sup>TM</sup> and EDI FlexAir<sup>™</sup> MiniPanel at 10 years and the Parkson HiOx<sup>®</sup> Messner<sup>®</sup> at 15 years. Replacement costs were estimated based on the manufacturers’ replacement cost quotes.
4. Salvage Value approximated based on the remaining anticipated service life of the equipment.
5. Total life cycle costs are based on a present worth analysis based on a 20-year planning period at and a 4% discount rate.

The present worth costs of the alternatives are equivalent and within a preliminary design range for assumptions included in comparisons such as this. The Aquarius Quantaer<sup>TM</sup> 9-inch membrane discs have the highest energy costs because they have the lowest oxygen transfer efficiency. The EDI FlexAir<sup>™</sup> MiniPanels and Ovivo Aerostrip<sup>®</sup> diffusers have a higher energy consumption due to the higher pressure drop through the diffusers for air delivery.

### 5.27.8 Diffused Aeration Recommendation

These diffuser alternatives will all meet the design requirements for the project and have similar present worth values. The recommended diffuser alternative is largely driven by non-cost factors and City staff preference. The 9-inch disc fine bubble diffusers are not recommended due to the lower oxygen transfer efficiency as well as the quantity of diffusers which will require periodic replacement. The City may also consider installing sufficient diffused aeration systems to meet the current flow and load needs with additional space for addition of more diffusers as flows and loads increase or as the need arises.

### 5.28 Area #27 – Distribution Box #3

Distribution Box #3 is an existing structure located downstream of the existing Aeration Tanks. Flow from the Aeration Tanks is transported to Distribution Box #3 via gravity through a dedicated 36-inch pipe. Flow enters Distribution Box #3 from the center and is split over four weirs into effluent boxes. Each of the four effluent boxes contains a manual isolation stop plate and a 30-inch pipe, which distributes flow to each Final Clarifier. The following figure shows the existing conditions associated with Distribution Box #3. The City staff have reported that Final Clarifier #3 is approximately 2-inches lower than the other three Final Clarifiers. Upgrades to Distribution Box #3 will include improved flow splitting capabilities to ensure even flow split between all four Final Clarifiers.
5.28.1 Distribution Box #3 Upgrades Summary

Flow from the new BNR tanks will be transported through Distribution Box #3 to the existing Final Clarifiers. A portion of the existing 36-inch Aeration Effluent piping system will be reused and connected to the effluent from the new BNR Tanks. The following upgrades are proposed for Distribution Box #3:

- Selective demolition of existing stop plates and frames
- Four new mill aluminum self-contained slide gates with manual crank operators
- New mill aluminum weir plates at each gate opening laser leveled to the same elevation to ensure even flow distribution between all four Final Clarifiers.

5.29 Areas #28-31 - Final Clarifiers #1-4

The WWTP has four existing Final Clarifiers. Each clarifier is 80 feet in diameter with a center feed and outboard effluent launder. Each clarifier has a 14-foot side water depth. Settled secondary sludge is collected and transported to a center box via eight draft tubes on the clarifier mechanism arms (four per arm). Secondary sludge is then withdrawn via a dedicated 16-inch pipe for each clarifier via gravity.

The secondary clarifiers are equipped with a full radius access bridge to the center feed column. Final Clarifier #1 also includes a dedicated scum pit which is shared with Final Clarifier #2. Final Clarifier #3 has a dedicated scum pit that is shared with Final Clarifier #4. Secondary scum is withdrawn via a partial radius scum beach. The rake arms include a partial radius scum skimmer. Each clarifier also includes fiberglass launder covers to prevent algal growth. The following figure is a photo of the Final Clarifiers.
The following table summarizes the design criteria for the existing Final Clarifiers.

### Table 5-18 Existing Final Clarifiers Design Criteria

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Clarifiers</td>
<td>4</td>
</tr>
<tr>
<td>Units Online</td>
<td>All</td>
</tr>
<tr>
<td>Type</td>
<td>Circular</td>
</tr>
<tr>
<td>Feed</td>
<td>Center Feed</td>
</tr>
<tr>
<td>Launder</td>
<td>Outboard</td>
</tr>
<tr>
<td>Diameter</td>
<td>80-feet</td>
</tr>
<tr>
<td>Scum Beach Type</td>
<td>Partial Radius</td>
</tr>
<tr>
<td>Skimmer Type</td>
<td>Surface</td>
</tr>
<tr>
<td>Access Bridge</td>
<td>Radius</td>
</tr>
<tr>
<td>Side Water Depth</td>
<td>14-feet</td>
</tr>
<tr>
<td>Influent Pipe</td>
<td>30-Inch</td>
</tr>
<tr>
<td>Effluent Pipe</td>
<td>18-Inch</td>
</tr>
<tr>
<td>Secondary Sludge Withdrawal Pipe</td>
<td>16-Inch</td>
</tr>
<tr>
<td>Sludge Removal System</td>
<td>Draft Tube</td>
</tr>
<tr>
<td>RAS Draft Tubes</td>
<td>8</td>
</tr>
<tr>
<td>Draft Tube Pipe Size</td>
<td>6-Inch</td>
</tr>
<tr>
<td>Secondary Clarifier Drive Motor</td>
<td>1 hp</td>
</tr>
<tr>
<td>Single Final Clarifier Volume</td>
<td>526,380 gallons</td>
</tr>
<tr>
<td>Single Final Clarifier Surface Area</td>
<td>5,026 ft²</td>
</tr>
<tr>
<td>Single Final Clarifier Weir Length</td>
<td>251-linear feet</td>
</tr>
<tr>
<td>Total Final Clarifier Volume</td>
<td>2,105,520 gallons</td>
</tr>
<tr>
<td>Total Final Clarifier Surface Area</td>
<td>20,104 ft²</td>
</tr>
<tr>
<td>Current Average SVI</td>
<td>108 mL/g</td>
</tr>
</tbody>
</table>

### 5.29.1 Final Clarifier Treatment Capacity Assessment

The design of Final Clarifiers is typically based on two parameters:

- Surface Overflow Rate (SOR)
- Solids Loading Rate (SLR)

The following table provides a summary of the treatment capacity evaluation for the Final Clarifiers.

**Table 5-19 Final Clarifier Treatment Capacity Evaluation**

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak SOR</td>
<td>1,200 gpd/ft²</td>
<td>MDNR Design Requirements</td>
</tr>
<tr>
<td>Peak SLR</td>
<td>40 lbs/ft²-day</td>
<td>MDNR Design Requirements</td>
</tr>
<tr>
<td>Design SVI</td>
<td>135</td>
<td>Typical Design Range 125 to 150 mL/g</td>
</tr>
<tr>
<td>Final Clarifiers Online</td>
<td>4</td>
<td>Assume All Online – All Flows</td>
</tr>
<tr>
<td>RAS Flow Required (Peak Flow)</td>
<td>80%</td>
<td>RAS Flow Required At Peak Flow</td>
</tr>
<tr>
<td>Actual Operating Peak SOR</td>
<td>836 gal/ft²-day</td>
<td>Less Than MDNR Design Requirements</td>
</tr>
<tr>
<td>Actual Operating SLR</td>
<td>37 lbs/ft²-day</td>
<td>Less Than MDNR Design Requirements</td>
</tr>
<tr>
<td>Existing Clarifier Diameter</td>
<td>80-feet</td>
<td>Existing Clarifier Diameter</td>
</tr>
<tr>
<td>Existing Clarifier Type</td>
<td>Circular</td>
<td>Circular – Draft Tube Type</td>
</tr>
<tr>
<td>Existing Launder Cover System</td>
<td>Yes</td>
<td>Control of Algal Growth in Launder</td>
</tr>
<tr>
<td>Density Current Baffles</td>
<td>Yes</td>
<td>Added for Settling Assistance &amp; Control</td>
</tr>
<tr>
<td>Existing Feed Type</td>
<td>Center</td>
<td>Center Feed – Energy Dissipating Inlet</td>
</tr>
</tbody>
</table>

As shown in the table above, the existing Final Clarifiers are appropriately sized to meet the MDNR’s typical design criteria for Surface Overflow Rate (SOR) and Solids Loading Rate (SLR) at peak flow conditions. The existing Final Clarifiers are appropriately sized for reuse as part of this upgrade.

### 5.29.2 Final Clarifier Upgrades Summary

Final Clarifiers #1 & #2 were upgraded in 2011, and Final Clarifier #3 was upgraded in 2016. As a result, refurbishment or replacement of Final Clarifiers #1-3 are not included in this project. Final Clarifier #4 has not been upgraded since original construction in 2001. The following upgrades are proposed for the Final Clarifiers:

- Refurbishment and/or replacement of selected components of Final Clarifier #4
- Addition of fiberglass Density Current Baffles to all four Final Clarifiers
- Existing fiberglass launder covers will be reused
- All existing scum pumps and associated appurtenances will be demolished and replaced with new scum pumps
- All scum pump piping, valves and supports will be replaced with new valves, piping and supports

Additional upgrades to the final clarifiers can be found in subsequent Chapters.

### 5.30 Area #32 – Junction Box #3

Junction Box #3 is a rectangular concrete structure that combines effluent flow from all four Final Clarifiers via four separate pipes. Flow exits the junction box to the UV Disinfection System or to the Effluent Flow Control Structure. The following figure provides a photo of Junction Box #3.
5.30.1 Junction Box #3 Upgrades Summary

The following upgrades are proposed for Junction Box #3:

- Selective demolition of the existing plywood cover system, grating and related appurtenances
- Installation of new sealed flat panel aluminum covers to prevent algal growth
- Relocation of the existing effluent sampler to the top of the Junction Box.

5.31 Area #26 – UV Disinfection System

In 2004 the WWTP underwent a disinfection upgrade and the means for disinfection changed from Chlorine Gas to UV Disinfection. The original UV disinfection system was an in-pipe closed vessel system. This system was replaced with an open-channel UV disinfection system in 2008. The current system includes two UV Banks positioned in series and was installed in 2008 as part of a stand-alone project. Effluent flow from Junction Box #3 flows via gravity by a 36-inch pipe into the UV Disinfection system influent box at the North end. The influent box is equipped with a dedicated manual slide gate to allow isolation of the UV channel. The UV channel is 4'-0" wide and approximately 69'-0" long at the straight run portion. The effluent end of the UV channel includes a continuous flow control gate to maintain level and submergence of the lamps in the channel. A second manual isolation slide gate is located on the downstream side of the UV channel. The following figure provides a photo of the existing UV Disinfection System.
The following table provides a summary of the existing UV Disinfection system.

**Table 5-20 Existing UV Disinfection System**

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>UV Banks</td>
<td>2</td>
</tr>
<tr>
<td>Lamps Per Bank</td>
<td>72 Lamps</td>
</tr>
<tr>
<td>Total Lamps</td>
<td>144 Lamps</td>
</tr>
<tr>
<td>Design Disinfection Capacity</td>
<td>17.5 MGD</td>
</tr>
<tr>
<td>Mounting Location</td>
<td>In-Channel</td>
</tr>
<tr>
<td>Channel Width</td>
<td>4'-0”</td>
</tr>
<tr>
<td>Channel Length</td>
<td>69'-0”</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Trojan Technologies, Inc.</td>
</tr>
<tr>
<td>Effluent Flow Control</td>
<td>Continuous Level Control Weir</td>
</tr>
<tr>
<td>Lamp Intensity Control</td>
<td>Yes</td>
</tr>
<tr>
<td>Wiper System</td>
<td>Yes - Hydraulic</td>
</tr>
<tr>
<td>Analog UV Intensity</td>
<td>Yes</td>
</tr>
<tr>
<td>Disinfection Limit – Mississippi River</td>
<td>126/100 mL (Monthly Average) E. Coli</td>
</tr>
<tr>
<td>Disinfection Limit – Mississippi River</td>
<td>630/100 mL (Weekly Average) E. Coli</td>
</tr>
<tr>
<td>Disinfection Limit – Perquie Creek</td>
<td>630/100 mL (Weekly Average) E. Coli</td>
</tr>
</tbody>
</table>

### 5.31.1 UV Disinfection System Treatment Capacity Assessment

Record documents indicate that the existing UV Disinfection System has a design disinfection capacity of 15.0 MGD. The manufacturer of the existing UV Disinfection System (Trojan Technologies, Inc.) was contacted and they confirmed that the existing two bank system can accommodate a peak flow 17.5 MGD and meet the current disinfection permit requirements without modification. The original disinfection system was also designed for a monthly average disinfection limit of 200/100 mL as a monthly average geometric mean. The manufacturer has indicated that the current
limits of 126/100 mL can be accommodated by the existing system as well. The manufacturer also indicated that the existing system can be expanded with additional lamps in the existing two bank system to disinfect up to 21 MGD. The existing system can accommodate the design flows and effluent permit requirements for disinfection which are required for both discharges.

5.31.2 UV Disinfection System Upgrades Summary

No treatment process related upgrades to the existing UV Disinfection system are included as part of this project. The existing UV disinfection system is appropriately sized for the design flows and disinfection permit limits.

5.32 Area #34 – Effluent Pump Station

The Effluent Pump Station structure consists of a below grade wet well and a below grade valve vault. The inlet pipe to the wet well is fed from either the UV Disinfection System or the Effluent Control Structure. The wet well also includes provisions for treated effluent to be discharged via gravity or be pumped to the Mississippi River. The gravity flow and pumped discharges connect to a single 30-inch effluent force main which runs approximately 6-miles to the Mississippi River. The Gravity Bypass Valve Vault (Area #35) downstream of the Effluent Pump Station contains a check valve and isolation valves to allow gravity flow.

The Effluent Pump Station wet-well includes four submersible centrifugal Effluent Pumps. The valve vault contains 14-inch discharge piping, check valves and isolation gate valves for each of the four submersible pumps along with a 24-inch common force main. The following figure is a photo of the Effluent Pump Station at ground level.

Figure 5-41 Effluent Pump Station

The following table summarizes the design criteria for the existing Effluent Pump Station.
Table 5-21 Existing Effluent Pump Station Design Criteria

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effluent Pumps</td>
<td>4</td>
</tr>
<tr>
<td>Redundancy Provided</td>
<td>100% 3 Duty &amp; 1 Standby</td>
</tr>
<tr>
<td>Pump Type</td>
<td>Submersible Centrifugal</td>
</tr>
<tr>
<td>Single Pump Capacity</td>
<td>8,000-9,000 gpm</td>
</tr>
<tr>
<td>Pump Motor</td>
<td>148 hp</td>
</tr>
<tr>
<td>Pump Motor Type</td>
<td>Variable Speed</td>
</tr>
<tr>
<td>Existing System Capacity</td>
<td>12.75 MGD</td>
</tr>
</tbody>
</table>

5.32.1 Effluent Pump Station – Treatment Capacity Assessment

The staff have indicated that currently, the capacity of the Effluent Pump Station is approximately 12.75 MGD when the Mississippi River is under flood conditions. As indicated in previous sections of this report the design peak flow to the WWTP is 16.5 MGD. During wet weather conditions the existing Effluent Pump Station does not have sufficient capacity. In the past this has led to flooding in the upstream UV disinfection channel. The proposed wet weather discharge to Peruque Creek which is included as part of this project will accommodate the excess flow which cannot be pumped to the Mississippi River by the existing Effluent Pump Station.

5.32.2 Effluent Pump Station Upgrades Summary

The following upgrades are proposed for the Effluent Pump Station:

- Replacement of 14-inch Check Valves & Isolation Valves (8-Total) in the Valve Vault with new valves
- Addition of pressure gauges to the pump discharge piping to allow for testing and troubleshooting
- Addition of an overflow weir and gravity effluent piping to the new high flow discharge wet well and pump station
- Surface preparation, prime and finished painting of all new and existing piping and supports in the Valve Vault

5.33 Area #35 – Gravity Bypass Valve Vault

The Gravity Bypass Valve Vault is a below grade structure which includes two 30-Inch plug valves and a swing check valve on the effluent pipe from the WWTP. The piping and valve system allows gravity effluent flow to the Mississippi River from the Effluent Pump Station wet well when the Mississippi River level is low. The following figure is a photo of the Gravity Bypass Valve Vault.
5.33.1 Gravity Bypass Valve Vault Upgrades Summary

No treatment upgrades to the Gravity Bypass Valve Vault are included as part of this project.

5.34 Area #36 – Old Chlorine Building

The Old Chlorine Building is located adjacent to the Old UV Building and to the south of the Final Clarifiers. The structure is a single-story building with an Electrical Room and a Chlorine Storage Room. The chlorine storage room was previously used as part of a Chlorine Gas disinfection system which is no longer in use at the WWTP. The Old Chlorine Building is a hub for electrical distribution equipment at the back end of the WWTP site. The building is fed with redundant electrical services via two exterior, pad-mounted transformers; one is owned by Ameren Missouri, and the other is owned by Cuivre River Electric Cooperative, Inc. The electrical service from the Old Chlorine Building provides power to many treatment unit processes and is critical to plant operation. The following figure provides a photo of the Old Chlorine Building.
5.34.1 Old Chlorine Building Upgrades Summary

No treatment process upgrades will occur at the Old Chlorine Building. Upgrades to electrical systems for treatment processes powered from the building will be included in this project and are further discussed in subsequent Chapters.

5.35 Area #37 – Process Water Pump Station

The Process Water Pump Station is located immediately south of Final Clarifier #2 and includes a dedicated building that houses two vertical turbine process water pumps. The pump station supplies final effluent as process water (non-potable water) to the Biosolids Treatment Building. The building sits atop a below-grade wet well. The following figure is a photo of the Process Water Pump Station.

The following table is a summary of the design criteria for the existing Process Water Pumping System.
Table 5-22 Process Water Pump System Design Criteria

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Water Pumps</td>
<td>2</td>
</tr>
<tr>
<td>Process Water Pump Type</td>
<td>Single Stage Vertical Turbine</td>
</tr>
<tr>
<td>Process Water Pump Motor</td>
<td>50 hp</td>
</tr>
<tr>
<td>Process Water Pump Motor Type</td>
<td>Variable Speed</td>
</tr>
<tr>
<td>Process Water Pump Capacity (Each)</td>
<td>450 gpm</td>
</tr>
<tr>
<td>Design TDH (Each)</td>
<td>46 ft H₂O</td>
</tr>
<tr>
<td>Pump Manufacturer</td>
<td>Fairbanks Nijhuis</td>
</tr>
</tbody>
</table>

5.35.1 Process Water Pump Station Upgrades Summary

No treatment process upgrades for the Process Water Pump Station are included in this project. Upgrades to the VFDs and electrical systems for the process water pumps are included in electrical upgrades described in subsequent Chapters. The existing pumping system has sufficient capacity to accommodate the non-potable water needs of the WWTP.

5.36 Area #46 – Blower Building

The Sludge Blower Building is a one-level structure which contains two multi-stage centrifugal aeration blowers which provide low pressure process air to the WAS Holding Tank (Area #40). The Sludge Blower Building also has motor control center for several pieces of equipment at the WWTP. The following figure is a photo of the existing Blower Building.

![Figure 5-45 Blower Building](image)

The following table summarizes the design criteria for the existing Sludge Blowers.
Table 5-23 Existing Sludge Blowers Design Criteria

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAS Tank Blowers</td>
<td>2</td>
</tr>
<tr>
<td>Blower Type</td>
<td>Multi-Stage Centrifugal</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Smith &amp; Loveless</td>
</tr>
<tr>
<td>Single Blower Capacity</td>
<td>2,400 SCFM</td>
</tr>
<tr>
<td>Total Blower Capacity</td>
<td>4,200 SCFM</td>
</tr>
<tr>
<td>Blower Motor</td>
<td>125 hp</td>
</tr>
</tbody>
</table>

5.36.1 Blower Building Upgrades Summary

The following upgrades are proposed for the Blower Building:

- Selective demolition of the existing blower air intake piping and intake air filters through the roof of the building. This piping contains lead paint as determined by a hazardous materials assessment. The existing piping will be demolished by a licensed abatement contractor.

- New air intake piping and valves routed through the side walls of the building to allow for ease of operator access to the filters

- New air intake filters and silencers

- New pipe insulation and jacket on the air intake piping to allow condensation mitigation

5.37 Area #48 – Main Office Building

The Main Office Building is used for multiple functions, including office space, restrooms, a conference area, a laboratory and garage space. The following figure is a photo of the Main Office Building.

Figure 5-46 Main Office Building
5.37.1 Main Office Building Upgrades Summary

No treatment processes upgrades are included at the Main Office Building. Upgrades to the control systems are included in the project and are discussed in subsequent Chapters of this report.

5.38 Area #49 – Old UV Building

The Old UV Building is located adjacent to the Electrical/Chlorine Building and to the south of the Final Clarifiers. This building is no longer utilized for its original purpose and serves for storage and houses electrical equipment which serves several unit processes including the Effluent Pumps and UV Disinfection System. The following figure is a photo of the Old UV Building.

Figure 5-47 Old UV Building

5.38.1 Old UV Building Upgrades Summary

No treatment process related upgrades are included as part of this project.

5.39 Area #51 – High Flow Discharge Pump Station

A new High Flow Discharge Wet Well and Pump Station will be constructed as part of this project. When the 12.75 MGD capacity of the existing Effluent Pump Station is exceeded during high-flow conditions, a new overflow weir in the existing Effluent Pump Station wet will divert flow to the High Flow Discharge Wet Well. The Wet Well will be a new structure constructed to the West of the Old UV Building.

Three new submersible pumps will be included and discharge to a common header. Each pump discharge will be outfitted with pressure indicators, isolation valves, check valves, and will share a common magnetic flow meter to measure flow discharged to Peruque Creek. Valves and dry-pit instruments will be in the basement of the Old UV Building to allow for ease of access. The piping system will discharge to a common force main to the new re-aeration system.
The following table provides a summary of the new High Flow Discharge Pump System.

**Table 5-24 High Flow Discharge Pump Station Design Criteria**

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Pumps</td>
<td>3</td>
</tr>
<tr>
<td>Redundancy Provided</td>
<td>100% - 2 Lead &amp; 1 Standby</td>
</tr>
<tr>
<td>Pump Type</td>
<td>Submersible Centrifugal Non-Clog</td>
</tr>
<tr>
<td>Pump Manufacturers</td>
<td>Flygt, ABS, Homa</td>
</tr>
<tr>
<td>Pump Motor</td>
<td>15 hp</td>
</tr>
<tr>
<td>Pump Motor Type</td>
<td>Variable Speed</td>
</tr>
<tr>
<td>Pump Capacity (Each)</td>
<td>1,570 gpm (2.26 MGD)</td>
</tr>
<tr>
<td>Pump Station Capacity (Total)</td>
<td>3,146 gpm (4.53 MGD)</td>
</tr>
<tr>
<td>Pump Discharge Force Main (Each)</td>
<td>10-Inch</td>
</tr>
<tr>
<td>Common Discharge Force Main</td>
<td>14-Inch</td>
</tr>
<tr>
<td>Flow Meter</td>
<td>In-Line Magnetic Type</td>
</tr>
</tbody>
</table>

**5.39.1 High Flow Pump Station Upgrades Summary**

The following upgrades are proposed for the High Flow Discharge Pump Station:

- New wet well and valve vault
- New submersible high flow discharge pumps
- New swing check valves and isolation plug valves
- New 304 stainless steel pipe supports
- New In-Line magnetic flow meter
- New discharge force main piping
- Concrete access road to allow for pump removal via the City’s boom truck
- Flygt Pump Lift Kits or Equal to allow for ease of pump removal

5.40 Area #52 – Cascade Aeration System

Following the High Flow Discharge Pump Station, a new Cascade Aeration system will be constructed as part of this project. The cascade reaeration system will be a physical structure only with no electrical or controls requirements. To meet the permitted effluent dissolved oxygen requirements for the high flow discharge to Peruque Creek, seven 12-inch steps are required. This results in a tank design with interior tank dimensions of approximately 20 feet long by 10 feet wide.

To achieve gravity flow into Peruque Creek when the creek is at flood elevation, the bottom step of the cascade must be at an elevation no lower than 1 foot above flood elevation. To ensure functionality at all possible creek levels the bottom step will be set to allow 3-feet of freeboard above the flood elevation. The tank top will be covered with flat panel aluminum covers to prevent algal growth. Access hatches will be included to allow for periodic maintenance, cleaning and inspection. The following figure shows an overview of the proposed location for the Cascade Reaeration System.

Figure 5-49 Cascade Aeration System
The following table provides a summary of the new Cascade Aeration System

Table 5-25 Cascade Aeration Design Criteria

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Systems</td>
<td>1</td>
</tr>
<tr>
<td>Current Plant Effluent Dissolved Oxygen</td>
<td>3.0 mg/L</td>
</tr>
<tr>
<td>Permitted Effluent Dissolved Oxygen</td>
<td>5.0 mg/L (Minimum)</td>
</tr>
<tr>
<td>Plant Minimum Water Temperature</td>
<td>12 °C</td>
</tr>
<tr>
<td>Plant Maximum Water Temperature</td>
<td>23 °C</td>
</tr>
<tr>
<td>System Design Effluent Dissolved Oxygen</td>
<td>6.0 mg/L</td>
</tr>
<tr>
<td>Bottom Step Elevation (3-Feet Flood Freeboard)</td>
<td>451.25 fasl</td>
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<tr>
<td>Top Step Elevation</td>
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<tr>
<td>Step Width (Each)</td>
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<td>Step Height (Each)</td>
<td>12-Inches</td>
</tr>
<tr>
<td>Total Number of Steps</td>
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<tr>
<td>Tank Width</td>
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<tr>
<td>Typical Design Hydraulic Loading Range</td>
<td>100,000 to 500,000 gal/ft-width-day</td>
</tr>
<tr>
<td>Design Hydraulic Loading</td>
<td>453,000 gal/ft-width-day</td>
</tr>
</tbody>
</table>

5.4.0.1 Cascade Reaeration System Upgrades Summary

The following upgrades are proposed for the new Cascade Reaeration System:

- New cast-in-place concrete structure
- Sealed aluminum covers for algal growth prevention with access hatches for cleaning and maintenance
- Flow baffles and shot rock projections to ensure air entrainment
- Fills and fillets to ensure complete draining of structure following use

5.41 Area #53 – High Flow Discharge Outfall

As shown in the previous figures a new high flow discharge outfall will be constructed to Peruque Creek. A new dedicated 24-inch PVC outfall pipe will be constructed downstream of the reaeration system to discharge treated effluent via gravity to Peruque Creek during high flow conditions.

5.41.1 High Flow Discharge Upgrades Summary

The following upgrades are proposed for the new High Flow Discharge Outfall:

- New 24-inch SDR 35 PVC outfall pipe
- New 24-inch EPDM elastomer sleeve (duck bill type) check valve at outfall pipe termination at Peruque Creek
- New 24-inch 304 stainless steel clamp or flange backing ring for elastomer sleeve check valve
- New Rip-Rap slope protection
5.42 General Operation & Maintenance Requirements

The proposed project does not require overly complex operation and maintenance requirements above the needs currently required at the existing WWTP. The laboratory requirements for the BNR activated sludge treatment process system are similar to existing process control testing which is conducted at the treatment plant currently. Testing such as BOD, TSS, mixed liquor concentration, RAS concentration, volatile solids and SVI will be required. All of these tests are currently regularly conducted, and parameters are regularly monitored by plant staff.

The existing laboratory at the treatment plant site can accommodate the typical day-to-day testing and monitoring requirements for monitoring and process control which are needed for the proposed project. Operation of the BNR activated sludge plant will be similar to the existing aeration tanks as part of the BF/AS process.

5.43 Operation & Maintenance Costs

A planning level estimate was conducted to quantify the anticipated plant operation and maintenance costs for the proposed project. The existing Sewer Plant Operations expenses were used in conjunction with planning level estimates for costs associated with the recommended BNR activated sludge alternative such as electrical power, chemical use and short-lived asset reserves. The City has adjusted user rates in anticipation of plant upgrades and has accounted for changes in operating costs. It is not anticipated that the proposed project will result in a significant change in operating expenses at the WWTP.

5.44 Treatment During Construction

Treatment during construction will be an integral component of the WWTP upgrades. The vast majority of the WWTP construction will be conducted to allow the existing WWTP to remain fully online and maintain permit compliance throughout the duration of construction. The existing facility will be maintained in continuous operation by the City at all times during the entire construction period except for periods specifically delineated within the Construction Contract Documents. The Contractor will be required to schedule and conduct work such that it will not impede any treatment process, create potential hazards to operating equipment and/or personnel, reduce the quality of the plant effluent, disrupt sludge processing operations, or cause odor or other nuisances. The following provides a brief outline to define a planning level approach to maintenance of plant operations and sequencing of construction for the proposed project in key areas. Additional details and a formal plan will be provided to the MDNR as part of the Construction Contract Document package in subsequent phases of the project. Refer to Chapter 10 for a detailed description of the proposed sequencing of upgrades for the existing electrical systems at the WWTP.

1. Area #4 - Headworks: Refer to Chapter 10 regarding a proposed sequence of construction for the Headworks equipment. During periods when power to the existing Influent Screen, Wash Press and Grit Removal system is being transferred to new electrical gear the existing Influent Equalization Tanks can be used to store influent flow to allow for an electrical cut-over. In addition, the influent bypass channel and the grit bypass channel can also be used to keep forward flow active through the WWTP.

2. Area #6 – Old Headworks: It is not anticipated that any interruption to plant operations will be required for the upgrades associated with the Old Headworks.

3. Area #7 – Distribution Box #1: Upgrades to Distribution Box #1 will require use of the plants Influent Equalization Tanks to allow the Contractor to install new gates and weir plates. Based on past projects of similar nature, the Contractor will require periodic use of the Influent Equalization Tanks to allow installation.
of a temporary wood bulkhead at each gate area. The bulkhead will allow for forward flow to be processed through the WWTP normally following installation. During this period one Primary Clarifier and Primary Sludge Pump will be required to be taken offline to allow for installation of new slide gates and to allow grout around the gates to fully cure. During this period, it is envisioned that the electrical system upgrades associated with the respective Primary Clarifier, Primary Sludge Pump and Primary Scum Pump will be conducted in parallel with each unit being offline to install new gates. This work will coincide with low flow periods at the WWTP when all four Primary Clarifiers are not needed.

4. Area #12 – Junction Box #4: It is not anticipated that any interruption to plant operations will be required for the upgrades.

5. Area #13 – Junction Box #1: It is not anticipated that any interruption to plant operations will be required for the upgrades.

6. Area #16 - Primary Effluent Pump Station: Currently the Primary Effluent Pumps provide flow to the top of the Bio-Filter towers. The existing Primary Effluent Pump discharge piping will be redirected through a force main to the new Aeration Splitter Box (Area #20). Aeration tank construction, splitter box construction, and piping connections must be fully completed before the Primary Effluent Pumps the flow path can be re-configured. During this transition period it is anticipated that pump discharge piping connections for the four pumps will be modified sequentially. For the first pump it is anticipated that no interruption of existing facilities will be required. For the three subsequent pumps it is anticipated that temporary bypass pumping will be required by the Contractor to allow for the pipe and fittings for the remaining three pumps to be installed. During this period, it is anticipated that bypass pumping operations will occur from Junction Box #1 as the suction point. The discharge point will be the new force main to the new BNR tanks and Aeration Splitter Box (Area #20). This bypass pumping will allow all work to be done in the Primary Effluent wet well and following this point the Bio-Filter Towers will no longer be used. This is anticipated to be one of the last pieces of the Construction contract.

7. Area #16 - Decommission Bio-Filter Towers: The existing Bio-Filter Towers will no longer be used for treatment and will need to be decommissioned. New Biological treatment processes must be completed before flow can be diverted away from the Bio-Filter Complex and decommissioning can begin.

8. Area #20 - New Aeration Splitter Box: Splitter Box will be entirely new and can be constructed independent of operation of existing treatment process. The entirety of the new system will be run with test water prior to tie over for treatment of sanitary wastewater.

9. Areas #22-25 - New Aeration Tanks: Aeration Tanks will be entirely new and can be constructed independent of operation of existing treatment process. The entirety of the new system will be run with test water prior to tie over for treatment of sanitary wastewater.

10. Decommission Existing Aeration Tanks: Following successful operation of the new biological treatment system, all four of the existing aeration tanks will be decommissioned. One existing tank will be used for the new RAS/WAS Pump system. The tie-in of the existing Fina Clarifier RAS Lines will be coordinated with sequential shut down of the Final Clarifiers for

11. Area #19 - New Aeration Blower Building: New Aeration Blower Building will be entirely new and can be constructed independent of operation of existing treatment process.

12. Seed New Treatment Process: The new treatment process will be seeded with activated sludge from the existing treatment process. The seed sludge will ensure biological treatment will occur in the new treatment
process once sanitary flow is first sent through the new treatment process. Initial seeding will help ensure permit compliance during the initial weeks of operation of the new facility.

13. **Area #17 - New RAS/WAS Wet Well:** New RAS/WAS Wet Well will utilize the footprint of an existing Aeration Tank. The Aeration Tank must be decommissioned before modifications can take place. Piping connections to the existing RAS/WAS lines from the Final Clarifiers must be coordinated with disconnection from the existing Primary Effluent Wet Well. The existing re-circulation pumps that will be re-purposed as RAS pumps can currently be taken offline sequentially and upgraded at any time. This will allow configuration for RAS pumping to take place independent of the new and existing treatment system. It is anticipated that there will be some periods during construction where the Primary Effluent Pumps are pumping a portion of both RAS and Primary Effluent while existing RAS piping is re-routed to the new RAS Wet Well. It is anticipated that the RAS pumps will be upgraded first along with the new Wet Well construction. Then sequentially new RAS piping can be re-routed to the new RAS wet well. A gate or valve will be provided on each line to allow each to be connected to a new active wet well and these connections will be sequenced with upgrades to each of the Final Clarifiers.

14. **Area #27 – Distribution Box #3:** Upgrades to Distribution Box #3 will require use of the plants Influent Equalization Tanks to allow the Contractor to install new gates and weir plates. Based on past projects of similar nature, the Contractor will require periodic use of the Influent Equalization Tanks to allow installation of a temporary wood bulkhead at each gate area. The bulkhead will allow for forward flow to be processed through the WWTP normally following installation. During this period one Final Clarifier and the associated scum pump will be required to be taken offline to allow for installation of new slide gates and to allow grout around the gates to fully cure. During this period, it is envisioned that the electrical system upgrades associated with the respective Final Clarifier and Scum Pump will be conducted in parallel with each unit being offline to install new gates. This work will coincide with low flow periods at the WWTP when all four Final Clarifiers are not needed. It is also anticipated that the Influent Equalization Tanks or some temporary piping will be needed to install the new 36-Inch Aeration Effluent Piping to connect to the existing 36-Inch piping prior to Distribution Box #3. Once the new Aeration Tanks are constructed, this piping connection can take place at any time.

15. **Area #32 – Junction Box #3:** It is not anticipated that any interruption to plant operations will be required for the upgrades.

16. **Area #34 – Effluent Pump Station:** The replacement of the four existing isolation valves and check valves in the Valve Vault will require some intermittent interruptions to Effluent Pumping. The existing force main includes a 30-inch plug valve which can be used to provide isolation to the header in the valve vault from the Mississippi River. During periods when the Effluent Pump Station is offline, effluent flow can be diverted to the Equalization Tanks to allow for replacement of check valves and isolation valves to be installed during low flow periods.

17. **Area #51 - High Flow Discharge Pump Station:** High Flow Discharge Wet Well will be entirely new and can be constructed independent of operation of existing treatment process. Adjacent piping construction will not significantly impact the existing treatment process. The entirety of the new system will be run with test water prior to tie over.

18. **Area #52 - Cascade Aeration System:** New Re-aeration System will be entirely new and can be constructed independent of operation of existing treatment process. Adjacent piping construction will not significantly impact the existing treatment process. The entirety of the new system will be run with test water prior to tie over.
19. Area #53 - Peruque Creek Outfall: Peruque Creek Outfall will be entirely new and can be constructed independent of operation of existing treatment process. Adjacent piping construction will not significantly impact the existing treatment process. The entirety of the new system will be run with test water prior to tie over.

5.45 Water & Energy Conservation Project Components

The following provides a listing of preliminary water and energy conservation components which are proposed to be incorporated into the project.

1. **Variable Speed Control:** One power saving measure is the use of variable speed control for pumping and other process equipment. For pumping applications, such as the Primary Effluent Pumps, RAS Pumps and High Flow Discharge Pumps, VFDs allow the pump speed and discharge flow to be matched to actual influent flow. This saves energy by reducing the pumping rate which reduces the dynamic head the pump sees and subsequent energy draw.

2. **Low Flow & High Flow Pump Configuration:** Select pumping systems will also be equipped with a system of normal duty and high-flow pumps or a series of pumps of equal size to allow for appropriate turn-down. The normal duty pumps or a single pump are configured to accommodate the typical normal dry weather flows. The high flow pumps or using multiple pumps in a system are configured to accommodate increased flows during wet weather events. This configuration provides an energy savings by allowing for a smaller or single pump to be used during the typical day-to-day operations. It also allows the pumps to hit higher efficiency points as the are each suited for the specific modes of operation.

3. **Lighting Systems:** The project is anticipated to include several systems to maximize energy efficiency with respect to lighting. Energy efficient LED lighting will be used on both the interior and exterior of buildings. Building occupancy sensors and photocells will also be included to allow lighting to shut off automatically when the buildings are not occupied or when illumination is not required on the exterior of the buildings.

4. **HVAC Systems:** The new HVAC systems will be designed to maximize energy efficiency while also providing the necessary ventilation for code compliance, staff safety and staff comfort. Energy costs and environmental concerns have necessitated innovative methods for delivering fresh, outdoor air that do not require large amounts of heating or cooling energy to be expended simply to temper the incoming air and maintain comfort within the continuously ventilated space. Energy Recovery Ventilation systems deliver fresh, outdoor air to maintain indoor air quality without the associated energy penalty which is typically required to condition the continuously ventilated outside air. By recovering a high percentage of the energy contained in the indoor air which is exhausted outdoors, the ERV systems use this energy to moderate the extremes of temperature and humidity of the incoming fresh ventilation air and thus provides an energy savings over past historical designs which required additional heating and cooling energy input into conditioning the outside air source. Over time this design feature will provide the City with an energy savings.

5. **Aeration Systems:** The aeration system will consume the greatest electrical load of any of the process areas at the new facility. The new aeration blowers will be sized to provide oxygen to the biological treatment system at influent flows ranging from current conditions to the design peak loading conditions. The new aeration system will be designed with state of the art, high efficiency blowers to maximize energy efficiency during process air delivery. In addition, the aeration system will use full floor coverage with ultra-fine bubble diffusers which maximize oxygen transfer efficiency. Maximizing oxygen transfer minimizes the associated energy needs for air delivery to the treatment process. The treatment system also includes a pre-anoxic zone which improves the aerobic zone’s alpha factor which increases aeration efficiency and thus lowers energy use. The aeration blowers will be controlled via real time dissolved oxygen probe measurements in each aeration reactor. This allows the facility to adjust blower speed and corresponding air delivery to meet the treatment system needs without over-aerating, thus reducing energy consumption.
6. **Mixing Systems:** Each of the anoxic selector zones in the Aeration Tanks includes a floating mixer. The control system will include timers to allow each mixer to cycle on and off thus minimizing equipment run time and maximizing energy savings.

**5.46 Requested Deviations from 10 CSR 20-8**

The following provides a listing of known deviations from 10 CSR 20-8. Each deviation has been listed along with the corresponding engineering justification for the proposed deviation.

1. **Proposed Deviation #1 (Return Sludge Measuring Devices):** 10 CSR 20-8.180 (4)(3)(E) requires the following for return sludge flow measurement: “Where the design provides for all return sludge to be mixed with raw sewage (or primary effluent) at one (1) location, the mixed liquor flow rate to each aeration unit should be measured.” The proposed approach for this project is to provide a dedicated splitter box ahead of the biological treatment trains. The splitter box will allow provisions for step feed or contact stabilization modes of operation. The splitter box will contain dedicated slide gates to isolate each process train. The gate box outs will also have dedicated rectangular weir plates. The weir plates will be leveled with a laser during construction to ensure an even flow split to all treatment trains which are online. Dedicated influent flow measurement at the Headworks and for Primary Effluent will be provided as part of the proposed project. The staff can use the total influent flow and the number of treatment trains online to determine the flow per train in lieu of online flow measurement to each treatment train. RAS flows will also be distributed evenly between process trains in the same manner via the use of laser leveled rectangular weirs. A dedicated RAS flow meter will measure the total RAS flow to the biological treatment process which can then be divided by the number of trains online. We have used this approach successfully in many facilities throughout the US and we request a deviation from the listed requirement in 10 CSR 20-8.

2. **Proposed Deviation #2 (Denitrification Oxygen Credit):** 10 CSR 20-8.180 (4)(C) does not include provisions for inclusion of a denitrification oxygen credit. The biological treatment system will experience this credit during day-to-day facility operations and it is an important consideration in appropriately sizing the City’s aeration system to allow for efficient and reliable air delivery equipment without unnecessarily oversized and costly equipment for the City. Unnecessarily oversized equipment will negatively impact the City with higher than necessary up-front capital costs as well as much higher life cycle costs over the planning period to run equipment that is larger than is necessary to effectively to meet the City’s full range of oxygen demand requirements.

   For all treatment alternatives, the full denitrification credit was significantly reduced at all design flow conditions and process oxygen requirements as previously indicated due to the changes and reductions in the performance of denitrifying organisms. Industry standard design references recommend taking denitrification oxygen recovery into consideration as part of the design. The EPA Manual-Nitrogen Control (1993), Table 2-4, Article 3, recommends that “a conservative denitrification design would assume only 50% of the applied soluble substrate is available is directly available for the denitrification reaction”. As part of our design we have conservatively assumed only 50% of the potential denitrification performance at peak flow conditions.

   It is also important to note that the overall process design as a whole also assumes that 100% of the Influent TKN is available to be nitrified and 100% of it will require 4.6 lbs O₂/lb TKN per MDNR design requirements and industry standards. This estimation is also inherently conservative and provides ample oxygen as not all of the TKN is available for oxidation in the influent. We feel that this conservatism combined with a conservative approach to the denitrification process oxygen credit is appropriate for this facility. We request that a partial denitrification credit of 50% be allowed for this project at peak flow conditions. We feel this value will appropriately meet the needs of the facility and it is in alignment with industry standard design practice. This approach will provide full discharge permit compliance without creating unnecessarily oversized and
costly aeration systems for the City both with regard to up-front cost and operational costs over the life of the system.

5.47 Emergency Operations

The proposed project will not significantly change emergency operational procedures at the WWTP. The WWTP is powered by two separate electrical service providers; Ameren Missouri and Cuivre River Electric Cooperative, Inc. thus allowing continued operations in the event that either utility experiences a power outage. New electrical distribution equipment will be adequately sized to allow for operation of critical equipment at all flow and with one of the electrical utilities out of service.
6. SITE CIVIL

This purpose of Chapter 6 is to provide the basis of design for the site/civil elements of the project, including the effluent piping, High Flow Discharge outfall, new yard piping systems, zoning and site development requirements, floodplain, grading and storm water management, landscaping, visual barriers and fencing, vehicle access and site utilities.

6.1 Pipelines and Related Structures

The following sections describe pipe line work and related systems for all project locations.

6.2 Yard Piping

The following table provides a summary of the proposed yard piping along with preliminary material, pipe rating selections and anticipated lengths for each application.

<table>
<thead>
<tr>
<th>Location &amp; Application</th>
<th>Proposed Upgrades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard - (Plant Forward Flow)</td>
<td>36-inch PVC (645 feet) – Gravity Flow</td>
</tr>
<tr>
<td>RAS - Splitter Box to BNR Tanks</td>
<td>30-inch PVC (200 feet) – Gravity Flow</td>
</tr>
<tr>
<td>Primary Effluent – Splitter Box to BNR Tanks</td>
<td>30-inch PVC (200 feet) – Gravity Flow</td>
</tr>
<tr>
<td>Outfall to Peruque Creek</td>
<td>24-inch PVC (370 feet) – Gravity Flow</td>
</tr>
<tr>
<td>Overflow from Effluent Pump Station</td>
<td>24-inch PVC (170 feet) – Gravity Flow</td>
</tr>
<tr>
<td>RAS – Yard from Clarifiers</td>
<td>16-inch PVC (80 feet) – Gravity Flow</td>
</tr>
<tr>
<td>RAS – Force Main to Aeration Splitter Box</td>
<td>24-Inch PVC-SDR 21 (300 feet) – Pressure Flow</td>
</tr>
<tr>
<td>WAS – Suction to RAS Wet Well</td>
<td>8-Inch PVC (50 feet) – Gravity Flow</td>
</tr>
<tr>
<td>Aeration Scum Force Main</td>
<td>4-inch PVC-SDR 21 (270 feet) – Pressure Flow</td>
</tr>
<tr>
<td>Low Pressure Air</td>
<td>28-inch SS-Sch. 10S (180 feet) – Pressure Flow</td>
</tr>
<tr>
<td>Storm Drain Piping</td>
<td>12-inch corrugated HDPE (400 feet) – Gravity Flow</td>
</tr>
<tr>
<td>Non-Potable Water</td>
<td>2-inch HDPE-DR-11 (400 feet) – Pressure Flow</td>
</tr>
</tbody>
</table>

6.3 Floodplain, Grading & Storm Water Management

The following sections describe the anticipated grading and improvements related to drainage and storm water management. In addition, work and structures within the 100-year floodplain is discussed. The site is largely filled, and storm water is currently managed primarily through grading and sheet flow from impervious areas to pervious vegetated areas. Underground drainage infrastructure is minimal. Drainage is currently directed to a narrow swale along the northwest edge of the WWTP and through a series of culverts along Firma Road. Drainage for the improvements will be consistent with existing drainage and directed to the existing swale.

6.3.1 Area #19 – Aeration Blower Building

The Aeration Blower Building will be located outside the floodplain. Ground elevation rises sharply from southwest to northeast. The Aeration Blower Building will be located above the base flood elevation. Sensitive mechanical and electrical equipment will be raised in elevation above the base flood elevation to maintain operation.
6.3.2 Area #20 – Aeration Splitter Box

The new Aeration Splitter Box is located within the floodplain. Sensitive mechanical and electrical equipment will be raised in elevation above the base flood elevation to maintain operation. Any equipment below the base flood elevation will be submersible.

6.3.3 Area #22-25 – New Aeration Tanks

The new Aeration Tanks are located within the floodplain. Tank wall height will be significantly higher than the base flood elevation, mitigating risk of inundation of the surrounding area leading to washout of aeration tank contents. All equipment below the base flood elevation will be submersible.

6.3.4 Area #51 – High Flow Discharge Pump Station

The High Flow Discharge Pump Station is located in the floodplain. The top of the pump station will provide at least three feet of freeboard above base flood elevation. Additionally, all equipment in the pump station is submersible and is designed for continuous operation under water.

6.3.5 Area #52 – Cascade Aeration System

The Reaeration System is located in the floodplain. Flow will be pumped to the Re-aeration System, and all steps are located above the base flood elevation. The final step in the re-aeration cascade provides three feet of freeboard above base flood elevation.

6.3.6 Area #53 – High Flow Discharge Outfall

The High Flow Discharge Outfall final location and alignment has not been determined. It will likely be within the floodplain; however, submergence is not inherently damaging to the outfall, and the gravity outfall will still have enough head to function when Peruque Creek is at flood stage. All systems will be designed for continuous use and protection in flood prone areas. The outfall will include appropriate signage and identification per MDNR requirements.

6.4 Landscaping, Visual Barriers, and Fencing

The WWTP does not currently have extensive landscaping or visual barriers. The necessity and extent of landscaping and barriers will be determined and addressed during the site plan application and review process. A 6-foot chain link fence currently encloses the site. Fencing also encloses an archaeological site at the southwest edge of the WWTP property. The Missouri Historic Preservation Commission has approved work in this area; the fence will be removed where necessary and fencing restricting access to treatment operations areas will be maintained as part of the project.

6.5 Access to Unit Processes

The following sections describe the proposed upgrades relating to access at each site location and new unit processes. Final layout of access roads and walkway locations will be determined further in the design process in partnership with City staff. Roadways, walkways, erosion control measures, and storm drainage features will be designed in accordance with City of O’Fallon standard details.

6.5.1 Access Roads – General

All new access roads will be reinforced concrete construction with designs to match existing concrete roads at the WWTP site along with City of O’Fallon standards.
6.5.2 Sidewalks – General

All new access sidewalks for pedestrian traffic will be reinforced concrete construction with designs to match existing sidewalks at the WWTP site along with City of O’Fallon standards.

6.5.3 Area #19 – Aeration Blower Building

Pedestrian access will be provided to the Aeration Blower Building, likely from the RAS/WAS wet well location. In addition, concrete driveway access will be provided to the building to allow the City to access equipment via their boom truck.

6.5.4 Area #20 – Aeration Splitter Box

Vehicle and pedestrian access will be provided to the aeration splitter box, likely from the access drive to the northwest of the WWTP. It is anticipated that the top of the structure will be located largely above grade. The access driveway will be configured to run adjacent to the structure to allow equipment and appurtenances to be lowered off the structure onto the ground or into the City’s boom truck.

6.5.5 Area #22-25 – New Aeration Tanks

Vehicle access will be provided to the southwest side of the new Aeration Tanks, likely from the access road to the northwest of the WWTP. Pedestrian access will be provided around the aeration tanks, likely from the access drive to the northwest of the WWTP and from the RAS/WAS location by the new Blower Building. It is anticipated that the top of the structure will be located largely above grade. The access driveway will be configured to run adjacent to the structure to allow equipment and appurtenances to be lowered off the structure onto the ground or into the City’s boom truck.

6.5.6 Area #51 – High Flow Discharge Pump Station

Pedestrian access will be provided to the High Flow Discharge Pump Station, likely from the Old Chlorine and Old UV Building location. An access driveway will be configured to run adjacent to the structure to allow equipment and appurtenances to be lowered off the structure onto the ground or into the City’s boom truck.

6.5.7 Area #52 – Cascade Aeration System

Pedestrian access will be provided to the Reaeration System, likely from the Old Chlorine and Old UV Building location. An access driveway will be configured to run adjacent to the structure to allow equipment and appurtenances to be lowered off the structure onto the ground or into the City’s boom truck.

6.5.8 Area #53 – High Flow Discharge Outfall

There is an existing dirt and gravel access road around the southeast side of the WWTP that will continue to be maintained and used. No new direct access will be provided to the high flow discharge outfall and this road area will serve to provide an access point for the outfall. Depending on the final outfall alignment a new pedestrian access gate will be added to the existing site fencing to allow access to the outfall.

6.6 Site Utilities

The following sections describe the proposed upgrades relating to utility systems.
6.6.1 Potable Water – High Flow Discharge Area

The 1½-inch water line serving the existing Old UV Building will likely be extended to a new yard hydrant adjacent to the High Flow Discharge Pump Station and Cascade Reaeration System to allow for high flow wash down and cleaning. The connection will occur after the water service entrance and backflow prevention system in the Old UV Building. The existing flow and pressure of this line will be reviewed with the City as part of subsequent design phases.

6.6.2 Potable Water – New BNR Tanks

Depending on the flow and pressure, the existing 1-inch water service to the yard hydrant next to the existing Aeration Tanks will likely be extended to serve Aeration Blower Building and the new BNR Tanks. If capacity in the existing line is insufficient, the line will be increased in size and connected to the existing 2-inch water service which currently feeds into the Sludge Pump Room below existing Bio-Tower #3. The existing flow and pressure of this line will be reviewed with the City as part of subsequent design phases.

6.6.3 Electrical

Underground electrical utilities will be brought to the new Blower Building, new BNR Tanks and the new High Flow Discharge Pump Station for operation of equipment and instrumentation. Upgrades related to the electrical systems are discussed in further detail in subsequent Chapters.

6.6.4 Communications

Underground communications utilities will be brought to areas containing new and existing control panels to allow all new and existing control systems to communicate directly to the Main Office Building and the main plant SCADA terminals. Upgrades related to communications systems are discussed in further detail in subsequent Chapters.
7. STRUCTURAL & ARCHITECTURAL

The purpose of Chapter 7 is to provide an overview for the structural and architectural elements related to the project. The criteria and proposed design considerations are discussed for both the existing and proposed components. In general, the structural and architectural design of the project will be configured to accommodate the treatment performance requirements of the WWTP, while also minimizing construction cost.

7.1 Building Codes & Design Standards

As of September 9, 2016, the City of O'Fallon has adopted the 2015 iteration of the International Building Code (IBC) design standards. The following table lists the building codes and standards enforced under the IBC.

<table>
<thead>
<tr>
<th>Version</th>
<th>Code</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>International Building Code (IBC)</td>
<td>Base code</td>
</tr>
<tr>
<td>2015</td>
<td>International Existing Building Code (IEBC)</td>
<td>Regulates the repair, alteration, change of occupancy, or addition to existing buildings.</td>
</tr>
<tr>
<td>2015</td>
<td>International Energy Conservation Code (IECC)</td>
<td>Insulation requirements for buildings</td>
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<tr>
<td>2010</td>
<td>ASCE 7-10 Minimum Design Loads for Building and Other Structures</td>
<td>Determination of design loads for structures</td>
</tr>
<tr>
<td>2013</td>
<td>ASCE 24-13 Flood Resistant design and Construction</td>
<td>Determination of flood loads for structures</td>
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<td>2014</td>
<td>ACI 318 Building Code Requirements for Structural Concrete</td>
<td>Concrete design</td>
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<td>2006</td>
<td>ACI 350 Code Requirements for Environmental Engineering Concrete Structures</td>
<td>Concrete tank design</td>
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<td>2010</td>
<td>ACI 350.1 Specification for Tightness Testing of Concrete Tanks</td>
<td>Leak test of concrete tanks</td>
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<tr>
<td>2010</td>
<td>ACI 360R Guide to Design of Slabs-on-Ground</td>
<td>Concrete slab design</td>
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<td>2013</td>
<td>ACI 530 Building Code Requirements for Masonry Structures</td>
<td>Masonry walls</td>
</tr>
<tr>
<td>2010</td>
<td>ADM1 Specification for Aluminum Structures</td>
<td>Aluminum design</td>
</tr>
<tr>
<td>2010</td>
<td>AISC 360 Specifications for Structural Steel Buildings</td>
<td>Structural Steel design</td>
</tr>
<tr>
<td>General</td>
<td>Occupational Safety &amp; Health Administration (OSHA)</td>
<td>Life safety standards</td>
</tr>
</tbody>
</table>

7.2 Design Criteria

The following provides a listing of the notable design criteria for the proposed upgrades design:

1. Concrete:
   a) Design strength: 4,500 psi at 28 days for liquid containing structures 4,000 psi at 28 days elsewhere;
   b) Maximum water to cement: 0.42 for liquid containing structures; 0.45 elsewhere;
   c) Reinforcing: ASTM A615, 60,000 psi minimum yield strength;
   d) All watertight joints will include a PVC or hydrophilic water stop mechanism;
   e) Exposed concrete surfaces will receive a grout cleaned (sack-rubbed) finish.
f) All applicable project concrete work will require adherence to the Eastern Missouri Pavement Consortium (EMPC) standards. This includes all structural concrete work as well as site concrete work including driveways and pedestrian sidewalks.

2. Steel:
   a. W-Shapes: ASTM A992, ASTM A36 all others, galvanized or epoxy coated in corrosive areas;
   b. Embedded anchor bolts: ASTM F593 Grade 316 stainless steel;
   c. Connection bolts: ASTM F3125 A325 galvanized high strength for steel, F593 Grade 316 stainless steel for aluminum;
   d. Welding: 70 ksi Electrodes for steel.

3. Aluminum:
   a. Shapes & Plates: ASTM B308, Alloy T6061-T6;
   b. Anchor Bolts and hardware: Type 316 stainless steel;
   c. Grating: Alloy T6061-T6 with banded edges and striated swaged lock l-bar sections for slip resistance;
   d. Safety Rails: Mill Aluminum with 4-inch high kick-plates; removable rail sections will be provided in strategic locations determined in partnership with City staff to allow for maintenance and removal of equipment via the City’s boom truck.
   e. Welding: 4043 filler wire for aluminum.

4. Design Loads

The following table summarizes the design loads for all new structures. These are the minimum structural loads required by the adopted codes and will provide the most economical design while satisfying the intent of the codes along with staff safety.

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Description</th>
<th>Designation</th>
<th>Minimum Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow</td>
<td>Ground Snow Load</td>
<td>$P_G$</td>
<td>20 psf</td>
</tr>
<tr>
<td>Wind</td>
<td>Basic Wind Speed (3-second gust)</td>
<td>$V$</td>
<td>120 mph (1)</td>
</tr>
<tr>
<td>Seismic</td>
<td>Seismic Coefficient</td>
<td>$S_S$</td>
<td>0.308</td>
</tr>
<tr>
<td>Seismic</td>
<td>Seismic Coefficient</td>
<td>$S_1$</td>
<td>0.135</td>
</tr>
<tr>
<td>Seismic</td>
<td>Seismic Site Class (A-F)</td>
<td>Site Class</td>
<td>D (2)</td>
</tr>
<tr>
<td>Seismic</td>
<td>A-Low risk site soils; F-High risk site soils</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seismic</td>
<td>Seismic Coefficient</td>
<td>$S_{DS}$</td>
<td>0.319</td>
</tr>
<tr>
<td>Seismic</td>
<td>Seismic Coefficient</td>
<td>$S_{D1}$</td>
<td>0.204</td>
</tr>
<tr>
<td>Seismic</td>
<td>Seismic Design Category (A-F)</td>
<td>SDC</td>
<td>D (3)</td>
</tr>
<tr>
<td></td>
<td>A-Low Seismic Risk; F-High Seismic Risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frost Depth</td>
<td>Frost Depth determined from Geotechnical Report</td>
<td></td>
<td>30 Inches</td>
</tr>
<tr>
<td>Load Type</td>
<td>Description</td>
<td>Designation</td>
<td>Minimum Load</td>
</tr>
<tr>
<td>------------</td>
<td>----------------------------------------------------------</td>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Flood</td>
<td>Base Flood Elevation (still water depth)</td>
<td>NAVD88</td>
<td>448 (4)</td>
</tr>
<tr>
<td>Slabs-on-Grade</td>
<td>Building Floor Slabs-on-grade</td>
<td>LL</td>
<td>300 psf</td>
</tr>
<tr>
<td>Stair Live Load</td>
<td>Stairs and Equipment Access Walkways</td>
<td>LL</td>
<td>100 psf (5)</td>
</tr>
</tbody>
</table>

1. Per code, structures will be designed for increased wind load pressures to account for speed-up of wind over flat open country.
2. Seismic Site Class = D is assumed based upon recommendations from the Geotechnical Report. Ground improvement will be provided below new structures.
3. Seismic Design Category = D, represents moderate-seismic risk area.
4. Existing facility is located outside of 100-year flood zone, only new structures west of site affected. Per City staff feedback flooding has reached elevations as high as 448 to 449 at the site in the past. These elevations will serve as a baseline for flood forces design in the project.
5. Tank access stairs will be designed for 100 psf live load. Tank walkways will be designed for minimum 100 psf uniform load, but not less than any anticipated concentrated loading placed on grating for maintenance, removal, or replacement of equipment.

Seismic Design Category D represents a high-seismic risk area. Chapter 13 of ASCE 7-10 requires that mechanical, electrical, piping, and architectural components comply with seismic force design requirements. Components exempt from seismic requirements include those weighing less than 400 pounds with a center of mass no higher than four feet from the adjacent floor, those weighing less than 20 pounds overall or 5 pounds per linear foot. New piping will fall under this requirement and thus require pipe supports designed with seismic restraints. The final Contract Documents will include provisions for this requirement.

### 7.3 Energy Conservation Code

All new building additions will comply with the 2015 International Energy Conservation Code, (IECC). Per the IECC, the City of O’Fallon is in Climate Zone 4A which specifies minimum thermal insulation for the building envelop per the following table.

<table>
<thead>
<tr>
<th>Building Element</th>
<th>Insulation System</th>
<th>Min R-Value</th>
<th>R-Value Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior Concrete Masonry Unit (CMU) Walls</td>
<td>Continuous 2-inch extruded (rigid) insulation placed over exterior face of CMU walls and sheathed with wall finish</td>
<td>9.5</td>
<td>10.0</td>
</tr>
<tr>
<td>Exterior Basement Walls</td>
<td>Continuous 2-inch extruded (rigid) insulation placed over exterior face of concrete basement walls</td>
<td>7.5</td>
<td>10.0</td>
</tr>
<tr>
<td>Slab-on-grade floors</td>
<td>2-inch extruded (rigid) insulation placed on the interior side of foundation walls a minimum of 24&quot; below the slab</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Roofs</td>
<td>Insulation entirely above deck</td>
<td>30.0</td>
<td>30.0</td>
</tr>
</tbody>
</table>

### 7.4 Geotechnical and Foundation Criteria

Per the preliminary geotechnical report prepared by Geotechnology, Inc., building foundations, tank base slabs, and below grade walls at the WWTP will be designed for the following criteria:

- **Subsurface Conditions**: Alluvial deposits of lean clay and clay underlain by sand. Refusal was not encountered in any of the 25-foot borings. Refusal was encountered in one Cone Penetrometer sounding at a depth of 77 feet.
- **Groundwater**: Observed or estimated between 19 and 27 feet below grade.
• **Excavations**: Use Type C soil classification with open-cut slopes not exceeding 1.5H:1V. If temporary excavation shoring is required due to site constraints, shoring shall be designed for elevated groundwater.

• **Liquefaction**: Site soils are potentially liquefiable and could settle between 2 to 6 inches during a seismic event. Liquefaction is when a saturated soil loses its shear strength and behaves like a liquid during seismic events. Per ASCE 7-10, the design seismic event has a 1% probability of occurring within a 50-year period.

• **Settlement**: Aside from settlement due to liquefaction, if grades are brought up 15 feet near the proposed Aeration Tanks, settlement would be on the order of 2 to 3 inches. These settlements could be reduced by using light weight fills, preloading the site for three to six months, over excavating 12 feet of soil, or installing aggregate pier ground improvements. Aggregate pier ground improvements are the least expensive option that does not increase the construction duration a prohibitive amount.

• **Ground Improvement**: To resolve liquefaction and settlement issues, ground improvement will be required below new structures. These will consist of earthquake drains to mitigate the liquefaction potential and aggregate piers to address settlement and bearing capacity deficiencies. Earthquake drains create a route for pore water to travel to, relieving pressure and preventing soils from liquefying during a seismic event. Aggregate piers are deep foundation elements that consisting of compacted stone columns installed in soils that reduce settlement and increase allowable bearing capacities. The alternative to ground improvements would be over excavating 45 feet of clay to prevent liquefaction. It is anticipated that aggregate piers in combination with earthquake drains will be used at the site to mitigate liquefaction and settlement issues.

• **Net Allowable Bearing Capacity**: Building footings and base slabs will be sized for a maximum soil bearing pressure of:
  - Shallow foundations bearing on native soil: 2,000 pounds per square foot (PSF)
  - Shallow foundations bearing on improved soils: 4,000 PSF
  - Mat slabs bearing on native soil: 1,300 PSF
  - Mat slabs bearing on improved soil: as required by structure

### 7.5 Concrete Tanks and Splitter Boxes

Proposed cast-in-place concrete process tanks and splitter boxes will be designed according to ACI 350 and water tightness tested per ACI 350.1. The American Concrete Institute (ACI) developed these codes specifically for the design and construction of water-containing concrete tanks.

Concrete tanks designed to these industry standards will develop shrinkage cracks as the freshly-placed concrete cures and shrinks. The extent of cracking that develops is difficult to predict and is the result of many factors (mix design, ready-mix concrete quality, placement techniques and workmanship, environmental factors, weather, curing methods, etc.). The contractor is required to repair all tank concrete cracks that actively leak when the structure is water tightness test as subsequently described in this section. There are three alternative available to address concrete cracking in new concrete tank construction:

#### 7.5.1 Alternative 1: Industry Standard

As indicated above, concrete tanks designed to the minimum requirements of ACI 350 will develop cracks as the concrete cures and these cracks will require field repairs prior to backfilling the tank. The extent of cracking varies depending on the size the tank, environmental conditions during construction, quality of concrete placement/curing methods and application of curing compounds and materials. This is considered standard practice and an economical
method of concrete tank construction. Once the cracks are adequately sealed with approved methods, the concrete tanks will be watertight and will provide a long-term, low-maintenance, durable structure.

7.5.2 Alternative 2: Provide Excessive Rebar throughout (Too Costly)

Design concrete tanks with additional rebar in excess of industry standards and above minimum requirements specified by ACI 350. Additional rebar is provided throughout the concrete tank in an attempt to avoid concrete cracking. Typical rebar spacing in concrete tanks is approximately 8-inches to 12-inches. Decreasing the rebar spacing to 4-inches to 6-inches on-center throughout the tank is considered cost-prohibitive, and the concrete tanks will likely still develop minor cracking.

7.5.3 Option 3: Provide Targeted Strengthening (Recommended)

Most shrinkage cracks that form in concrete tanks during the curing process develop at the base of the walls and extend vertically upward one-third to one-half the wall height. Based on past project experience, decreasing the horizontal rebar spacing at the base of the walls reduces the number of cracks that develop. This targeted strengthening approach reduces cracking with minimal increase in the construction cost of the tanks; however, minor sporadic cracks will still develop and will require field repair.

7.5.4 Cast-in-Place Concrete Tank Water Tightness Testing

After cast-in-place concrete tanks are constructed, they will be water tightness tested according to ACI350.1, which involves the following: individually filling each individual tank cell with water up to its maximum design water level; sealing any visible active leaks viewed from the exterior of tank walls; and passing a drop test (commonly called a bucket test). Tank testing and crack repair work must be accounted for in the construction schedule.

The sequence and procedure of water tightness testing each tank involves the following steps:

- The tank base slab, exterior walls and interior walls are constructed.
- PRIOR to backfilling the tank, the structure is filled with water and all exterior tank walls are visually inspected from outside the tank for leaks along the wall face and to inspect the construction joint at the base of the wall and top of the tank floor slab.
- PRIOR to commencing the water tightness test, the concrete must obtain its full 28-day design compressive strength, as verified by laboratory test cylinders. Contractors are encouraged to take additional test cylinders to verify concrete strength gains between the standard 7-day and 28-day cylinder breaks.
- Each tank cell is individually tested to ensure quality and to allow any individual tank cell to be taken offline for maintenance and cleaning while adjacent tank cells remain in operation.
- Each tank cell is filled with water to the maximum design water level.
- During a 3-day absorption or “soak” period, the Contractor must visually inspect the walls of the tested cell. If any water is observed on the exterior surface where moisture can be transferred to a dry hand, the defect (leak) must be repaired prior to passing the visual inspection.
- After the 3-day absorption period, the Contractor may begin the drop (bucket) test. During this test, the water level of the tank is measured for a minimum of 3-days with additional days required depending on the depth of water within the tank cell.
- After all tank cells are tested, all leaks are identified and sealed, and the tank passes both the visual and drop tests, the tank may be backfilled.
The Contractor determines the means and methods to expedite the testing procedure, such as performing simultaneous testing of tank cells that do not share a common wall.

7.5.5 Cast-in-Place Concrete Tank Crack Sealing Methods

The Contractor is responsible for the means and methods of repairing actively leaking cracks identified during the water tightness test; however, only two repair methods are approved for construction:

- Polyurethane Crack Injection (maximum tank stored liquid pH= 9.0)
- Crystalline Waterproofing Surface Coating (maximum tank stored liquid pH=11)

7.5.5.1 Polyurethane Crack Injection

Polyurethane crack injection can be used when the tank’s stored liquid is below a pH=9.0. Higher pH liquids will slowly degrade the polyurethane foam. The product is injected, under pressure, into predrilled access holes. The injection holes are typically drilled at a 45-degree angle along either side of the active leak at an initial spacing of 6-inches to 24-inches.

The installation contractor field mixes the liquid polyurethane with an accelerator prior to injecting into the concrete walls. Once injected into the wall, the liquid polyurethane expands to 15 to 30 times the liquid volume to form a permanently flexible polyurethane grout that infills voids and cracks to stop water infiltration.

The degree of difficulty and success rate of sealing leaks with this product is dependent on the experience of the installer. One to five rounds of applications, per crack, may be required depending on site conditions, quantity of accelerator used, locations of drill access holes, and overall tenacity of the cracked concrete. Each round of injection involves drilling additional holes between previously injected locations in an attempt to intersect the crack near the mid-depth of the concrete’s thickness. After cracks are sealed, the contractor is required to grind-off excess foam, remove injection ports and infill with grout for all areas that will be exposed to view and along all interior tank surfaces. Injected cracks at the exterior face of walls below final grade (not exposed to view) can have injection ports and excess foam remain in place.

7.5.5.2 Crystalline Waterproofing Surface Coating

Crystalline waterproofing products are more resistant to high pH liquids and can be used when the tank’s stored liquid is below a pH of 11.0. Crystalline waterproofing technologies are a chemical treatment that fills the capillaries and pores of cured concrete with a non-soluble crystalline structure. The crystalline structure penetrates or “grows” into the concrete, and seals cracks and concrete porosity. Crystalline waterproofing is supplied in dry, pre-blended Portland cement mortars (concentrated product) that can be added at the batch plant as a concrete admixture, incorporated throughout the concrete mass, or supplied to the field for isolated surface applied treatments.

Providing crystalline waterproofing as a concrete admixture, supplied by the batch plant and mixed integrally into the wet concrete, is cost-prohibitive and not recommend for use. However, using crystalline waterproofing as a field applied surface treatment to seal actively leaking cracks in concrete tanks is a cost-effective solution and preferred by some contractors to field repair leaks in concrete tanks.

Actively leaking concrete cracks are sealed by the following approach: rout out the crack and surface apply a thin slurry coat of concentrated product to the prepared surface; apply a fast-setting, non-shrink hydraulic cement; and top-coating with a finish coat of concentrated product. The appearance of repair varies from barely visible to very noticeable depending on the quality of the installation. Unlike polyurethane crack injection, these products require field curing and development time to seal a crack. Actively-leaking cracks treated with these products will often continue to leak for
several days after treatment, but they will typically seal the leak in one application after a few days of curing. The crystalline surface treatment will continue to migrate into the wall for several months after application with overall growth dependent on environmental conditions, crack width, and moisture content of the concrete.

7.5.6 Concrete Curing, Finishes, And Sealers

All new concrete work will be finished and sealed per the table below. All existing building and tank concrete surfaces will be untreated. In general, painting new or existing concrete surfaces is not recommended and should be avoided.

### Table 7-4 Concrete Finish and Sealing Schedule

<table>
<thead>
<tr>
<th>Concrete Element</th>
<th>Allowable Curing Methods</th>
<th>Concrete Finish</th>
<th>Concrete Sealer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Cure &amp; Seal Compound</td>
<td>Float Power Trowel Sack-Rubbed Broom None Water Sealer Hardener</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below Grade Foundation Walls</td>
<td>X X N/A X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposed Foundation Walls</td>
<td>X X X X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inside face of Basement Walls</td>
<td>X X NR(2) X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inside Face of Concrete Tanks</td>
<td>X X NR(2) X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior Face of Concrete Tanks</td>
<td>X X X(2) X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tank Slabs</td>
<td>X X X X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Floor Slabs</td>
<td>X(3) X X N/A X(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete Containment Areas (Flood)</td>
<td>X(3) X N/A X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior Conc Equip Pads</td>
<td>X X X NR(2) X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior Conc Equip Pads</td>
<td>X X X NR(2) X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sidewalks &amp; Driveways</td>
<td>X X X N/A X X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Abbreviations: X = Chosen Option (design basis); NR= Not Recommended; N/A= Not Applicable, Not Available
2. Sack-rubbed concrete finishes are expensive and not recommended for use in wall formwork. The appearance of formed wall surfaces will have slight irregularities, bug holes, and voids within the tolerances specified in project specifications. In addition, for budget purposes, sack rubbing for inside face of tank walls and interior concrete pads is not recommended. Only exterior, exposed wall surfaces will have this finish.
3. Building floor slabs and the inside of containment areas (flood containment) must be wet-cured. If curing compounds are used, they will need to be removed by acid etch and subsequent neutralization prior to applying concrete painting or hardener.
4. All proposed concrete floor slabs left exposed to view will be treated with a clear floor hardener to permanently seal the concrete and provide a cleanable surface.
7.5.7 Concrete Tank Coatings and Linings

Concrete tank coating and lining systems protect concrete tanks from rapid concrete deterioration from chemical attack including concentrated levels of hydrogen sulfide gas (H₂S) within treatment tanks or acidic spills within concrete secondary containment structures. There are no areas of the project where coatings or linings will be required.

7.5.8 Existing Tank Repair

A thorough concrete condition survey of all existing interior and exterior concrete tank surfaces was not performed. As part of the project it is anticipated that unit price-based repair work allowances will be included for the following concrete repairs for existing concrete tanks and structures which will be reused on the project:

- Shallow Concrete Spall Repair – Unit Price per Square Foot
- Deep Concrete Spall Repair – Unit Price per Square Foot
- Rout & Seal Crack Repair – Unit Price per Linear Foot
- Polyurethane Injection – Unit Price per Linear Foot

The above repairs will be included to allow the contractor to rehabilitate any deterioration that is found during the upgrades. It is important to note that these unit prices will not be permitted to be used for repair of new construction on the project.

7.6 Area #4 – Headworks Building Upgrades Summary

This project does not include a complete upgrade to the building. Upgrades to the Meter Room and Grit Room are not included in this project. Upgrades in the existing Electrical Room, Screen Room and an Electrical Room Expansion are the only proposed structural items for the Headworks Building.

7.6.1 Electrical Room Upgrades Summary

The following Structural upgrades are proposed for the existing Electrical Room:

- Any leaks in Concrete walls, CMU walls, roof slab, or louvers will be repaired.
- Existing metal door and frame to existing Grit Room will be demolished and CMU wall will be infilled to physically separate the Electrical Room from the Grit Room
- Walls will be repainted
- Floor will be repaired in area of existing MCC which will be demolished
- Louvers and wall openings will be infilled to accommodate HVAC upgrades to the space. This includes the North and West Walls
- A new insulated hollow metal door and frame with lintel support structure will be added to the North side of the existing Electrical Room to allow direct access to the room.
- Reroute existing roof scupper and downspout to allow for new door
7.6.2 Screen Room Upgrades Summary

The following Structural upgrades are proposed for the existing Screen Room:

- Screen Room common CMU wall with electrical room expansion will be repaired and repainted. Areas with existing cracking will be repointed to protect new Electrical equipment.
- Existing wall louver on West wall will be demolished and infilled with CMU block.
- Existing grating, safety rails and flat panel aluminum cover decking will be demolished and replaced with sealed aluminum covers for odor control as indicated in Chapter 5.

7.6.3 Headworks Expansion Upgrades Summary

The following is a summary of recommended Structural improvement elements associated with an expansion of the Headworks of the WWTP:

- Expansion of the Electrical Room is recommended to physically separate this room from other rooms of the Headworks Building which are related to treatment unit processes. Access will be provided by an exterior door from the south by extending the existing concrete platform and driveway in front of the Screen Room. Access will be coordinated with the existing odor control support pier located in front of the Screen Room.
- The expansion will be located over the existing Meter Room, using the reinforced concrete walls and roof slab as a foundation, reducing site work without affecting traffic flow. If the existing roof slab does not have sufficient capacity to support new equipment, it will be reinforced from below. The existing roof mounted exhaust fan equipment will be demolished, and the roof penetration will be infilled. A new ventilation opening will be provided in the meter room wall below.
- Three new CMU walls will be constructed to enclose the area. The exterior of the walls will be clad with metal siding over foil-faced polyisocyanurate insulation to meet current energy codes. The siding will be matched to the existing Biosolids Treatment Building in color, texture and appearance. It is recommended that wall cladding be used in this area as it provides the most robust moisture protection for interior wall mounted electrical gear and it also allows for increased energy efficiency.
- The new roof will consist of metal decking over painted steel framing. A mechanically fastened membrane roof with tapered insulation and flashing to match the existing will be provided. Scuppers and downspouts will be included to match the other flat roof structures of the building.
- Any existing HVAC louvers or ducts in this area will be relocated or re-routed. This includes the supply louver for the Screen Room and this CMU wall opening will be infilled and sealed.
- Interior finishes will be in accordance with the following schedule:

<table>
<thead>
<tr>
<th>Area</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Floor Slab</td>
<td>Finished with a concrete hardener</td>
</tr>
<tr>
<td>Interior Walls</td>
<td>Painted CMU</td>
</tr>
<tr>
<td>Ceiling</td>
<td>Painted Steel framing and galvanized metal decking</td>
</tr>
<tr>
<td>Man Doors</td>
<td>Flush, painted double hollow metal</td>
</tr>
</tbody>
</table>

Table 7-5 Headworks Building Expansion Interior Finish Schedule
7.7 **Area #6 – Old Headworks Upgrades Summary**

The following Structural upgrades are proposed for the Old Headworks:

- Selective demolition of mechanical equipment and any associated concrete repairs.
- Existing railings, grating, and other safety guards which are unsafe or not code compliant will be corrected with improved handrails, sealed aluminum cover coverage, and safety guards.
- Sealed aluminum covers for odor control will be added as indicted in Chapter 5.
- Exterior of concrete walls and structure will be repainted to match existing color.
- Any settled or cracked sections of concrete sidewalk will be replaced in kind, to remove any trip hazards. Any undermined areas will be repaired with new subgrade to restore uniform bearing of sidewalks.

7.8 **Area #7 – Distribution Box #1 Upgrades Summary**

The following Structural upgrades are proposed for Distribution Box #1:

- Additional height will be required at the splitter box to ensure sufficient freeboard following the weir plate addition to improve flow splitting. The walls will be extended upward 2'-3" in height to elevation 460.25.
- New IBC and OSHA compliant aluminum stairs will be provided, and existing concrete stairs and safety rails will be demolished.
- An aluminum safety railing will be provided at the perimeter.
- Existing serrated galvanized steel grating will be replaced with new flat panel aluminum cover system designed for odor control. The configuration will protect gate openings with toe plates to improve safety for personnel.
- Any concrete cracking or spalling identified during construction will be repaired as part of unit price repair items.
- The exterior of the structure will be repainted to match the current color and finish

7.9 **Area #12 – Junction Box #4 Upgrades Summary**

The following Structural upgrades are proposed for Junction Box #4:

- An aluminum safety railing will be provided at the perimeter.
- Exterior of structure will be repainted to match the current color and finish
- Any concrete defects which are found will be repaired per unit price concrete repair items

7.10 **Area #13 – Junction Box #1 Upgrades Summary**

The following Structural upgrades are proposed for Junction Box #1:

- New IBC and OSHA compliant aluminum stairs will be provided.
• An aluminum safety railing will be provided at the perimeter.

• New aluminum grating of proper depth fastened to support framing.

• Any concrete cracking or spalling identified during construction will be repaired as part of unit price repair items.

• Exterior of structure will be repainted to match existing color and finish

7.11 Area #16 – Bio-Filter Complex

The Bio-Filter Complex includes several rooms, wet wells and spaces. Each of the rooms along with associated findings will be discussed in the following sections.

7.11.1 Primary Effluent Wet Well Upgrades Summary

The following Structural upgrades are proposed for Bio-Filter Complex Primary Effluent Wet Well:

• The North side of the wet well has a flat shelf area which is above the normal water operating level. During high wet well levels, solids deposition occurs on the shelf. A fillet or other means to prevent solids deposition will be provided.

• A significant amount of site erosion and undermining has occurred in the area of the downspouts from the roof of the Bio-Filter Complex Restroom & Office area. The storm water drainage will be upgraded in this area.

• The existing discharge piping and support rack will be reconfigured. Pipes will make a 90 degree turn along the support rack, will be supported off of the existing Bio-Filter Complex building and then transition to below grade in the Area of Bio-Filter Tower #1. Additional structural steel will be added to the support rack as required by static and seismic analysis.

• Existing concrete structure will be repainted both interior and exterior

• Pipe support grout pads will be demolished and replaced

• Existing structural steel and piping will be repainted

• Old grout pads and anchors for previously demolished screw pumps will be demolished and concrete will be repaired

7.11.2 Bio-Filter Towers Upgrades Summary

The following Structural upgrades are proposed for Bio-Filter Complex Towers:

• Selective demolition of all items above the existing concrete base slab including the existing Bio-Filter Towers, Feed Piping, Supports, Media, and related appurtenances.

• Installation of a fully adhered membrane roofing system with new structural steel supports, steel deck and tapered insulation to ensure a water-tight roof and no accumulation of rainwater or debris in these areas.

• Side wall areas of the existing concrete deck and ventilation holes for the Bio-Towers will be infilled
Existing access stairs will be demolished and access to the roof (Wet Well) will be provided by a new OSHA compliant ladder system.

**7.11.3 Bio-Filter Complex Basement Upgrades Summary**

The following Structural upgrades are proposed for Bio-Filter Complex Basement:

- All lift hooks will be analyzed by a structural engineer and labeled with signage indicating the appropriate load rating as the lack of load rating is an OSHA violation and a safety hazard.
- A monorail, hoist and manual push-trolley will be added to allow maintenance and lifting provisions for the RAS Pumps and motors.
- The access hatch to the basement will receive safety netting for fall protection.

**7.11.4 Bio-Filter Complex Upper Level Wet Well Upgrades Summary**

The following Structural upgrades are proposed for Bio-Filter Complex Upper Level Wet Well:

- Wet well has four heavy cover plates that are corroded and galvanized steel grating panels that will be replaced with a solid sealed aluminum cover system.
- New aluminum safety rails will be provided around the entire perimeter to replace existing unstable safety rails for fall protection.

**7.11.5 Bio-Filter Complex Garage Upgrades Summary**

The following Structural upgrades are proposed for Bio-Filter Complex Garage:

- Repair of existing flat membrane roof over the garage area in accordance with demolition of the existing Bio-Filter Towers. Penetrations for existing demolished piping and HVAC equipment will be infilled and any deteriorated steel deck or insulation will be repaired. Existing skylights and roof drains will be replaced as needed following detailed evaluation.
- The existing Office and Storage Area will be converted to a new Electrical Room.
- A concrete flood barrier wall be installed at the front of the office to an elevation above the 100-year floodplain. The concrete landing from the adjacent existing Electrical Room will be extended to provide access over the flood barrier wall.
- Existing wood partition walls will be demolished and rebuilt with CMU.
- A double door will provide access to the area, swinging in the direction of egress with panic hardware. The door will be 6'-0" wide by 9'-0" tall to allow for easy installation of new MCC’s. Electrical gear will be arranged to provide double clearance so only one exit will be required by the NEC code. MCC’s will be top fed to avoid penetrations in the existing floor.
- New room walls will be painted

**7.11.6 Bio-Filter Complex Electrical Room Upgrades Summary**

The following Structural upgrades are proposed for Bio-Filter Complex Electrical Room:
• The lift hook in the room will be analyzed by a structural engineer and labeled with signage indicating the appropriate load rating as the lack of load rating is an OSHA violation and a safety hazard.

• The concrete floor will be repaired where existing concrete equipment pads are demolished.

• Walls will be repainted to match existing colors in areas of demolished electrical equipment

• CMU wall openings for demolished electrical conduits will be infilled

• Stairway down to Basement will be evaluated for possible physical separation between Basement & Electrical Room to allow independent ventilation of the existing spaces. This is dependent on the City’s determination on the desired approach and location for RAS pumping.

7.11.7 Bio-Filter Complex Blower Room Upgrades Summary

The following Structural upgrades are proposed for Bio-Filter Complex Blower Room:

• Existing concrete equipment pads for blowers will be demolished and floor will be repaired and repainted

• Existing wall louver openings will be infilled with concrete

• Interior and exterior walls will be repainted in areas of demolished equipment or modifications to match existing color and texture

• Existing sound attenuating partition walls will remain in place around stairway

• Existing monorail and hoist system will remain in place. The existing system is currently not used and will not be evaluated as part of this project.

7.11.8 Bio-Filter Complex Administrative Areas Upgrades Summary

The administrative areas of the Bio-Filter Complex include an Office, Restroom, Storage Room and Corridor areas. No Structural upgrades are proposed for Bio-Filter Complex Administrative Areas.

7.12 Area #17 - New RAS Wet Well Upgrades Summary

Existing Aeration Tank #2 will be converted into the RAS wet well. As part of this upgrade the following structural items will be incorporated into the design:

• Any cores in existing concrete tank walls will be structurally evaluated and sealed with double rows of mechanical link-seals.

• New aluminum safety rails will be installed along the north walls to meet current code for fall protection.

• Any concrete cracking or spalling identified during construction will be repaired as part of unit price repair items.

• The existing tank will be compartmentalized with concrete walls to allow for a smaller wet well and liquid containment space

• Concrete fills and fillets will be added to the pump suction point
7.13 **Area #21 – WAS Valve Vault Upgrades Summary**

The following Structural upgrades are proposed for the WAS Valve Vault:

- New IBC and OSHA compliant aluminum stairs will be provided.
- An aluminum safety railing will be provided at the perimeter.
- Any concrete cracking or spalling identified during construction will be repaired as part of unit price repair items.
- Exterior of Structure will be repainted

7.14 **Existing Areas #22-#25 – Aeration Tanks Upgrades Summary**

The existing aeration tanks will be decommissioned and abandoned in place as part of this project. Aeration Tank #2 will be repurposed as a RAS/WAS wet well. The following Structural upgrades are proposed:

- Existing concrete in reused structures will be repaired per unit price repair items as encountered
- Safety rails will be added to all structures that will be reused in areas which are needed for OSHA compliance

7.15 **Area #20 – New Aeration Splitter Box Upgrades Summary**

The project will include a new Aeration Splitter Box. This will be a cast-in-place concrete structure. The top of the wall of the structure will be at an elevation of approximately 467.50 and the existing grade is currently at an elevation of 446.00. The following structural items will be incorporated into the design:

- Ground improvements consisting of earthquake drains and/or aggregate piers to mitigate liquefaction and settlement issues. Ground improvement will also increase allowable bearing pressures allowing for deeper structures with less plan area.
- Aluminum safety railing with toe boards. Removable rails will be provided to allow removal and lowering of equipment to grade for access via the City’s boom truck
- Mill aluminum grating will be provided on top of the splitter box and individual cells
- IBC and OSHA compliant aluminum access stairs.
- The structure will be designed for ASCE 24-13 flood loads. Given potential flooding at the site the structure will be evaluated to ensure anti-floatation provisions are included. Pressure relief valves and other provisions will be evaluated during subsequent design phases.
- Base slab will be provided with sloped concrete fill to dedicated recessed sumps in each chamber.
- Exterior tank wall facing Highway 79 and Firma Road will be finished with Sack-Rubbed finish and architectural considerations will be coordinated with the City due to the large concrete tank exposure surface.
- Aluminum access bridge and stairs will be provided to connect from Aeration Splitter Box to Aeration Tanks
7.16 Area #22-25 – New Aeration Tank Upgrades Summary

The project will include four new aeration tanks (BNR Tanks). These will be cast-in-place concrete structures. The top of wall will be approximately at elevation 465.50, and existing grade is currently at an elevation of 446.00. Refer to Appendix H for a conceptual rendering of this structure from Highway 79. The following structural items will be incorporated into the design:

- Ground improvements consisting of earthquake drains and/or aggregate piers to mitigate liquefaction and settlement issues. Ground improvement will also increase allowable bearing pressures allowing for deeper structures with less plan area.
- Precast concrete walkways to eliminate the need for elevated formwork decreasing construction duration and costs. Planks will have a broom finish and be crowned to drain.
- Aluminum safety railing with toe boards. Removable rails will be provided to allow removal and lowering of equipment to grade for access via the City’s boom truck.
- IBC and OSHA compliant aluminum access stairs.
- FRP baffle walls to separate anoxic zones to reduce cost.
- The structure will be designed for ASCE 24-13 flood loads. Given potential flooding at the site the structure will be evaluated to ensure anti-floatation provisions are included. Pressure relief valves and other provisions will be evaluated during subsequent design phases.
- Base slab will be provided with sloped concrete fill to a dedicated recessed sump in each tank. Sump will contain a dedicated tank drain pump. Due to the length of the tanks the sloped fill will occur along the sides of each tank with a flat center area along the entire length of the tank.
- Exterior tank wall facility Highway 79 and Firma Road will be finished with Sack-Rubbed finish and architectural considerations will be coordinated with the City due to the large concrete tank exposure surface.
- Aluminum access bridge and stairs will be provided to connect from Aeration Splitter Box to Aeration Tanks.

7.17 Area #27 – Distribution Box #3 Upgrades Summary

The following Structural upgrades are proposed for Distribution Box #3:

- Additional height will be required at the splitter box to ensure sufficient freeboard. The walls will be extended upward 3’-3” in height to elevation 460.25.
- New IBC and OSHA compliant aluminum stairs will be provided.
- Existing concrete stairs will be demolished.
- An aluminum safety railing will be provided at the perimeter.
- Existing serrated galvanized steel grating will be replaced with new aluminum grating of proper depth fastened to support framing. The configuration will protect gate openings with toe plates to improve safety for personnel.
- Any concrete cracking or spalling identified during construction will be repaired as part of unit price repair items.
- Structure exterior surfaces and top of walls will be repainted to match existing color and texture

### 7.18 Areas #28–#31 – Final Clarifiers Upgrades Summary

The following Structural upgrades are proposed for the Final Clarifiers:

- An aluminum safety railing will be added along the entirety of each tank perimeter to meet current code for fall protection. Rails will be configured for removal to allow access to FRP clarifier launder covers. As an alternative to safety rails the site grading will be evaluated closely during subsequent design phases to determine if re-grading could provide sufficient concrete wall height to eliminate the need for safety rails.
- Area #28 – Area #31: Areas #28, #29, #30, and #31 tank walls have 43, 40,52, and 50 vertical cracks, respectively. A rout and seal concrete repair for each crack will be provided via unit price pay items. Exterior exposed surface areas receiving repairs will be repainted.
- Area #28 – Area #31: Concrete spalling is present around some of the existing railing posts. Concrete will be repaired.
- Area #28, #30, and #31: Scum Pit access hatch has no fall protection and hatch frames are full of debris. Safety netting will be added to match other locations at the WWTP and debris will be removed from frames.
- Area #30: Concrete around Scum Pit hatch is in poor condition with extensive cracking and spalling. Spalled concrete will be repaired
- Any additional concrete cracking or spalling identified during construction will be repaired as part of unit price repair items.
- Final Clarifier #4 will be refurbished. Structural steel and other ferrous metallic surfaces will be repainted in the field. No repainting is anticipated for Final Clarifiers #1–#3.

### 7.19 Area #32 – Junction Box #3 Upgrades Summary

The following Structural upgrades are proposed for Junction Box #3:

- Existing serrated galvanized steel grating and plywood cover will be replaced with new flat panel aluminum covers to prevent algal growth in the box.
- New IBC and OSHA compliant aluminum stairs will be provided.
- An aluminum safety railing will be provided at the perimeter.
- Any concrete cracking or spalling identified during construction will be repaired as part of unit price repair items.
- Exterior of structure will be repainted to match the existing color and texture

### 7.20 Area #34 – Effluent Pump Station Upgrades Summary

The following Structural upgrades are proposed for the Effluent Pump Station:
• New IBC and OSHA compliant aluminum stairs will be provided.
• An aluminum safety railing will be provided at the perimeter on sides as needed for fall protection. Area by access driveway will include removable safety rails
• Wet Well and Valve Vault access hatches will receive safety netting for fall protection and hatch frames will be cleaned of debris.
• The lifting systems within the valve vault will be analyzed by a structural engineer and labeled with signage indicating the appropriate load rating.
• Any concrete cracking or spalling identified during construction will be repaired as part of unit price repair items.
• Exterior of Structure will be repainted
• Interior of valve vault, structural steel and process piping will be repainted

7.21 Area #35 – Gravity Bypass Valve Vault Upgrades Summary
The following Structural upgrades are proposed for the Gravity Bypass Valve Vault:
• Cracks in concrete cover slab will receive rout & seal repairs
• The source of water intrusion should be investigated (groundwater leaking through concrete cracks, joints or pipe penetrations, leaking valves or piping, etc.) and the proper repairs should be made.
• Any additional concrete cracking or spalling identified during construction will be repaired as part of unit price repair items.

7.22 Area #36 – Old Chlorine Building Upgrades Summary
The following Structural upgrades are proposed for the Old Chlorine Building:
• Asphalt roof shingles will be replaced, and self-adhered underlayment provided for the entire roof area.
• All wood roof eave and rake trim will be demolished and replaced with painted poly-ash trim.
• Gable end attic vents will be replaced
• Gable end siding will be demolished and replaced with fiber cement siding
• Gutters and down spouts will be replaced with a new seamless gutter system.
• Existing CMU openings will be infilled where louvers are demolished.
• Exterior of structure will be repainted to ensure weather tight seal
• Interior CMU walls will be repainted in areas of demolished equipment or in areas with louver infills
• Existing windows between existing Electrical Room & chlorine rooms will be demolished and infilled with CMU to allow for mounting of new electrical gear.
• The monorail beam will be analyzed by a structural engineer and labeled with signage indicating the appropriate load rating as the lack of load rating is an OSHA violation and a safety hazard.

• The interior partition wall, window and door between the former Chlorine Feeder Room and Chlorine Supply Room will be demolished to make room for new electrical equipment.

• New concrete equipment pads will be provided under proposed electrical equipment.

• The concrete floor will be repaired where existing concrete equipment pads are demolished.

7.23 Area #37 – Process Water Pump Station Upgrades Summary

The following Structural upgrades are proposed for the Process Water Pump Station:

• Interior and exterior CMU will be repainted in areas of demolished equipment and appurtenances.

• CMU walls where new electrical gear will be mounted will receive crack and joint repairs in CMU.

• New concrete equipment pads will be provided under proposed electrical equipment.

• The concrete floor will be repaired where existing concrete equipment pads are demolished. Also, numerous cracks in concrete floor should receive rout & seal repairs.

7.24 Area #46 – Blower Building Upgrades Summary

The following Structural upgrades are proposed for the Blower Building:

• The through-fastened metal roof will be replaced in kind with the addition of insulation, seamless gutters and downspouts.

• Existing exterior metal wall panel openings will be infilled where louvers are demolished. Exterior will be repainted to match existing colors and finishes.

• The lifting systems will be analyzed by a structural engineer and labeled with signage indicating the appropriate load rating as the lack of load rating is an OSHA violation and a safety hazard.

• New concrete equipment pads will be provided under proposed equipment.

• The concrete floor will be repaired where existing concrete equipment pads are demolished.

7.25 Area #49 – Old UV Building Upgrades Summary

The following Structural upgrades are proposed for the Old UV Building:

• Asphalt roof shingles will be replaced, and self-adhered underlayment provided for the entire roof area. The roof ridge and ventilation box (old skylight area) that protrudes out of the roof will demolished and the roof rebuilt with a conventional ridge vent matching into the adjacent roof lines.

• All wood roof eave and rake trim will be demolished and replaced with painted poly-ash trim.

• Gutters and down spouts will be replaced with a new seamless gutter system.
- Existing CMU openings will be infilled where louvers are demolished.

- The upper level crane rail system and lower level lift hooks will be analyzed by a structural engineer and labeled with signage indicating the appropriate load rating as the lack of load rating is an OSHA violation and a safety hazard.

- New concrete equipment pads will be provided under proposed equipment.

- The concrete floor will be repaired where existing concrete equipment pads are demolished.

- Interior and exterior CMU walls will be repainted in areas with selective demolition of equipment

- Interior ceiling will be reframed with added insulation in area of demolished skylight. Ceiling and trim will be repaired in areas which experienced water intrusion.

- Gable end attic vents will be replaced

- Gable end siding will be demolished and replaced with fiber cement siding

**7.26 Area #51 – High Flow Discharge Pump Station Upgrades Summary**

A new High Flow Discharge Wet Well will be constructed as part of this project. The structure will be a below grade and above grade structure to ensure the top of the structure is at least 3-feet above the flood elevation. Hatches in the cover system will be aligned with the pumps below for easy maintenance access and be provided with safety netting for fall protection. Ground improvements below the structure will consist of earthquake drains and/or aggregate piers to mitigate liquefaction and settlement issues. Ground improvement will also increase allowable bearing pressures allowing for deeper structures with less plan area. The following Structural upgrades are proposed for the High Flow Discharge Pump Station:

- Below grade cast-in-place concrete wet well and valve vault
- Sealed aluminum cover system with access hatches and safety netting for wet well
- Pre-cast concrete plank or cast-in-place cover for valve vault
- IBC and OSHA compliant aluminum access stairs and safety rails
- Concrete fills and fillets sized for pumps in wet well
- Sloped concrete fill in valve vault to allow for drainage to sump
- Structure will be evaluated with regard to anti-floatation given the installed location in the floodplain

**7.27 Area #52 – Cascade Aeration System Upgrades Summary**

The Cascade Reaeration System will be an approximately 20-foot-long, 10-foot-wide, 9-foot-deep, cast-in-place concrete structure. The interior will be configured to provide seven 12-inch steps with concrete fill, splitter piers and shot rock projecting three to four inches out of each step. It will be designed as a water-tight structure utilizing typical tank construction details. The structure bottom step will be located 3 feet above the 100-year flood elevation. An aluminum cover system with access hatches will be provided. The structure will include IBC and OSHA compliant aluminum access stairs and safety rails for fall protection.
7.28 Area #53 – High Flow Discharge Outfall Upgrades Summary

A portion of the new outfall to the Peruque Creek will be incased in concrete to protect the piping from debris and impact. The concrete will be reinforced to provide temperature and shrinkage steel ratios as recommended by the American Concrete Institute.

7.29 Area #19 – New Aeration Blower Building

The New Aeration Blower Building will have approximate interior dimensions of 61'-0" by 33'-0" and an interior ceiling clear height of 15'-6". The following structural features will be incorporated into the design:

- Exterior CMU walls cladded with metal siding over foil-faced polyisocyanurate insulation to meet current energy codes. Metal siding will be designed to match the existing color and appearance of the Main Office Building and Biosolids Treatment Building to ensure uniformity of the architecture at the project site.

- The new roof will consist of metal decking over painted steel framing. A mechanically fastened membrane roof with tapered insulation to roof scuppers and downspouts to a storm drainage system will be provided.

- 2-ton rated monorail beams, with manual hoists and push-type trolleys over blowers for maintenance.

- Interior finishes will be in accordance with the following schedule:

  Table 7-6 New Aeration Blower Building Interior Finish Schedule

<table>
<thead>
<tr>
<th>Area</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Floor Slab</td>
<td>Finished with a concrete hardener</td>
</tr>
<tr>
<td>Interior Walls</td>
<td>Painted CMU</td>
</tr>
<tr>
<td>Ceiling</td>
<td>Painted Steel framing and galvanized metal decking</td>
</tr>
<tr>
<td>Man Doors</td>
<td>Flush, painted hollow metal double doors</td>
</tr>
</tbody>
</table>

7.30 Hazardous Materials

Geotechnology, Inc. conducted limited asbestos and lead-based paint surveys of the Bio-filter Complex and Sludge Blower Building given the age of these buildings. A copy of the survey is included in Appendix N.

The following items were identified as asbestos-containing:

- The floor tile and mastic within the Bio-Filter Complex. This is primarily located in the administrative spaces and will not be impacted by the work of this project.

- Interior door / window caulk within the Sludge Blower Building. These joint sealants will be demolished as applicable for improvements to the building as part of this project. The contract documents will contain provisions for licensed mitigation contractors to conduct this work.

- Exterior window glazing of the Sludge Blower Building. This will not be impacted by the work of this project.

- Exterior seam caulk of the Sludge Blower Building. These joint sealants will be demolished as applicable for improvements to the building as part of this project. The contract documents will contain provisions for licensed mitigation contractors to conduct this work.
The following items were identified to contain lead-based paint:

- The yellow metal pump piping on the Digested Sludge Pumps located in the southeast lower pump room of the Bio-Filter Complex below Bio-Filter Tower #3. This piping will not be impacted by the work of this project.

- The green metal blower and piping of the Sludge Blower Building. The blower suction piping will be modified and will require removal by a licensed abatement contractor prior to any demolition or renovation activities that may impact it.
8. HVAC

The purpose of Chapter 8 is to provide an overview of the design criteria and considerations for the Heating, Ventilation & Air Conditioning (HVAC) elements related to the project. Design criteria, codes, standards and the preliminary design approach for each area of the project have been included. Upgrades have been organized for each building, unit process room and space as part of the proposed project.

8.1 Building Codes and Design Standards

The City of O’Fallon has adopted the 2015 IBC for regulating and governing the construction, alteration, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal, and demolition of all buildings and structures. All HVAC work will comply with the building codes and standards adopted by IBC and listed in the following table.

<table>
<thead>
<tr>
<th>Version</th>
<th>Code</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>International Mechanical Code (IMC)</td>
<td>Requirements for HVAC</td>
</tr>
<tr>
<td>2015</td>
<td>International Existing Building Code (IEBC)</td>
<td>Regulates the repair, alteration, change of occupancy, or addition to existing buildings.</td>
</tr>
<tr>
<td>2015</td>
<td>International Energy Conservation Code (IECC)</td>
<td>Insulation requirements for buildings</td>
</tr>
<tr>
<td>2016</td>
<td>American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 62.1</td>
<td>Ventilation for Acceptable Indoor Air Quality</td>
</tr>
<tr>
<td>2016</td>
<td>ASHRAE 90.1</td>
<td>HVAC Standards for Buildings</td>
</tr>
<tr>
<td>2016</td>
<td>National Fire Protection Association (NFPA) 54</td>
<td>National Fuel Gas Code</td>
</tr>
<tr>
<td>2016</td>
<td>NFPA 820</td>
<td>Fire Regulations</td>
</tr>
</tbody>
</table>

8.2 Area #4: Headworks Building HVAC Upgrades Summary

The Headworks Building currently has deficiencies in the Screen Room and Electrical Room. In the Electrical Room the current HVAC system does not adequately cool the electrical equipment. Also, in the Electrical Room the HVAC system brings in dust and pollen from outside. In the Screen Room the HVAC system does not provide adequate air movement throughout the space, which is caused by the location of the louvers and fans in the room. The Screen Room has broken and corroded HVAC equipment. The City staff have also noted that the existing HVAC system creates significant frosting of equipment during the winter months. The existing odor control system is connected to the entire screen room space and fights with the rooms ventilation systems rendering both less effective. New design criteria for the HVAC systems in the existing and new Headworks Building spaces are summarized in the following tables and sections:

8.2.1 Existing & New Electrical Room HVAC Upgrades Summary

The following table and section provides a summary of design criteria and upgrades for the existing and new Electrical Rooms.
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Design Temperature</td>
<td>50°F</td>
</tr>
<tr>
<td>Cooling Design Temperature</td>
<td>85°F</td>
</tr>
<tr>
<td>Hazard Rating</td>
<td>Unclassified</td>
</tr>
<tr>
<td>Sheet Metal Material</td>
<td>Galvanized Steel</td>
</tr>
<tr>
<td>Ventilation Rate</td>
<td>Not Ventilated</td>
</tr>
</tbody>
</table>

- Ductless mini split inverter heat pump for heating and cooling of the new Electrical Room and associated electrical gear.
- Ductless mini-split inverter heat pump for cooling of the existing Electrical Room and associated electrical gear.
- Existing Electric Unit Heater in existing Electrical Room will be salvaged, reused and relocated as needed for improvements to the space.
- Existing wall mounted supply and exhaust louvers along with motor operated dampers will be demolished in existing Electrical Room.
- Existing roof mounted exhaust fan over Meter Room will be demolished. A new exhaust fan will be provided and mounted to the side-wall of the Meter Room. The existing fan will be evaluated during subsequent design for possible reuse depending on condition.

### 8.2.2 Screen Room HVAC Upgrades Summary

The following table and section provides a summary of design criteria and upgrades for the Screen Room.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Design Temperature</td>
<td>50°F</td>
</tr>
<tr>
<td>Cooling Design Temperature</td>
<td>N/A</td>
</tr>
<tr>
<td>Hazard Rating</td>
<td>C1/D1, Group D Explosion Proof</td>
</tr>
<tr>
<td>Sheet Metal Material</td>
<td>Aluminum</td>
</tr>
<tr>
<td>Ventilation Rate</td>
<td>12 ACH Occupied</td>
</tr>
<tr>
<td></td>
<td>3 ACH Unoccupied</td>
</tr>
</tbody>
</table>

- Selective demolition of existing electric unit heaters, louvers, and exhaust fan to provide more even airflow and distribution to the Screen Room.
- Existing supply air louver and motor operated damper (currently broken) on West wall will be demolished and relocated to facilitate the new Electrical Room expansion.
- Existing FRP odor control duct will be extended and connected to headspace below new aluminum flat panel cover system over channels. Exhaust air flows to the odor control system will be coordinated with the room ventilation.
- Electric unit heaters with Heresite® or equivalent coating for heating the Screen Room to provide improved corrosion resistance.
• Exhaust fan will be provided with variable speed control and a Hand/Off/Remote selector switch to allow for a decreased or no ventilation during un-occupied periods to allow for energy efficiency during the winter months. Fan will be provided with a ducted supply to allow scouring of corrosive sewer gasses which typically accumulate lower in the room.

• New supply louver and motor operated damper.

• Exhaust louver will be reused with new motor operated damper.

8.2.3 Grit Room HVAC Upgrades Summary

There will be no work done to the HVAC system in the Grit Room as part of this project.

8.3 Area #16 - Bio-Filter Complex HVAC Upgrades Summary

The City staff have indicated that the Bio-Filter Complex Garage Air Handling Unit is currently not functioning properly. Upgrades to this unit specifically are not included in the scope of this upgrade. The Garage Air Handling Unit also services several other rooms, all of which are discussed in the following sections. Design criteria for the HVAC equipment at the Bio-Filter Complex have been summarized in the following sections. The upgrades have been broken down into different spaces.

8.3.1 Garage Area HVAC Upgrades Summary

The following table and section provides a summary of design criteria and upgrades for the Garage Area.

• Existing Air Handling Unit (AHU) supports and portions of duct work in Garage will remain

• Existing electric unit heaters in garage space will remain in place.

• Existing roof mounted Exhaust Fan (EF) will be salvaged and reused. Controls will be provided as part of new electrical upgrades to allow manual operation of the fan to allow use as needed for maintenance activities within the Garage.

• Existing Supply Fan (SF) which feeds outside air to the WAS wet well will remain and be reused. Controls will be provided as part of new electrical upgrades to allow for manual operation as needed by staff. New intake hood will be provided at roof.

8.3.2 Existing Garage Area Electrical Room HVAC Upgrades Summary

The following section provides a summary upgrades for the existing Garage Area Electrical Room.

• Existing air conditioning unit and exterior condensing unit will remain in place.

• No additional HVAC upgrades to this space are planned for this project.

8.3.3 New Garage Area Electrical Room HVAC Upgrades Summary

The following section provides a summary upgrades for the New Garage Area Electrical Room. The existing office and storage space adjacent to the existing Electrical Room in the Garage will be repurposed as a new Electrical Room.
Table 8-4  New Electrical Room HVAC Design Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Design Temperature</td>
<td>50°F</td>
</tr>
<tr>
<td>Cooling Design Temperature</td>
<td>85°F</td>
</tr>
<tr>
<td>Hazard Rating</td>
<td>Unclassified</td>
</tr>
<tr>
<td>Sheet Metal Material</td>
<td>Galvanized Steel</td>
</tr>
<tr>
<td>Ventilation Rate</td>
<td>Not Ventilated</td>
</tr>
</tbody>
</table>

- The new Electrical Room will be equipped with a ductless mini-split inverter heat pump for cooling and heating of the new Electrical Room and associated electrical gear.

8.3.4 Existing Interior Electrical (MCC) Room HVAC Upgrades Summary

The following section provides a summary of upgrades for the existing Interior Electrical (MCC) Room.

- Existing ductwork, diffusers, registers and grilles will remain in place.
- No additional HVAC upgrades will occur in this space as part of this project

8.3.5 Existing Blower Room HVAC Upgrades Summary

The following section provides a summary of upgrades for the existing Blower Room.

- Two existing ductless mini-split heat pumps cooling existing Blower Room will be salvaged and relocated to another space of the facility
- Existing wall mounted louvers and dampers to be demolished
- No additional HVAC upgrades will occur as part of this project

8.3.6 Existing Basement HVAC Upgrades Summary

The following section provides a summary of upgrades for the existing Basement (Pump Room).

Table 8-5  Basement HVAC Design Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Design Temperature</td>
<td>60°F</td>
</tr>
<tr>
<td>Cooling Design Temperature</td>
<td>85°F</td>
</tr>
<tr>
<td>Sheet Metal Material</td>
<td>Aluminum</td>
</tr>
<tr>
<td>Hazard Rating</td>
<td>Unclassified with Ventilation</td>
</tr>
<tr>
<td>Ventilation Rate</td>
<td>6 ACH</td>
</tr>
</tbody>
</table>

- Evaluation of heating, cooling, and ventilation requirements for the Pump Room
- Heat Recovery Ventilator (HRV) located in Garage to serve pump room to provide six air changes per hour (ACH)
• Heating of the space is anticipated to be via new electric unit heaters or an electric duct coil in the HRV supply air duct.

• Currently the Basement is equipped with Supply and Return duct which is connected to the AHU in the Garage. The duct for this space is proposed to be disconnected from the AHU and connected to an HRV which is dedicated to serve and condition the Basement independently of the rest of the rooms and spaces of the Building. This approach will be evaluated as part of subsequent design phases in conjunction with the ability to physically separate the Basement from the existing Electrical Room.

8.3.7 Sludge Pump Room HVAC Upgrades Summary

No HVAC Upgrades in the existing Sludge Pump Room below Bio-Filter Tower #3 are proposed for this project.

8.3.8 Office, Restroom & Administrative Spaces HVAC Upgrades Summary

No HVAC Upgrades in the existing Office, Restroom or Administrative spaces are proposed as part of this project.

8.4 Area #19 - New Blower Building Upgrades Summary

Design criteria and upgrades for the HVAC equipment for the New Aeration Blower Building are summarized in the following table and section.

<table>
<thead>
<tr>
<th>Table 8-6 New Aeration Blower Building HVAC Design Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria</td>
</tr>
<tr>
<td>Heating Design Temperature</td>
</tr>
<tr>
<td>Cooling Design Temperature</td>
</tr>
<tr>
<td>Hazard Rating</td>
</tr>
<tr>
<td>Sheet Metal Material</td>
</tr>
<tr>
<td>Ventilation Rate</td>
</tr>
</tbody>
</table>

• New AHU for heating, cooling, and ventilation of the space. Due to the size and cooling load associated with this building it is anticipated that the new AHU will be a ground mounted unit.

8.5 Area #34 - Effluent Pump Station HVAC Upgrades Summary

Design criteria and upgrades for the HVAC equipment at the Effluent Pump Station are summarized in the following table.

<table>
<thead>
<tr>
<th>Table 8-7 Effluent Pump Station HVAC Design Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria</td>
</tr>
<tr>
<td>Heating Design Temperature</td>
</tr>
<tr>
<td>Cooling Design Temperature</td>
</tr>
<tr>
<td>Electrical Hazard Rating</td>
</tr>
<tr>
<td>Sheet Metal Material</td>
</tr>
<tr>
<td>Occupied Ventilation Rate</td>
</tr>
<tr>
<td>Unoccupied Ventilation Rate</td>
</tr>
</tbody>
</table>

• Valve Vault: Existing corroded electric unit heater supports, and thermostat will be demolished.
8.6 Area #36 – Old Chlorine Building HVAC Upgrades Summary

The Old Chlorine Building HVAC system does not adequately cool the electrical equipment. Also, in the Electrical Room the HVAC system brings in dust and pollen from outside. Design criteria for the HVAC equipment at the Old Chlorine Building have been summarized in the following table. The building contains two separate spaces, an existing Electrical Room and old Chlorine Gas delivery equipment spaces that will be repurposed into a new Electrical Room as part of this project.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Design Temperature</td>
<td>50°F</td>
</tr>
<tr>
<td>Cooling Design Temperature</td>
<td>85°F</td>
</tr>
<tr>
<td>Electrical Room Hazard Rating</td>
<td>Unclassified</td>
</tr>
<tr>
<td>Sheet Metal Material</td>
<td>Galvanized Steel</td>
</tr>
<tr>
<td>Ventilation Rate</td>
<td>Not Ventilated</td>
</tr>
</tbody>
</table>

Demolition of existing louvers, dampers and exhaust fan in the existing Electrical Room

Ductless mini split inverter heat pumps for cooling of existing Electrical Room and associated electrical gear

Ductless mini split inverter heat pumps for cooling of new Electrical Room and associated electrical gear

Existing Electric Unit Heaters will be salvaged and reused. Heaters will be relocated as needed to accommodate new electrical gear

Existing exhaust fan, louvers and dampers for the old chlorine rooms will be demolished

Existing electric unit heaters in existing Electrical Room will be salvaged, reused and relocated as needed.

8.7 Area #37 - Process Water Pump Station HVAC Upgrades Summary

The existing Process Water Pump Station HVAC system does not adequately cool the electrical equipment. Also, the HVAC system currently brings in dust and pollen from outside. Design criteria and upgrades for the HVAC equipment in the Process Water Pump Station are summarized in the following table.
### Table 8-9  Process Water Pump Station HVAC Design Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Design Temperature</td>
<td>50°F</td>
</tr>
<tr>
<td>Cooling Design Temperature</td>
<td>85°F</td>
</tr>
<tr>
<td>Hazard Rating</td>
<td>Unclassified</td>
</tr>
<tr>
<td>Sheet Metal Material</td>
<td>Galvanized Steel</td>
</tr>
<tr>
<td>Occupied Ventilation Rate</td>
<td>33.5 ACH (Existing System)</td>
</tr>
<tr>
<td>Unoccupied Ventilation Rate</td>
<td>Not Ventilated</td>
</tr>
</tbody>
</table>

- Existing exhaust fans, louvers and dampers will remain and be reused.
- Ductless mini split inverter heat pumps for cooling
- Louvers and exhaust fan to ventilate space while occupied or desired by plant staff. System will not operate while space is unoccupied. The system will be equipped with a dedicated Start/Stop switch to allow for operation as desired by City staff.
- Existing electric unit heater will be salvaged and reused.

### 8.8 Area #46 - Sludge Blower Building HVAC Upgrades Summary

The existing Sludge Blower Building HVAC system does not adequately cool the electrical equipment. Also, the HVAC system currently brings in dust and pollen from outside. Design criteria and upgrades for the HVAC equipment in the Sludge Blower Building are summarized in the following table and sections.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Design Temperature</td>
<td>50°F</td>
</tr>
<tr>
<td>Cooling Design Temperature</td>
<td>85°F</td>
</tr>
<tr>
<td>Hazard Rating</td>
<td>Unclassified</td>
</tr>
<tr>
<td>Sheet Metal Material</td>
<td>Galvanized Steel</td>
</tr>
<tr>
<td>Ventilation Rate</td>
<td>ASHRAE 62.1</td>
</tr>
</tbody>
</table>

- Demolition of existing exhaust fans, louvers and dampers
- Installation of smaller exhaust fans, louvers and dampers to allow for ventilation of the space as desired by City staff.
- Ductless mini split inverter heat pumps or air handling unit for heating and cooling

### 8.9 Area #49 - Old UV Building Upgrades Summary

The existing Old UV Building HVAC system does not adequately cool the electrical equipment. Also, HVAC system currently brings in dust and pollen from outside. Design criteria and upgrades for the HVAC equipment in the Old UV Building are summarized in the following table and section.
### Table 8-11 Old UV Building HVAC Design Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Design Temperature</td>
<td>50°F</td>
</tr>
<tr>
<td>Cooling Design Temperature</td>
<td>85°F</td>
</tr>
<tr>
<td>Hazard Rating</td>
<td>Unclassified</td>
</tr>
<tr>
<td>Sheet Metal Material</td>
<td>Galvanized Steel</td>
</tr>
<tr>
<td>Ventilation Rate</td>
<td>ASHRAE 62.1</td>
</tr>
</tbody>
</table>

- Selective demolition of existing exhaust fan, supply fan, electric duct coil, louver, and dampers
- Existing electric unit heaters will be salvaged and reused
- Existing sheet metal duct work will be salvaged and reused as applicable to new ventilation
- Ductless mini split inverter heat pumps for cooling
- Louvers and exhaust fan to ventilate space according to ASHRAE standards
- Ceiling-mounted circulation fan to provide better mixing of air in the space. Fan will be coordinated with existing overhead hoist system and other ceiling mounted equipment.
9. PLUMBING

The purpose of Chapter 9 is to provide an overview of the design criteria and considerations for the Plumbing elements related to the project. Design criteria, codes, standards and the preliminary design approach for each area of the project have been included. Upgrades have been organized for each building, unit process room and space as part of the proposed project.

9.1 Building Codes and Design Standards

The City of O’Fallon has adopted the 2015 International Building Code (IBC) for regulating and governing the construction, alteration, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal, demolition of all buildings and structures. All plumbing work will comply with the building codes and standards adopted by IBC and listed in the following table.

<table>
<thead>
<tr>
<th>Version</th>
<th>Code</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>International Plumbing Code (IPC)</td>
<td>Requirements for Plumbing (With Missouri Amendments)</td>
</tr>
<tr>
<td>2015</td>
<td>International Existing Building Code (IBC)</td>
<td>Regulates the repair, alteration, change of occupancy, or addition to existing buildings.</td>
</tr>
<tr>
<td>2016</td>
<td>NFPA 820</td>
<td>Fire Regulations</td>
</tr>
</tbody>
</table>

9.2 Area #16 - Bio-Filter Complex Upgrades Summary

The following upgrades are proposed in relation to the Bio-Filter Complex plumbing systems. Upgrades are delineated by each room or area.

9.2.1 Bio-Filter Complex Basement Upgrades Summary

The following plumbing upgrades will be provided in the Bio-Filter Complex Basement:

- Existing corroded copper Cold Water (CW) piping, valves, fittings, supports and related appurtenances in Basement will be demolished and replaced with new piping.
- Existing water service entrance will be demolished and replaced with new water service entrance.
- CW piping to each pump seal water system will be provided if the City chooses flushed mechanical seals for new pumps.
- Existing sump pump, discharge piping, supports and related system will be demolished and replaced with new sump pump system.
- Existing floor drains will be cleaned out.
- New CW hose station and rack will be provided with safety signage.
- All new CW piping will be provided with insulation and jacket for condensation mitigation.
- A new dedicated float alarming system will be provided just above the sump to alert City staff in the event of a sump pump failure.
9.2.2 **Bio-Filter Complex Garage Upgrades Summary**

The following plumbing upgrades will be provided in the Bio-Filter Complex Garage:

- An inspection of the existing roof drains will be done. Old roof drains will be demolished, and new roof drains with PVC discharge piping will be provided where required. Roof drain piping will be insulated to prevent condensation.
- New roof drains and CPVC roof leader drain piping will be provided for new roof structures over the demolished Bio-Filter areas. CPVC piping is proposed in this area due to the potential temperature of this space. New roof drain piping will be insulated to prevent condensation if routed through occupied spaces.

9.3 **Area #34 - Effluent Pump Station Upgrades Summary**

The following plumbing upgrades will be provided in the Effluent Pump Station:

- Valve Vault: Existing sump pump, piping, valves and supports will be demolished.
- Valve Vault: New sump pump, piping, valves and supports will be provided.
10. ELECTRICAL

The purpose of Chapter 10 is to provide an overview of the design criteria and considerations for the Electrical elements related to the project. Design criteria, codes, standards and the preliminary design approach for each area of the project have been included. Upgrades have been organized for each building, unit process room and space as part of the proposed project. The following Chapter also identifies the current electrical configuration, as well as the proposed work to be completed in each area. A detailed preliminary approach to sequencing of electrical upgrades along with new Electrical Spaces has been provided.

10.1 Electrical Hazard Classifications

The following table provides a summary of the Electrical Hazard Area Classifications of building spaces, tanks and unit processes included as part of this project. The Area Classifications have been determined in accordance with the National Fire Protection Association (NFPA) Standard for Fire Protection in Wastewater Treatment & Collection Facilities (2016). Electrical and controls work will be designed for compliance with the following Area Classifications as a part of the upgrades.
### Table 10-1 NFPA Electrical Hazard Area Classifications

<table>
<thead>
<tr>
<th>Area</th>
<th>Space Rating</th>
<th>NFPA 820 (2016) Table Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area #4 - Headworks New Electrical Room</td>
<td>Unclassified</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Area #4 – Headworks Control Room</td>
<td>Unclassified</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Area #4 – Headworks Screen Room</td>
<td>Class 1 – Division 1</td>
<td>Table 5.2.2, Row 2, Line a</td>
</tr>
<tr>
<td>Area #6 – Old Headworks (Interior)</td>
<td>Class 1 – Division 1</td>
<td>Table 5.2.2, Row 29, Line a</td>
</tr>
<tr>
<td>Area #6 – Old Headworks (Exterior)</td>
<td>Unclassified</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Area #7 – Junction Box #1 (Interior)</td>
<td>Class 1 – Division 1</td>
<td>Table 4.2.2, Row 29, Line a</td>
</tr>
<tr>
<td>Area #7 – Junction Box #1 (Exterior)</td>
<td>Unclassified</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Areas #8-11 – Primary Clarifiers (Interior)</td>
<td>Class 1 – Division 2</td>
<td>Table 5.2.2, Row 7, Line c</td>
</tr>
<tr>
<td>Areas #8-11 – Primary Clarifiers (Exterior)</td>
<td>Unclassified</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Area #16 – Primary Effluent Pump Station</td>
<td>Unclassified</td>
<td>Table 5.2.2, Row 21</td>
</tr>
<tr>
<td>Area #16 - Biofilter Complex Electrical Room</td>
<td>Unclassified</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Area #16 - Biofilter Complex Basement</td>
<td>Unclassified Via Ventilation</td>
<td>Table 6.2.2, Row 9, Line b</td>
</tr>
<tr>
<td>Area #16 – WAS Parshall Flume (Interior)</td>
<td>Class 1, Division 2</td>
<td>Table 6.2.2, Row 10, Line c</td>
</tr>
<tr>
<td>Area #19 - New Blower Building</td>
<td>Unclassified</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Area #20 – Aeration Splitter Box</td>
<td>Unclassified</td>
<td>Table 5.2.2, Row 21</td>
</tr>
<tr>
<td>Area #21 – WAS Valve Vault</td>
<td>Class 1, Division 2</td>
<td>Table 6.2.2, Row 9</td>
</tr>
<tr>
<td>Area #22-25 – New Aeration Tanks</td>
<td>Unclassified</td>
<td>Table 5.2.2, Row 8</td>
</tr>
<tr>
<td>Area #26 – UV Disinfection System</td>
<td>Unclassified</td>
<td>Table 5.2.2, Row 26</td>
</tr>
<tr>
<td>Area #27 – Junction Box #3</td>
<td>Unclassified</td>
<td>Table 5.2.2, Row 21</td>
</tr>
<tr>
<td>Areas #28-31 – Final Clarifiers</td>
<td>Unclassified</td>
<td>Table 5.2.2, Row 16</td>
</tr>
<tr>
<td>Areas #28-31 – Final Clarifier Scum Pits (Interior)</td>
<td>Class 1 – Division 1</td>
<td>Table 6.2.2, Row 4</td>
</tr>
<tr>
<td>Area #32 – Junction Box #3</td>
<td>Unclassified</td>
<td>Table 5.2.2, Row 27</td>
</tr>
<tr>
<td>Area #34 – Effluent Pump Station Valve Vault</td>
<td>Unclassified</td>
<td>Table 5.2.2, Row 27</td>
</tr>
<tr>
<td>Area #34 – Effluent Pump Station Wet Well</td>
<td>Unclassified</td>
<td>Table 5.2.2, Row 27</td>
</tr>
<tr>
<td>Area #36 – Old Chlorine Building</td>
<td>Unclassified</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Area #37 – Process Water Pump Station</td>
<td>Unclassified</td>
<td>Table 5.2.2, Row 21</td>
</tr>
<tr>
<td>Area #46 – Sludge Blower Building</td>
<td>Unclassified</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Area #49 – Old UV Building</td>
<td>Unclassified</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Area #51 – High Flow Discharge Pump Station</td>
<td>Unclassified</td>
<td>Table 5.2.2, Row 27</td>
</tr>
<tr>
<td>Area #52 – Cascade Aerator</td>
<td>Unclassified</td>
<td>Table 5.2.2, Row 27</td>
</tr>
</tbody>
</table>

#### 10.2 Area #4 - Headworks

The Headworks Building, also referred to as Area #4, houses MCC-4. MCC-4 feeds the influent screening panel, primary clarifiers, grit tank, and feeds MCC-5 in the Process Water Pump Station (Area #37). MCC-4 is rated at 480VAC 3-phase and fed via a 400A circuit breaker located in the Old Chlorine Building (Area #36) Switchboard. The existing motor control center is original to the 1998 Headworks building construction and shows visible signs of age and evidence of corrosion; many of the MCC pilot lights are no longer operational.

#### 10.2.1 Headworks Summary of Upgrades

It is recommended that MCC-4 be replaced. It is also proposed that MCC-5 (Process Water Pump Station) be re-fed from the Old Chlorine Building (Area #36) and a new switchboard, in lieu of MCC-4. The new MCC-4, along with all replacement motor control centers in this project, is proposed to be designed around an Allen-Bradley IntelliCenter MCC. Utilizing and Intelligent, Communications based MCC will allow for connection to the plants existing SCADA...
network via ethernet communications. A new feeder to MCC-4 is proposed including a new reinforced, concrete encased duct bank (under road areas) originating from the Old Chlorine Building. In addition to the items described above, the following upgrades are also proposed as part of the Headworks electrical upgrades:

- Separate the existing Electrical Room from the adjacent grit processing room to allow compliance with NFPA 820 and to prevent corrosion to electrical. Reference Structural Chapter 7 for further discussion on the proposed new dedicated electrical spaces. A sketch of the proposed new electrical area and approximate MCC footprint is presented in Appendix J.

- Replacement of light fixtures in the existing Electrical Room and addition of new fixtures in the new dedicated electrical space. All new lighting to be LED type fixtures.

- New grounding will be tied into the existing grounding system.

- Replacement of Panelboard LP5 and associated dry type transformer. Existing branch circuit conduit and cable to be spliced, extended, and reconnected to the new panelboard. The panelboard will also be evaluated to remain in the same location but with a completely new panelboard depending on the new and existing loads.

- In general, existing 480V wiring will be spliced and extended to the new MCC location.

- Housekeeping pads will be provided for the MCC and dry type transformer. This is typical for all proposed new motor control centers and floor mounted electrical equipment.

10.3 Area #6 - Old Headworks

The Old Headworks was previously fed from the Bio-filter MCC, MCC-1, at the time of the 1981 WWTP Upgrades. The loads included two 1HP comminutors fed from 30A NEMA 3R disconnect switches and associated controls. Both comminutors were fed from starters located in the biofilter MCC at 480VAC 3-Phase. The upgrades in 1991 added a mechanical bar screen, but significant operational issues prevented consistent usage. For all intents and purposes, the electrical equipment located at the Old Headworks building is currently abandoned. Several existing junction boxes are mounted to walls of the existing headworks and some contain active power and control wiring serving other active unit processes. All existing junction boxes are severely corroded and in need of replacement.

10.3.1 Old Headworks Summary of Upgrades

The following upgrades are proposed for the Old Headworks.

- Electrical associated with abandoned and/or non-operational mechanical equipment to be demolished complete back to source.

- All existing electrical conduit, enclosures, and supporting devices showing heavy corrosion will be demolished and active raceways, boxes and supporting devices will be replaced with 304 stainless steel or aluminum enclosures, boxes and supports.

- All existing active wiring and appurtenances shall be replaced and/or re-routed (where applicable) to existing equipment still in service.

10.4 Areas #8-11 - Primary Clarifiers

The Primary Clarifiers are fed from MCC-4, which resides in the Headworks building. Each primary clarifier has a drive motor, a scum collector motor, and a few primary clarifiers have a dedicated scum pump. These pumps and motors
are located at each clarifier, and have junction boxes, conduit, and supporting devices where they transition from underground to above ground wiring. The primary clarifiers are essential components of the process and phasing of all modifications will be considered to ensure minimal system downtime during cutovers.

10.4.1 Primary Clarifiers Upgrades Summary

Significant age-related degradation is present with regards to the primary clarifiers electrical appurtenances. The following electrical upgrades are proposed to the existing primary clarifiers:

- Repair of electrical conduits and junction boxes showing signs of rust and UV degradation (Typ. of all 4 clarifiers). Junction box replacements to be NEMA 4, 4X Stainless steel or aluminum to prevent future corrosion or UV damage.

- To the extent practical, existing wiring will be re-used spliced and extended to the new MCC location.

10.5 Area #16 - Bio-Filter Complex

The Bio-Filter complex houses one of the main electrical distribution points and service entrances for the front end of the plant, this includes two main service circuit breakers, an automatic transfer switch, and a motor control center (MCC). The building is fed by two 14400V primary - 480/277V secondary, 1000kVA transformers, one owned by Ameren Missouri and one by Cuivre River Electric Cooperative, Inc.; the former (Ameren) serves as the primary source. The secondaries extend underground and into two 1200A circuit breakers in the Northwest corner of the garage area, in an un-conditioned containment area. Each enclosed circuit breaker is then connected to the line side of a 1200A rated open-transition ATS, also in the same location, that switches between the primary and secondary feeders upon loss of power. The feed provided by Cuivre River is redundant and provides backup of the Bio-Filter building and associated loads. The existing service configuration, as noted, is 480VAC 3-phase, however this is accomplished through a grounded B-phase configuration which is no longer a typical or current recommended industry standard design approach. The Bio-Filter Complex MCC powers loads related to the final clarifiers, associated sludge pumps, aeration systems (including the blowers), the Main Office Building, as well as loads relating to the Bio-Filter process and Bio-Filter building.

10.5.1 Bio-Filter Complex Upgrades Summary

The proposed upgrades will include replacement of each underground secondary service into the building, both 1200A main circuit breakers, the ATS, and the existing MCC. The proposed design includes configuring each service for a standard 480VAC, 3-phase, 4 wire configuration, with a solid grounded neutral. This design includes a new 3000A rated main switchboard with what is referred to as a “main-tie-main” configuration. Refer to Appendix J for a preliminary one-line sketch which captures this proposed distribution topology. With this, the main bus is doubled-ended with electronically interlocked incoming main-circuit breakers. These interlocked breakers and associated electronic transfer controls would serve as the means to automatically provide an open-transition transfer between each of the available utilities. Additionally, it is proposed that a tie breaker be included in the lineup. This tie breaker allows for additional flexibility during maintenance and reduces impact if a fault condition on either side of the tie breaker. This proposed breaker and feeder approach has been reviewed preliminarily with both Ameren and Cuivre River Electric and it is not anticipated that either utility will have an issue with this approach. Additional continued coordination will occur throughout design.

The new “main-tie-main” switchboard will include feeder breakers for the following:

- New Biofilter MCC
- New Blower Building MCC
- Main Office Building Feeder
- Primary Effluent Pump MDP

The Main Office Building feeder is proposed to be spliced and extended from the existing MCC location to the new Bio-filter MCC location. New feeders will be provided for the New Biofilter Building MCC, Blower Building MCC and the Primary Effluent Pump MDP.

The new Bio-Filter switchboard and Bio-filter MCC is proposed to be installed in an existing office space located on the West side of the garage, adjacent to the room that houses the Primary Effluent Pump VFDs. It is also proposed that a new Biofilter Building MCC would go in this same space and would accommodate the motor controllers that were originally housed within the existing Bio-filter Building MCC. Refer to Appendix J for a preliminary sketch of the proposed new dedicated electrical space.

The following electrical upgrades and distribution modifications will occur at the Bio-Filter Building:

- Replacement of both Ameren and Cuivre River secondary cabling to new switchboard.
- Work with utility companies to evaluate possible replacement of the Ameren and Cuivre River Transformers depending on utility evaluation of system load flow and requirements to accommodate elimination of the grounded B-phase system configuration. New transformer pads would be provided. Currently an allowance for these utility related costs has been included in Chapter 13. Additional coordination will occur in subsequent design phases and a final determination will be provided for each transformer by each utility.
- New main switchboard with a main-tie-main configuration.
- Migration and refeeding of existing loads in the Bio-Filter Building MCC from the new MCC. Existing wiring to be spliced, extended and connected to the new MCC.
- Integration of new surge protection devices.
- Replacement of panelboards and associated dry type transformers located in the biofilter complex existing electrical room. Existing branch circuits would be spliced, extended and reconnected.
- Provisions for a power feed and communications to the new blower building proposed in the scope of this project.
- High bay lighting in the Garage will be replaced by new LED lighting
- Lighting in the new Electrical Room, Existing Electrical Rooms, Basement, Blower Room, Upper Wet Well Roof area, Primary Effluent Pump Wet Well and Building exterior will be replaced with LED Lighting
- Existing lighting in the areas of the demolished Bio-Filter Towers will be demolished completely back to the source.
- No Electrical Upgrades will occur in the Office and Administrative spaces of the building
- No Electrical Upgrades will occur in the Digested Sludge Pump Room under Bio-Filter #3.
10.6 Area #19 – New Aeration Blower Building

The new Aeration Blower Building being constructed as part of this project will be fed via a 480/277VAC feeder from a 1600A breaker in the new switchboard to be installed in the Biofilter Complex (Area #16). The new Blower Building MCC will house the new VFD’s for the new aeration blowers. The new MCC will also feed a panelboard via a step-down transformer to accommodate building loads which include receptacles and lighting. The MCC also houses motor controllers associated with the BNR Tank motor loads. Each BNR Tank includes the following electrical equipment: Four (4) Anoxic Zone Mixers, one (1) Nitrate Recycle Pump, and one (1) Tank Drain Pump. The MCC has provisions for a future recycle pump for each BNR Tank to be installed, for a total of four (4) spaces within the MCC as well.

10.7 Areas #22-25 – New BNR Tanks

All electrical equipment relevant to the BNR Tanks will be powered via feeds in the Blower Building MCC. Lighting, instrumentation and receptacles will also be powered out of power and lighting panels located in the new Blower Building.

10.7.1 Areas #28-31 - Final Clarifiers

The Final Clarifiers are fed from the Bio-Filter Complex MCC, located in the Bio-Filter Building. Each final clarifier has a drive motor and several have dedicated scum pumps. These pumps and motors are located at each clarifier, with junction boxes, conduit, and supporting devices where they transition from underground to above ground wiring occurs at each clarifier. The final clarifiers are essential components of the process and proper phasing of all modifications will be considered to ensure minimal system downtime during cutovers. Existing wiring originating from the original Bio-filter building MCC will be spliced and extended to the new MCC.

10.7.2 Final Clarifiers Upgrades Summary

The following electrical upgrades are proposed for the existing final clarifiers:

- Replacement of miscellaneous junction boxes which have been painted to prevent further degradation. All conduit associated with junction boxes in areas 28-31 should be demolished and replaced in kind. NEMA 4 or 4X aluminum or stainless-steel junction boxes would be utilized for the replacement boxes and enclosures.

- Provide weatherproof While-In-Use covers for the existing receptacles located at the Final Clarifiers.

- Replacement of Final Clarifier #4 drive motor and associated cable and conduit.

- Selective demolition of all scum pumps, control panels and instrumentation. All scum pumps will be replaced with new scum pumps and control instruments. All new scum pumps will be powered out of new MCC buckets in the Old Chlorine Building or Bio-Filter Complex depending upon the distance and routing of wiring.

10.8 Area #36 - Old Chlorine Building

The Old Chlorine Building is an additional electrical service or the WWTP. The building, similar to the Bio-filter Building, is fed at 480V-3 phase from two separate transformers, one 1000kVA primary service transformer owned by Ameren, and one 750kVA backup service transformer owned by Cuivre River. The Cuivre River transformer was installed in 2001 as part of the treatment plant expansion. The Ameren transformer was replaced in 2009 as indicated in the drawings from "Contract B-WWTP and Lift Station Improvements". Similar to the biofilter building electrical service configuration, an automatic transfer switch provides automatic open transition from the primary Ameren service to the Cuivre River service. The Old Chlorine building serves loads at the Headworks Building, the Process Water Pump Station, the Sludge Blower Building, and the Old UV Building. Much of the electrical equipment located in the Old
Chlorine building has been installed since 1991 and was retrofitted in 2004 during the UV Disinfection Project with a split bus and larger primary service cabling. Much of this equipment is older, and past its useful service life. Due to the critical nature of this distribution equipment and its age, the recommendation is for complete replacement of the front end electrical distribution equipment. The new configuration would also provide for consistency between the Old Chlorine Building and Biofilter Building electrical distribution systems.

10.8.1 Old Chlorine Building Upgrades Summary

Consistent with the Bio-Filter Complex electrical upgrades, utilization of a new switchboard with a main-tie-main configuration in Building 36 is recommended in lieu of the existing configuration, which utilizes an ATS to switch between the primary and backup utility services. Refer to Appendix J for a preliminary one-line sketch of the proposed topology. The proposed approach is to utilize the old chlorine storage rooms adjacent to the existing electrical room and repurpose those as a dedicated electrical space. This approach will allow for the new equipment and portions of the new services to be installed in parallel with the existing active equipment to help minimize downtime. Refer to Appendix J for a preliminary sketch of the proposed new electrical space.

The following loads are proposed to be fed from the new Old Chlorine Building switchboard:

- New Headworks MCC-4
- Existing North Lift Station disconnect switch – The new breaker and/or frame in the switchboard for the North Lift Station will be sized to take into account the potential for a future expansion of the North Lift Station as part of a future planned CIP project by the City
- New panelboard in Old Chlorine Building
- New MCC in the Sludge Blower Building
- New MCC-5 in the Process Water Pump Station Building
- New MCC in Old UV Building including integral Effluent Pump VFDs
- New Final Clarifier Scum Pumps – These will either be powered out of the new Old UV Building MCC or the new MCCs in the new Blower Building or Bio-Filter Complex depending on final conduit and cable lengths.

The Chlorine/Electrical building MCC would be removed, and the remaining loads will be fed from a new panelboard and switchboard. With the refeeding of the four existing Effluent Pumps from the Old UV building and the migration of the North Lift Station Feeder to the new switchboard SWBD-001, an MCC wouldn’t be necessary to feed the remaining loads in the Old Chlorine Building, which include power panel PP-1 and the 30kVA transformer feeding LP1. The loads from panel PP-1 will be migrated to the new power panel, and new feeder circuit breakers will be provided for new HVAC equipment and the existing 30kVA transformer that feeds LP1. This change will simplify the electrical system, as one feed to a central power panel from the new switchboard will feed all loads in the Old Chlorine Building and to other buildings and unit processes.

The following items are also proposed to be replaced due to equipment age and degradation:

- Building lighting. Existing lighting on the interior and exterior will be replaced with LED fixtures.
- Panel LP-1 and associated 30kVA dry type transformer. Existing branch wiring would be spliced, extended and reconnected.
- New receptacles in both new and former electrical rooms.
10.9 Area #37 - Process Water Pump Station

The Process Water Pump Station and associated motor control center, MCC-5 is fed underground at 480V-3 phase from a 300A breaker housed within the Headworks Building MCC, MCC-4. MCC-5 feeds a local unit heater, transformer T6, and the Process Water Pump control panel. This Process Water Pump control panel feeds the two 50HP Process Water Pump VFDs.

10.9.1 Process Water Pump Station Upgrades Summary

It is recommended that existing MCC-5 be replaced with a new MCC. The current MCC is used to provide feeder breakers to the process water pump control panel and other miscellaneous loads. The new MCC will house new VFDs for the process water pumps and buckets for other associated motors and loads in the building. The new MCC would be fed from the new Old Chlorine Building switchboard.

The following are also recommended for replacement due to typical age-related degradation:

- Existing Process Water Pump VFDS (Typ. Of 2), VFDs
- Replacement of existing 15kVA step down transformer feeding panel LP6, evaluation of existing load on panel LP6, to determine if transformer upsizing is required.
- Existing building interior and exterior lighting will be replaced with LED fixtures

10.10 Area #46 – Sludge Blower Building

The Sludge Blower Building is fed at 480V-3 phase power via a 400A Breaker in the Old Chlorine Building Switchboard. The electrical distribution equipment located within this building is original to the 1970’s construction. The Blower Building Westinghouse MCC, also referred to as the Old Lab MCC, feeds the two 125HP Sludge Blowers. The MCC also feeds the control panel located at the Influent Equalization Tanks. The remaining loads on the MCC are loads local to the Building, which include exhaust fans, lights, receptacles, unit heaters, etc.

10.10.1 Sludge Blower Building Upgrades Summary

The MCC located in the Sludge Blower Building #46 will be demolished and replaced. The Westinghouse MCC is well past its useful service life and should be replaced. The MCC loads will be migrated in an order that does not interrupt the full functionality of the plant. The new MCC located in Building #46 will be fed from the new switchboard installed in the Old Chlorine Building (Building #36). The existing dry type transformer and downstream panelboard are also proposed to be replaced. Existing branch circuit conduit and cable to be spliced, extended and reconnected. The existing feeder from the Old Chlorine Building to the Sludge Blower Building will be re-fed due to age and condition of the wiring.

10.10.2 Area #49 - Old UV Building

The Old UV Building is currently fed at 480V-3 phase via multiple separate feeders. The area houses the Effluent Pump VFDs, and multiple panelboards. The building itself previously housed a UV disinfection system, which was eventually demolished and replaced with the current open channel UV system in 2008. The old system, which was installed in 2004, included a panelboard, sub-panel, and some lighting and power loads specific to the building itself. These loads were left and the breakers that fed the old UV disinfection equipment were abandoned in place. The building topology is cumbersome for maintenance and fully de-energizing the building, as no single switch de-energizes the Old UV Building.
10.10.3 Old UV Building Upgrades Summary

The upgrades will include installation of a new MCC in the UV building to house VFDs for the four existing Effluent Pumps. The UVP Panel, UVP 2 Panel, UVL Panel and subsequent loads will be powered out of existing 480-volt panelboards. Previously, the UV building had multiple feeds, one for the panelboards, and a separate feed for each wall mounted Effluent Pump VFD (Typ. Of 4). This topology has the potential to introduce confusion, as there are multiple feeds into the building that come from two different pieces of gear within the Old Chlorine Building (Area #36). The feeds for the 4 VFDs come from the MCC, while the UVP panel power comes from a feeder in the existing upstream switchboard. To simplify this configuration, a new, single feed will come from the new switchboard SWBD-001 in the Old Chlorine Building, to feed another new MCC in the Old UV Building (Area #49). This new MCC in the Old UV building will feed the Effluent Pump VFDs and High Flow Discharge Pump VFDs.

The following items are also proposed for replacement due to typical age-related degradation:

- Transformer located to the right of the Effluent Pump VFD #1. The transformer was warm to the touch and will be evaluated for potential size increase.
- The Existing Effluent Pump VFDS are recommended for replacement. These VFDs will be integral to a new MCC in this building.
- The new MCC will also house motor controls and VFDs for the High Flow Discharge Effluent Pump Station which is located adjacent to the Old UV Building.
- Existing interior and exterior building lighting will be replaced with LED lighting

10.11 Area #51 - High Flow Discharge Pump Station

The High Flow Discharge Pump Station being constructed as part of this project will be served via the new MCC to be installed in the Old UV Building. The MCC includes provisions for the three High Flow Discharge Pumps. VFDs which are integral to the MCC will be used for each of these High Flow Discharge Pumps.

10.12 Lighting Upgrades

The following areas are proposed to be upgraded with LED lighting fixtures including all associated conduit, cable, boxes, and switches.

- Area #16 – Bio-Filter Complex Building
  - New electrical room (former office/storage space in Garage)
  - Existing ABF Pump (Primary Effluent Pump) Electrical Room
  - Basement
  - Former MCC room (Old Electrical Room)
  - Open garage area, including high bay lighting
  - Blower Room
  - Upper Level Wet Well – Building Exterior
- Roof Structure – Building Exterior At Blower Room
- Building Exterior Lighting

- Area #36 - Old Chlorine Building
  - Former electrical room
  - New electrical room
  - Exterior Building Lighting

- Area #4 - Headworks Building
  - Former electrical room
  - New electrical room
  - Addition of a full cutoff wall pack for exterior of new electrical room structure
  - Exterior Building Lighting

- Area #46 – Sludge Blower Building
  - Existing Blower Room

- Area #49 – Old UV Building
  - Interior Lighting – Both Levels
  - Exterior Building Lighting

- Area #19 – New Blower Building
  - All new interior and exterior building lighting

- Area #20 – New Aeration Splitter Box
  - All new exterior mounted lighting

- Areas #22-25 – New BNR Tanks
  - All exterior mounted lighting at the new BNR Tanks

- Area #51 – High Flow Discharge Pump Station
  - All exterior mounted lighting at wet well and valve vault

- Area #52 – Cascade Reaeration System
  - All exterior mounted lighting at Cascade Reaeration System

- Exterior
10.13 Fire Detection Evaluation

The areas addressed in the scope of this project have been evaluated with respect to the International Building Code. Our investigations have yielded that these areas are classified as F-1 “Low-hazard factory industrial” spaces, and as such there is no code requirement for a fire protection system that provides direct notification to the fire department. The recommended approach is to provide heat and smoke detectors and tie each into the new plant SCADA system, providing local notification, and allowing the operators to determine whether the need exists to notify the fire department. These alarms will also be provided for remote notification during periods when City staff may not be at the WWTP. The areas listed below will be provided with separate heat and/or smoke detectors as indicated:

- Area #4: Headworks Building – New & Existing Electrical Rooms
- Area #16: Bio-Filter Complex – Garage, All Electrical Rooms, Basement & Blower Room
- Area #19: New Blower Building
- Area #37: Old Chlorine Building – New and existing Electrical Rooms
- Area #36: Process Water Pump Station
- Area #46: Old Blower Building – Blower Room
- Area #49: Old UV Building

10.14 Electrical Cutover and Sequencing

The intent is to keep all essential process gear operational throughout the duration of construction and downtime kept to a minimum. The new infrastructure is intended to be installed in parallel with the existing electrical equipment wherever possible. The beginning of this section lays out the overall cutover order proposed. The areas are also detailed out below individually to identify the anticipated cutover order of specific critical process loads. All sequencing is preliminary and a final sequencing and cut-over plan will be reviewed in detail with City staff and included in the Contract Documents.

10.14.1 General Cutover Sequence

The general cutover sequence for the affected services is detailed below. The order shown is based on the installation of main, critical path items first, then subsequent items in logical order.

Proposed Cutover Sequence, Bio-Filter Service (By Area)

1. Area 16 – Bio-Filter Complex
2. Area 48 – Main Office Building
3. Area 19 - New Blower Building

Proposed Cutover Sequence, Old Chlorine Building Service (By Area)

1. Area 36 – Old Chlorine Building
2. Area 49 – Old UV Building
3. Area 37 – Process Water Pump Station
4. Area 4 - Headworks
5. Area 46 – Blower Building

10.14.2 Area #4 Headworks

The Headworks MCC, MCC-4 will be replaced and relocated, with a new underground feeder extending from the Old Chlorine Building. The intent is to construct a new room directly above the existing Meter Room. This room will house the new MCC, as well as the replacement lighting panels and associated transformers intended to replace existing equipment in the Control Room. Following is the cutover sequence for Area 4.

Proposed Cutover Sequence

- All electrical from MCC-4 associated with primary clarifier #1 shall be refed, and functionality confirmed before work begins on additional primary clarifiers.
- All electrical from MCC-4 associated with primary clarifier #2 shall be refed, and functionality confirmed before work begins on additional primary clarifiers.
- All electrical from MCC-4 associated with primary clarifier #3 shall be refed, and functionality confirmed before work begins on additional primary clarifiers.
- All electrical from MCC-4 associated with primary clarifier #4 shall be refed, and functionality confirmed.
- All electrical associated with the grit and screening systems, including the blower, screen, wash press, and grit screw, shall be refed, and functionality confirmed. The influent bypass channel can be used during periods when the Influent Screen and Wash Press are taken out of service for re-wiring and re-connection.
- Primary Sludge Pumps will be taken offline sequentially in conjunction with the associated Primary Clarifier.
- All electrical associated with the Headworks building general loads will be migrated to new panels, and functionality confirmed.

10.14.3 Area #6 - Old Headworks

The electrical gear located at the Old Headworks building is mostly abandoned. Any loads still required to be active at this site will be reconnected to their respective sources of power and provided with new cabling and conduit, routing to be consistent with the prior installation. The cutover for this area is not extensive, and the intent is to cut over loads that are existing individually and refeed, until all circuits are replaced.

10.14.4 Areas #8-11 - Primary Clarifiers

The electrical raceways, junction boxes, and supports located at the four Primary Clarifiers are being replaced in kind with more corrosion resistant materials. Any loads still required to be active at this site will be reconnected to their respective sources of power and provided with new cabling and conduit, routing to be consistent with the prior installation. The cutover for this area is not extensive, and the intent is to cut over loads that are existing individually and refeed, until all circuits are replaced. Electrical supporting devices and cabling associated with the 4th clarifier will be removed and replaced in its entirety, allowing the remaining three to be active. The remaining clarifiers will be done individually, with cutover of all electrical to be completed before work begins on the next clarifier. This will ensure that a minimum of 3 clarifiers will be online at any point in time, which means no adverse impact to the process system.
This cutover will be coordinated with City staff and the weather and will not occur during high flow wet weather periods. Below is the cutover sequence for Areas 28-31:

**Proposed Cutover Sequence**

- Area 11 - Primary Clarifier 4: All electrical supporting devices and cabling will be replaced individually, until all circuits have been reconnected and full clarifier functionality confirmed. This includes the supporting Primary Sludge Pump.

- Area 10 - Primary Clarifier 3: All electrical supporting devices and cabling will be replaced individually, until all circuits have been reconnected and full clarifier functionality confirmed. This includes the supporting Primary Sludge Pump.

- Area 9 - Primary Clarifier 2: All electrical supporting devices and cabling will be replaced individually, until all circuits have been reconnected and full clarifier functionality confirmed. This includes the supporting Primary Sludge Pump.

- Area 8 - Primary Clarifier 1: All electrical supporting devices and cabling will be replaced individually, until all circuits have been reconnected and full clarifier functionality confirmed. This includes the supporting Primary Sludge Pump.

**10.14.5 Area #16 - Bio-Filter Complex**

The biofilter distribution system will be installed in tandem with the existing, the intent being to feed it from a new 1000kVA transformer provided to replace the existing Ameren transformer. The new switchboard will be installed in the existing office space in the Garage, which will be repurposed and upgraded to meet the needs of the electrical gear. The repurposed office space will also provide a space for the new Bio-Filter MCC, as well as the MDP Panel replacement. All existing lighting panels and power panels will be replaced in kind, along with any associated transformers. Below is the cutover sequence for Area #16.

**Proposed Cutover Sequence**

- New Switchboard and transformer shall be installed in tandem with existing gear

- New MCC shall be installed in tandem with existing gear

- Electrical gear associated with the Final Clarifiers will be refed from the new MCC, and phased correctly to only allow one clarifier to be down at a time.

- One of the existing Primary Effluent Pumps must remain online at all times (unless bypass pumping occurs by the Contractor) with both the new BNR and existing BF/AS treatment system. The primary effluent pumps will be refed sequentially such that only one pump is offline at any one time. The existing influent Equalization Basins can be used during periods (if any) when all Primary Effluent Pumps need to be take offline for a short duration.

- The Sludge Recirculation Pumps (new RAS Pumps) will be refed sequentially such that only one pump is taken offline at one time

- The existing WAS Pumps will be refed sequentially such that only one pump is taken offline at one time.

- The existing Aeration Blowers will remain fully online until the new Aeration Blower Building electrical systems, MCC, Blowers and BNR Tanks are brought online and fully operational.
10.14.6 Areas #28-31 - Final Clarifiers

The electrical raceways, junction boxes, and supports located at the four Final Clarifiers are being replaced in kind with more corrosion resistant materials. Any loads still required to be active at this site will be reconnected to their respective sources of power and provided with new cabling and conduit, routing to be consistent with the prior installation. The cutover for this area is not extensive, and the intent is to cut over loads that are existing individually and refeed, until all circuits are replaced. Electrical supporting devices and cabling associated with the 4th clarifier will be removed and replaced in its entirety, allowing the remaining three to be active. The remaining clarifiers will be done individually, with cutover of all electrical to be completed before work begins on the next clarifier. This will ensure that a minimum of 3 clarifiers will be online at any point in time, which means no adverse impact to the process system. Below is the cutover sequence for Areas 28-31:

Proposed Cutover Sequence

- Area 31 Final Clarifier 4: All electrical supporting devices and cabling will be replaced individually, until all circuits have been reconnected and full clarifier functionality confirmed. The scum pump will be replaced and refed as part of this sequencing as well.

- Area 30 Final Clarifier 3: All electrical supporting devices and cabling will be replaced individually, until all circuits have been reconnected and full clarifier functionality confirmed. The scum pump will be replaced and refed as part of this sequencing as well.

- Area 29 Final Clarifier 2: All electrical supporting devices and cabling will be replaced individually, until all circuits have been reconnected and full clarifier functionality confirmed.

- Area 28 Final Clarifier 1: All electrical supporting devices and cabling will be replaced individually, until all circuits have been reconnected and full clarifier functionality confirmed. The scum pump will be replaced and refed as part of this sequencing as well.

10.14.7 Area #36 - Old Chlorine Building

The Old Chlorine Building will house critical infrastructure. The new switchboard, MCC, and power panels will be installed in tandem with the existing gear, and each load will be migrated over individually to avoid any interruption to process systems. Below is the proposed cutover sequence for Area #36.

Proposed Cutover Sequence

- Install new Switchboard and Power Panel, as well as associated subpanels and transformers in tandem with existing gear

- Install new feed to Process Water Pump Station, refer to Area #37 sequencing for details.

- Install new feed to Old UV Building MCC, refer to Area #49 sequencing for more details.

- Install new feed to new Sludge Blower Building MCC, refer to Area #46 sequencing for further details.

- Install new feed to Headworks Building and new Electrical Room, refer to Area #4 sequencing for further details.

- Install new feed for North Lift Station, this sequencing will occur during low flow and dry weather periods. The timing will be evaluated in more detail during subsequent design phases and temporary power or temporary bypass pumping may be required by the Contractor.
10.14.8 Area #37 - Process Water Pump Station
The process water pump station will have the existing MCC replaced with a new MCC, to be installed in tandem, and
fed from the new switchgear located in the Old Chlorine building. The existing MCC in the Process Water Pump Station
does not house many loads, but the loads served are critical to the process system. Below is the proposed cutover
sequence for Area #37.

Proposed Cutover Sequence

- Install new power panel alongside existing MCC
- Migrate feeds from existing lighting panel and transformer to new power panel
- Cut over the process water pump control panel, the largest and most critical load in this area. Cutover will
  require downtime as the control panel is a unit, with one feed from a 225A breaker in the existing MCC. The
downtime should be minimal but will be unavoidable. This cutover will be coordinated with City staff and
sludge dewatering operations which require process water as a wash-water source.

10.14.9 Area #46 - Blower Building
The Blower Building will have a new MCC installed in tandem with the existing gear. The loads that still exist in the
MCC will be migrated over individually, and critical process loads shall be identified and swapped over such that
process functionality of the plant is not impeded. One of the WAS Holding Tank blowers will be migrated over at one
time such that aeration service is not lost in the WAS Holding Tank.

10.14.10 Area #49 Old UV Building
The Old UV Building will be provided with a new MCC to replace the existing configuration, which includes multiple
feeds into the building to individual VFDs and a set of power panels. The new MCC will house the effluent pump VFD’s
and High Flow Discharge Pump VFDs. There is one redundant effluent pump, so the process system can remain online
as each is swapped over. The UVP Panel will be refed from a power panel or the new MCC, and downtime should be
minimal. This connection for the UV system can also occur during the non-disinfection season when the UV equipment
is off and not needed. Below is the proposed cutover sequence for Area #37. Any downtime will be coordinated with
City staff. The existing Effluent Control Structure (Area #33) can be used to divert treated effluent to Equalization Basin
#1 during any periods when all Effluent Pumps have to be de-energized.

Proposed Cutover Sequence

- Install New VFD for Effluent Pump #4, reconnect and refeed from new power panel
- Install New VFD for Effluent Pump #3, reconnect and refeed from new power panel
- Install New VFD for Effluent Pump #2, reconnect and refeed from new power panel
- Install New VFD for Effluent Pump #1, reconnect and refeed from new power panel
- Disconnect UVP Panel, reconnect and refeed from power panel or new MCC
11. INSTRUMENTATION & CONTROLS

The purpose of Chapter 11 is to provide an overview of the design criteria and considerations for the Instrumentation & Controls elements related to the project. Design criteria, codes, standards and the preliminary design approach for each area of the project have been included. Upgrades have been organized for each building, unit process room and space as part of the proposed project. The following sections also identify the current controls configuration, as well as the proposed work to be completed in each area.

11.1 Area #48 – Main Office Building

The existing SCADA PC is running a Wonderware ArchestrA HMI application and Allen-Bradley PLC programming and development software. The PLC software will be updated to the latest version to take advantage of new functionality and security advances in the new version. The PLC programming software allows the City to add, remove, or modify program functions to adjust to the changing needs of the equipment and staff. As will be discussed in subsequent sections of this Chapter, the existing Wonderware HMI software will be changed and replaced with a new more robust HMI operating system.

The existing wall-mounted SCADA control panel is located in the basement of the Main Office Building. It consists of an obsolete ControlLogix processor and Flex I/O modules that utilize DH+ communication. Other auxiliary components installed in the control panel that are approaching the end of their usable life consist of an Ethernet switch, fiber-to-copper media converters, UPS, internet modem/router, and power supplies.

11.1.1 Main Office Building Upgrades Summary

The project will upgrade the existing SCADA system for the WWTP as PLC and network components approach the end of their usable life. PLC hardware tends to last anywhere from 10-20 years and during that time replacement parts become more scarce and obsolete. By upgrading the system, the WWTP will have up to date hardware and software versions to ensure SCADA reliability, maintain plant-wide communication equipment consistency, and uphold operational efficiency. The proposed plant-wide network upgrades are represented in the network drawing in Appendix J. The Main office building SCADA and network equipment will be upgraded in this section as described below.

A new floor-mount rack, complete with process servers, demilitarized zone (DMZ) server, managed layer 3 Ethernet switch, fiber media converters and a UPS sized to support all equipment within it, will be installed in the designated location. The process servers will be configured as primary and backup, with mirrored or redundant HMI applications for the plant, including a historian application sized to store historical data for all sites in the SCADA system. A desktop PC, including 24-inch monitor, wireless mouse, keyboard, UPS and laser printer for report printing will be provided in the plant control room to act as the engineering workstation to manage the operation of the servers.

A next-generation firewall (Cisco ASA-5506 series) will be installed to separate the SCADA and city networks. The firewall would be setup in a demilitarized zone (DMZ) architecture, wherein traffic is not allowed to pass directly between the SCADA and city networks, instead terminating in the DMZ. Any data or service that must be shared between the business and control networks must be facilitated by an intermediary asset in the DMZ. Remote access would be facilitated by an SSL VPN session, with user-based access to specified assets using specific protocols. For added security, the VPN would require two-factor authentication (Duo service), requiring users to possess their mobile device in addition to their password. The DMZ architecture, coupled with granular restriction of traffic, drastically reduces the attack surface of the site. Firewalls are not ‘plug and play’ devices, as they contain sets of rules that govern what traffic (in or out) is permitted and what traffic is blocked. The firewall rules will be customized to fit the needs of the site and system and should be reviewed regularly to ensure they are still effective.

A remote alarm notification application (WIN-911) and an automated reporting application (XLReporter) will be installed on the process server. The remote alarm notification application will be programmed to alert staff via voice call, text...
message or email (or combination of those three) when there is a condition that requires their attention. The alarms will be categorized via priority to ensure only the highest priority alarms are remotely communicated to operations staff, reducing nuisance alarm callouts. The WIN-911 application will be configured to call out alarms for all sites in the system. A new autodialer will be installed as a backup to the WIN-911 application in case of server hardware or software failure. If a critical alarm is not acknowledged within a specified period, the SCADA system will trigger an output on the PLC for the autodialer to notify operations staff of an alarm. The automated reporting application will be configured to generate the daily, weekly and monthly reports required by operations staff and regulatory agencies. The existing reports already in use by operations staff will be recreated in XLReporter.

A thin client application (ThinManager) will be installed on the process servers. This application serves instances of the HMI application to the thin client hardware installed in the facility, reducing the number of computers required for visualization in the plant. The hardware requirements for thin clients is greatly reduced and less expensive than traditional desktop PCs, making it more cost-effective in the long run for the City to maintain the system. In addition to the lower cost of hardware and HMI licenses to maintain, the thin client hardware does not run a full Windows OS, eliminating the need for frequent patching and OS obsolescence (i.e. when Microsoft moves to a new Windows release and stops supporting the older releases, requiring new hardware and updated software).

11.1.2 Main Office Building Control Panel Upgrades

It is recommended to upgrade the existing control panel with a new pre-fabricated sub-panel assembled with new ControlLogix PLC hardware and communication equipment that include the following:

- 5580 processor with onboard fast Ethernet communication
- Chassis based I/O modules
  - Discrete I/O will utilize 24VDC. In the case existing field device signals utilize 120VAC, interposing relays will be installed to isolate voltage to maintain this standard PLC design.
  - Analog instrument signals configured for 4-20mA at 24VDC
- Pre-wired IFM modules
- Layer 2 Stratix 5700 series Ethernet switch
- 24VDC power supplies, universal power supply
- Provisions for a future CalAmp Viper radio modem is recommended to serve as the polling master for collection system sites to communicate to the overall SCADA system. The future radio will be used in conjunction with a newly installed antenna mounted on the most appropriate building roof for communication to the remote stations throughout the City. This communication equipment will not be installed as part of this project, but the systems will be setup such that the City can easily include communications, remote monitoring and read/write capabilities to the 18 Lift Stations from the WWTP as part of a planned future CIP Lift Stations Controls Project.

Existing field device I/O will be re-terminated after the new sub panel is installed in the existing control panel enclosure.

11.1.3 Cybersecurity Measures for Network Hardening

The servers and PCs installed as part of this project will be configured based on recognized security benchmarks, including the CIS Security Information Benchmarks, published by the Center for Internet Security (CIS). These benchmarks include recommended technical control rules for hardening operating systems, middleware and software applications, and network devices. The configurations used in the SCADA PCs will be customized to ensure the best performance based on the site’s specific SCADA system architecture.
The SCADA networks will be segmented by logically separating devices into different sub-networks. In a segmented network, devices are not all on the same logical network; a router or layer 3 switch is used to move traffic to different networks. From a network health perspective, failing devices or configuration errors can flood a non-segmented network with traffic, degrading or even halting performance. From a security perspective, an attacker has a much easier time of mapping and manipulating a non-segmented network. Controls may additionally be placed on the routing devices to block unneeded traffic between sub-networks.

11.1.4 Cybersecurity Measures for Managed Services

Once the installation is complete, the City’s IT department (pending coordination) can provide the following additional services for the SCADA system, installed on the proposed DMZ server:

- **Active Directory (AD):** This Windows server role is used to manage assets and users within a domain. It would be used to manage policy for the SCADA machines, such as control user permissions, firewall rules, and permitted software rules. The group policies developed and deployed through AD can be tested and validated with the Windows Security Compliance Manager (SCM) to further ensure compliance with the latest in security advances.

- **Windows Server Update Services (WSUS):** This Windows server role is used to manage operating system updates. Since traffic should not directly traverse the firewall by convention, the WSUS server provides updates to machines in the domain. The WSUS would be configured to only update PCs with patches that have been tested to ensure there is no impact to the SCADA software.

- **File Transfer:** Since traffic cannot directly cross the firewall, and since a hardened PC has removable media disabled, inclusion of a file transfer service facilitates moving data into and out of the control network, such as bringing in new software or providing spreadsheet data to a city network.

- **Antivirus:** In many legacy installations, integrators eschewed the use of antivirus, wary of interoperability with SCADA software. However, today’s threat landscape requires that endpoints be protected. An antivirus server is used to manage the software on the endpoints and to deploy virus definition updates.

- **Security Information and Event Monitor (SIEM):** Without near-continuous detection of strange network or device activity, it is extremely difficult to determine if your SCADA system is compromised. Powerful open-source software will be used to collect logs from all applicable devices, such as PCs, switches, and firewalls. Logs will be monitored to report both on device health and on suspicious network events. This will allow the City to address issues in a timelier fashion and provide visibility into what is occurring on their network. Alerts will be generated to notify designated individuals when anomalous events occur.

11.1.5 Cybersecurity Measures for Disaster Recovery

A SCADA control system requires a plan to recover in case of a hardware failure (i.e. a computer hard drive fails, making all data contained inaccessible), or in the case of a cyber security incident, such as a virus or malware infection. Also, to be considered is a physical catastrophic event, such as a fire, flood, physical damage or theft, which impacts the SCADA system infrastructure. In all cases mentioned above it is imperative that steps have been taken to get the system operational as quickly as possible. The City can utilize the fiber optic network and new server architectures to create a system that will insulate against issues that completely destroy the backup information for the SCADA system. New technology also enhances the volume and frequency of data backup, while fully automating the process.

Critical process information, including historical data, will be stored on a server at the WWTP. Utilizing the secure remote access and file transfer provided by the Cisco ASA and DMZ server, an offsite or cloud backup location can be established for backup images, historical information and other files. Automated scripts will be developed to back up critical images and files across the network to the designated location.
In addition to the technological and physical systems outlined above, we will work with City stakeholders during the design, including the City’s Information Technology (IT) department, to develop a disaster recovery plan that defines the goals of the systems, the information to be backed up, the frequency and timing of backing up files and procedures to periodically test the efficacy of both the data being stored and the media on which it is stored. The IT department may already have backup and data storage processes in place that can be utilized by the new SCADA system. Without proper testing of the stored data and practicing the procedure to restore the system from backup data, there is no guarantee that information will be available or usable when the real need arises.

11.2 Area #4 – Headworks Building

The existing wall-mounted SCADA control panel is located next to MCC-4 in the headworks building existing Electrical Room. It consists of an obsolete ControlLogix processor and Flex I/O modules that utilize DH+ communication. Other auxiliary components installed in the control panel that are approaching the end of their usable life consist of an Ethernet switch, fiber-to-copper media converter, UPS, and power supplies.

11.2.1 Headworks Building Upgrades Summary

This project will include an upgrade the existing SCADA control panel in this area to maintain equipment consistency, gain process visibility, provide local SCADA access, and ensure reliability. The upgrades to the existing control panel consist of replacing the sub-panel and installing a new pre-fabricated sub-panel assembled with new ControlLogix PLC hardware and communication equipment that include the following:

- 5580 processor with onboard fast Ethernet communication
- Chassis based I/O modules
  - Discrete I/O will utilize 24VDC. In the case existing field device signals utilize 120VAC, interposing relays will be installed to isolate voltage to maintain this standard PLC design.
  - Analog instrument signals configured for 4-20mA at 24VDC
- Pre-wired IFM modules
- Layer 2 Stratix 5700 series Ethernet switch
- Thin client touchscreen HMI terminal
- Fiber patch panel, 24VDC power supplies, universal power supply

The control panel will be connected to the existing SCADA network via existing fiber-optic cable from the Main Office Building. To ensure reliability of this communication link, it is recommended the existing fiber optic cable have new connectors installed on each strand and then re-tested prior to final termination to the new fiber patch panel.

Because the existing MCC is being replaced with an intelligent MCC, existing hard-wired motor control conductors will be demolished. A Cat6 Ethernet connection will be installed from the new control panel Ethernet switch to the new MCC Ethernet switch (multiple ethernet drops or daisy trained ethernet connections depending on the MCC manufacturer). This communication link is the only means necessary to control and monitor all loads associated with the new intelligent MCC, freeing up space in the new control panel to accommodate additional controls for new and existing HVAC equipment and future upgrades. The existing influent screening system, grit removal system, primary clarifiers, primary sludge pump stations controls and field devices will be re-terminated after the new sub-panel is installed in the existing control panel enclosure.

The sump in the grit processing room did not include a small float switch to alarm in the event of a sump pump failure and piping leak in the room. A float for alarming is recommended.
11.3 Area #16 – Bio-Filter Complex

The existing floor-mounted SCADA control panel is located in an adjacent storage room from the Bio-Filter Complex Electrical Room. It consists of an obsolete ControlLogix processor and Flex I/O modules that utilize DH+ communication. Other auxiliary components installed in the control panel that are approaching the end of their usable life consist of an Ethernet switch, fiber-to-copper media converter, UPS, and power supplies.

11.3.1 Bio-Filter Complex Upgrades Summary

The project will include upgrades to the existing SCADA control panel in this area to maintain equipment consistency, gain process visibility, provide local SCADA access, and ensure reliability. The upgrades to the existing control panel consist of replacing the sub-panel and installing a new pre-fabricated sub-panel assembled with new ControlLogix PLC hardware and communication equipment that include the following:

- 5580 processor with onboard fast Ethernet communication
- Chassis based I/O modules
  - Discrete I/O will utilize 24VDC. In the case existing field device signals utilize 120VAC, interposing relays will be installed to isolate voltage to maintain this standard PLC design.
  - Analog instrument signals configured for 4-20mA at 24VDC
- Pre-wired IFM modules
- Layer 2 Stratix 5700 series Ethernet switch
- Thin client touchscreen HMI terminal
- Fiber patch panel, 24VDC power supplies, universal power supply

The control panel will be connected to the existing SCADA network via existing fiber-optic cable from the Main Office Building. To ensure reliability of this communication link, it is recommended the existing fiber optic cable have new connectors installed on each strand and then re-tested prior to final termination to the new fiber patch panel.

The new switchboard will be networked to the control panel for breaker status and power monitoring. Because the existing MCC is being replaced with an intelligent MCC, existing hard-wired motor control conductors will be demolished. A Cat6 Ethernet connection will be installed from the new control panel Ethernet switch to the new MCC Ethernet switch. This communication link is the only means necessary to control and monitor all loads associated with the new intelligent MCC, freeing up space in the new control panel to accommodate additional controls for the new HVAC system. Existing field device wiring associated with the primary effluent pump station, final clarifiers, and the RAS/WAS pumping system will be re-terminated after the new sub-panel is installed in the existing control panel enclosure.

11.4 Area #19 – New Aeration Blower Building

The New Aeration Blower Building will contain controls for new electrical equipment for new process upgrades in the area including five aeration blowers, four new aeration tanks (BNR Tanks), and building HVAC. A new SCADA control panel will be provided in this area to expand the SCADA network, gain process visibility, and provide local SCADA access. The new floor-mounted control panel will be installed in the building and assembled with new ControlLogix PLC hardware and communication equipment that include the following:

- 5580 processor with onboard fast Ethernet communication
- Chassis based I/O modules
Discrete I/O will utilize 24VDC. In the case existing field device signals utilize 120VAC, interposing relays will be installed to isolate voltage to maintain this standard PLC design.

Analog instrument signals configured for 4-20mA at 24VDC

- Pre-wired IFM modules
- Layer 2 Stratix 5700 series Ethernet switch
- Thin client touchscreen HMI terminal
- Fiber patch panel, 24VDC power supplies, universal power supply

A new fiber optic cable is required to be installed from the Bio-Filter Complex to the control panel to establish SCADA communications. The routing will coincide with the new duct back to be installed for the new power feeders to the building. A new Cat6 Ethernet connection will be installed from the new control panel Ethernet switch to the new MCC Ethernet switch. This communication link is the only means necessary to control and monitor all loads associated with the new intelligent MCC.

The new control panel will accommodate new controls for the new HVAC system, aeration tank instrumentation (control valves, flow meters, analytical transmitters and level transmitters), aeration blower instrumentation (inlet/outlet differential pressure transmitters and temperature switches), and future I/O capacity.

### 11.5 Area #36 – Old Chlorine Building

An existing wall-mounted SCADA control panel is located in the Old Chlorine Building electrical room. The control panel is connected to the existing SCADA network via existing fiber-optic cable from the Main Office Building and extends the network to the Old UV Building control panel via a media converter. The control panel consists of an obsolete ControlLogix processor and Flex I/O modules that utilize DH+ communication. Other auxiliary components installed in the control panel that are approaching the end of their usable life consist of an Ethernet switch, fiber-to-copper media converter, UPS, and power supplies.

#### 11.5.1 Old Chlorine Building Upgrades Summary

The existing SCADA control panel in this area will be upgraded to maintain equipment consistency, gain process visibility, provide local SCADA access, and ensure reliability. The upgrades to the existing control panel consist of replacing the sub-panel and installing a new pre-fabricated sub-panel assembled with new ControlLogix PLC hardware and communication equipment that include the following:

- 5580 processor with onboard fast Ethernet communication
- Chassis based I/O modules
  - Discrete I/O will utilize 24VDC. In the case existing field device signals utilize 120VAC, interposing relays will be installed to isolate voltage to maintain this standard PLC design.
  - Analog instrument signals configured for 4-20mA at 24VDC
- Pre-wired IFM modules
- Layer 2 Stratix 5700 series Ethernet switch
- Thin client touchscreen HMI terminal
- Fiber patch panel, 24VDC power supplies, universal power supply
To ensure reliability of this communication link, it is recommended the existing fiber optic cable have new connectors installed on each strand and then re-tested prior to final termination to the new fiber patch panel. The new switchboard will be networked to the control panel for breaker status and power monitoring. Refer to Chapter 10, for additional details associated with this new Switchboard. The new control panel will accommodate additional controls for the new HVAC systems in this building as well as other miscellaneous control signals in this area. Existing field device wiring will be re-terminated after the new sub-panel is installed in the existing control panel enclosure.

11.6 Area #37 – Process Water P.S.

The existing SCADA control panel is located in a section of the MCC in the Process Water Pump Station Building. The control panel is standalone consists of an obsolete controls equipment. Operations personnel currently have no means to access data in this area remotely.

11.6.1 Process Water Pump Station Upgrades Summary

A new SCADA control panel will be installed in this area to expand the SCADA network, gain process visibility, and provide local SCADA access. The new wall-mounted control panel will be assembled with new CompactLogix 5370 L2 series PLC hardware and communication equipment that include the following:

- Onboard PLC fast Ethernet communication
- Chassis based I/O modules
  - Discrete I/O will utilize 24VDC. In the case existing field device signals utilize 120VAC, interposing relays will be installed to isolate voltage to maintain this standard PLC design.
  - Analog instrument signals configured for 4-20mA at 24VDC
- Pre-wired IFM modules
- Layer 2 Stratix 5700 series Ethernet switch
- Thin client touchscreen HMI terminal
- Fiber patch panel, 24VDC power supplies, universal power supply

A new fiber optic cable is required to be installed from the Old Chlorine Building control panel to establish SCADA communications.

A new Cat6 Ethernet connection will be installed from the new control panel Ethernet switch to the new MCC Ethernet switch. This communication link is the only means necessary to control and monitor all loads associated with the new intelligent MCC. Existing field device wiring will be re-used and re-terminated after the new control panel is installed.

The existing wet well submersible level transmitter will remain in place and migrated into the new control panel.

11.7 Area #46 – Sludge Blower Building

There is currently no SCADA communication in the Sludge Blower Building. Operations personnel currently have no means to access data in this area remotely.

11.7.1 Sludge Blower Building Proposed Upgrades

The project will include a new SCADA control panel in this area to expand the SCADA network, gain process visibility, and provide local SCADA access. The new wall-mounted control panel will be assembled with new CompactLogix 5370 L2 series PLC hardware and communication equipment that includes the following:
- Onboard PLC fast Ethernet communication
- Chassis based I/O modules
  - Discrete I/O will utilize 24VDC. In the case existing field device signals utilize 120VAC, interposing relays will be installed to isolate voltage to maintain this standard PLC design.
  - Analog instrument signals configured for 4-20mA at 24VDC
- Pre-wired IFM modules
- Layer 2 Stratix 5700 series Ethernet switch
- Thin client touchscreen HMI touchscreen
- Fiber patch panel, 24VDC power supplies, universal power supply

A new fiber optic cable is required to be installed from the Old Chlorine Building control panel to establish SCADA communications. The routing will coincide with the new duct back to be installed for the new power feeders to the building.

A new Cat6 Ethernet connection will be installed from the new control panel Ethernet switch to the new MCC Ethernet switch. This communication link is the only means necessary to control and monitor all loads associated with the new intelligent MCC, including two existing Sludge Blowers.

The new control panel will accommodate additional controls for the new HVAC system and future I/O capacity. New signal wiring for the existing Sludge Blower instrumentation will be installed and routed to the new control panel.

### 11.8 Area #49 – Old UV Building

The existing floor-mounted SCADA control panel is located in the Old UV Building upper level. The control panel is connected to the existing SCADA network via existing fiber-optic cable from the Old Chlorine Building control panel via a media converter. The control panel consists of an obsolete ControlLogix processor and Flex I/O modules that utilize DH+ communication. Other auxiliary components installed in the control panel that are approaching the end of their usable life consist of a UPS and power supply.

#### 11.8.1 Old UV Building Summary of Upgrades

The existing SCADA control panel in this area will be upgraded to maintain equipment consistency, gain process visibility, provide local SCADA access, and ensure reliability. The upgrades to the existing control panel consist of replacing the sub-panel and installing a new pre-fabricated sub-panel assembled with new ControlLogix PLC hardware and communication equipment that includes the following:

- 5580 processor with onboard fast Ethernet communication
- Chassis based I/O modules
  - Discrete I/O will utilize 24VDC. In the case existing field device signals utilize 120VAC, interposing relays will be installed to isolate voltage to maintain this standard PLC design.
  - Analog instrument signals configured for 4-20mA at 24VDC
- Pre-wired IFM modules
- Layer 2 Stratix 5700 series Ethernet switch
- Thin client touchscreen HMI terminal
- Fiber patch panel, 24VDC power supplies, universal power supply

To ensure reliability of this communication link, it is recommended the existing fiber optic cable have new connectors installed on each strand and then re-tested prior to final termination to the new fiber patch panel.

The new control panel will accommodate new controls for the new HVAC system in the Old UV Building. The control panel will also accept control signals from the new High Flow Discharge Pump Station. A new Cat6 Ethernet connection will be installed from the new control panel Ethernet switch to the new MCC Ethernet switch. This communication link is the only means necessary to control and monitor all loads associated with the new intelligent MCC, including the Effluent Pumps and new High Flow Discharge Pumps.

Existing field device wiring will be evaluated and re-terminated after the new sub-panel is installed in the existing control panel enclosure. New submersible level and flow transmitters for the High Flow Discharge Pumps Station and will be installed and wired to this control panel. Existing level instrumentation from the existing Effluent Pump Station will also be integrated into this new Control Panel.
12. FACILITY PROTECTION

The purpose of Chapter 12 is to provide an overview of the design criteria and considerations for the Facility Protection System elements related to the project. Facility protection items include fire protection systems, system safety items, security and hygiene.

12.1 Fire Protection Systems

The existing WWTP does not currently have dedicated Fire Alarm systems or notification stations. A new Fire Alarm system will not be provided as part of the project. As mentioned in Chapter 10, the project will include smoke detectors, heat detectors and duct smoke detectors as applicable for buildings, rooms and HVAC equipment. These devices will be wired into the facilities SCADA system to allow for remote alarming and notification.

The new and existing WWTP buildings and unit processes were all examined with respect for the need for code required fire suppression (sprinkler) systems. None of the new and existing building spaces on the project that are being worked on require a dedicated sprinkler system as part of the project and no new fire suppression systems will be provided as part of the project. Dedicated fire extinguishers will also be provided for all rooms and spaces governed by the associated code requirements.

12.2 Security System

The existing O’Fallon WWTP does not currently have dedicated Security Systems or Closed-Circuit Television (CCTV) systems. New security systems and CCTV systems will not be provided as part of the project. The project will include dedicated door intrusion switches for new buildings and doors which will be connected to the facilities SCADA system to allow for alarming to the plant staff of any unauthorized entry into buildings.

The WWTP site will be enclosed within a perimeter fence to match the existing fence in all areas following the upgrades. Access gates will be provided for plant personnel in several locations and manual vehicle gates will be provided which will be closed and locked when not in use. No additional electrically operated vehicle gates are proposed as part of this project.

12.3 Lightning Protection System

Due to the high value and criticality of the electrical systems a lightning protection system is recommended for the facility as part of the upgrades especially for new buildings and structures or those existing structures which are undergoing roof repairs. The lightning protection systems will be designed to be installed by a certified UL system installer and a UL master label will be provided for the facility for respective spaces following installation. Typically, lightning protection systems cost less than 1% of the value of the critical electrical systems that they protect.
13. PROJECT IMPLEMENTATION

The purpose of Chapter 13 is to summarize the recommended next steps for implementation of the proposed project. An opinion of probable cost, overview of required permits, schedule for construction, and a discussion of next steps are included.

13.1 Opinion of Probable Construction Cost

The total anticipated cost of the project is presented in the table below in 2018 dollars.

**Table 13-1 Opinion of Probable Construction Cost**

<table>
<thead>
<tr>
<th>Bid Item</th>
<th>Description</th>
<th>Unit</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Administration</td>
<td>LS</td>
<td>1</td>
<td>$2,700,000</td>
<td>$2,700,000</td>
</tr>
<tr>
<td>2</td>
<td>Excavation of Unsuitable Materials</td>
<td>CY</td>
<td>500</td>
<td>$30</td>
<td>$15,000</td>
</tr>
<tr>
<td>3</td>
<td>Select Backfill</td>
<td>CY</td>
<td>500</td>
<td>$30</td>
<td>$15,000</td>
</tr>
<tr>
<td>4</td>
<td>Rock Excavation</td>
<td>CY</td>
<td>100</td>
<td>$180</td>
<td>$18,000</td>
</tr>
<tr>
<td>5</td>
<td>Concrete Pavement</td>
<td>SY</td>
<td>350</td>
<td>$70</td>
<td>$25,000</td>
</tr>
<tr>
<td>6</td>
<td>Test Pits</td>
<td>EA</td>
<td>15</td>
<td>$80</td>
<td>$12,000</td>
</tr>
<tr>
<td>7</td>
<td>Testing Allowance</td>
<td>AL</td>
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<td>8</td>
<td>Electrical Service Allowance</td>
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<td>9</td>
<td>Hazardous Materials Demolition</td>
<td>LS</td>
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<td>$20,000</td>
<td>$20,000</td>
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<tr>
<td>10</td>
<td>Grit Removal &amp; Disposal</td>
<td>CY</td>
<td>100</td>
<td>$300</td>
<td>$30,000</td>
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<tr>
<td>11</td>
<td>Two Inch Rigid Insulation</td>
<td>LF</td>
<td>1,000</td>
<td>$10</td>
<td>$10,000</td>
</tr>
<tr>
<td>12</td>
<td>Chain Link Fence</td>
<td>LF</td>
<td>500</td>
<td>$45</td>
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<tr>
<td>13</td>
<td>Type A - Shallow Concrete Spall Repair</td>
<td>SF</td>
<td>500</td>
<td>$60</td>
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<tr>
<td>14</td>
<td>Type B - Deep Concrete Spall Repair</td>
<td>SF</td>
<td>300</td>
<td>$80</td>
<td>$24,000</td>
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<tr>
<td>15</td>
<td>Type C - Concrete Route &amp; Seal Crack Repair</td>
<td>LF</td>
<td>500</td>
<td>$50</td>
<td>$25,000</td>
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<td>16</td>
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<td>LF</td>
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<td>$40</td>
<td>$16,000</td>
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<td>17</td>
<td>Ammonia &amp; High Flow Discharge Upgrades</td>
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<td>18</td>
<td>Special Foundation Construction</td>
<td>LS</td>
<td>1</td>
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<td>$1,000,000</td>
</tr>
</tbody>
</table>

**TOTAL CONSTRUCTION COST** $25,631,000

15% CONSTRUCTION CONTINGENCY $3,845,000

**TOTAL CONSTRUCTION COST (WITH CONTINGENCY)** $29,476,000

*Indeterminate Quantity Used for Bid Comparison

The expected level of accuracy of the cost estimates presented in this Facility Plan is Class 3 in accordance with the Association for the Advancement of Cost Engineering International (AACEI). The expected accuracy for Class 3 estimates and the cost estimate presented in this DBR are within (10-30%) over the estimate to (10-20%) under the estimate. This is appropriate with a Preliminary Design evaluation such as this Facility Plan.
13.2 Permit Application & Regulatory Review

This project includes building of new structures and new buildings. A Wastewater Facility Construction Permit will be required from the MDNR. Additionally, this Facility Plan will require review by the MDNR as a change in a plant unit process will occur as part of this project. This Facility Plan has been configured to include required components of the MDNR PUB2416 which is an Engineering Report/Facility Plan Guidance for WWTFs with a Design Flow of 22,500 gpd or Greater which do not include State or Federal project funding. The MDNR requires an approved Engineering Report/Facility Plan prior to the application for Construction Permit and submission of final Drawings and Specifications. The MDNR Application form MO 780-2617 is required to be completed and included with the report submission.

13.3 Final Design

Final Design is scheduled to be completed in January 2019. A revised project schedule based on the anticipated MDNR Facility Plan and Final Design review times has been included. These review times were based on our preliminary design meeting held with MDNR at the beginning of the project. An updated project schedule has been included in Appendix L.

13.4 Bid Phase

Based on the work previously defined in this report it is anticipated that at 60-days should be allotted for bidding the project following Final Design and Contract Document approval by the MDNR. An updated project schedule has been included in Appendix L.

13.5 Proposed Bid Format

It is recommended that the project will be bid with the following breakout for the Bid Form and the Measurement & Payment basis. The final breakout of bid items will be coordinated with the City as part of the Final Design process and in conjunction with the final approach to pre-procurement of the sludge dewatering and thickening equipment.

Table 13-2 Proposed Measurement & Payment Basis

<table>
<thead>
<tr>
<th>ITEM #1: ADMINISTRATION (Mobilization/Demobilization)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement</strong></td>
<td>Portion of Work completed and accepted</td>
</tr>
<tr>
<td><strong>Payment</strong></td>
<td>Lump Sum (LS)</td>
</tr>
<tr>
<td><strong>Schedule of Payment</strong></td>
<td>50% at Project Commencement &amp; 50% at Substantial Completion. Installation of all Project Signs shall be completed prior to receipt of initial payment at the first Pay Application.</td>
</tr>
</tbody>
</table>

Includes delivery to and removal of equipment from the Project Site, temporary utilities, facilities and controls, obtaining necessary permits including associated fees, insurance and bond costs, signage, development of pre-construction schedules and plans required by the General Conditions, Supplementary Conditions and General Requirements; necessary pre-construction investigations, verifying existing field conditions, coordination, and Site clean-up, restoration and closeout.
<table>
<thead>
<tr>
<th>ITEM #2: EXCAVATION OF UNSUITABLE MATERIALS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement</strong></td>
</tr>
<tr>
<td><strong>Payment</strong></td>
</tr>
<tr>
<td><strong>Schedule of Payment</strong></td>
</tr>
</tbody>
</table>

All materials, equipment, services and construction inherent to the Work and as specified in Division 31. Item includes over-excavation and removal of unsuitable materials outside the limits specified or indicated on the Drawings.

**ITEM #3: SELECT BACKFILL**

| **Measurement**                           | As encountered and as directed by the Engineer |
| **Payment**                               | Unit price per Cubic Yard (CY) |
| **Schedule of Payment**                   | Monthly – based on progress of work |

Includes all materials, equipment, services and construction inherent to the Work. Includes suitable crushed limestone (MoDOT Type 5), compaction and testing associated to replace unsuitable materials.

**ITEM #4: ROCK EXCAVATION**

| **Measurement**                           | As encountered in place prior to excavation within the pay limits as specified and as indicated on the Drawings |
| **Payment**                               | Unit price per Cubic Yard (CY) |
| **Schedule of Payment**                   | Monthly – based on progress of Work |

Includes all materials, equipment, services and construction inherent to the Work. Includes transport and disposal of rock and boulders greater than 2 cubic yards each and replacement as necessary with suitable material.

**ITEM #5: CONCRETE PAVEMENT**

| **Measurement**                           | In place prior to excavation within the pay limits as specified and as indicated on the Drawings.  
| **Measurement for Single Pipe & Utility Trenches:** Square Yard (SY) based on the length of the pipe or utility trench in the paved area and a maximum width of 8 feet measured 4 feet from each side of the center of the pipe, duct or utility.  
| **Measurement for Dual Pipe or Utility Trenches:** Square Yard (SY) based on the length of the pipe or utility trench in the paved area and a maximum width of 8 feet measured 4 feet from each side of the center of the dual pipe, duct or utility trench. |
| **Payment**                               | Unit price per Square Yard (SY) |
| **Schedule of Payment**                   | Monthly – based on actual costs incurred |

All materials, equipment, services, and construction inherent to the Work. Includes shimming, fine grading, bonding agents, base and sub-base below concrete pavement, pavement markings, forms, reinforcement, curing, placement, finishing, expansion joints, sealants, compaction, testing and adjusting all frames, covers and valve boxes and matching into existing driveways and sidewalks.
ITEM #6: TEST PITS

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Number of units installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment</td>
<td>Unit price per Each (EA)</td>
</tr>
<tr>
<td>Schedule of Payment</td>
<td>Monthly – based on progress of Work</td>
</tr>
</tbody>
</table>

All materials, equipment, services, and construction inherent to the Work. Includes, excavation, bedding, backfill, shoring and bracing, compaction, surface restoration, survey of location, size and determination of elevation of existing below grade pipe, utility or structure, and determination of potential conflicts with pipe, utility or structures.

ITEM #7: TESTING ALLOWANCE

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Submit bills from testing firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment</td>
<td>Allowance (AL) - Actual costs incurred</td>
</tr>
<tr>
<td>Schedule of Payment</td>
<td>Monthly – based on actual costs incurred</td>
</tr>
</tbody>
</table>

All materials, equipment, services, and construction inherent to the Work. Includes testing costs, such as compaction tests, concrete testing, etc., that are specified shall be paid for by the Contractor using the allowance allotted in this item. Testing items specified to be the Owner’s responsibility shall also be included under this item. All testing costs shall be billed directly to the Contractor, and a final Change Order will be issued balancing the actual testing costs to the Owner, and the stated allowance.

ITEM #8: ELECTRICAL SERVICE ALLOWANCE

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Submit bills from Ameren Missouri &amp; Cuivre River Electric Cooperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment</td>
<td>Allowance (AL) - Actual costs incurred</td>
</tr>
<tr>
<td>Schedule of Payment</td>
<td>Monthly – based on actual costs incurred</td>
</tr>
</tbody>
</table>

All materials, equipment, services, and construction inherent to the Work. Includes installation of new electrical services and new pad-mounted transformers.

ITEM #9: HAZARDOUS MATERIALS DEMOLITION

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Progress of Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment</td>
<td>Lump Sum (LS)</td>
</tr>
<tr>
<td>Schedule of Payment</td>
<td>Monthly – based on progress of Work</td>
</tr>
</tbody>
</table>

All materials, equipment, services, and construction inherent to the Work. Includes demolition, disposal, site mitigation and related work associated with demolition and disposal of hazardous materials at the project site. Includes all work not included in other bid items.

ITEM #10: GRIT REMOVAL & DISPOSAL

<table>
<thead>
<tr>
<th>Measurement</th>
<th>As encountered and as directed by the Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment</td>
<td>Unit price per Cubic Yard (CY)</td>
</tr>
<tr>
<td>Schedule of Payment</td>
<td>Monthly – based on progress of Work</td>
</tr>
</tbody>
</table>

All materials, equipment, services, and construction inherent to the Work. Includes removal, hauling, and lawful disposal of grit in tanks and structures of the project site locations prior to commencement of selective demolition or new Work. Item shall be based on a typical unit weight of grit of 120 lbs/ft³.
ITEM #11: TWO INCH RIGID INSULATION

| Measurement | In place along the pipe or as directed by the Engineer. |
| Payment     | Unit price per Linear Foot (LF)                         |
| Schedule of Payment | Monthly - based on progress of Work                   |

All materials, equipment, services, and construction inherent to the Work.

ITEM #12: CHAIN LINK FENCE

| Measurement | Along the center line of the fence |
| Payment     | Unit price per Linear Foot (LF)    |
| Schedule of Payment | Monthly – based on progress of work |

All materials, equipment, services, and construction inherent to the Work. Includes posts, tension wire, bracing, rails, stretcher bars, wire fabric, excavation, concrete footings, curing, backfill, compaction and site restoration.

ITEM #13: TYPE A – SHALLOW CONCRETE SPALL REPAIR

| Measurement | As encountered and as directed by the Engineer |
| Payment     | Unit price per Square Foot (SF)                 |
| Schedule of Payment | Monthly – based on progress of Work |

All materials, equipment, services, and construction inherent to the Work. Includes cutting, chipping, surface preparation, repair compounds, bonding agents, patching, curing and finishing in accordance with Specification 03 01 05 – CONCRETE REPAIR and the Drawings. Pay item shall be for Concrete Spall Repair of existing concrete surfaces only. Spall repair of newly constructed concrete included in this project shall not be eligible for payment under this pay item. Spall repair of newly constructed concrete included in this project shall be incidental to all pay items.

ITEM #14: TYPE B – DEEP CONCRETE SPALL REPAIR

| Measurement | As encountered and as directed by the Engineer |
| Payment     | Unit price per Square Foot (SF)                 |
| Schedule of Payment | Monthly – based on progress of Work |

All materials, equipment, services, and construction inherent to the Work. Includes cutting, chipping, surface preparation, repair compounds, bonding agents, patching, curing and finishing in accordance with Specification 03 01 05 – CONCRETE REPAIR and the Drawings. Pay item shall be for Concrete Spall Repair of existing concrete surfaces only. Spall repair of newly constructed concrete included in this project shall not be eligible for payment under this pay item. Spall repair of newly constructed concrete included in this project shall be incidental to all pay items.
ITEM #15: TYPE C – ROUT & SEAL CRACK REPAIR

<table>
<thead>
<tr>
<th>Measurement</th>
<th>As encountered and as directed by the Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment</td>
<td>Unit price per Linear Foot (LF)</td>
</tr>
<tr>
<td>Schedule of Payment</td>
<td>Monthly – based on progress of Work</td>
</tr>
</tbody>
</table>

All materials, equipment, services, and construction inherent to the Work. Includes cutting, chipping, surface preparation, bonding agents, crack sealing, surface patching, curing and finishing in accordance with the Drawings. **Pay item shall be for crack repair of existing concrete surfaces only.** Crack repair of newly constructed concrete included in this project shall not be eligible for payment under this pay item. Crack repair of newly constructed concrete included in this project shall be incidental to all pay items.

ITEM #16: TYPE D – POLYURETHANE GROUT INJECTION

<table>
<thead>
<tr>
<th>Measurement</th>
<th>As encountered and as directed by the Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment</td>
<td>Unit price per Linear Foot (LF)</td>
</tr>
<tr>
<td>Schedule of Payment</td>
<td>Monthly – based on progress of Work</td>
</tr>
</tbody>
</table>

All materials, equipment, services, and construction inherent to the Work. Includes cutting, chipping, surface preparation, bonding agents, crack injection grouting, surface patching, curing and finishing in accordance with Specification 03 63 00 – INJECTION GROUTING and the Drawings. **Pay item shall be for Polyurethane Injection Grouting of existing concrete surfaces only.** Crack repair of newly constructed concrete included in this project shall not be eligible for payment under this pay item. Crack repair of newly constructed concrete included in this project shall be incidental to all pay items.

ITEM #17: AMMONIA & HIGH FLOW DISCHARGE UPGRADES

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Progress of Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment</td>
<td>Lump Sum (LS)</td>
</tr>
<tr>
<td>Schedule of Payment</td>
<td>Monthly – based on progress of Work</td>
</tr>
</tbody>
</table>

All materials, equipment, services, and construction inherent to the Work. Includes demolition, bypass pumping, excavation, shoring, bracing, dewatering, backfill, concrete forming, cast-in-place concrete, concrete reinforcement, form removal, insulation, erosion control, site work, piping, pipe fittings, valves, plumbing, electric, controls, structural, architectural, HVAC, communications, process equipment, testing, startup and all work not included in other bid items.

ITEM #18: SPECIAL FOUNDATION CONSTRUCTION

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Progress of Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment</td>
<td>Lump Sum (LS)</td>
</tr>
<tr>
<td>Schedule of Payment</td>
<td>Monthly – based on progress of Work</td>
</tr>
</tbody>
</table>

All materials, equipment, services, and construction inherent to the Work. Includes excavation, shoring, bracing, dewatering, backfill, earthquake drains, stone columns, testing, startup and all work not included in other bid items.

13.6 Project Schedule

An updated preliminary project schedule has been included in Appendix L. This schedule includes updates for anticipated MDNR review times for the Facility Plan and the Final Construction Documents. In addition, the construction schedule reflects updates due to the likelihood of special foundation construction requirements.
13.7 Construction Schedule

Based on the work previously defined in this report and the required sequencing of construction presented in the next section, a construction contract duration of 730 calendar days (2-years) to Substantial Completion is anticipated to be sufficient to complete all the work without paying an additional price premium for an overly expedited schedule. A preliminary project schedule is included in Appendix L.

13.8 Equipment Pre-Procurement & Selection

No Equipment Pre-Procurement or selection is anticipated for this project. The only equipment on the project which could warrant this consideration is the Ultra-Fine Bubble Aeration Equipment and the Aeration Blowers. In both cases open specifications and competitive bidding can be provided with like equipment.

13.9 Permit & Regulatory Review Requirements

The following sections provide an overview of the anticipated local, state and federal permits that will be required for the project.

13.9.1 City of O'Fallon

The following reviews and approvals from the City of O’Fallon are anticipated to be required:

- Erosion and Storm Water Run-Off Control Plan
- Floodplain Development Permit
- Building Permits (Excavation Permit)
- Site Plan

13.9.2 MDNR

The following reviews and approvals from MDNR are anticipated to be required prior to bidding:

- MDNR review of 100% Contract Documents (MDNR 10 CSR 20-8.110)
- MDNR Application for Construction Permit (Form MO 780-2189) (O’Fallon WWTP Upgrades)
  - Anticipated fee = $3,000 + $200 for operating permit modifications

The following permits are anticipated to be required from MDNR for construction:

- Construction Permit
- Operating Permit
- Land Disturbance Permit for City, County or Other Government Entity
- Storm Water Pollution Prevention Plan (SWPPP)

13.9.3 US Army Corp of Engineers

The following permits are anticipated to be required from USACE:
13.10 Survey

A site survey was conducted by BAX Engineering. A copy of the preliminary site survey is included in Appendix M.
APPENDIX A: MDNR PUB2416 COMPLIANCE TABLE
APPENDIX B: MDNR ARCHEOLOGICAL SITE CLEARANCE LETTER
July 27, 2017

Chris Horvath
Public Works Department
100 North Main Street
O'Fallon, Missouri 63366

Re: 23SC556, City of O'Fallon, St. Charles County, Missouri

Dear Mr. Horvath:

Thank you for submitting information on the above referenced project for our review pursuant to Section 106 of the National Historic Preservation Act (P.L. 89-665, as amended) and the Advisory Council on Historic Preservation's regulation 36 CFR Part 800, which requires identification and evaluation of cultural resources.

We have reviewed the July 2017 report entitled Cultural Resource Investigations, 23SC556, St. Charles County, Missouri by the Environmental Research Center of Missouri, Inc. Based on this review it is evident that a thorough and adequate mitigation has been previously completed for archaeological site 23SC556. The site has been fully mitigated, and would no longer be considered eligible for inclusion in the National Register of Historic Places.

Please be advised that, should project plans change, information documenting the revisions should be submitted to this office for further review. In the event that cultural materials are encountered during project activities, all construction should be halted, and this office notified as soon as possible in order to determine the appropriate course of action.

If you have any questions, please write Judith Deel at State Historic Preservation Office, P.O. Box 176, Jefferson City, Missouri 65102 or call 573/751-7862. Please be sure to include the SHPO Log Number (105-SC-17) on all future correspondence or inquiries relating to this project.

Sincerely,

STATE HISTORIC PRESERVATION OFFICE

Toni M. Prawl, Ph.D. 61
Director and Deputy State
Historic Preservation Officer

TMP:jd

c Craig Sturdevant, ERC

Promoting, Protecting and Enjoying our Natural Resources. Learn more at dnr.mo.gov
APPENDIX C: ST. LOUIS LAMBERT AIRPORT WIND ROSE
WIND ROSE PLOT:
St. Louis, MO Airport

DATE: 3/13/2007

COMMENTS: Based on hourly average wind speed and direction from the airport at St. Louis (measured at 10 meters)

DATA PERIOD: 1991-2006
Jan 1 - Dec 31
00:00 - 23:00

CALM WINDS (less than 1 mph): 0.16%

AVG. WIND SPEED: 9.12 mph

TOTAL COUNT: 5788 hrs.

DATE: 3/13/2007
APPENDIX D: GEOTECHNICAL REPORT
June 7, 2018

Mr. Kevin White
Woodard & Curran
1520 South Fifth Street, Suite 306
St. Charles, Missouri 63303

GEOTECHNICAL EXPLORATION
WASTEWATER TREATMENT PLANT IMPROVEMENTS
O'FALLON, MISSOURI

Dear Mr. White:

Presented in this report are the results of a geotechnical exploration conducted for the referenced project. This report includes our project understanding, observed site conditions, conclusions and/or recommendations, and support data as given in the Table of Contents.

It has been our pleasure to provide geotechnical services to you, and we would welcome the opportunity to provide other services during the course of the project. Please contact us if you need further information or clarification about this document.

Very truly yours,

GEOTECHNOLOGY, INC.

Senthil Kumar, P.E.
Principal Engineer

SK/DWG/JAW/FC:sk/ccg

Copies submitted:  (2) hard copy
                   (1) pdf
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- Purpose and Scope of Services
- Project and Site Description

## III. Field Exploration and Laboratory Testing
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- Electrical Resistivity Survey
- Piezometer
- Laboratory Testing

## IV. Subsurface Conditions
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- Groundwater

## V. Design Considerations and Recommendations
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<tr>
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<td>Electrical Resistivity Survey Results</td>
<td>D</td>
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<td></td>
</tr>
</tbody>
</table>
GEOTECHNICAL EXPLORATION
WASTEWATER TREATMENT PLANT IMPROVEMENTS
O’FALLON, MISSOURI

SECTION I - EXECUTIVE SUMMARY

The executive summary is provided solely for the purposes of overview, and a number of details are omitted, any one of which could be crucial to the proper application of this report. Any party who relies on this report must read the full report.

- The project includes improvements to the O’Fallon Wastewater Treatment Plant (WWTP) at the southeast corner of the intersection of State Route 79 and Firma Road in O’Fallon, Missouri. We understand new structures and plant roads are planned.
- Site grading plans were not provided. We understand that the site will be raised to match the developed portions of the plant. Hence, we anticipate approximately 15 to 21 feet of fill be placed at the site.
- Based on provided data, we understand that the base elevations of the structures will be at or near existing surface grades, and the fill will be subsequently placed around the structures.
- The soil stratigraphy generally consists of alluvial deposits of lean clay and clay underlain by sand. The consistency of the cohesive materials vary from soft to very stiff, and the density of the sand varies from loose to very dense. Auger refusal was not encountered in the 25-foot borings. Refusal was encountered in one Cone Penetrometer (CPT) sounding at a depth of 77 feet.
- Groundwater was observed/estimated between 19 and 27 feet deep.
- The site soils are potentially liquefiable during the design earthquake event. Post-liquefaction settlement is estimated to be in the range of 2 to 6 inches.
- Ground modification can be considered to a depth of approximately 45 feet to mitigate potential liquefaction. Ground modification could include installation of aggregate piers or earthquake drains.
- Due to the presence of liquefiable soils, the seismic site class is considered Class F. If liquefiable soils are improved, or if the fundamental period of vibration of the structures is 0.5 seconds or less, the site can be considered Class D.
Settlement of the existing soils due to the anticipated fill placement will be in the range of 2 to 4 inches. Settlement of the structures due to structural loading is estimated to be 1 inch.

The anticipated settlements can be reduced by placing light-weight fill, preloading the sites, or delaying construction of the structures after placement of the fill. Delaying construction by about 8 to 12 months will be required if the structures are to be supported on shallow foundations. Installing wick drains can help reduce the time for settlement dissipation.

Strip footings may be proportioned for a net allowable bearing pressure of 2,000 pounds per square foot (psf), provided they bear on naturally occurring soil or compacted fill. Alternatively, the structures may be supported on mat foundations.

If higher bearing pressures are required specialty ground improvement techniques such as stone columns or rammed aggregate piers can be used to improve the subgrade. Reportedly, bearing pressures of 5,000 psf or more can be achieved. These systems are proprietary and a specialty contractor should be consulted to determine the resultant footing bearing pressure and settlements.

Geotechnology should be contacted to re-evaluate the recommendations if there are substantial changes to the assumed fill amount, bearing elevations and/or structural loads.

SECTION II - PROJECT DATA

AUTHORIZATION

The services documented in this report were provided in accordance with the terms, conditions and scope of services described in Geotechnology’s March 5, 2018 proposal numbered P031812.01. The project was authorized by your signed acceptance of the proposal terms.

PURPOSE AND SCOPE OF SERVICES

The purpose of our services was to develop recommendations for geotechnical aspects of the design and construction of the project as described in our proposal. Briefly, services consisted of site reconnaissance, drilling seven borings, pushing ten CPT soundings, obtaining seven Shelby tubes for thermal resistivity testing, Wenner electrical resistivity survey, shear wave velocity survey, laboratory testing, engineering analyses and preparation of this report.
Important information prepared by The Geotechnical Business Council for studies of this type is presented in Appendix A for your review.

PROJECT AND SITE DESCRIPTION

Improvements are planned at the O’Fallon wastewater treatment plant at the southeast corner of the intersection of State Route 79 and Firma Road in O’Fallon, Missouri. The site is situated in terrace deposits of the Mississippi River floodplain, and Peruque Creek flows approximately along the south property line. The site location and general topography of the area from the 2015 USGS map of the vicinity are shown on Plate 1. It appears the plant site grades were raised above original floodplain elevations. Developed portions of the plant are approximately at mid El 450's to mid El 460s. The surrounding areas are typically in the mid El 440s. We understand the grades in areas around the new aeration and anoxic zones will be raised to match the existing grades.

The proposed construction will include aeration tank splitter box, aeration tanks, anoxic zones, high flow discharge well, cascade aerator and high flow discharge outfall pipe. The proposed layout of the planned structures is shown on Plate 2.

Brief descriptions of the planned structures are given below. Proposed grades, elevations, and structural loads were not provided.

- **Aeration Tank Splitter Box** – a below-grade concrete structure with base mat slab at El 442.2 and top of wall at El 468. The upper 2 to 3 feet of the 30- by 30-foot structure is anticipated to be above grade with the remainder below grade. We anticipate approximately 21 feet of fill around the splitter box to achieve the planned grades. Base pressure on the tank will be 1,620 psf.

- **Aeration Tanks** – three below-grade structures with base mat slabs at approximately El 442 and top of wall at El 465.5. The upper 4 to 5 feet of the 120- by 300-foot structures are anticipated to be above grade with the remainder below grade. Fill is planned to match the existing aeration tank grades. We anticipate as much as 16 feet of fill to achieve planned grades. The tank base pressure will be 1,500 psf.

- **Anoxic Zones** – a below-grade concrete structure with base mat slab and a wall height of approximately 20 feet. The upper 4 to 5 feet of the 98- by 40-foot structure is anticipated to be above grade with the remainder below grade. Fill will be added to the site to match the existing Aeration Tank grading. We anticipate as much as 15 feet of fill to achieve planned grades.

---

1 Elevations herein are in units of feet and refer to the WGS84 EGM96 Geoid.
High Flow Discharge Wet Well – a below-grade concrete structure with base mat slab at El 431 and top of wall at El 465.5. The upper 2 to 3 feet of the 20- by 20-foot structure is anticipated to be above grade with the remainder below grade. We anticipate an excavation of approximately 15 feet to construct the wet well.

Cascade Aerator – a below-grade concrete structure with base mat slab and a wall height of approximately 15 feet. The upper 2 to 3 feet of the 20- by 20-foot structure is anticipated to be above grade with the remainder below grade.

High Flow Discharge Outfall Pipe – The high flow pipe will be constructed at the southeast corner of the site near Peruque Creek.

In addition to the construction of the various new structures, approach/access roads to the planned structures are planned, details of which were not available. Site grading plans have not been developed at this time.

SECTION III - FIELD EXPLORATION AND LABORATORY TESTING

FIELD EXPLORATION

The field exploration consisted of drilling seven test borings and pushing ten CPT soundings, designated as the B- and CPT- series, respectively at the approximate locations shown on Plate 2. The borings and soundings were drilled/pushed to predetermined depths of 15 to 50 feet. An exception is Sounding CPT-2, which was pushed to cone refusal at a depth of 77 feet. In addition to the borings/soundings, seven borings (R-series on Plate 2) were drilled to obtain Shelby tube samples at a depth of 2.5 feet for thermal resistivity testing. The borings were located in the field by Geotechnology by measuring distances from existing site features. The elevations at the boring locations, as shown on the boring logs, were estimated using Google Earth® maps. The locations and elevations are approximate. If more precise data are required, the client should retain a registered surveyor to establish boring locations and elevations.

The test borings were completed using a CME 55 rotary drill rig equipped with hollow-stem augers and rotary wash drill tools. Standard penetration tests (SPTs) were performed using an automatic hammer. The CME 55 automatic hammer has an efficiency of 83 percent. Split-spoon samples and relatively undisturbed Shelby tube sample were obtained at the depths indicated on the boring logs, which are presented in Appendix B. An explanation of the terms and symbols used on the boring logs is provided in Appendix B.

The CPT soundings were advanced using a 20-ton, track-mounted Vertek direct-push rig. The data were collected using a 15-square-centimeter end area, seismic piezometric cone with a u2 pore pressure location (i.e., behind the cone) manufactured by Vertek, a division of Applied
Research Associates, Inc. The CPT measurements are presented in Appendix B, along with interpreted soil behavior types and selected soil properties. Seismic cone penetration test (SCPT) was performed in Sounding CPT-2 at approximately 3-foot depth intervals to collect shear wave velocity data to the refusal depth of 77 feet. Shear wave velocity was extrapolated from the refusal depth to 100-foot depth to evaluate the IBC weighted average shear wave velocity in the upper 100 feet (V_s100). Shear wave velocity measurement versus depth is presented as Plate 3.

Engineers from Geotechnology provided direction during field exploration, observed drilling and sampling, assisted in obtaining samples, prepared logs of the material encountered and operated the CPT rig. The boring logs represent conditions observed at the time of exploration, and have been edited to incorporate results of the laboratory tests.

Unless noted on the boring logs, the lines designating the changes between various strata represent approximate boundaries. The transition between materials could be gradual or could occur between recovered samples. The stratification given on the boring logs, or described herein, is for use by Geotechnology in its analyses and should not be used as the basis of design or construction cost estimates without realizing that there can be variation from that shown or described.

The boring logs and related information depict subsurface conditions only at the specific locations and times where sampling was conducted. The passage of time could result in changes in conditions, interpreted to exist, at or between the locations where sampling was conducted.

**ELECTRICAL RESISTIVITY SURVEY**

Electrical resistivity surveying is a surface geophysical technique used to determine the apparent resistivity of the subsurface. The method involves inducing current into the subsurface with two current electrodes and measuring the resulting ground voltage using two potential electrodes. Resistivity values are calculated using the field measurements and electrode geometry. For this project we used the Wenner resistivity array which involves placing the two potential electrodes between the two current electrodes on a straight survey line. For each measurement, the distances between adjacent electrodes are the same and referred to as the “A” spacing. The A spacing is increased by equally increasing the distance between all electrodes. The line is expanded by centering about the mid-point of the survey line. The electrical field and corresponding measurements attain greater depths with greater A spacings. Wenner array apparent resistivity values are calculated using the following equation:

\[
\text{Resistivity} = 2\pi(A\text{-Spacing})(\text{Resistance})
\]

Wenner resistivity surveying was performed at ten locations on the subject site as shown on Plate 2. The data were collected using an Advanced Geosciences, Inc. SuperSting-R8 earth
resistivity meter using A spacings of 2, 5, 10, 20, and 30 feet. Recorded resistance data and calculated apparent resistivity values are presented in Appendix C.

PIEZOMETER

An open-standpipe piezometer was installed in Boring B-3 to permit measurement of the groundwater levels after drilling. The piezometer consists of 1-inch diameter PVC pipe with a 10-foot long screen placed at the bottom of the borehole. The piezometer was backfilled with sand to a depth of 10 feet and sealed with bentonite pellets to a depth of 8 feet; the remainder of the piezometer was backfilled with cuttings. An above-ground protective casing was installed for the piezometer. Details of the piezometer installation at the boring are presented in Appendix D.

LABORATORY TESTING

Laboratory testing was performed on the soil samples to estimate engineering and index properties. Moisture contents and Atterberg limits tests were performed on selected cohesive samples. Unconfined compression tests were performed on selected Shelby tube samples. A consolidation test was performed on a representative fine-grained sample. Thermal resistivity tests were performed on Shelby tube samples recovered from select locations shown on Plate 2 (i.e., R series borings). Laboratory test results are presented in Appendices B, E and H.

Three soil samples were selected by Geotechnology for pH, chemical and redox testing. Teklab, Inc. performed the chemical and redox tests. Analytical laboratory test results are presented in the table below and in Appendix F.

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Sample Depth (ft)</th>
<th>Soil Type</th>
<th>pH</th>
<th>Chloride (mg/kg-dry)</th>
<th>Sulfide (mg/kg-dry)</th>
<th>Sulfate (mg/kg-dry)</th>
<th>Oxidation-Reduction Potential (mv)</th>
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</thead>
<tbody>
<tr>
<td>B-1</td>
<td>8.5 to 15</td>
<td>Lean Clay</td>
<td>8.2</td>
<td>21</td>
<td>&lt;36</td>
<td>110</td>
<td>121</td>
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<td>B-7</td>
<td>6.0 to 8.0</td>
<td>Lean Clay</td>
<td>6.8</td>
<td>32</td>
<td>&lt;36</td>
<td>95</td>
<td>109</td>
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<tr>
<td>B-14</td>
<td>16.0 to 18.0</td>
<td>Lean Clay</td>
<td>6.9</td>
<td>32</td>
<td>&lt;37</td>
<td>129</td>
<td>112</td>
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SECTION IV - SUBSURFACE CONDITIONS

STRATIGRAPHY

The overburden soil consists of alluvial material associated with transport and deposition by Peruque Creek and the Mississippi River located approximately 4 miles to the northeast. Below the topsoil, the test borings and CPT soundings encountered interlayered alluvial deposits of lean clays, clays and silty sands to approximate depths of 24 to 30 feet. The sands are generally present in thin layers. The consistency of the cohesive soils varies between soft to stiff, occasionally very stiff. The borings and CPT-15, CPT-16 and CPT-17 were terminated in this stratum.

Below the upper predominantly cohesive stratum, loose to very dense sand is present. The sand extends to the depth of CPT sounding termination or cone refusal.

CPT cone refusal was encountered in CPT-2 at a depth of 77 feet. Cone refusal may represent either a hard soil layer or bedrock. Since rock coring was not performed at these locations, the character of these materials could not be determined.

GROUNDWATER

Groundwater was observed while drilling Borings B-11 and B-14 at approximate depths of 24 and 19 feet, respectively. Groundwater is estimated to be between depths of approximately 24 and 27 feet in the CPT soundings based on pore pressure measurements. Groundwater levels shown on the logs might not have stabilized before backfilling, which is typical in less permeable cohesive soil. Consequently, the indicated/lack of observed groundwater levels might not represent present or future levels. Groundwater levels can vary over time due to the effects of seasonal variation in precipitation, recharge, the stage of Peruque Creek and the Mississippi River or other factors not evident at the time of exploration. Free water might be trapped in permeable zones of fill and in utility trenches backfilled with clean rock. Excavation that remains open could collect water.

SECTION V - DESIGN CONSIDERATIONS AND RECOMMENDATIONS

The loose to medium dense sands present at the site are susceptible to liquefaction during a strong ground motion event. If required, mitigation of liquefaction could consist of ground improvement such as aggregate piers or earthquake drains installed through the liquefiable interval. Liquefaction mitigation methods are discussed in subsequent sections.
We understand that approximately 15 to 21 feet of fill will be required to raise the ground surrounding the splitter box, aeration tank and anoxic zones. The recommendations given in this report were developed based on this assumption. The client should recognize that the recommendations given herein might require modifications and related analysis if the final plans are different from those assumed herein.

Consolidation settlement due to fill placement may be in the range of 2 to 4 inches. Floor loads of the splitter box and tanks will be in the order of 1,500 to 1,600 psf. Settlement at the mid-point of the structures from the weight of the splitter box and tanks is estimated to be 1 inch. Hence, the differential settlements between the center and edge of the structures are anticipated in the range of approximately 1 to 3 inches. The time needed to accomplish the consolidation settlement may vary from 8 to 12 months. If the project schedule is critical, additional borings and an evaluation of deep foundations could be considered.

Settlement can be accelerated by placing a surcharge embankment or by installing wick drains. We recommend installing 2-inch equivalent diameter wick drains at 6-foot intervals to a depth of 25 feet and then placing the planned fill. Substantial consolidation can be expected to occur during the sixty days following placement of the fill. Alternatively, the combined settlement from fill placement and structure loads can be reduced to approximately 1-inch if light-weight fill (such as blast furnace slag) is used, or the site is improved using aggregate piers.

SITE GRADING

Site Preparation. Site grading plans and the anticipated construction sequences were not provided. We anticipate that the proposed structures will be constructed and then the surrounding area will be raised by placing fill. In general, cut areas and areas to receive fill and backfill should be stripped of topsoil, soft soil, and other deleterious materials. The exposed subgrade should be proofrolled. Soft soil or yielding areas should be excavated and backfilled with cohesive soil or crushed rock compacted to the levels provided in the Compaction Summary.

Temporary Excavation. We anticipate that site geometry will permit excavation slopes to be laid back to a stable configuration. For excavations less than 20 feet deep, the OSHA classification for the cohesive soil encountered in the excavation can be considered as Type B. Sand should be considered as Type C. Consequently, temporary slopes in Type C soil may be constructed at 1V:1.5H, and temporary slopes in Type B soils at 1V: 1H. However, cut slopes that intersect the water table should be graded to 1V:1.5H, or flatter.

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2 Wick drains are devices installed into the subgrade to more rapidly drain the soils and increase consolidation rate.
The contractor should review slope height, slope inclination or excavation depths with respect to local, state or federal safety regulations, e.g. OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations. The owner, contractor or earthwork or utility subcontractors could be liable for substantial penalties if regulations are not followed. Ultimately construction site safety and OSHA classification of the soil is the sole responsibility of the contractor.

Fill and Backfill Placement. Fill or backfill should be placed in maximum 8-inch thick loose lifts and compacted to the levels provided in the Compaction Summary. The soil should be placed at a moisture content compatible with the required unit weight. Depending on the soil moisture at the time of construction, aeration or wetting could be required to achieve compaction. Deleterious material should not be included in fill, and the fill should not be placed on soft materials or frozen ground.

<table>
<thead>
<tr>
<th>COMPACTION SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category</strong></td>
</tr>
<tr>
<td>General soil fill</td>
</tr>
<tr>
<td>Rock backfill</td>
</tr>
<tr>
<td>(1- or 2-inch minus or MoDOT Type 5)</td>
</tr>
</tbody>
</table>

a Measured as a percent of the maximum dry unit weight as determined by the modified Proctor test (ASTM D 1557).

Suitable Fill Materials. In general, fill materials should consist of low plasticity, cohesive soils or well-graded, granular materials (e.g., well-graded crushed rock). Acceptable inorganic fill soils include materials designated CL, ML, CL-ML, SW, and GW by ASTM D 2487.

Trench Backfill. Settlement of trench backfill can be reduced by mechanically compacting the backfill in lifts to the levels provided in the Compaction Summary. Permeable backfill (i.e., clean rock and sand) should not be used for backfill. Permeable backfill can collect water and promote subgrade softening, and/or result in the migration of fines and loss of subgrade support.

Subgrade Protection. Drainage of the construction areas should be provided to protect the foundation excavations and subgrades from the detrimental effects of weather conditions during construction. Finished subgrades and foundation excavations should be kept free of standing water. Concrete should be placed in foundations the same day they are excavated.

Collection and Disposal of Site Water. Management of the site water is important in the successful performance of pavement and foundations. Water from surface runoff, downspouts, and subsurface drains, if any, should be collected and discharged through an effective site drainage system. Control of surface runoff should be maintained in compliance with the rules
and regulations set forth in the Federal Water Pollution Control Act. Additionally, permits related to site grading activities and control of storm water during construction activities should be obtained from the applicable governmental jurisdiction(s).

SEISMICITY

Liquefaction Potential. During an earthquake, sudden increases in pore pressures could develop within saturated soil deposits due to seismic shaking. Soil deposits, where the increased pore water pressure exceeds the total overburden pressure, could experience a sudden loss of strength. This phenomenon is called liquefaction. Liquefaction results in loss of bearing capacity, permanent lateral displacement, and/or settlement of the ground surface.

Since the site is in the floodplain of the Peruque Creek and Mississippi River, the groundwater depth is anticipated to be relatively shallow. Due to the presence of low density, saturated sands with relatively uniform grain size distributions, potentially high groundwater levels, and the magnitude of ground shaking expected at the site from the building-code-mandated earthquake event, the site has a potential for liquefaction.

Geotechnology performed a liquefaction evaluation based on CPT data using the analysis method published by Idriss and Boulanger\(^3\). The liquefaction analysis was performed utilizing a design PGA of 0.23g, representing a probability of exceedance of 2% in 50 years (2,500-year return interval).

Based on the liquefaction results it appears the site is potentially liquefiable, with multiple zones between depths of 26 and 60 feet, where the calculated factor of safety (F.O.S) is less than 1.0. Dynamic settlement is estimated to range from approximately 2 to 6 inches. The site generally has a cap of approximately 25 feet of clay overlying the liquefiable sands, and an additional 15 feet of grade-raise fill is anticipated, which would help reduce the impact of liquefiable settlement. The Liquefaction Potential Index (LPI) is another method of evaluating seismic risk. The LPI values are less than 5, which represent a low risk of liquefaction potential. Liquefaction analysis results for each CPT sounding are presented in Appendix G.

Liquefaction Remediation. If remediation of potentially liquefiable soils is considered, the soil improvement at the site could include installation of aggregate piers or earthquake drains through the liquefiable zone (i.e., approximately 45 feet). Aggregate piers could be constructed by vibro replacement methods. In this method the vibrator penetrates to the design depths and crushed rock is added and compacted to form a stone column. Alternatively, earthquake drains can be installed to mitigate liquefaction. Earthquake drains consist of installing high flow capacity, prefabricated vertical drains. Other soil improvement methods such as vibro-compaction or compaction grouting can also be considered.

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Soil improvement should generally extend beyond the proposed structure footprints laterally one-half the depth of the soil improvement.

Site Class. The seismic Site Class D (Stiff Soil) was determined based on the CPT shear wave velocity profile (site average of 1,037 feet per second) included in Plate 3 and per the general procedures of International Building Code (IBC) 2012/15. However, because the site soils have the potential for liquefaction, the site is classified as Site Class F which requires a site specific seismic evaluation. If the site soil is improved (via aggregate piers, earthquake drains, etc.) or the proposed structures have a period of vibration equal to or less than 0.5 seconds, the site soil can be defined without regard for liquefaction and, as such, would be a Site Class D.

Acceleration Coefficients. Seismic design parameters (assuming a Site Class D) for the site are summarized below, which are based on design values on 2012/15 IBC Tables and computer application published by the USGS National Seismic Hazards Mapping Project (NSHMP), and an assumed Risk Category of I/II/III. Structural design using Site Class F will require a site specific analysis to determine seismic design parameters.

<table>
<thead>
<tr>
<th>SEISMIC DESIGN PARAMETERS (SITE CLASS D)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Coefficient $F_a$</td>
<td>1.553</td>
</tr>
<tr>
<td>Site Coefficient $F_v$</td>
<td>2.258</td>
</tr>
<tr>
<td>Spectral Response Acceleration at 0.2 sec. ($S_s$)</td>
<td>0.309</td>
</tr>
<tr>
<td>Spectral Response Acceleration at 1.0 sec. ($S_1$)</td>
<td>0.136</td>
</tr>
<tr>
<td>Design Spectral Response Acceleration at 0.2 sec. ($S_{os}$)</td>
<td>0.320</td>
</tr>
<tr>
<td>Design Spectral Response Acceleration at 1.0 sec. ($S_{o1}$)</td>
<td>0.204</td>
</tr>
<tr>
<td>Seismic Design Category at 0.2 sec.</td>
<td>B</td>
</tr>
<tr>
<td>Seismic Design Category at 1.0 sec.</td>
<td>D</td>
</tr>
</tbody>
</table>

FOUNDATIONS

As discussed above, isolated layers of the site soils are susceptible to liquefaction during seismic events. The following paragraphs provide recommendations for shallow foundations if liquefaction is ignored due to the natural period of the structure or if the liquefiable soil layers are remediated.

Shallow Footings. The ring foundation for the tanks can be supported on conventional shallow footings bearing on existing soils. The structure footings bearing on existing soils or
compacted fill can be designed using a net allowable bearing pressure of 2,000 psf. Alternatively, if the site is improved using aggregate piers, the ring foundation can be proportioned to bear on the compacted crushed rock fill for a net allowable bearing pressure of 5,000 psf or more. The allowable bearing pressures of these systems should be confirmed with the manufacturer. These values can be increased by 33 percent for seismic, wind or other transitory loads.

It should be noted that aggregate piers are proprietary foundation systems designed and constructed by a ground improvement contractor. Consequently, a ground improvement contractor should be contacted to determine the suitability of their system for use at this location as well as to confirm the bearing capacity value for the final foundation design. The following ground improvement contractors are available in the St. Louis Region: Geopier Foundation Company Inc., Hayward Baker Inc., Subsurface Constructors, Inc and Helitech Civil Construction. The contractor should prepare its design based on the allowable design bearing pressure while maintaining total settlements of less than 1 inch. Also, negative skin friction (i.e., downdrag) on aggregate piers could occur due to settlement of subgrade soils resulting from the weight of proposed fill. Downdrag occurs as the soil strata move downward relative to the aggregate piers due to settlement of the surrounding soil layers. The contractor should address the downdrag forces in the design of the aggregate piers. Geotechnology is available to review and advise on specific ground improvement methods.

Shallow footing foundations, proportioned and constructed as recommended herein, could settle approximately 1 inch due to structure loads. An additional 1 inch of settlement is estimated from the loading on the floor, as discussed previously. Differential settlement between opposite ends of the ring foundation could be in the range of 3/4 inch. Estimated values of settlement contained in this report are based on index properties of the soil.

Uplift loads can be resisted with the dead weight of the footing, and the weight of soil above the footing. A unit weight of 120 or 130 pounds per cubic foot (pcf) can be used for determining the soil or crushed rock weight above the footing, respectively, and the volume of soil/rock acting on the footing can include a wedge of material within a line that extends from the top of footing and away from the footing edge to the ground surface at an angle of 30 degrees from the vertical.

Lateral loads can be resisted by available frictional resistance between the base of the footing and the underlying natural soil or compacted fill. Resistance to sliding can be computed assuming an ultimate coefficient of friction of 0.4 for existing soils, and 0.5 for crushed rock; however, the maximum resistance should be limited to 1,000 psf. Ultimate passive resistance, if required, can be computed assuming an equivalent fluid pressure of 300 and 400 pcf for soil and rock, respectively. Safety factors of 2 and 3 should be applied to determine the allowable sliding and passive resistance, respectively. Passive resistance in the top 30 inches of soil/crushed rock should be neglected due to seasonal variations in moisture and frost penetration.
The minimum lateral dimension for conventional strip footings should be 18 inches. Exterior footings and footings in unheated interior areas should be embedded 30 inches below the lowest adjacent exterior grade to provide protection from seasonal moisture variations and frost penetration.

**Mat Foundation.** The proposed structure floor grades will be at or near existing surface grades. The structure can be supported on a mat foundation designed for a maximum allowable contact stress between the slab and subgrade of 1,000 to 1,600 psf. A modulus of vertical subgrade reaction \( (K_v) \) of 50 pounds per cubic inch (pci) may be used in the design analysis of the foundation slab. Depending on the floor grade, the structure should be designed to resist buoyant forces by having anchors or a thickened base slab with a footprint larger than the structure, so that the weight of the backfill material above the base slab can be utilized for resisting uplift. Buoyant densities should be used when calculating uplift capacities. Low strength concrete could be placed as a mud mat on the soil subgrade prior to construction of the base slab as a means to reduce disturbance to the subgrade. Areas or subgrades which exhibit soft, unstable or pervious characteristics should be overexcavated and backfilled as recommended in a previous section.

Based on the provided dimensions and base pressures of the splitter box and aeration tanks, the settlement at the center of the mat foundation, proportioned and constructed as recommended above, will be in the range of 1 to 2 inches. Differential settlement between the center and edge of the mat foundation due to structural loads would be in the range of 3/4 inch. If the settlement due to fill is taken into account the differential settlement between the center and edge of the mat foundation will be in the range of 1 to 3 inches.

**FLOOR SLABS**

The slab-on-grade should be underlain by a 4- to 6-inch layer of crushed rock and compacted to the levels provided in the Compaction Summary. Notwithstanding other structural considerations, the slab-on-grade floor should be designed to allow for differential movements that normally occur between the floor slab and foundation walls.

**LATERAL EARTH PRESSURES**

Below-grade walls shall be designed to resist lateral soil loads. Design lateral pressures from surcharge loads shall be added to the lateral earth pressure load. Lateral earth pressures can vary with wall restraint conditions, type of backfill, slope of ground surface behind the wall, and method of backfill compaction.

Design values are given herein for soil lateral loads on walls with horizontal backfill, subject to active and at-rest conditions. Conventional concrete walls can be designed for active
earth pressures if the top is permitted to tilt (after construction) approximately 0.5 percent of its height. Walls with fixed-heads or rigid walls should be designed for at-rest earth pressures.

<table>
<thead>
<tr>
<th>Description of Backfill</th>
<th>Design soil lateral load (psf per foot of depth)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At-rest</td>
</tr>
<tr>
<td>Inorganic clays</td>
<td></td>
</tr>
<tr>
<td>of low to medium plasticity (CL)</td>
<td>69h + 0.58q</td>
</tr>
<tr>
<td>Well graded gravel-sand mix (GW/SW) (e.g., 1-inch-minus, but not screenings)</td>
<td>57h + 0.44q</td>
</tr>
</tbody>
</table>

Where:

\[ h = \text{depth below adjacent grade, feet} \]
\[ q = \text{surcharge load, psf} \]

In giving these values, it is assumed that hydrostatic pressures will not develop behind walls and that the wall backfill will be compacted as recommended in the Site Grading section of this report. High plasticity clays should not be used as wall backfill.

If the walls are planned to be designed for undrained conditions the previously provided design values should be modified as follows:

<table>
<thead>
<tr>
<th>Description of Backfill</th>
<th>Design soil lateral load (psf per foot of depth)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At-rest</td>
</tr>
<tr>
<td>Inorganic clays</td>
<td></td>
</tr>
<tr>
<td>of low to medium plasticity (CL)</td>
<td>95h + 0.58q</td>
</tr>
<tr>
<td>Well graded gravel-sand mix (GW/SW) (e.g., 1-inch-minus, but not screenings)</td>
<td>92h + 0.44q</td>
</tr>
</tbody>
</table>

For the above equations to be valid for sand or gravel backfill, the backfill should be placed in a wedge extending upward and away from the edge of the wall footing at a 45-degree angle or flatter. If sand and gravel are to be placed within a steeper wedge, the values for low plasticity soil given above should be used. Further, any soft uncompacted soil on the excavation slope should be removed prior to placement of backfill. Design drawings should reflect this requirement.

PAVEMENTS

A pavement design and analysis was beyond the scope of our services. Standard asphaltic concrete pavement design for a given service life requires evaluation of the soil by
California Bearing Ratio (CBR) tests or other methods, estimates of daily traffic volumes and axle weights, drainage requirements, and the desired level of maintenance.

Asphaltic pavement sections are frequently used that are thinner than would typically result from a pavement design. These reduced thickness sections often perform adequately; however, maintenance or an overlay is generally required sooner than would be required for a thicker, designed section. Based on our experience with projects of similar nature, pavement sections consisting of 3 inches of asphalt over 6 inches of well-graded crushed rock and 4 inches of asphalt over 8 inches of well-graded, crushed rock are often used in parking areas and main drive lanes, respectively, subjected to automobile traffic only. The pavement performance can be enhanced by lime treating the subgrade soils or incorporating a geogrid below the crushed rock. Where heavy wheel loads are concentrated such as heavy truck driveways concrete pavement should be used.

Regardless of which pavement sections are selected, the soil subgrade should be stable and the top 12 inches compacted to the levels provided in the Compaction Summary. Pavement service life can decrease substantially if the pavement is constructed on a poor subgrade, if it has poor surface or subsurface drainage, and/or if the pavement is not maintained. Periodic maintenance, such as filling cracks and sealing, is required for any pavement section.

If pavements are not constructed immediately after grading, the subgrade should be shaped to prevent ponding. Minor ponding, of even short duration, can cause softening of a soil subgrade. If there is a lapse of time between grading and paving, or if the subgrade is disturbed by construction activities, the subgrade should be proof-rolled with a loaded, tandem-wheeled dump truck. Soft spots observed during initial construction or proof-rolling should be removed and replaced with compacted soil or rock, possibly combined with a geotextile or geogrid. The rock base course and soil subgrade should be compacted to the levels provided in the Compaction Summary.

Depending on when the pavement is constructed, the subgrade might not support construction equipment such as rock trucks or asphalt trucks which have heavier axle loads than those vehicles which the pavement section is expected to support. Such conditions will be more apparent during wetter periods of the year. Overexcavation of soft subgrade and placement of additional base course and/or geogrid could be required to construct the pavement during these periods.

**SLOPES**

Slope stability analysis of the existing and/or proposed slopes is beyond the scope of services. Stability of a slope depends on many factors including the slope geometry, slope height, soil type, and surface pressures, if any. In general, permanent cut and fill slopes,
constructed at 1 vertical (V) on 3 horizontal (H), have been observed to perform satisfactorily. Therefore, it is our opinion that, as a minimum, slopes should be constructed at 1V:3H or flatter. Existing slopes greater than 1V:5H should be benched before placement of fill directly on them. Bench shelves should be approximately 10 feet wide, and bench faces should not be higher than 4 feet. Fill slopes should be constructed by extending the compacted fill beyond the planned slope profile slope and then trimming the slope to the desired configuration.

**CORROSIVITY AND CEMENT TYPE**

*Corrosion Potential.* Analytical tests were conducted on a select soil sample to evaluate the corrosion potential of the subgrade soils. Oxidation/reduction potential, pH, chloride concentration, and sulfate concentration tests were performed in the laboratory. The test results are summarized in the Laboratory Testing section and presented in Appendix F and are discussed below. Soil resistivity was measured in the field using geophysical methods, as previously discussed.

The Ductile Iron Pipe Research Association (DIPRA) in conjunction with the American Water Works Association has established a point system to determine corrosion potential on buried ductile-iron pipe based on the individual tests. DIPRA concludes that corrosive conditions exist if the point total is 10 or more. The soil resistivity and chemical test results indicate that the soils are corrosive to buried ductile-iron pipe at Locations E-1, E-2, E-5, E-6 and E-10 shown on Plate 2. It should be noted, however, that subsurface conditions could vary substantially over short distances.

*Cement Type.* The analytical laboratory reported an elevated reporting limit for sulfate concentration due to sample composition. The soil sample was reported to have a sulfate composition of less than 0.1 percent by weight. Concrete has a negligible sulfate exposure in soils containing less than 0.1 percent sulfate by weight. Therefore, use of Type I Cement for below-grade construction would be adequate.

**SECTION VI – RECOMMENDED ADDITIONAL SERVICES**

The conclusions and recommendations given in this report are based on: Geotechnology’s understanding of the proposed design and construction, as outlined in this report; site observations; interpretation of the exploration data; and our experience. Since the intent of the design recommendations is best understood by Geotechnology, we recommend that Geotechnology be included in the final design and construction process, and be retained to review the project plans and specifications to confirm that the recommendations given in this report have been correctly implemented. We recommend that Geotechnology be retained to participate in prebid and preconstruction conferences to reduce the risk of misinterpretation of
the conclusions and recommendations in this report relative to the proposed construction of the subject project.

Since actual subsurface conditions between boring locations may vary from those encountered in the borings, our design recommendations are subject to adjustment in the field based on the subsurface conditions encountered during construction. Therefore, we recommend that Geotechnology be retained to provide construction observation services as a continuation of the design process to confirm the recommendations in this report and to revise them accordingly to accommodate differing subsurface conditions. Construction observation is intended to enhance compliance with project plans and specifications. It is not insurance, nor does it constitute a warranty or guarantee of any type. Regardless of construction observation, contractors, suppliers, and others are solely responsible for the quality of their work and for adhering to plans and specifications.

SECTION VII - LIMITATIONS OF REPORT

This report has been prepared on behalf of, and for the exclusive use of, the client for specific application to the named project as described herein. If this report is provided to other parties, it should be provided in its entirety with all supplementary information. In addition, the client should make it clear that the information is provided for factual data only, and not as a warranty of subsurface conditions presented in this report.

Geotechnology has attempted to conduct the services reported herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions. The recommendations and conclusions contained in this report are professional opinions. The report is not a bidding document and should not be used for that purpose.

Our scope did not include: any services to investigate or detect the presence of mold or any other biological contaminants (such as spores, fungus, bacteria, viruses, and the by-products of such organisms) on and around the site; or any services, designed or intended, to prevent or lower the risk of the occurrence of an infestation of mold or other biological contaminants.

The analyses, conclusions, and recommendations contained in this report are based on the data obtained from the geotechnical exploration. The field exploration methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Consequently, subsurface conditions may vary gradually, abruptly, and/or nonlinearly between sample locations and/or intervals.
The conclusions or recommendations presented in this report should not be used without Geotechnology’s review and assessment if the nature, design, or location of the facilities is changed, if there is a substantial lapse in time between the submittal of this report and the start of work at the site, or if there is a substantial interruption or delay during work at the site. If changes are contemplated or delays occur, Geotechnology must be allowed to review them to assess their impact on the findings, conclusions, and/or design recommendations given in this report. Geotechnology will not be responsible for any claims, damages, or liability associated with any other party’s interpretations of the subsurface data or with reuse of the subsurface data or engineering analyses in this report.

The recommendations included in this report have been based in part on assumptions about variations in site stratigraphy that may be evaluated further during earthwork and foundation construction. Geotechnology should be retained to perform construction observation and continue its geotechnical engineering service using observational methods. Geotechnology cannot assume liability for the adequacy of its recommendations when they are used in the field without Geotechnology being retained to observe construction.

A copy of "Important Information about This Geotechnical-Engineering Report" that is published by the Geotechnical Business Council (GBC) of the Geoprofessional Business Association (GBA) is included in Appendix A for your review. The publication discusses some other limitations, as well as ways to manage risk associated with subsurface conditions.
NOTES
1. Plan adapted from a 7.5 minute U.S.G.S. map for O'Fallon, Missouri, last revised in 2015.
NOTES
1. Plan adapted from "2015 Aerial Imagery for the St. Louis Region" supplied by East-West Gateway Council of Governments.
2. Exploration locations were established in the field with reference to site features and are shown approximate only.

LEGEND
- Boring Location (B-#)
- Boring / Monitoring Well Location (B-3)
- CPT Sounding Location (CPT-#)
- Thermal Resistivity Boring (R-#)
- Wenner Array Location (E-#)

Drawn By: WAH
Checked By: SK
Approved By: DWG
Date: 5-25-18
Date: 5-25-18
Date: 5-25-18

Wastewater Treatment Plant Improvements
O'Fallon, Missouri
AERIAL PHOTOGRAPH OF SITE
AND EXPLORATION LOCATIONS

PLATE 2

Project Number: J031812.01
Shear-Wave Velocity ft/sec

Depth ft

\[ V_{s(100)} = 1,037 \text{ (ft/sec)} \]

LEGEND
- Shear Wave Velocity Profile
- Average Shear Wave Velocity for Top 100 Feet

Date: 4-4-18  Ck'd By: SK  App'vd By: DWG

Wastewater Treatment Plant Improvements
O'Fallon, Missouri

SHEAR WAVE VELOCITY PROFILE

Drawn By: WAH

Project Number J031812.01

PLATE 3
APPENDIX A

IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL-ENGINEERING REPORT
Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared solely for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. And no one — not even you — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client’s goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

• not prepared for you;
• not prepared for your project;
• not prepared for the specific site explored; or
• completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

• the function of the proposed structure, as when it’s changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
• the elevation, configuration, location, orientation, or weight of the proposed structure;
• the composition of the design team; or
• project ownership.

As a general rule, always inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. Do not rely on a geotechnical-engineering report whose adequacy may have been affected by: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. Contact the geotechnical engineer before applying this report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report’s Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. Confirmation-dependent recommendations are not final, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report’s confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations’ applicability.

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members’ misinterpretation of geotechnical-engineering reports has resulted in costly
problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team’s plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer’s Logs
Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

Give Constructors a Complete Report and Guidance
Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, but preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report’s accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. Be sure constructors have sufficient time to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely
Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered
The equipment, techniques, and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. Do not rely on an environmental report prepared for someone else.

Obtain Professional Assistance To Deal with Mold
Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the express purpose of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold-prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical-engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; none of the services performed in connection with the geotechnical engineer’s study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance
Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733  Facsimile: 301/589-2017
e-mail: info@geoprofessional.org  www.geoprofessional.org

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APPENDIX B

LOGS OF BORINGS AND CPT SOUNDINGS
BORING LOG: TERMS AND SYMBOLS
Topsoil - 12 inches

Stiff to soft, brown and gray, LEAN CLAY - (CL)

Boring terminated at 25 feet.

---

**GROUNDWATER DATA**

X FREE WATER NOT ENCOUNTERED DURING DRILLING

**DRILLING DATA**

_ AUGER _ 3 3/4" HOLLOW STEM

WASHBORING FROM _ FEET

KJB DRILLER KLR LOGGER

CME 5STRK DRILL RIG

HAMMER TYPE Auto

HAMMER EFFICIENCY 83%

---

**REMARKS:**

---

**LOG OF BORING: B-1**

Project No. J031812.01
### Topsoil - 12 inches
Soft to very stiff, brown and gray, LEAN CLAY - (CL) with sand seams

Boring terminated at 25 feet.

### Description of Material

<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Topsoil - 12 inches</td>
</tr>
<tr>
<td></td>
<td>Soft to very stiff, brown and gray, LEAN CLAY - (CL) with sand seams</td>
</tr>
<tr>
<td></td>
<td>Boring terminated at 25 feet</td>
</tr>
</tbody>
</table>

### Groundwater Data

X FREE WATER NOT ENCOUNTERED DURING DRILLING

### Drilling Data

- **Auger**: 3 3/4" Hollow Stem
- **Washboring from**: __ feet
- **KJB Driller**: KLR Logger
- **CME 55TRK Drill Rig**: HAMMER TYPE Auto
- **Hammer Efficiency**: 83 %

### Remarks:

### Log of Boring: B-3

**Wastewater Treatment Plant Improvements**
**O'Fallon, Missouri**

**Project No.: J031812.01**
**DESCRIPTION OF MATERIAL**

<table>
<thead>
<tr>
<th>DEPTH IN FEET</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
</tr>
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<tbody>
<tr>
<td>446</td>
<td>Topsoil - 12 inches</td>
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<tr>
<td>2-3-6</td>
<td>2-3-6 SS1</td>
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<tr>
<td>1-2-2</td>
<td>1-2-2 SS2</td>
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<tr>
<td>1-3-4</td>
<td>1-3-4 SS4</td>
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</tr>
<tr>
<td>1-1-2</td>
<td>1-1-2 SS5</td>
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<td>1-3-4</td>
<td>1-3-4 SS4</td>
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<tr>
<td>1-1-2</td>
<td>1-1-2 SS5</td>
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<tr>
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<tr>
<td>2-2-2</td>
<td>2-2-2 SS7</td>
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</tbody>
</table>

**GROUNDWATER DATA**

- **FREE WATER NOT ENCOUNTERED DURING DRILLING**

**DRILLING DATA**

- **AUGER 3 3/4" HOLLOW STEM**
- **WASHBORING FROM 25 FEET**
- **KJB DRILLER KLR LOGGER**
- **CME 55TRK DRILL RIG**
- **HAMMER TYPE Auto**
- **HAMMER EFFICIENCY 83 %**

**DRY UNIT WEIGHT (pcf)**

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<th>WATER CONTENT, %</th>
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<tbody>
<tr>
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</table>

**COMMENTS:**

- X FREE WATER NOT ENCOUNTERED DURING DRILLING

**LOG OF BORING:** B-7

**Wastewater Treatment Plant Improvements O'Fallon, Missouri**

**REMARKS:**

**DRAWN BY:** EKG  **CHECKED BY:** SK  **APPROVED BY:** DWG

**DATE:** 4/11/18  **DATE:** 4/26/18  **DATE:** 4/26/18

**Surface Elevation:** 446  **Completion Date:** 3/28/18

**Datum:** WGS84 EGM96 Geoid

**Project No.:** J031812.01
DESCRIPTION OF MATERIAL

Topsoil - 12 inches

Soft to medium stiff, brown, LEAN CLAY - CL

trace sand

Medium dense, brown SAND - SP

Boring terminated at 25 feet.

GROUNDWATER DATA

x FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM ___ FEET

KJB DRILLER KLR LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

HAMMER EFFICIENCY 83%

REMARKS:

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES
AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

LOG OF BORING: B-9

Wastewater Treatment Plant Improvements O'Fallon, Missouri

Project No. J031812.01
Topsoil - 12 inches
Stiff to soft, brown and tan, LEAN CLAY - CL

Medium stiff, gray and brown, FAT CLAY - (CH)
trace sand

Boring terminated at 25 feet.

GROUNDBORING DATA
ENCOUNTERED AT 24 FEET

DRILLING DATA
AUGER 3 3/4" HOLLOW STEM
WASHBORING FROM ___ FEET

KJB DRILLER KLR LOGGER
CME 5STRK DRILL RIG
HAMMER TYPE Auto
HAMMER EFFICIENCY 83 %

Wastewater Treatment Plant Improvements
O'Fallon, Missouri

LOG OF BORING: B-11
Project No. J031812.01
Topsoil - 12 inches
Soft to very stiff, brown and gray, LEAN CLAY - (CL)

Boring terminated at 25 feet.

**Groundwater Data**
- Free water not encountered during drilling

**Drilling Data**
- Auger 3 3/4" hollow stem
- Washboring from ___ feet
- KJB driller
- KLR logger
- CME 5STRK drill rig
- Hammer type: Auto
- Hammer efficiency: 83%

**Remarks:**

**Log of Boring:** B-12

---

**Project No:** J031812.01

---

**Groundwater Data**

**Drilling Data**

**Remarks:**

---

**Log of Boring:** B-12
<table>
<thead>
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<th>Description of Material</th>
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</thead>
<tbody>
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<td>Topsoil - 18 inches</td>
<td>Stiff to soft, brown, LEAN CLAY - CL</td>
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<tr>
<td>25</td>
<td>Boring terminated at 25 feet.</td>
</tr>
</tbody>
</table>

**Groundwater Data**

Encountered at 19 feet.

**Drilling Data**

- Auger 3 3/4" Hollow Stem
- Wash boring from 20 feet
- KJB Driller
- KLR Logger
- CME 5STRK Drill Rig
- Hammer Type: Auto
- Hammer Efficiency: 83%

**Remarks:**

**Groundwater Data**

Encountered at 19 feet.

**Drilling Data**

- Auger 3 3/4" Hollow Stem
- Wash boring from 20 feet
- KJB Driller
- KLR Logger
- CME 5STRK Drill Rig
- Hammer Type: Auto
- Hammer Efficiency: 83%

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- Wash boring from 20 feet
- KJB Driller
- KLR Logger
- CME 5STRK Drill Rig
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- Hammer Efficiency: 83%

**Groundwater Data**

Encountered at 19 feet.

**Drilling Data**

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- Wash boring from 20 feet
- KJB Driller
- KLR Logger
- CME 5STRK Drill Rig
- Hammer Type: Auto
- Hammer Efficiency: 83%
CPT-4
Total depth: 50.07 ft, Date: 3/26/2018
Surface Elevation: 446.00 ft
Coords: 38 50.6984, -90 41.8135
Cone Type: 15cm2
Cone Operator: DWJ

Geotechnology, Inc
11816 Lackland Road
St. Louis, Missouri
http://www.geotechnology.com
Project: O'Fallon WWTP
Location: O'Fallon, Missouri

Cone resistance qt
Sleeve friction
Pore pressure u
Shear strength
Norm. Soil Behaviour Type
SPT N60

Tip resistance (tsf)
Friction (tsf)
Pressure (psi)
Su (tsf)
SBTn (Robertson, 1990)
N60 (blows/ft)

Depth (ft)
Depth (ft)
Depth (ft)
Depth (ft)
Depth (ft)

CPT-IT v.2.0.2.5 - CPTU data presentation & interpretation software - Report created on: 4/16/2018, 10:56:39 AM
Project file: H:\Projects\3031\031812.01-O'Fallon WWTP Improvements\Data\CPT Data\031812.01-O'Fallon WWTP.cpt

5
:: Unit Weight, $g$ (kN/m$^2$) ::

\[ g = g_w + \left( 0.27 \cdot \log(R_d) + 0.36 \cdot \log\left( \frac{S_k}{P_k} \right) + 1.235 \right) \]

where $g_w$ = water unit weight

:: Permeability, $k$ (m/s) ::

\begin{align*}
& I_c < 3.27 \text{ and } I_c > 1.00 \text{ then } k = 10^{-0.552 - 3.04 I_c} \\
& I_c \leq 4.00 \text{ and } I_c > 3.27 \text{ then } k = 10^{-4.32 - 1.32 I_c} 
\end{align*}

:: $N_{dr}$ (blows per 30 cm) ::

\begin{align*}
& N_{dr} = \left( \frac{Q_m}{P_k} \right) \left( \frac{1}{10^{1.65 - 0.52 I_c}} \right) \\
& N_{dr} = Q_m \left( \frac{1}{10^{1.59 - 0.52 I_c}} \right)
\end{align*}

:: Young's Modulus, $E_s$ (MPa) ::

\[ (\sigma_s - \sigma_v) = 0.015 \cdot 10^{0.61 I_c + 1.14 I_c} \]

( applicable only to $I_c < 1_{L_{cw,ext}}$)

:: Relative Density, $D_r$ (%) ::

\[ 100 \cdot \frac{Q_m}{Q_{dr}} \]  

( applicable only to $S_{BT} = 5, 6, 7$ and $8$ or $I_c < 1_{L_{cw,ext}}$)

:: State Parameter, $\psi$ ::

\[ \psi = 0.36 - 0.53 \cdot \log(Q_{dr,aw}) \]

:: Peak drained friction angle, $\phi$ (°) ::

\[ \phi = 17.60 + 11 \cdot \log(Q_{dr}) \]

( applicable only to $S_{BT} = 5, 6, 7$ and $8$)

:: 1-D constrained modulus, $M$ (MPa) ::

\begin{align*}
& \text{If } I_c > 2.20 \\
& n = 27 \text{ for } Q_{dr} > 14 \\
& n = Q_{dr,aw} \text{ for } Q_{dr} \leq 14 \\
& M_{CPT} = a \cdot (Q_{dr} - \sigma_v) \\
& \text{If } I_c \leq 2.20 \\
& M_{CPT} = (Q_{dr} - \sigma_v) \cdot 0.0186 \cdot 10^{0.55 I_c + 1.68}
\end{align*}

:: Small strain shear Modulus, $G_0$ (MPa) ::

\[ G_0 = \left( \frac{Q_{dr}}{P_k} \right) \cdot 0.0186 \cdot 10^{0.35 I_c + 1.68} \]

:: Shear Wave Velocity, $V_s$ (m/s) ::

\[ V_s = \left( \frac{Q_{dr}}{P_k} \right) \]

:: Undrained peak shear strength, $S_u$ (kPa) ::

\[ S_u = \left( \frac{Q_{dr}}{P_k} \right) \cdot 10^{2.25} \]

( applicable only to $S_{BT} = 1, 2, 3, 4$ and $9$ or $I_c > 1_{L_{cw,ext}}$)

:: Remolded undrained shear strength, $S_u$ (kPa) ::

\[ S_u = \left( \frac{Q_{dr}}{P_k} \right) \]

( applicable only to $S_{BT} = 1, 2, 3, 4$ and $9$ or $I_c > 1_{L_{cw,ext}}$)

:: Overconsolidation Ratio, OCR ::

\[ k_{OCR} = \left[ 0.25 \left( 10^{0.5 - 7 \cdot \log(Q_{dr,aw})} \right) \right]^{0.25} \text{ or user defined} \]

( applicable only to $S_{BT} = 1, 2, 3, 4$ and $9$ or $I_c > 1_{L_{cw,ext}}$)

:: In situ Stress Ratio, $K_o$ ::

\[ K_o = \left( 1 - \sin\psi \right) \cdot OCR^{\phi/\psi} \]

( applicable only to $S_{BT} = 1, 2, 3, 4$ and $9$ or $I_c > 1_{L_{cw,ext}}$)

:: Soil Sensitivity, $S_s$ ::

\[ S_s = \frac{Q_{dr}}{P_k} \]

( applicable only to $S_{BT} = 1, 2, 3, 4$ and $9$ or $I_c > 1_{L_{cw,ext}}$)

:: Effective Stress Friction Angle, $\phi_{\text{eff}}$ ::

\[ \phi^{\text{eff}} = 29.5 \cdot \frac{\theta_1 - \phi_{\text{w}}}{\theta_1 - \phi_{\text{w}}} \cdot \left( 0.256 - 0.336 \cdot \frac{Q_{dr}}{P_k} \cdot \log Q_{dr} \right) \]

( applicable for $0.1 < Q_{dr} < 1.0$)

References

**BORING LOG: TERMS AND SYMBOLS**

**LEGEND**

<table>
<thead>
<tr>
<th>Symbol</th>
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<td>NQ Rock Core</td>
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<td>PST</td>
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<td>SS</td>
<td>Split-Spoon Sample (Standard Penetration Test)</td>
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<td>ST</td>
<td>Three-Inch Diameter Shelby Tube Sample</td>
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<td>PL</td>
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<td>LL</td>
<td>Liquid Limit (ASTM D4318)</td>
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<td>SV</td>
<td>Shear Strength from Field Vane (ASTM D2573)</td>
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<td>Shear Strength from Unconsolidated-Undrained Triaxial Compression Test (ASTM D2850)</td>
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<td>QU</td>
<td>Shear Strength from Unconfined Compression Test (ASTM D2166)</td>
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**SOIL GRAIN SIZE**

**US STANDARD SIEVE**

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**SOIL GRAIN SIZE IN MILLIMETERS**

**UNIFIED SOIL CLASSIFICATION SYSTEM**

**SOIL GRAIN SIZE**

**US STANDARD SIEVE**

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<th>Major Divisions</th>
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<td>Clean Gravels</td>
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<td>MH</td>
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**STRENGTH OF COHESIVE SOILS**

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<tr>
<th>Consistency</th>
<th>Undrained Shear Strength (tsf)</th>
<th>Unconfined Comp. Strength (tsf)</th>
<th>Descriptive Term</th>
<th>Approximate N&lt;sub&gt;60&lt;/sub&gt; Value Range</th>
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<td>0.5 to 1.0</td>
<td>Medium Dense</td>
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**DENSITY OF GRANULAR SOILS**

N-Value (Blow Count) is the last two, 6-inch drive increments (i.e. 4/7/9, N = 7 + 9 = 16). Values are shown as a summation on the grid plot and shown in the Unit Dry Weight/SPT column.

**RELATIVE COMPOSITION**

| Trace       | 0 to 10% | Layer - Inclusion greater than 3 inches thick. |
| Little      | 10 to 20% | Seam - Inclusion 1/8-inch to 3 inches thick |
| Some        | 20 to 35% | Parting - Inclusion less than 1/8-inch thick |
| And         | 35 to 50% | Pocket - Inclusion of material that is smaller than sample diameter |

**OTHER TERMS**

Relative composition and Unified Soil Classification System (USCS) designations are based on visual descriptions and are approximate only. If laboratory tests were performed to classify the soil, the USCS designation is shown in parenthesis.
APPENDIX C

ELECTRICAL RESISTIVITY SURVEY RESULTS
<table>
<thead>
<tr>
<th>Electrode Spacing (feet)</th>
<th>Apparent Resistivity (ohm-feet)</th>
<th>Resistance (ohms)</th>
<th>Current (mA)</th>
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APPENDIX D

PIEZOMETER INSTALLATION DETAILS
Date Installed: March 28, 2018
Location: Northing -1,096,587.29
Easting - 764,083.09
(Missouri State Plane Coordinates - East Zone)

Above Ground, Locking Steel Well Cover

Ground Elevation: 447, Datum: NAVD88

Riser Type: PVC
Diameter: 1-Inch

Backfill: Cuttings

Seal: Bentonite Chips

Sand: Silica Sand

Screen Diameter: 1-Inch
Type: PVC
Slot Size: 0.01"
Length: 10.00"

Borehole Diameter: 8.25-Inch
Drill Method: HSA

Drawn By: WAH
Ck'd By: JAK
App'vd By: AWL
Date: 4-16-18
Date: 4-17-18
Date: 4-20-18

Geotechnology Inc.
Wastewater Treatment Plant Improvements
O'Fallon, Missouri

MONITORING WELL B-3

Project Number
J031812.01
APPENDIX E

THERMAL RESISTIVITY TEST RESULTS
**Determination of Thermal Conductivity of Soil and Soft Rock by Thermal Needle Probe**

**ASTM D5334**

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Depth feet</th>
<th>Sensor</th>
<th>K W/(m·K)</th>
<th>rho °C·cm/W</th>
<th>Err</th>
<th>Temp °C</th>
<th>Read Time minutes</th>
<th>Moisture Content %</th>
<th>Wet Density pcf</th>
<th>Dry Density pcf</th>
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**Thermal Conductivity Results**

**Thermal Resistivity Results**
APPENDIX F

ANALYTICAL TEST RESULTS
April 13, 2018

Senthil Kumar
Geotechnology, Inc.
11816 Lackland Road
St. Louis, MO 63146
TEL: (314) 997-7440
FAX: (314) 997-2067

RE: OFallon WWTP/J031812.01

WorkOrder: 18040206

Dear Senthil Kumar:

TEKLAB, INC received 3 samples on 4/3/2018 5:20:00 PM for the analysis presented in the following report.

Samples are analyzed on an as received basis unless otherwise requested and documented. The sample results contained in this report relate only to the requested analytes of interest as directed on the chain of custody. NELAP accredited fields of testing are indicated by the letters NELAP under the Certification column. Unless otherwise documented within this report, Teklab Inc. analyzes samples utilizing the most current methods in compliance with 40CFR. All tests are performed in the Collinsville, IL laboratory unless otherwise noted in the Case Narrative.

All quality control criteria applicable to the test methods employed for this project have been satisfactorily met and are in accordance with NELAP except where noted. The following report shall not be reproduced, except in full, without the written approval of Teklab, Inc.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Emily Pohlman
Project Manager
(618)344-1004 ex 44
epohlman@teklabin.com
This reporting package includes the following:

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<td>Cover Letter</td>
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<td>Report Contents</td>
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<td>3</td>
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Definitions

Client: Geotechnology, Inc.
Client Project: OFallon WWTP/J031812.01

Abbr Definition

- Analytes on report marked with an asterisk are not NELAP accredited
- CCV Continuing calibration verification is a check of a standard to determine the state of calibration of an instrument between recalibration.
- DF Dilution factor is the dilution performed during analysis only and does not take into account any dilutions made during sample preparation. The reported result is final and includes all dilutions factors.
- DNI Did not ignite
- DUP Laboratory duplicate is an aliquot of a sample taken from the same container under laboratory conditions for independent processing and analysis independently of the original aliquot.
- ICV Initial calibration verification is a check of a standard to determine the state of calibration of an instrument before sample analysis is initiated.
- ILPH IL Dept., of Public Health
- LCS Laboratory control sample, spiked with verified known amounts of analytes, is analyzed exactly like a sample to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. The acceptable recovery range is in the QC Package (provided upon request).
- LCSD Laboratory control sample duplicate is a replicate laboratory control sample that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
- MBLK Method blank is a sample of a matrix similar to the batch of associated sample (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences should present at concentrations that impact the analytical results for sample analyses.
- MDL Method detection limit means the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.
- MS Matrix spike is an aliquot of matrix fortified (spiked) with known quantities of specific analytes that is subjected to the entire analytical procedures in order to determine the effect of the matrix on an approved test method's recovery system. The acceptable recovery range is listed in the QC Package (provided upon request).
- MSD Matrix spike duplicate means a replicates matrix spike that is prepared and analyzed in order to determine the precision of the approved test method. The acceptable recovery range is listed in the QC Package (provided upon request).
- MW Molecular weight
- ND Not Detected at the Reporting Limit
- NELAP NELAP Accredited
- PQL Practical quantitation limit means the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operation conditions. The acceptable recovery range is listed in the QC Package (provided upon request).
- RL The reporting limit the lowest level that the data is displayed in the final report. The reporting limit may vary according to customer request or sample dilution. The reporting limit may not be less than the MDL.
- RPD Relative percent difference is a calculated difference between two recoveries (ie. MS/MSD). The acceptable recovery limit is listed in the QC Package (provided upon request).
- SPK The spike is a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery deficiency or for other quality control purposes.
- Surrogate compounds which are similar to the analytes of interest in chemical composition and behavior in the analytical process, but which are not normally found in environmental samples.
- TIC Tentatively identified compound: Analytes tentatively identified in the sample by using a library search. Only results not in the calibration standard will be reported as tentatively identified compounds. Results for tentatively identified compounds that are not present in the calibration standard, but are assigned a specific chemical name based upon the library search, are calculated using total peak areas from reconstructed ion chromatograms and a response factor of one. The nearest Internal Standard is used for the calculation. The results of any TICs must be considered estimated, and are flagged with a "T. If the estimated result is above the calibration range it is flagged "ET"
- TNIC Too numerous to count (> 200 CFU)

Qualifiers

- # - Unknown hydrocarbon
- B - Analyte detected in associated Method Blank
- C - Value above quantitation range
- E - Value above quantitation range
- H - Holding times exceeded
- I - Associated internal standard was outside method criteria
- J - Analyte detected below quantitation limits
- K - Manual Integration used to determine area response
- M - Not Detected at the Reporting Limit
- N - Acceptable recovery limits
- P - Spike Recovery outside recovery limits
- R - TIC(Tentatively identified compound)
- S - Spike Recovery outside recovery limits
- T - Value exceeds Maximum Contaminant Level
- X - Value exceeds Maximum Contaminant Level
Redox potential (ORP) analysis was performed by PDC Laboratories, Inc. See attached report for quality control data.

The method SM 2380B for ORP analysis on soil is a modified water method. No holding time requirement has been established for the modified method.
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### Laboratory Results

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**Client Project:** OFallon WWTP/031812.01  
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**Matrix:** SOLID  
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**Sulfide, Total**

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# Quality Control Results

**Client:** Geotechnology, Inc.  
**Client Project:** OFallon WWTP/3031812.01  
**Work Order:** 18040206  
**Report Date:** 13-Apr-18

### SW-846 9030B, 9134

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<tr>
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<td>145</td>
<td>126.4</td>
<td>75.59</td>
<td>53.6</td>
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Receiving Check List

Client: Geotechnology, Inc.
Client Project: OFallon WWTP/J031812.01

Carrier: Nick Reed
Received By: KF
Completed by: Kalyn Feecke
Reviewed by: Emily Pohlman

04-Apr-18
04-Apr-18

---

<table>
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<tr>
<th>Pages to follow: Chain of custody</th>
<th>Extra pages included</th>
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</thead>
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<tr>
<td>1</td>
<td>5</td>
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- **Shipping container/cooler in good condition?** Yes ✓ No □
- **Type of thermal preservation?** None □ Ice ✓ No □
- **Chain of custody present?** Yes ✓ No □
- **Chain of custody signed when relinquished and received?** Yes ✓ No □
- **Chain of custody agrees with sample labels?** Yes ✓ No □
- **Samples in proper container/bottle?** Yes ✓ No □
- **Sample containers intact?** Yes ✓ No □
- **Sufficient sample volume for indicated test?** Yes ✓ No □
- **All samples received within holding time?** Yes ✓ No □
- **Reported field parameters measured:** Field □ Lab □ NA ✓
- **Container/Temp Blank temperature in compliance?** Yes ✓ No □

---

*When thermal preservation is required, samples are compliant with a temperature between 0.1°C - 6.0°C, or when samples are received on Ice the same day as collected.*

- **Water - at least one vial per sample has zero headspace?** Yes □ No □ No VOA vials ✓
- **Water - TOX containers have zero headspace?** Yes □ No □ No TOX containers ✓
- **Water - pH acceptable upon receipt?** Yes □ No □ NA ✓
- **NPDES/CWA TCN interferences checked/treated in the field?** Yes □ No □ NA ✓

---

*Any No responses must be detailed below or on the COC.*
APPENDIX G

LIQUEFACTION ANALYSIS REPORTS
(FOR PEAK GROUND ACCELERATION=0.23g AND EARTHQUAKE MAGNITUDE=7.7)
Liquefaction analysis overall plot

Input parameters and analysis data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Analysis method</td>
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<tr>
<td>Fines correction method</td>
<td>B&amp;I (2014)</td>
</tr>
<tr>
<td>Points to test</td>
<td>Based on Ic value</td>
</tr>
<tr>
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<td>7.70</td>
</tr>
<tr>
<td>Peak ground acceleration</td>
<td>0.23</td>
</tr>
<tr>
<td>Depth to water table (feet)</td>
<td>24.00</td>
</tr>
<tr>
<td>Depth to GWT (feet)</td>
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</tr>
<tr>
<td>Average results interval</td>
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</tr>
<tr>
<td>I&lt;sub&gt;c&lt;/sub&gt; cut-off value</td>
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<td>Very likely to liquefy</td>
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<td>Low risk</td>
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CPT name: CPT-2
**Liquefaction analysis overall plot**

**Input parameters and analysis data**

- **Analysis method:** B61 (2014)
- **Fines correction method:** B61 (2014)
- **Points to test:** Based on its value
- **Earthquake magnitude Mₑ:** 7.0
- **Peak ground acceleration:** 0.23 g
- **Depth to water table (trawl):** 26.00 ft

<table>
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<th>Depth to GWT (trawl):</th>
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<td>Unit weight calculation:</td>
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<tr>
<td>Use fill:</td>
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<tr>
<td>Kₑ applied:</td>
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</tr>
<tr>
<td>Clay line behavior applied:</td>
<td>Sands only</td>
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<tr>
<td>Limit depth applied:</td>
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</tr>
<tr>
<td>Limit depth:</td>
<td>60.00 ft</td>
</tr>
</tbody>
</table>

**F.S. color scheme**
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no fill are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

**LPI color scheme**
- Very high risk
- High risk
- Low risk

---

**Project file:** H:\Projects\031812.01-O'Fallon WWTP Improvements\Data\CPT Data\031812.01 O'Fallon WWTP Liq.clq
Liquefaction analysis overall plot

Input parameters and analysis data

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<td>Depth to GWFT (ethyg)</td>
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<td>Limit depth</td>
<td>60.00 ft</td>
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F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefy are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk
Liquefaction analysis overall plot

Input parameters and analysis data

- Piles correction method: B&J (2014)
- Points to test: Based on ic value
- Earthquake magnitude Mw: 7.70
- Peak ground acceleration: 0.23
- Depth to water table (msbl): 24.00 ft

- Depth to GW (feet): 24.00 ft
- Average results interval: 3
- ic cut-off value: 2.50
- Unit weight calculation: Based on SBT
- Use fill: No
- Fill height: N/A
- Fill weight: N/A
- Transition detect: applied: No
- K<sub>p</sub> applied: Yes
- Clay like behavior: applied: Sends only
- Limit depth applied: Yes
- Limit depth: 60.00 ft

F.S. color scheme:
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction is likely
- Likely to liquefy
- Unlikely to liquefy
- Almost certain it will not liquefy

LPI color scheme:
- Very high risk
- High risk
- Medium risk
- Low risk
- Almost certain it will liquefy

Clique v.2.1.6.7 - CPT Liquefaction Assessment Software - Report created on: 4/16/2016, 11:50:56 AM
Project file: H:\Projects\0311\031118\12.01-O'Fallon WWTP Improvements\Data\CPT Data\031118\12.01 O'Fallon WWTP Liquefaction Analysis.dat
Liquefaction analysis overall plot

Input parameters and analysis data

- Analysis method: 88a (2014)
- Fines correction method: 88a (2014)
- Points to test: Based on Lc value
- Earthquake magnitude Mw: 7.70
- Peak ground acceleration: 0.23
- Depth to water table (ft/su): 24.00 ft
- Depth to GWT (in situ): 24.00 ft
- Average results interval: 3
- Lc cut-off value: 2.60
- Unit weight calculation: Based on SBT
- Liquefaction: No
- Fill height: N/A
- Fill weight: N/A
- Transient detect. applied: No
- Kp applied: Yes
- Clay like behavior: Sands only
- Limit depth applied: Yes
- Limit depth: 60.00 ft

F.S. color scheme:
- Almost certain it will liquefy
- Very certain to liquefy
- Very likely to liquefy
- High risk
- Medium risk
- Low risk

LPI color scheme:
- Very high risk
- High risk
- Medium risk
- Low risk
- Almost certain it will not liquefy

CLiq v.2.1.6.7 - CPT Liquefaction Assessment Software - Report created on: 4/16/2018, 11:50:59 AM
Project file: H:\Projects\0031\031812.01\O'Fallon WWTP Improvements\Data\CPT Data\031812.01 O'Fallon WWTP Liq.clq
Liquefaction analysis overall plot

Input parameters and analysis data

- Analysis method: B67 (2014)
- Finite element method: BRX (2014)
- Points to tests: Based on IC value
- Earthquake magnitude Mw: 7.29
- Peak ground acceleration: 0.23
- Depth to water table (ft): 24.00 ft
- Depth to GWGT (ft): 24.00 ft
- Average results interval: 3
- IC cut-off value: 2.60
- Unit weight calculation: Based on SBT
- Use fill: No
- Fill height: N/A
- Fill weight: N/A
- Tension ductile applied: No
- Kp applied: Yes
- Clay line behavior applied: Sands only
- Limit depth applied: Yes
- Limit depth: 60.00 ft

F.S. color scheme:
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefied equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

LPI color scheme:
- Very high risk
- High risk
- Medium risk
- Low risk

CLIQ v.2.1.6.7 - CPT Liquefaction Assessment Software - Report created on: 4/16/2018, 11:51:11 AM
Project file: H:\Projects\2031\2031812.01-O'Fallon WWTP Improvements\Data\CPT\Data\2031812.01 O'Fallon WWTP Site.cdx
APPENDIX H

CONSOLIDATION TEST RESULTS
Void Plot

Effective Vertical Stress, $\sigma''$, (tsf)

Void Ratio, $e$

SAMPLE INFORMATION
Boring: B-9 Sample: ST5 Depth: 13-15 feet

SAMPLE DATA
Moisture Content (%): 20.8
Dry Unit Weight (pcf): 93.2

RESULTS
Compression Index, $Cc$: 0.20
Recompression Index, $Cr$: 0.01
Preconsolidation Pressure (tsf): 1.70
Initial Void Ratio: 0.81

Tested By: EG Calc'd By: AGB Check'd By: EG
Date: 5/16/2018 Date: 5/23/2018 Date: 5/23/2018

Wastewater Treatment Plant Improvements
O'Fallon, Missouri

ONE-DIMENSIONAL INCREMENTAL
CONSOLIDATION TEST ASTM D2435
Project Number: J031812.01
APPENDIX E: MDNR WATER QUALITY & ANTIDEGRADATION REVIEW
Mr. Mike Pratt  
100 North Main Street  
O'Fallon, MO 6336

RE: Water Quality and Antidegradation Review Preliminary Determination for  
O'Fallon WWTF MO-0028720

Dear Mr. Pratt:

In accordance with the Missouri Antidegradation Rule and Implementation Procedure (AIP), your proposed discharge is subject to an Antidegradation Review. The enclosed Water Quality and Antidegradation Review (WQAR) summarizes this preliminary determination based upon your Peruque Creek High Flow Discharge Report dated June 28, 2017, which proposed an alternate discharge to Peruque Creek during times when the Mississippi River is under flood conditions.

The WQAR contains pertinent antidegradation review information based on the use of existing water quality, effluent limitations and monitoring requirements for the facility discharge. It was developed in accordance with 10 CSR 20-7.031, the Clean Water Commission approved Missouri Antidegradation Rule and Implementation Procedure (AIP) dated July 13, 2016, U.S. Environmental Protection Agency (US EPA) guidance, the applicant-supplied antidegradation review documentation, and the State of Missouri’s effluent regulations (10 CSR 20-7.015). Please refer to the General Assumptions of the Water Quality and Antidegradation Review section of the enclosed WQAR. The WQAR is preliminary and subject to change as new information becomes available during future permit application processing.

Based on the Missouri Department of Natural Resources (Department) initial review, preliminary determination is that the applicant-supplied antidegradation review documentation satisfies the requirements of the AIP. This WQAR/preliminary determination may be appealed within 30 days of this letter in accordance with the AIP Section II.F.4.

You may proceed with submittal of an application for an operating permit and antidegradation review public notice, an engineering report, or a complete application for a construction permit to the Department or to the financial assistance center for projects that are seeking funding assistance from the Department of Natural Resources. These submittals must reflect the design flow, facility description, and general treatment components of this WQAR or this preliminary determination may have to be revisited. Following the Department’s public notice of draft Missouri State Operating Permit, including the antidegradation review findings and preliminary determination, the
Department will review any public notice comments received. If significant comments are made, the project may require another public notice and potentially another antidegradation review. If no comments are received or comments are resolved without another public notice, these findings and determinations will be considered final. Following issuance of the construction permit and completion of the actual facility construction, the Department will proceed with the issuance of the operating permit.

If you should have questions, please feel free to contact Ms. Sonali Siriwardana by telephone at (573) 751-7466, by e-mail at sonali.siriwardana@dnr.mo.gov, or by mail at P.O. Box 176, Jefferson City, Missouri 65102-0176.

Sincerely,

WATER PROTECTION PROGRAM

[Signature]

Refaat Meifrakis, P.E., Engineering Section Chief
Water Pollution Control Branch

Enclosures

RKM:ssn

c: Mr. Robert T. Polys, P.E.
St. Louis Regional Office
Water Quality and Antidegradation Review

For the Protection of Water Quality
and Determination of Effluent Limits for Discharge to
Peruque Creek

by

O’Fallon Wastewater Treatment Facility

February 2018
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1. FACILITY INFORMATION

FACILITY NAME: O'Fallon Wastewater Treatment Facility (WWTF) NPDES #: MO-0028720

FACILITY TYPE: POTW – Residential Subdivision – SIC #4952

FACILITY DESCRIPTION: The current facility utilizes a Bio-Filter/Activated Sludge treatment process that discharges to the Mississippi River. The consultant has proposed a high flow discharge to Peruque Creek when the Mississippi River is under flood conditions during wet weather events. As a result of the submitted alternative analysis, the applicant’s preferred alternative is the Conventional Activated Sludge (CAS) system with provisions for Biological Nutrient Removal (BNR) in an MLE type configuration and UV disinfection. The design flow will be 4.53 MGD.

COUNTY: St. Charles UTM COORDINATES: X=700051 / Y=4301947
12-DIGIT HUC: 07110009-0102 LEGAL DESCRIPTION: SE ¼, SW ¼, Section 469, T0N, R0E
EDU*: Central Plains/ Cuivre/Salt ECOREGION: Ozark Border

* - Ecological Drainage Unit

2. WATER QUALITY INFORMATION

In accordance with Missouri’s Water Quality Standard [10 CSR 20-7.031(3)] and federal antidegradation policy at Title 40 Code of Federal Regulation (CFR) Section 131.12 (a), the Missouri Department of Natural Resources (MDNR) developed a statewide antidegradation policy and corresponding procedures to implement the policy. A proposed discharge to a water body will be required to undergo a level of Antidegradation Review which documents that the use of a water body’s available assimilative capacity is justified. Effective August 30, 2008, and revised July 13, 2016, a facility is required to use Missouri’s Antidegradation Implementation Procedure (AIP) for new and expanded wastewater discharges.

2.1. WATER QUALITY HISTORY:

Monthly averages for the facility’s discharge monitoring report: 11.1 mg/L BOD₅, 12.4 mg/L TSS, 16.1 mg/L Ammonia, 97#/100mL E. coli for the 30-day geometric mean. This facility is not under enforcement. No receiving water information. Peruque Creek is on the 303(d) list for dissolved oxygen and fishes bioassessments for segments 215 and 218. There is not a TMDL for Peruque Creek. The discharge in segment 216 is approximately 2,200 ft from impaired segment 215 of Peruque Creek. The low-flow value for Peruque Creek was calculated by using flow data from Peruque Creek on days when the Mississippi River was at flood level.

<table>
<thead>
<tr>
<th>OUTFALL</th>
<th>DESIGN FLOW (CFS)</th>
<th>TREATMENT LEVEL</th>
<th>RECEIVING WATERBODY</th>
<th>DISTANCE TO CLASSIFIED SEGMENT (MI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>002</td>
<td>7.01</td>
<td>Secondary</td>
<td>Peruque Creek</td>
<td>0.0</td>
</tr>
</tbody>
</table>

3. RECEIVING WATERBODY INFORMATION

<table>
<thead>
<tr>
<th>WATERBODY NAME</th>
<th>CLASS</th>
<th>WBID</th>
<th>FLOW VALUES (CFS)</th>
<th>DESIGNATED USES*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peruque Creek</td>
<td>P</td>
<td>216</td>
<td>1Q10 7Q10 3Q10 704**</td>
<td>AQL, HHP, IRR, LWW, SCR, WBC(B), General Criteria</td>
</tr>
</tbody>
</table>

* Irrigation (IRR), Livestock & Wildlife Protection (LWP), Protection of Warm Water Aquatic Life (AQL), Human Health Protection (HHP), Cool Water Fishery (CLF), Cold Water Fishery (CDF), Whole Body Contact Recreation – Category A (WBC-A), Whole Body Contact Recreation – Category B (WBC-B), Secondary Contact Recreation (SCR), Drinking Water Supply (DWS), Industrial (IND), Groundwater (GRW).

** Flow conditions under which the discharge will occur. 704 CFS was calculated using data from US Gage Station 05514712 during days which the Mississippi River was flooded.
RECEIVING WATER BODY SEGMENT #1: Peruque Creek
Upper end segment* UTM coordinates: X=700051 / Y=4301947 (Outfall)
Lower end segment* UTM coordinates: X= 700312/ Y=4301750 (meets segment 215 of Peruque Creek)

* Segment is the portion of the stream where discharge occurs. Segment is used to track changes in assimilative capacity and is bound at a minimum by existing sources and confluences with other significant water bodies.

4. GENERAL COMMENTS

Woodard & Curran, Inc. Engineering prepared, on behalf of the City of O’Fallon, the Peruque Creek High Flow Discharge Antidegradation Report for the City of O’Fallon dated June 28, 2017. Applicant elected to assume that all pollutants of concern (POC) are significantly degrading the receiving stream in the absence of existing water quality. An alternative analysis was conducted to fulfill the requirements of the AIP. A dissolved oxygen modeling (Appendix C) analysis was submitted for review. Staff believes that the results of the model are protective of the water quality standards for dissolved oxygen. Information that was provided by the applicant in the submitted report and summary forms in Appendix D was used to develop this review document.

Geohydrological Evaluation was submitted with the request and the receiving stream is gaining for discharge purposes (Appendix A: Map).

A Missouri Department of Conservation Natural Heritage Review was obtained by the applicant; Indiana bats (Myotis sodalis, federal and state-listed endangered) may occur within the project area. Bald eagles (Haliaeetus leucocephalus) may nest near streams or water bodies in the project area. While no longer listed as endangered, eagles continue to be protected by the federal government under the Bald and Golden Eagle Protection Act. The applicant should follow recommendations given in the Natural Heritage Review (Appendix B) and if any trees need to be removed should contact the U.S. Fish and Wildlife Service for further coordination under the Endangered Species Act.

5. ANTIDEGRADATION REVIEW INFORMATION

The following is a review of the Peruque Creek High Flow Discharge Antidegradation Report dated June 28, 2017.

5.1. TIER DETERMINATION

Below is a list of pollutants of concern reasonably expected to be in the discharge (see Appendix D), Pollutants of concern are defined as those pollutants “proposed for discharge that affects beneficial use(s) in waters of the state. POCs include pollutants that create conditions unfavorable to beneficial uses in the water body receiving the discharge or proposed to receive the discharge.” (AIP, Page 7). Tier 2 was assumed for all POCs (see Appendix D).
Table 1. Pollutants of Concern and Tier Determination

<table>
<thead>
<tr>
<th>POLLUTANTS OF CONCERN</th>
<th>TIER*</th>
<th>DEGRADATION</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD$_5$/DO</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Suspended Solids (TSS)</td>
<td>**</td>
<td>Significant</td>
<td></td>
</tr>
<tr>
<td>Ammonia</td>
<td>2</td>
<td>Significant</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>***</td>
<td>Significant</td>
<td>Permit limits applied</td>
</tr>
<tr>
<td>*Escherichia coli (E. coli)</td>
<td>2</td>
<td>Significant</td>
<td></td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>2</td>
<td>Significant</td>
<td></td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Tier assumed. Tier determination not possible: ** No in-stream standards for these parameters. *** Standards for these parameters are ranges

The following Antidegradation Review Summary attachments in Appendix D were used by the applicant:

For pollutants of concern, the attachments are:
✓ Attachment A, Tier 2 with significant degradation.

### 5.2. EXISTING WATER QUALITY

Existing water quality data was submitted for ammonia. The Zone of Initial Dilution (ZID) is the 1Q10 value for the stream and the 30Q10 is considered the mixing zone when calculating ammonia limits. All POCs except dissolved oxygen and BOD$_5$ were considered to be Tier 2 and significantly degrading in the absence of existing water quality. Dissolved oxygen and BOD$_5$ are considered to be Tier 1 POCs due to the dissolved oxygen impairment in segment 215 of Peruche Creek.

Stone Ridge Meadows Subdivision WWTF’s Outfall No. 002 discharges under two miles away from Outfall No. 002 from the O’Fallon WWTF. Stone Ridge Meadows Subdivision WWTF’s outfall is located on an unnamed tributary to Peruche Creek. Stone Ridge Meadows Subdivision WWTF has an actual flow of 1,700 gpd.

### 5.3. NO DISCHARGE EVALUATION

According to 10 CSR 20-6.010 (4)(D), reports for the purpose of constructing a wastewater treatment facility shall consider the feasibility of constructing and operating a no discharge facility. Because Missouri’s antidegradation implementation procedures specify that if the proposed activity results in significant degradation then a demonstration of necessity (i.e., alternatives analysis) and a determination of social and economic importance are required. Part of that analysis as shown below is the non-degrading or no discharge evaluation. See Section 5.4.1 discussion for the regionalization alternative.

The first non-discharging alternative was land application with seasonal storage. This option would require an additional storage basin, which would take up about 10 acres of land, and a large amount of land suited for land application, approximately 21 acres. The land the WWTF site is located on is nearly built out and cannot accommodate for the acreage required to upgrade for land application. Typically, land application is prohibited for about six months of the year due to weather. The storage area and land required for this facility’s wet weather flows deems this option impractical.
The second non-discharging alternative was subsurface disposal with seasonal storage. This option would require the land to be completely dug up and reconstructed to install the subsurface distribution and disposal system. This would require the purchase of approximately 50 acres of land that could be disturbed to install the distribution system. This option is deemed economically impractical for the high flow discharge.

The third non-discharging alternative was recycling or reuse. Examples of reuse could be treated effluent irrigating golf courses, washing of trucks, or groundwater recharge. The source of flow is so high that it will not be used in its entirety for non-potable uses within the facility itself. Since this source of flow is not reliable, this cannot be used for a truck washing stations or golf courses, which usually depend on a continuous source. This option is deemed impractical for the high flow discharge.

The fourth non-discharging alternative was regionalization. O’Fallon WWTF has the highest permitted flow out of any of the neighboring facilities. In addition, the only time O’Fallon WWTF will see high flow discharge is during sustained high precipitation events, which is when all surrounding facilities also see high flow conditions. This would prevent them from accepting an additional high volume of flow. This option is deemed impractical for the high flow discharge.

The fifth non-discharging alternative was an alternative discharge location. Peruque Creek is the only stream in the immediate area with a significant flow which is maintained year round. It would be cost prohibitive and disruptive to the environment to run a pipe line to any other receiving water body due to disturbance of the natural landscape and acquisitions of property easements. This option is deemed impractical for the high flow discharge.

The sixth non-discharging alternative was improved operations & maintenance. The City and the WWTP staff are currently maximizing the hydraulic capacity to its fullest available extent to manage sustained high flow conditions while running all available treatment units during high flow events. Even with these management techniques, the Effluent Pump Station was still a limiting factor. The City is maximizing the ability of the collection system to convey wastewater to the WWTP and minimizing inflow and infiltration in the collection system. With all of these precautions being taken, the improved operations and maintenance is considered an impractical alternative and is already being done by the City to the extent possible.

The seventh non-discharging alternative is additional effluent pump capacity. This option would involve the construction of a new pump station that would include two 1,000 HP pumps with a new electrical system to accommodate the new electrical loads from pumps of that size. This would cost upward of eight million dollars. This option is deemed impractical and not economically feasible for the city.

The eighth non-discharging alternative is a parallel effluent force main. This option consists of the construction of a new 30-inch force main adjacent to the existing effluent force main to the Mississippi River. This cost for this is estimated to be $12,873,000. This project is considered impractical and not economically feasible for the city.
5.3.1. REGIONALIZATION ALTERNATIVE

Within Section II B 1. of the AIP, discussion of the potential for discharge to a regional wastewater collection system is mentioned. The applicant provided discussion of this alternative. O’Fallon WWTP itself has the highest permitted flow of any neighboring facility. The high discharge flow that O’Fallon WWTP sees during sustained high precipitation events is when all surrounding facilities also see high flow conditions. There are no treatment facilities in the immediate area that could take and treat the additional flow during wet weather events.

NEEDS A WAIVER TO PREVENT CONFLICT WITH AREA WIDE MANAGEMENT PLAN APPROVED UNDER SECTION 208 OF THE CLEAN WATER ACT AND/OR UNDER 10 CSR 20-6.010(3) (B) 1 OR 2 CONTINUING AUTHORITIES? (Y OR N) N

5.4. DEMONSTRATION OF NECESSITY AND SOCIAL AND ECONOMIC IMPORTANCE

Missouri’s antidegradation implementation procedures specify that if the proposed activity does result in significant degradation then a demonstration of necessity (i.e., alternatives analysis) and a determination of social and economic importance are required. Twelve alternatives from non-degrading to less degrading to degrading were evaluated. Only those alternatives that were considered practicable were included in the economic efficiency analysis.

The first degrading alternative was the Conventional Activated Sludge system. This is the base case option that includes provisions for Biological Nutrient Removal (BNR) in an MLE type configuration with suspended-growth treatment processes. This consists of a series of reactors for biological treatment including BOD and Ammonia-Nitrogen removal. This option also has the capability for Total Nitrogen and Total Phosphorus nutrient removal with an upgrade in the future.

The second degrading alternative is the same as the first but includes the addition of an effluent Tertiary Filtration system.

The third degrading alternative is identical to the second alternative with the addition of a chemical coagulant for improved treatment performance. This option can also be used to achieve Total Phosphorus removal. Chemical feed and storage systems would need to be included to accommodate chemical addition to the treatment process.

The fourth degrading alternative is a Membrane Bioreactor (MBR). This option involves a suspended growth activated sludge treatment which utilizes filtration for solids-liquid separation within the biological reactor. UV disinfection will be used.

All four degrading options mentioned above are practical alternatives. This analysis showed that the return on environmental benefits with increasing cost of treatment did not justify more expenditure beyond the base case treatment alternative (see Appendix D, Attachment A). The base case, conventional activated sludge system, was the preferred alternative based on this analysis.
Table 2: Alternatives Analysis Comparison

<table>
<thead>
<tr>
<th></th>
<th>Conventional Activated Sludge (CAS) (Base Case)</th>
<th>CAS with Tertiary Filtration</th>
<th>CAS with Tertiary Filtration &amp; Chemical Addition</th>
<th>Membrane Bioreactor</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD₅ (mg/L)</td>
<td>45</td>
<td>10</td>
<td>&gt;5-10</td>
<td>5</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>45</td>
<td>15</td>
<td>&gt;5-10</td>
<td>1</td>
</tr>
<tr>
<td>DO (mg/L) (Minimum)</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ammonia (mg/L)</td>
<td>23.8</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Oil &amp; Grease (mg/L)</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>pH (S.U.)</td>
<td>6.5-9.0</td>
<td>6.5-9.0</td>
<td>6.5-9.0</td>
<td>6.5-9.0</td>
</tr>
<tr>
<td>E. coli (#/100mL)</td>
<td>630</td>
<td>126</td>
<td>126</td>
<td>126</td>
</tr>
<tr>
<td>Zinc (TR)**</td>
<td>&gt;50% Removal</td>
<td>50-75% Removal</td>
<td>70-90% Removal</td>
<td>50-90% Removal</td>
</tr>
<tr>
<td>Copper (TR)**</td>
<td>&gt;50% Removal</td>
<td>50-75% Removal</td>
<td>70-90% Removal</td>
<td>50-90% Removal</td>
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<td>Practical</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>Economical</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Life Cycle Cost*</td>
<td>$34,889,000</td>
<td>$48,685,000</td>
<td>$58,937,000</td>
<td>$61,512,000</td>
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<tr>
<td>Base to Alternate Ratio</td>
<td>1.00</td>
<td>1.40</td>
<td>1.69</td>
<td>1.76</td>
</tr>
</tbody>
</table>

* Life cycle cost at 20 year design life and 1.2% interest
** Total Recoverable

5.4.1. LOSING STREAM ALTERNATIVE DISCHARGE LOCATION

Under 10 CSR 20-7.015(4) (A), discharges to losing stream shall be permitted only after other alternatives including land application, discharge to gaining stream and connection to a regional facility have been evaluated and determined to be unacceptable for environmental and/or economic reasons. The discharge does not enter a losing stream segment and will not discharge within two miles of a losing stream segment.

5.4.2. SOCIAL AND ECONOMIC IMPORTANCE EVALUATION

The applicant first identified the community that will be affected by the proposed degradation of water quality. Secondly, a number of relevant factors were identified including affordable housing, needed growth, increased land value and tax base, and environmental factors. Within a Social and Economic Benefits section each factor was evaluated. Appendix D, Attachment A: Tier 2 with Significant Degradation form contains a summary of this information.

The new high flow effluent discharge to Peruque Creek from the facility will increase the community’s potential to grow and can lead to more jobs being generated in the area which will continue to raise the median household income (MHI) for the cities served by the O’Fallon WWTF. The increase in population increases the need for businesses of all types. These businesses increase the need for jobs while decreasing the poverty level in the surrounding area, which will help to increase the value to existing property in the community. The existing infrastructure will be more easily funded with the expanded tax revenue that is expected from the additional development.
6. **GENERAL ASSUMPTIONS OF THE WATER QUALITY AND ANTIDEGRADATION REVIEW**

1. A Water Quality and Antidegradation Review (WQAR) assumes that [10 CSR 20-6.010(3) Continuing Authorities and 10 CSR 20-6.010(4) (D), consideration for no discharge] has been or will be addressed in a Missouri State Operating Permit or Construction Permit Application.

2. A WQAR does not indicate approval or disapproval of alternative analysis as per [10 CSR 20-7.015(4) Losing Streams], and/or any section of the effluent regulations.

3. Changes to Federal and State Regulations made after the drafting of this WQAR may alter Water Quality Based Effluent Limits (WQBEL).

4. Effluent limitations derived from Federal or Missouri State Regulations (FSR) may be WQBEL or Effluent Limit Guidelines (ELG).

5. WQBEL supersedes ELG only when they are more stringent. Mass limits derived from technology based limits are still appropriate.

6. A WQAR does not allow discharges to waters of the state, and shall not be construed as a National Pollution Discharge Elimination System or Missouri State Operating Permit to discharge or a permit to construct, modify, or upgrade.

7. Limitations and other requirements in a WQAR may change as Water Quality Standards, Methodology, and Implementation procedures change.

8. Nothing in this WQAR removes any obligations to comply with county or other local ordinances or restrictions.

9. If the proposed treatment technology is not covered in 10 CSR 20-8 Design Guides, the treatment process may be considered a new technology. As a new technology, the permittee will need to work with the review engineer to ensure equipment is sized properly. The operating permit may contain additional requirements to evaluate the effectiveness of the technology once the facility is in operation. This Antidegradation Review is based on the information provided by the facility and is not a comprehensive review of the proposed treatment technology. If the review engineer determines the proposed technology will not consistently meet proposed effluent limits, the permittee will be required to revise their Antidegradation Report.

7. **MIXING CONSIDERATIONS**

   **Mixing Zone (MZ):** One-quarter (1/4) of the stream volume of flow; length one-quarter (1/4) mile. [10 CSR 20-7.031(5)(A)4.B.(III)(a)].

   **Zone of Initial Dilution (ZID):** One-tenth (0.1) of the mixing zone volume of flow, not to exceed 10 times the effluent design flow. [10 CSR 20-7.031(5)(A)4.B.(III)(b)].

The proposed discharge to Perquie Creek from the O'Fallon WWTF is based on higher stream flows than the critical low-flow conditions for Perquie Creek. The definition of low flow conditions is the minimum amount of stream flow occurring immediately upstream of a wastewater discharge, as per 10 CSR 20-7.031(1)(O). According to 10 CSR 20-7.031(5)(A)4.F, discharge limitations may be based on higher stream flows if the discharge volume or quality may be adjusted to correlate with stream flows. This proposed discharge is a unique case where the discharge will only occur during wet weather events during which the Mississippi River is under flood conditions. As per 10 CSR 20-7.015(9)(A)2.B.(I) and (II), the water quality based effluent limitations incorporating mixing zones may be based on stream flows other than critical low-flow conditions if the proposed limits are protective of critical low-flow conditions and the permit requires instream flow measurements. The discharge is only expected to occur 0-5 times per year. Weekly Average and Daily Maximum effluent limits have been proposed for each pollutant of concern.
The consultant analyzed precipitation data from NOAA weather station GHCND: USW00053904 in St. Charles County and flow data from US Gage Station 05514712 on Perque Creek. Stream flows for twelve days of high precipitation were used to determine the typical stream flow in Perque Creek during periods of high precipitation. The flow in Perque Creek was determined to be approximately 704 CFS during high flow precipitation events.

8. PERMIT LIMITS AND MONITORING INFORMATION

Table 3. Effluent Limits Outfall No. 002

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>UNITS</th>
<th>DAILY MAXIMUM ***</th>
<th>WEEKLY AVERAGE</th>
<th>BASIS FOR LIMIT (NOTE 2)</th>
<th>MONITORING FREQUENCY (NOTE 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLOW</td>
<td>MGD</td>
<td>*</td>
<td></td>
<td>PEL</td>
<td>ONCE/DAY</td>
</tr>
<tr>
<td>BIOCHEMICAL OXYGEN DEMAND**</td>
<td>MG/L</td>
<td></td>
<td>45</td>
<td>PEL</td>
<td>TWICE/WEEK</td>
</tr>
<tr>
<td>TOTAL SUSPENDED SOLIDS**</td>
<td>MG/L</td>
<td></td>
<td>45</td>
<td>PEL</td>
<td>TWICE/WEEK</td>
</tr>
<tr>
<td>pH</td>
<td>SU</td>
<td>6.5–9.0</td>
<td>6.5–9.0</td>
<td>FSR</td>
<td>ONCE/DAY</td>
</tr>
<tr>
<td>AMMONIA AS N (SUMMER)</td>
<td>MG/L</td>
<td>23.8</td>
<td>23.8</td>
<td>PEL</td>
<td>ONCE/MONTH</td>
</tr>
<tr>
<td>AMMONIA AS N (WINTER)</td>
<td>MG/L</td>
<td>23.8</td>
<td></td>
<td>PEL</td>
<td>ONCE/MONTH</td>
</tr>
<tr>
<td>ESCHERICHIA COLIFORM (E. COLI) SUMMER</td>
<td>NOTE 1</td>
<td></td>
<td>630</td>
<td>FSR</td>
<td>TWICE/WEEK</td>
</tr>
<tr>
<td>OIL &amp; GREASE</td>
<td>MG/L</td>
<td>15</td>
<td></td>
<td>FSR</td>
<td>ONCE/MONTH</td>
</tr>
<tr>
<td>TOTAL NITROGEN</td>
<td>MG/L</td>
<td>*</td>
<td></td>
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<td>ONCE/QUARTER</td>
</tr>
<tr>
<td>TOTAL PHOSPHORUS</td>
<td>MG/L</td>
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<td></td>
<td>FSR</td>
<td>ONCE/QUARTER</td>
</tr>
<tr>
<td>COPPER, TOTAL RECOVERABLE</td>
<td>µG/L</td>
<td>*</td>
<td></td>
<td>PEL</td>
<td>ONCE/QUARTER</td>
</tr>
<tr>
<td>ZINC, TOTAL RECOVERABLE</td>
<td>µG/L</td>
<td>*</td>
<td></td>
<td>PEL</td>
<td>ONCE/QUARTER</td>
</tr>
</tbody>
</table>

Note 1 – COLONIES/100 ML
Note 2 – WATER QUALITY-BASED EFFLUENT LIMITATION – WQBEL; OR MINIMALLY DEGRADING EFFLUENT LIMIT – MDEL; OR PREFERRED ALTERNATIVE EFFLUENT LIMIT – PEL; OR TECHNOLOGY-BASED EFFLUENT LIMIT – TBEL; OR NO DEGRADATION EFFLUENT LIMIT – NDEL; OR FEDERAL/STATE REGULATION – FSR; OR NOT APPLICABLE – N/A.
Also, please see the GENERAL ASSUMPTIONS OF THE WQAR #4 & #5.
Note 3 – ONLY DURING WET WEATHER DISCHARGE.

* Monitoring requirements only.
** This facility is required to meet a removal efficiency of 85% or more for BOD₅ and TSS. Treatment is the same as for Outfall No. 001; therefore, overall removal efficiency will be calculated using both Outfall No. 001 and Outfall No. 002.
*** All pollutants of concern will have either weekly average or daily maximum limits and no monthly average effluent limits since the discharge to Perque Creek is not continuous as per 40 CFR 122.45(e). The efficiency removal for the O’Fallon WWTF will include the overall discharge to both Perque Creek and the Mississippi River.

9. RECEIVING WATER MONITORING REQUIREMENTS

No receiving water monitoring requirements recommended at this time.
10. DERIVATION AND DISCUSSION OF LIMITS

Wasteload allocations and limits were calculated using two methods:

1) Water quality-based – Using water quality criteria or water quality model results and the dilution equation below:

\[ C = \frac{(C_s \times Q_s) + (C_e \times Q_e)}{(Q_s + Q_e)} \]  

(EPA/505/2-90-001, Section 4.5.5)

Where
- \( C \) = downstream concentration
- \( C_s \) = upstream concentration
- \( Q_s \) = upstream flow
- \( C_e \) = effluent concentration
- \( Q_e \) = effluent flow

Chronic wasteload allocations were determined using applicable chronic water quality criteria (CCC: criteria continuous concentration) and stream volume of flow at the edge of the mixing zone (MZ). Acute wasteload allocations were determined using applicable water quality criteria (CMC: criteria maximum concentration) and stream volume of flow at the edge of the zone of initial dilution (ZID).

Water quality-based maximum daily and average monthly effluent limitations were calculated using methods and procedures outlined in USEPA’s “Technical Support Document For Water Quality-based Toxics Control” (EPA/505/2-90-001).

2) Alternative Analysis-based – Using the preferred alternative’s treatment capacity for conventional pollutants such as BOD\(_5\) and TSS that are provided by the consultant as the WLA, the significantly-degrading effluent average monthly and average weekly limits are determined by applying the WLA as the average monthly (AML) and multiplying the AML by 1.5 to derive the average weekly limit (AWL). For toxic and nonconventional pollutant such as ammonia, the treatment capacity is applied as the significantly-degrading effluent monthly average (AML). A maximum daily can be derived by dividing the AML by 1.19 to determine the long-term average (LTA). The LTA is then multiplied by 3.11 to obtain the maximum daily limitation. This is an accepted procedure that is defined in USEPA’s “Technical Support Document For Water Quality-based Toxics Control” (EPA/505/2-90-001).

Note: Significantly-degrading effluent limits have been based on the authority included in Section III. Permit Consideration of the AIP. Also under 40 CFR 133.105, permitting authorities shall require more stringent limitations than equivalent to secondary treatment limitations for 1) existing facilities if the permitting authority determines that the 30-day average and 7-day average BOD\(_5\) and TSS effluent values could be achievable through proper operation and maintenance of the treatment works, and 2) new facilities if the permitting authority determines that the 30-day average and 7-day average BOD\(_5\) and TSS effluent values could be achievable through proper operation and maintenance of the treatment works, considering the design capability of the treatment process.

10.1. OUTFALL #002 – MAIN FACILITY OUTFALL LIMIT DERIVATION

- **Flow.** In accordance with [40 CFR Part 122.44(i)(1)(ii)] the volume of effluent discharged from each outfall is needed to assure compliance with permitted effluent limitations. If the permittee is unable to obtain effluent flow, then it is the responsibility of the permittee to inform the Department, which may require the submittal of an operating permit modification.
• **Biochemical Oxygen Demand (BOD₅).** BOD₅ limits of 45 mg/L weekly average.

To protect beneficial uses within segment 216 of Peruque Creek, the consultant uses 40 mg/L CBOD₅ as input to the Streeter Phelps analysis. Streeter Phelps modeling simulated using the proposed design flow indicated the modeled lowest dissolved oxygen or critical dissolved oxygen sag was 5.5 mg/L. The Department agrees that this is protective of the impairment for dissolved oxygen in Peruque Creek.

**As a result of this analysis, MDNR staff concludes that the above mentioned effluent limits are protective of beneficial uses and existing water quality.**

A reaeration system is proposed to be included as part of any future wet weather discharge to Peruque Creek. With a reaeration system, the dissolved oxygen level of the creek would consistently stay above 5 mg/L.

Influent monitoring may be required for this facility in its Missouri State Operating Permit.

• **Total Suspended Solids (TSS).** TSS limits of 45 mg/L daily maximum. According to the EPA, because TSS and BOD₅ are closely correlated, the same limits are applied for TSS as BOD₅.

Influent monitoring may be required for this facility in its Missouri State Operating Permit.

• **pH.** 6.5-9.0 SU. Technology based effluent limitations of 6.0-9.0 SU [10 CSR 20-7.015] are not protective of the Water Quality Standard, which states that water contaminants shall not cause pH to be outside the range of 6.5-9.0 SU.

• **Total Ammonia Nitrogen.** Early Life Stages Present Total Ammonia Nitrogen criteria apply [10 CSR 20-7.031(S)(B)]7.C. & Table B3]. Background total ammonia nitrogen = 0.01 mg/L

<table>
<thead>
<tr>
<th>Season</th>
<th>Temp (°C)</th>
<th>pH (SU)</th>
<th>Total Ammonia Nitrogen CCC (mg N/L)*</th>
<th>Total Ammonia Nitrogen CMC (mg N/L)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>26</td>
<td>7.8</td>
<td>1.7</td>
<td>6.8</td>
</tr>
<tr>
<td>Winter</td>
<td>6</td>
<td>7.8</td>
<td>2.7</td>
<td>6.8</td>
</tr>
</tbody>
</table>


* Values calculated from existing data.

**Summer**

\[ C_e = ((Q_c + Q_e) \times C) - (Q_e \times C_e) / Q_e \]

Chronic WLA: \[ C_e = ((7.01 + 176) \times 1.7 - (176 \times 0.01)) / 7.01 \]

\[ C_e = 44.1 \text{ mg/L} \]

Acute WLA: \[ C_e = ((7.01 + 17.6) \times 6.8 - (17.6 \times 0.01)) / 7.01 \]

\[ C_e = 23.8 \text{ mg/L} \]

\[ \text{LTA}_e = 44.1 \text{ mg/L (0.927) = 40.9 mg/L} \] [CV = 0.18, 99th Percentile, 30 day avg.]

\[ \text{LTA}_e = 23.8 \text{ mg/L (0.672) = 16.0 mg/L} \] [CV = 0.18, 99th Percentile]

\[ \text{MDL} = 16.0 \text{ mg/L (1.49) = 23.8 mg/L} \] [CV = 0.18, 99th Percentile]
Winter

Chronic WLA: \[ C_c = ((7.01 + 176) \times 2.7 - (176 \times 0.01))/7.01 \]
\[ C_c = 70.2 \text{ mg/L} \]

Acute WLA: \[ C_a = ((7.01 + 17.6) \times 6.8 - (17.6 \times 0.01))/7.01 \]
\[ C_a = 23.8 \text{ mg/L} \]

\[ \text{LTA}_c = 70.2 \text{ mg/L (0.636) = 64.4 mg/L} \]
\[ \text{LTA}_a = 23.8 \text{ mg/L (0.917) = 15.17 mg/L} \]
\[ \text{CV} = 0.21, \ 99^{th} \text{ Percentile, 30 day avg.} \]
\[ \text{CV} = 0.21, \ 99^{th} \text{ Percentile} \]

\[ \text{MDL} = 15.17 \text{ mg/L (1.57) = 23.8 mg/L} \]
\[ \text{CV} = 0.21, \ 99^{th} \text{ Percentile} \]

With the mixing zone allowed for Peruque Creek, the water quality based maximum daily effluent limits for ammonia are less stringent than the proposed effluent limits for the preferred alternative. Therefore, the limits in the table below will be used for ammonia.

<table>
<thead>
<tr>
<th>Table 4. Ammonia Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Season</td>
</tr>
<tr>
<td>Summer</td>
</tr>
<tr>
<td>Winter</td>
</tr>
</tbody>
</table>

- **Escherichia coli (E. coli)**. Weekly average of 630 per 100 mL during the recreational season (April 1 – October 31), to protect Whole Body Contact Recreation (B) designated use of the receiving stream, as per 10 CSR 20-7.031(5)(C). A maximum rate of discharge is required by 40 CFR 122.45(e) and 10 CSR 20-7.015(9)(B)1.E. Please see **General Assumptions of the WQAR #7**.

- **Oil & Grease**. Conventional pollutant, [10 CSR 20-7.031, Table A]. Effluent limitation for protection of aquatic life; 10 mg/L monthly average, 15 mg/L daily maximum.

**Metals**

Hardness Dependent Metals:

Effluent limitations for total recoverable metals were developed using methods and procedures outlined in EPA/505/2-90-001 and “The Metals Translator: Guidance for Calculating a Total Recoverable Permit Limit from a Dissolved Criterion” (EPA 823-B-96-007). General warm-water fishery criteria apply and water hardness = 162 mg/L. The Missouri state default receiving stream hardness value of 162 mg/L was used for the analysis of all metals in the **Peruque Creek High Flow Discharge Antidegradation Report**.

Due to the absence of contemporaneous effluent and instream data for total recoverable metals, dissolved metals, hardness, and total suspended solids with which to calculate metals translators, partitioning between the dissolved and adsorbed phases was assumed to be minimal (Section 5.7.3, EPA/505/2-90-001). Freshwater criteria conversion factors for dissolved metals were used as the metals translator as recommended in guidance (Section 1.3, 1.5.3, and Table 1, EPA 823-B-96-007). If concurrent site-specific data for total recoverable metals, dissolved metals, hardness, and total suspended solids are provided to the Department, partitioning evaluations may be considered and site-specific translators developed.
<table>
<thead>
<tr>
<th>METAL</th>
<th>Conversion Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ACUTE</td>
</tr>
<tr>
<td>Copper</td>
<td>0.960</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.978</td>
</tr>
</tbody>
</table>

Conversion factors for Cd and Pb are hardness dependent. Values calculated using equation found in Section 1.3 of EPA 823-B-96-007 and hardness = 162 mg/L.

- **Copper, Total Recoverable.** Monitoring only. Monitoring is required to determine if reasonable potential exists for this facility’s discharge to exceed water quality standards.

- **Zinc, Total Recoverable.** Monitoring only. Monitoring is required to determine if reasonable potential exists for this facility’s discharge to exceed water quality standards.

**NUTRIENTS**

- **Total Phosphorus and Total Nitrogen.** Monitoring required for facilities greater than 100,000 gpd design flow per 10 CSR 20-7.015(9)(D)7. Once per day sampling for one permit cycle or up to 5 years if permit cycle is less than 5 years.

11. **ANTIDEGRADATION REVIEW PRELIMINARY DETERMINATION**

The proposed new facility discharge, O’Fallon WWTF, 4.53 MGD will result in significant degradation of the segment identified in Peruque Creek. Conventional Activated Sludge (CAS) was determined to be the base case technology (lowest cost alternative that meets technology and water quality based effluent limitations). The cost effectiveness of the other technologies was evaluated, and the Conventional Activated Sludge system was found to be cost effective and was determined to be the preferred alternative.

It has also been determined that the other treatment options presented (Convention Activated Sludge with Tertiary Filtration, Convention Activated Sludge with Tertiary Filtration and Chemical Addition, and Membrane Bioreactor) may also be considered reasonable alternatives provided they are designed to be capable of meeting the effluent limitations developed based on the preferred alternative. If any of these options are selected, you may proceed with the appropriate facility plan, construction permit application, or other future submittals without the need to modify this Antidegradation review document.

To proceed with a new technology, your construction permit application must address approvability of the technology in accordance with the [New Technology Definitions and Requirements factsheet available at http://dnr.mo.gov/pubs/pub2453.htm](http://dnr.mo.gov/pubs/pub2453.htm). If you have any questions regarding the new technology factsheet, please contact the Water Protection Program. The permittee will need to work with the review engineer to ensure equipment is sized properly and that the technology will consistently achieve the proposed effluent limits. The operating permit may contain additional requirements to evaluate the effectiveness of the technology once the facility is in operation.

Per the requirements of the AIP, the effluent limits in this review were developed to be protective of beneficial uses and to attain the highest statutory and regulatory requirements. MDNR has determined that the submitted review is sufficient and meets the requirements of the AIP. No further analysis is needed for this discharge.

**Reviewer:** Sonali Siriwardana  
**Date:** February 28, 2018  
**Unit Chief:** John Rustige, P.E.  
**JR**
Appendix A: Map of Discharge Location to Perquie Creek

Location of Outfall No. 002.
Natural Heritage Review Report

Missouri Department of Conservation

June 9, 2017

ROBERT POLYS
WOODARD & CURRAN, INC
41 HUTCHINS DR
PORTLAND, ME 04102

Project Site: WASTEWATER
Location/Scope: LANDGRANT 468
County: ST CHARLES
Query reviewed: O'FALLON WWTF
Query revised: 5/4/2017

1. NATURAL HERITAGE REVIEW is designed to identify and document resources known to have been altered, lost, or altered potentially affected by the proposed project. While verification is the responsibility of the project, Natural Heritage records are identified at the same data and location. This report considers records near but not necessarily at the project site. Animals move and, over time, so do plant communities. To say 'there is a record' does not mean the species/distribution is still there. To say that 'there is no record' does not mean a protected area will not be encroached. These records may provide use reference and other information such as walls or ends maps, on-site inspections or surveys and could be considered. Look for additional information about the biological and historical trends of records listed in order to avoid or minimize impacts. More information is at http://dendro.missouri.edu/Orange-Research/area-species.html in order to see the project area at other times.

level 3 Issues: Records of federal-listed (these are also state-listed) species or critical habitats near the project site:

natural Heritage records identify no wildlife preserves, no designated wilderness areas or critical habitats, and no federal-listed species records within the project area, or in the public land survey section listed above or sections adjacent.

level 2 Issues: Records of state-listed (not federal-listed) endangered species AND / OR late-ranked (not state-listed endangered) species and natural communities of conservation concern. The Department tracks these species and natural communities due to population declines and/or apparent vulnerability.

natural Heritage records identify no state-listed endangered species within the project area.

natural Heritage records identify no state-ranked species and/or natural communities within the project area.


General recommendations related to this project or site, or based on information about the historic range of species (unrelated to any specific Natural Heritage records):

Indiana bats (Myotis sodalis, federal and state-listed endangered) occur in St. Charles County and could occur within the project area. Indiana bats and Northern long-eared bats (Myotis septentrionalis, federal-listed threatened) hibernate during winter months in caves and mines. During the summer months, they roost and raise young under the bark of trees in riparian forests and upland forests near perennial streams. During project activities, avoid degrading stream quality and where possible leave snags standing and preserve mature forest canopy. Do not enter caves known to harbor Indiana bats or Northern long-eared bats, especially from September to April. If any trees need to be removed by your project, please contact the U.S. Fish and
Wildlife Service (Ecological Services, 101 Park Deville Drive, Suite A, Columbia, Missouri 65203-0007; Phone 573-234-2132 Ext. 100 for Ecological Services) for further coordination under the Endangered Species Act.

- Bald eagles (*Haliaeetus leucocephalus*) may nest near streams or water bodies in the project area. Nests are large and fairly easy to identify. While no longer listed as endangered, eagles continue to be protected by the federal government under the Bald and Golden Eagle Protection Act. Work managers should be alert for nesting areas within 1500 meters of project activities, and follow federal guidelines at: [http://www.fws.gov/midwest/MidwestBird/EaglePermitting/index.html](http://www.fws.gov/midwest/MidwestBird/EaglePermitting/index.html) if eagle nests are seen.

- St. Charles County has known karst geologic features (e.g. caves, springs, and sinkholes, all characterized by subterranean water movement). Few karst features are recorded in Natural Heritage records, and ones not noted here may be encountered at the project site or affected by the project. Cave fauna (many of which are species of conservation concern) are influenced by changes to water quality, so check your project site for any karst features and make every effort to protect groundwater in the project area.

- Clean Water Act permits issued by other agencies regulate both construction and operation of wastewater systems, and provide many important protections for fish and wildlife resources throughout the project area and at some distance downstream. Fish and wildlife almost always benefit when unnatural pollutants are removed from water, and concerns are minimal if construction is managed to minimize erosion and sedimentation/runoff to nearby streams and lakes, including adherence to any "Clean Water Permit" conditions.

- Revegetation of disturbed areas is recommended to minimize erosion, as is restoration with of native plant species compatible with the local landscape and for wildlife needs. Annuals like ryegrass may be combined with native perennials for quicker green-up. Avoid aggressive exotic perennials such as crown vetch and sainfoin lespedeza.


- Invasive exotic species are a significant issue for fish, wildlife and agriculture in Missouri. Seeds, eggs, and larvae may be moved to new sites on boats or construction equipment, so inspect and clean equipment thoroughly before moving between project sites.
  - Remove any mud, soil, trash, plants or animals from equipment before leaving any water body or work area.
  - Drain water from boats and machinery that have operated in water, checking motor cavities, live-well, bilge and transom wells, tracks, buckets, and any other water reservoirs.
  - When possible, wash and rinse equipment thoroughly with hard spray or HOT water (≥140°F, typically available at do-it-yourself carwash sites), and dry in the hot sun before using again.

*Note: Recommendations are based on project management efforts provided in this memorandum, a general understanding of species needs and land/scape conditions. Natural Heritage records typically reflect sites visited by specialists in the last 10 years. Many primarily wooded patches have old bank vegetation and could have expansion of aquatic species but no longer contain...*
Appendix C: Streeter Phelps Model – Applicant Results

A Maximum Day effluent \(BOD_5\) of 45 mg/L was assumed as the treated effluent value for the wet weather discharge based on the weekly average Technology Based Limits previously presented. The Streeter-Phelps formula was used to calculate the minimum dissolved oxygen concentration in the Summer months that would occur in Peruche Creek during a typical high flow discharge event.

With the anticipated maximum daily \(BOD_5\) limit of 45 mg/L and an effluent DO of 5 mg/L, the DO of Peruche Creek will not fall below state WQO*. The following figure depicts the summer DO sag curve at the proposed maximum daily \(BOD_5\) discharge limit with a wet weather discharge flow of 4.53 MGD (7.02 CFS).

*Figure 2-1  Peruche Creek Dissolved Oxygen Sag Curve (Summer)*

![Dissolved Oxygen Sag Curve (Summer)](image-url)
As previously mentioned the Strickler - Philips equation was used to determine the DO sag curves, and ultimately help analyze the proposed effluent limits for BOD. The equation which was used and variable explanations are provided as follows:

\[ D_t = (t \cdot K_d \cdot t^2)/(K_d + K_u) + (c \cdot e^{-K_u \cdot t} - e^{-K_d \cdot t}) + D_0 \cdot e^{-K_d \cdot t} \]

\[ D_t = \text{Observed Oxygen Deficit (mg/L)} \]
\[ t = \text{Time measured downstream from the point of discharge (days)} \]
\[ D_0 = \text{Oxygen Deficit at point of discharge (mg/L)} \]
\[ D_0 = D_{0,\text{infl}} - D_{0,\text{out}} \]
\[ \text{BOD}_5 = \text{BOD of the river and WWTF effluent mixed (mg/L)} \]
\[ L_u = \text{Ultimate BOD at point of discharge (mg/L)} \]
\[ L_u = f \cdot \text{OIl}_{u} \cdot (1 - e^{-K_u \cdot t}) \]

\[ K_d = \text{Deoxygenation coefficient, base 0, (days}^{-1}\text{)} \]
\[ K_u = \text{Reoxygenation (Reaeration) coefficient, base 0, (days}^{-1}\text{)} \]
\[ K_{01} = \text{Reaeration coefficient temperature correction factor} \]
\[ 1.058 \text{ was assumed for temperatures between 20}^\circ\text{C} \& 20^\circ\text{C to account for Summer conditions} \]
\[ K_i = \text{Reoxygenation (Reaeration) coefficient, base 0, (days}^{-1}\text{)} \]
\[ 1.024 \text{ was assumed for summer conditions} \]
\[ Q_s = \text{O'Fallon WWTF High Flow Event Effluent Flow = 4.53 MGD (7.02 CFS)} \]
\[ S_s = \text{O'Fallon WWTP Effluent BOD} \_5 = 45 \text{ mg/L (Daily Maximum)} \]
\[ D_{0,\text{infl}} = \text{O'Fallon WWTP Effluent Dissolved Oxygen = 8 mg/L} \]
\[ Q_r = \text{Pereque Creek Mixing Zone Flow = 176 CFS} \]
\[ T_{\text{summer}} = \text{Pereque Creek Summer Temperature = 26.4}^\circ\text{C} \]
\[ T_{\text{winter}} = \text{Pereque Creek Winter Temperature = 4.2}^\circ\text{C} \]
\[ T_{\text{summer}} = \text{O'Fallon WWTP Summer (June - September) Temperature = 21.6}^\circ\text{C} \]
\[ T_{\text{winter}} = \text{O'Fallon WWTP Winter (Nov. - March) Temperature = 14.8}^\circ\text{C} \]
\[ S_{\text{p}} = \text{Pereque Creek Background BOD} \_5 = 7.66 \text{ mg/L. Average Summer BOD} \_5 \text{ concentration obtained from data provided by the MDNR for periodic sampling from January 1978 to August 1990. This background BOD} \_5 \text{ data was typically recorded at low flows and Summer temperatures in Pereque Creek. It is anticipated that any time the Pereque Creek discharge will be used the Creek will be experiencing high flows with reduced background BOD} \_5. \text{ The discharge} \]
Appendix D: Antidegradation Review Summary Attachments

The attachments that follow contain summary information provided by the applicant, O’Fallon WWTP, MDNR staff determined that changes must be made to the information contained within these attachments.

The following were modified and can be found within the MDNR WQAR:

1) Attachment A: Ammonia limits under section 9 for Identifying Alternatives should match the daily maximum limits given under Section 8 since these are the limits the facility will be expected to meet.
**Facility**

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Address</th>
<th>City</th>
<th>State</th>
<th>Zip</th>
</tr>
</thead>
<tbody>
<tr>
<td>O'Fallon Wastewater Treatment Plant</td>
<td>3 North Main Street</td>
<td>O'Fallon</td>
<td>MO</td>
<td>63366</td>
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**Owner**

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<th>Name</th>
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<th>State</th>
<th>Zip</th>
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<tbody>
<tr>
<td>y of O'Fallon, MO</td>
<td>3 North Main Street</td>
<td>O'Fallon</td>
<td>MO</td>
<td>63366</td>
</tr>
</tbody>
</table>

**Continuing Authority:** The regulatory requirement regarding continuing authority is found in 10 CSR 20-6.010(3) available at [www.sos.mo.gov/regulations/cap/current/10CSR/10C00-66a.pdf](http://www.sos.mo.gov/regulations/cap/current/10CSR/10C00-66a.pdf).

**Receiving Water Body Segment #1**

1. **UPPER END OF SEGMENT (Location of discharge):**
   - **UTM** OR Lat: **38.648614** Long: **-90.048528**

2. **LOWER END OF SEGMENT:**
   - **UTM** OR Lat: **38.036817** Long: **-90.648657**

**Wet Weather Anticipations:**

An applicant anticipates excessive inflow or infiltration and permits approval from the department to bypass secondary treatment, a feasibility analysis is required. The feasibility analysis must comply with the criteria of all applicable state and federal regulations, including 36 CFR Part 282. After completing the feasibility analysis to the antidegradation review board.

Is the Wet Weather Flow Peaking Factor in relation to design flow? **Not Applicable (N/A)**

**Weather Design Summary:**

The proposed Perque Creek outfall will be used only when sustained high flows are seen at the WTP and the Mississippi River is at or above the National Weather Service Flood Stage.
### Existing Water Quality Data or Model Summary

Existing water quality data is provided by the Missouri Department of Natural Resources. Data is reviewed and approved by the Department of Natural Resources and then made available to the public. Additional information needed is obtained from the Missouri Department of Natural Resources. This data is used to determine the impact of the proposed treatment facilities on the water quality.

### Summary of the Pollutants of Concern and the Proposed Effluent Limits

The table below lists the pollutants of concern and their respective effluent limits for the proposed treatment facilities.

<table>
<thead>
<tr>
<th>Pollutants of Concern</th>
<th>Limit</th>
<th>Conditional Allocation</th>
<th>Average Variability Limit</th>
<th>Daily Maximum Limit</th>
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<tbody>
<tr>
<td>CBOD</td>
<td>CBOD</td>
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<tr>
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<td>SEDIMENT CONCEN</td>
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<td>NITRITES N. O.</td>
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<td>Al. &amp; MPO</td>
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<td>CO &amp; O.</td>
<td>CO</td>
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<td>Total Phosphorus &amp; Nitrogen</td>
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<td></td>
</tr>
<tr>
<td>Sb &amp; E.</td>
<td>Sb</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Identifying Alternatives

It is important to consider the environmental impact of the proposed facilities. The alternatives listed in the table below are based on the best available data and technology.

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Level of Treatment Attainable</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBOD</td>
<td>CBOD</td>
</tr>
<tr>
<td>SS</td>
<td>SS</td>
</tr>
<tr>
<td>SEDIMENT CONCEN</td>
<td>SEDIMENT CONCEN</td>
</tr>
<tr>
<td>NITRITES N. O.</td>
<td>NITRITES N. O.</td>
</tr>
<tr>
<td>Al. &amp; MPO</td>
<td>Al. &amp; MPO</td>
</tr>
<tr>
<td>CO &amp; O.</td>
<td>CO &amp; O.</td>
</tr>
<tr>
<td>Total Phosphorus &amp; Nitrogen</td>
<td>Total Phosphorus &amp; Nitrogen</td>
</tr>
<tr>
<td>Sb &amp; E.</td>
<td>Sb &amp; E.</td>
</tr>
</tbody>
</table>

### Level of Treatment Attainable for Each Pollutant of Concern

The table below shows the level of treatment attainable for each pollutant of concern.

<table>
<thead>
<tr>
<th>Pollutants of Concern</th>
<th>BIO-C09</th>
<th>TS9</th>
<th>AN-O2</th>
<th>Ap N</th>
<th>Oil &amp; Grease</th>
<th>Car Basel</th>
<th>BBPPC Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBOD</td>
<td>&gt;4.0</td>
<td>&lt;4</td>
<td>&gt;1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS</td>
<td>&gt;4.0</td>
<td>&lt;4</td>
<td>&gt;1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEDIMENT CONCEN</td>
<td>&gt;1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NITRITES N. O.</td>
<td>&gt;1</td>
<td>&gt;1</td>
<td>&gt;1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al. &amp; MPO</td>
<td>&gt;1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO &amp; O.</td>
<td>&gt;1</td>
<td>&gt;1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Phosphorus &amp; Nitrogen</td>
<td>&gt;1</td>
<td></td>
<td>&gt;1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sb &amp; E.</td>
<td>&gt;1</td>
<td>&gt;1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. DETERMINATION OF THE REASONABLE ALTERNATIVE

As the Anoxic Degradation Implementation Procedure Section II B 2B, a reasonable alternative is one that is practical, economically feasible and achievable. Provide basis and supporting documentation in the Anoxic Degradation Review report. Please do not write "see report" for any box below.

Economic Summary

The practicability of an alternative is considered by evaluating the effectiveness, reliability, and operational environmental impacts, according to the Anoxic Degradation Implementation Procedure Section II B 2B. Examples of items to consider, including economic, environmental aspects, are given in the Anoxic Degradation Implementation Procedure Section II B 2B.

The discharge to the receiving alternatives were considered based on WWTP location, land availability & cost. Of these eight alternatives, construction of a high flow pump station to pump all flows to the Mississippi River and construction of a parallel of these were considered to be practical. Less degasifying alternatives were also considered as part of the analysis. The alternatives modeled were a Conventional Activated Sludge (CAS) with Biological Nutrient Removal (BNR) treatment process, with less degasifying alternatives being CAS with tertiary treatment, CAS with Tertiary Treatment and chemical addition and Membrane Treatment at the well degasifying alternatives were considered for the practical.

Economic Efficiency Summary

Alternatives that are deemed practicable must undergo a direct cost comparison in order to determine economic efficiency. Means to determine economic efficiency are provided in the Anoxic Degradation Implementation Procedure Section II D 2B.

Of the practicable alternatives, both no discharge and less degasifying had cost analysis performed to determine if they were economically efficient when compared to the base CAS project with a High Flow discharge to the Perequ Creek. Although the cost analysis showed that both no discharge alternatives were not economically efficient when compared to the Perequ Creek High Flow discharge. The cost analysis also showed that the less degasifying alternatives were not economically efficient when compared to the base CAS treatment process.

Nondischarge Summary

Alternatives identified as most practicable and economically efficient are considered affordable if the applicant does not supply an affordability analysis. An Affordability analysis per the Anoxic Degradation Implementation Procedure Section II D 2B. It may be used to determine if the alternative is too expensive to reasonably implement.

Affordable Chosen Alternative

A Conventional Activated Sludge Treatment Alternatives with Biological Nutrient Removal and a High Flow Discharge to Perequ Creek was evaluated as the preferred alternative due to its ability to meet State Water Quality Standards and also remain economically viable.

Reasons for Rejecting the Other Evaluated Alternatives

Of the discharge alternatives were determined to be either not practicable or not affordable for the City. The less degasifying alternatives were not affordable for the City.
11. SOCIAL AND ECONOMIC IMPORTANCE OF THE PREFERRED ALTERNATIVE

The preferred alternative was based on a review of all available information and is described as the social and economic benefits to the community that will result from any activity involving a new or existing wastewater treatment plant. The benefits are expected to increase the quality of life for residents and businesses in the community. The social and economic benefits are expected to increase the quality of life for residents and businesses in the community.

Identify the affected community.

The affected community is defined as the community in which the wastewater treatment plant will be built. The affected community includes the City of O'Fallon, Missouri.

Identify relevant factors that characterize the social and economic conditions of the affected community.

Examples of social and economic factors that are relevant to the Antidegradation Implementation Procedure include:

- The City of O'Fallon is a growing community with numerous new commercial and residential developments throughout the City. With over 90% of the growth, the median household income has gone up over the past ten years and unemployment has fallen. The majority of the City's residents are on a public sewer system and much of the new development relies on the ability for the wastewater system to handle their flows.

Describe the important social and economic development associated with the project.

- Determining benefits for the community and environment should be site specific and in accordance with the Antidegradation Implementation Procedure. The City of O'Fallon has been working on a new wastewater treatment plant to handle the increased growth and development.

PROPOSED PROJECT SUMMARY.

- When the WWTP is under groundwater conditions, and the Mississippi River is at or above the National Weather Service Flood Stage the effluent from the WWTP is discharged to the Mississippi River. As a result of the high levels of phosphorus in the USGS and USFWS data, the City has been working on reducing the phosphorus load to the Mississippi River. The proposed project will include a new flow control station and a dedicated outfall to the Mississippi River.

Contributor: I have reviewed and approved the prepared documents and agree with the submitted report.

Continuing Authority: I have reviewed and approved the prepared documents and agree with the submission.

Signature: Sam C. As Owner

Date: 6/7/17
APPENDIX F: MDNR GEOHYDROLOGIC EVALUATION
June 21, 2017

Robert Polys, PE
Woodard & Curran, Inc
1520 South Fifth Street
St. Charles, MO 63303

RE: Geohydrologic Evaluation of Liquid-Waste Treatment Site, LWE17071, O'Fallon WWTP-Perisque Creek High Flow Discharge Outfall, 38 50 40.54 Latitude, -90 41 46.02 Longitude, St. Charles County, Missouri

Dear Robert Polys, PE:

On May 12, 2017, the Missouri Geological Survey (MGS) received a Request for Geohydrologic Evaluation of Liquid-Waste Treatment Facility/Site for O'Fallon WWTP-Perisque Creek High Flow Discharge Outfall located at 38 50 40.54 Latitude, -90 41 46.02 Longitude in St. Charles County, Missouri.

On May 24, 2017, the MGS conducted a geohydrologic evaluation for a proposed mechanical treatment plant that will discharge to waters of the state for human (domestic) wastewater. Based on the geologic and hydrologic characteristics observed, the site receives an slight overall geologic-limitations rating.

No bedrock was observed on site. According to logs of nearby wells, the surficial material thickness in this area is approximately 100 feet. Due to the thickness and horizontal extent of the alluvium, the underlying bedrock can be considered inconsequential to potential impacts of wastewater from this site. Surficial materials at the site consists of low to highly permeable silty and gravelly Mississippi River alluvium that has been reworked for the construction of the wastewater treatment facility.

The proposed outfall will discharge to Perisque Creek, which has been classified as gaining for at least 2 miles downstream of the outfall. The potential for regional groundwater contamination is minimal, but in the event of wastewater treatment failure, the local and shallow groundwater, and surface waters of Perisque Creek, may be adversely impacted.

This letter does not constitute a permit or approval for construction of any proposed facility. Additional data may be required by the Department of Natural Resources prior to issuance of a permit or letter of approval. This report is valid only for the location evaluated.
If you are in need of further assistance from our office or have questions regarding this letter please feel free to contact me at P.O. Box 250, Rolla, Missouri 65402-0250 or call (573) 368-2161.

Sincerely,

MISSOURI GEOLOGICAL SURVEY

John Corley, Geologist

Environmental Geology Section

c: Michael Pratt; WPP; St. Louis Regional Office

06/21/2017
APPENDIX G: HYDRAULIC PROFILE
APPENDIX H:  PRELIMINARY DRAWINGS
APPENDIX I: EXISTING CONDITIONS ASSESSMENT
APPENDIX J: PROPOSED MCC LOCATIONS
APPENDIX K: PROPOSED WWTP NETWORK ARCHITECTURE
APPENDIX L: PRELIMINARY PROJECT SCHEDULE
<table>
<thead>
<tr>
<th>Task</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start Date</th>
<th>Finish Date</th>
<th>Baseline Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Project Kick-off</td>
<td>1 day</td>
<td>Wed 4/11/18</td>
<td>Wed 4/11/18</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Geotech</td>
<td>27 days</td>
<td>Mon 3/26/18</td>
<td>Thu 5/1/18</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Survey</td>
<td>29 days</td>
<td>Mon 4/9/18</td>
<td>Thu 5/17/18</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Wetland Delineation</td>
<td>21 days</td>
<td>Tue 4/10/18</td>
<td>Fri 6/8/18</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Hazardous Material Assessment</td>
<td>20 days</td>
<td>Mon 4/2/18</td>
<td>Fri 4/27/18</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>ALTERNATIVE EVALUATION</td>
<td>65 days</td>
<td>Mon 3/26/18</td>
<td>Fri 5/25/18</td>
<td>NA</td>
</tr>
<tr>
<td>7</td>
<td>DRAFT Alternative Evaluation (City Review)</td>
<td>30 days</td>
<td>Mon 3/26/18</td>
<td>Fri 5/4/18</td>
<td>Fri 5/4/18</td>
</tr>
<tr>
<td>8</td>
<td>Deliverable - Final Alternative Evaluation Memo</td>
<td>16 days</td>
<td>Fri 5/4/18</td>
<td>Fri 5/25/18</td>
<td>Fri 5/18/18</td>
</tr>
<tr>
<td>9</td>
<td>DESIGN BASIS REPORT</td>
<td>105 days</td>
<td>Mon 3/26/18</td>
<td>Fri 8/17/18</td>
<td>NA</td>
</tr>
<tr>
<td>10</td>
<td>DRAFT Design Basis Report (City Review)</td>
<td>55 days</td>
<td>Mon 3/26/18</td>
<td>Fri 6/8/18</td>
<td>NA</td>
</tr>
<tr>
<td>11</td>
<td>Design Basis Report Review Meeting</td>
<td>1 day</td>
<td>Wed 6/20/18</td>
<td>Wed 6/20/18</td>
<td>NA</td>
</tr>
<tr>
<td>12</td>
<td>DRAFT Facility Plan (MDNR Review)</td>
<td>5 days</td>
<td>Mon 8/25/18</td>
<td>Fri 6/29/18</td>
<td>NA</td>
</tr>
<tr>
<td>13</td>
<td>MDNR Facility Plan Review Meeting <strong>(Pending MDNR Review)</strong></td>
<td>5 days</td>
<td>Mon 8/25/18</td>
<td>Fri 8/10/18</td>
<td>NA</td>
</tr>
<tr>
<td>14</td>
<td>Deliverable - Final Facility Plan <strong>(Pending MDNR Review)</strong></td>
<td>5 days</td>
<td>Mon 8/13/18</td>
<td>Fri 8/17/18</td>
<td>NA</td>
</tr>
<tr>
<td>15</td>
<td>60% DESIGN PSE <strong>(Pending MDNR Review)</strong></td>
<td>265 days</td>
<td>Mon 8/20/18</td>
<td>Fri 8/23/19</td>
<td>NA</td>
</tr>
<tr>
<td>16</td>
<td>Begin Design Drawings and Specifications</td>
<td>50 days</td>
<td>Mon 8/20/18</td>
<td>Fri 10/26/18</td>
<td>NA</td>
</tr>
<tr>
<td>17</td>
<td>DRAFT 60% Drawings, TOC and CE (City Review)</td>
<td>6 days</td>
<td>Fri 10/26/18</td>
<td>Fri 11/2/18</td>
<td>NA</td>
</tr>
<tr>
<td>18</td>
<td>60% Review Meeting</td>
<td>5 days</td>
<td>Mon 11/5/18</td>
<td>Fri 11/9/18</td>
<td>NA</td>
</tr>
<tr>
<td>19</td>
<td>Deliverable - Final 60% PSE</td>
<td>5 days</td>
<td>Mon 11/12/18</td>
<td>Fri 11/16/18</td>
<td>NA</td>
</tr>
<tr>
<td>20</td>
<td>100% DESIGN PSE <strong>(Pending MDNR Review)</strong></td>
<td>200 days</td>
<td>Mon 11/19/18</td>
<td>Fri 8/23/19</td>
<td>NA</td>
</tr>
<tr>
<td>21</td>
<td>Prepare Final PSE</td>
<td>50 days</td>
<td>Mon 11/19/18</td>
<td>Fri 1/25/19</td>
<td>NA</td>
</tr>
<tr>
<td>22</td>
<td>DRAFT Final PSE (City and MDNR Review)</td>
<td>130 days</td>
<td>Mon 1/28/19</td>
<td>Fri 7/26/19</td>
<td>NA</td>
</tr>
<tr>
<td>23</td>
<td>Final Review Meeting</td>
<td>5 days</td>
<td>Mon 7/29/19</td>
<td>Fri 8/2/19</td>
<td>NA</td>
</tr>
<tr>
<td>24</td>
<td>Deliverable - Final PSE <strong>(Pending MDNR Review)</strong></td>
<td>15 days</td>
<td>Mon 8/5/19</td>
<td>Fri 8/23/19</td>
<td>NA</td>
</tr>
<tr>
<td>25</td>
<td>Bidding <strong>(Pending MDNR Review)</strong></td>
<td>45 days</td>
<td>Mon 8/26/19</td>
<td>Fri 10/25/19</td>
<td>NA</td>
</tr>
<tr>
<td>26</td>
<td>Bidding</td>
<td>45 days</td>
<td>Mon 8/26/19</td>
<td>Fri 10/25/19</td>
<td>NA</td>
</tr>
<tr>
<td>27</td>
<td>Project Award <strong>(Pending MDNR Review)</strong></td>
<td>40 days</td>
<td>Mon 10/26/19</td>
<td>Fri 12/20/19</td>
<td>NA</td>
</tr>
<tr>
<td>28</td>
<td>Project Award</td>
<td>40 days</td>
<td>Mon 10/26/19</td>
<td>Fri 12/20/19</td>
<td>NA</td>
</tr>
<tr>
<td>29</td>
<td>Construction <strong>(Pending MDNR Review)</strong></td>
<td>525 days</td>
<td>Mon 1/6/20</td>
<td>Fri 1/7/22</td>
<td>NA</td>
</tr>
<tr>
<td>30</td>
<td>Construction</td>
<td>525 days</td>
<td>Mon 1/6/20</td>
<td>Fri 1/7/22</td>
<td>NA</td>
</tr>
<tr>
<td>31</td>
<td>Project Close-out <strong>(Pending MDNR Review)</strong></td>
<td>41 days</td>
<td>Mon 1/10/22</td>
<td>Mon 3/7/22</td>
<td>NA</td>
</tr>
<tr>
<td>32</td>
<td>Project Close-out</td>
<td>41 days</td>
<td>Mon 1/10/22</td>
<td>Mon 3/7/22</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Project: City of O'Fallon Wastewater Treatment Plant Ammonia Upgrades (Project 18-101)**

**Date:** Fri 6/8/18
APPENDIX M  SURVEY
APPENDIX N  HAZARDOUS MATERIALS ASSESSMENT
LIMITED ASBESTOS AND
LEAD-BASED PAINT SURVEYS
BIOFILTER BUILDING
O’FALLON WASTE WATER TREATEMENT PLANT
O’FALLON, MISSOURI

Prepared for:
WOODARD & CURRAN
ST. CHARLES, MISSOURI

Prepared by:
GEOTECHNOLOGY, INC.
ST. LOUIS, MISSOURI

Date:
APRIL 16, 2018

Geotechnology Project No.:
J030160.01
April 16, 2018

Mr. Kevin White  
Woodard & Curran  
1520 South Fifth Street, Suite 306  
St. Charles, Missouri 63303

Re: Limited Asbestos and Lead-Based Paint Surveys  
Biofilter Building  
O'Fallon Waste Water Treatment Plant  
150 Firma Road  
O'Fallon, Missouri  
Geotechnology Project No. J030160.01

Dear Mr. White:

In accordance with our proposal P030160.01, dated March 6, 2018, Geotechnology, Inc. (Geotechnology) is pleased to provide this limited asbestos and lead-based paint (LBP) surveys report for the referenced project. Our scope of services included limited asbestos and LBP surveys, sampling of suspect asbestos-containing material (ACM), X-ray fluorescence (XRF) LBP screening, laboratory analysis of samples, and a letter report.

SITE AND PROJECT DESCRIPTION

The subject property consists of an approximately 19.8-acre waste water treatment plant located southeast of the intersection of Missouri Route 79 and Firma Road in O'Fallon Missouri. The extent of the asbestos and LBP surveys was limited to the Biofilter Building.

LIMITED ASBESTOS SURVEY

The objective of the limited asbestos survey was to identify potential ACM in suspect building materials located within the subject building. In general conformance with the National Emission Standards for Hazardous Air Pollutants (NESHAPs) and the Missouri Department of Natural Resources (MDNR) requirements, the survey was conducted on April 3, 2018, by Mr. Brad Lohrum, a Missouri-licensed asbestos inspector. Copies of Mr. Lohrum’s training certificate and asbestos inspector license are included in Appendix A.

Samples were collected in general conformance with the NESHAPs and MDNR requirements. The identified suspect ACMs were subdivided into homogeneous areas (an area of surfacing material, thermal system insulation material or miscellaneous material that is uniform in color
and texture). Samples were collected from each identified homogeneous area, consistent with industry practice.

Using standard chain-of-custody procedures, the suspect ACM samples were submitted to QuanTEM Laboratories of Oklahoma City, Oklahoma, a National Voluntary Laboratory Accreditation Program (NVLAP)-accredited laboratory, for identification by Polarized Light Microscopy (PLM) coupled with dispersion staining, according to the test method, “Method for Determination of Asbestos in Bulk Building Materials” (EPA/600/R-93/116). Separable layered samples were analyzed by layer. A copy of the asbestos survey summary is included in Appendix B.

**LIMITED ASBESTOS SURVEY RESULTS**

Laboratory analyses of the submitted samples detected the presence of asbestos in the following materials in the building.

**TABLE 1**

**ASBESTOS-CONTAINING MATERIALS SUMMARY**

<table>
<thead>
<tr>
<th>Material Description</th>
<th>Estimated Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor Tile / Mastic – 12” x 12” Tan Mottled (Mastic Only) *</td>
<td>425 SF</td>
</tr>
<tr>
<td>Floor Tile / Mastic – 12” x 12” Cream Mottled (Mastic Only) *</td>
<td>12 SF</td>
</tr>
</tbody>
</table>

SF = square feet  
LF = linear feet

*Non-ACM floor tile should be treated as ACM because asbestos-containing black mastic cannot be removed from floor tile.

Geotechnology will not be able to represent that the site contains no asbestos beyond that detected or observed by Geotechnology during the survey. Furthermore, the quantities listed in the asbestos survey summary sheets in Appendix B should be considered approximate only. For bidding purposes, we strongly recommend that contractors prepare abatement bids only after conducting a site reconnaissance. Copies of the asbestos laboratory analytical results are included in Appendix C.

**LIMITED LEAD-BASED PAINT SURVEY**

A limited LBP survey of painted surfaces was conducted at the subject building in general accordance with the *HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* (HUD Guidelines) of June 1995 (updated July 2012). The limited LBP survey was performed by Mr. Brad Lohrum, a Missouri-licensed Lead Risk Assessor, on April 3, 2018. Copies of Mr. Lohrum’s training certificate and lead risk assessor license are included in Appendix A. The purpose of the limited LBP survey was to provide a professional opinion as to the potential extent of lead-based painted components, which may require future remedial
action. A Niton XRF Spectrum Analyzer, Model XLp 702A, was used to identify the total lead content of surface coatings (e.g., paints, varnishes, etc.) in units of milligrams of lead per square centimeter of surface area (mg/cm²).

Lead-based paint is generally defined as a surface coating containing greater than or equal to 1.0 mg/cm² lead. Total lead content should not be confused with Toxicity Characteristic Leaching Procedure (TCLP) lead content used to determine if lead is present at levels deemed as hazardous (5 ppm). Geotechnology is not aware of a definitive relationship between total lead content and TCLP lead content.

LIMITED LEAD-BASED PAINT SURVEY RESULTS

The survey included accessible areas of the subject building. A total of 46 XRF readings and six calibration readings were obtained during the survey. Of the 46 XRF readings, one was positive for lead-based paint, three were proximity button misfires (null), and 42 were negative.

XRF results indicated the presence of LBP on the following surface and material:

- Yellow metal pump piping located within the southeast lower pump room.

The LBP XRF calibration and survey logs which contain the XRF screening locations and results collected during the survey are included in Appendix D. The XRF survey data sheets are included in Appendix E.

The Niton XRF Spectrum Analyzer 702 Series was calibrated against manufacturer-supplied standards at the beginning and end of the survey. Calibration data is also included in the attached field survey data sheets.

ASBESTOS RECOMMENDATIONS

Our recommendations are summarized below:

- The identified floor tile / mastic appears to be Category I Non-Friable ACM and should be removed by a licensed abatement contractor prior to demolition or renovation activities that may impact these materials.

- For demolition and renovation projects which require the removal of friable and/or Category I Non-Friable and/or Category II Non-Friable ACM, NESHAPs and MDNR notifications are required.

- Third party clearance sampling and testing may be required.

- Geotechnology has performed third-party monitoring on similar projects and would be pleased to submit a proposal to conduct those services at your request.
LEAD-BASED PAINT RECOMMENDATIONS

The results of the XRF screening indicated the presence of LBP on one material and surface. The identified lead-based paint should be removed by a licensed abatement contractor prior to demolition or renovation activities that may impact this material. Geotechnology recommends that a licensed lead project designer specify removal requirements and that a licensed abatement contractor (using licensed abatement personnel) remove LBP or lead-based painted components as appropriate.

Lead removal regulations that are outlined in Missouri Revised Statutes, Chapter 701, Sections 701.300-701.338 and administered by the Missouri Department of Health and Senior Services (MDHSS), contain provisions for lead-abatement activities, including project notifications and clearance requirements.

* * * * *

The following attachments are included in and complete this report:

Appendix A  -  Certificates and Licenses of Environmental Professional
Appendix B  -  Asbestos Survey Summary
Appendix C  -  Asbestos Laboratory Analytical Results
Appendix D  -  XRF LBP Survey Logs
Appendix E  -  XRF Survey Data Sheets
Appendix F  -  Limitations of Report

* * * * *

We appreciate the opportunity to be of service to Woodard & Curran. If you have any questions or comments, please contact me at (314) 997-7440.

Very truly yours,

GEOTECHNOLOGY, INC.

Bradley J. Lohrum
Senior Scientist

BJL/DTK:bjl
APPENDIX A

CERTIFICATES AND LICENSES OF ENVIRONMENTAL PROFESSIONAL
Does hereby certify

Bradley Lohrum
11816 Lackland Road, St. Louis, MO 63146

Has successfully completed and passed the course examination with at least 70% for re-accreditation under AHERA (Title II)

Asbestos Building Inspector Refresher

Class Date: January 05, 2018
Examination Date: 01/05/2018
STC Certificate Number: STC-01052018-002017ABIR
Certification Expiration: 01/05/2019

David M. Mendoza – President/Training Director
Certified Environmental Specialist
OSHA Authorized Instructor

This training course is accredited by the Illinois Department of Public Health and the Missouri Department of Natural Resources
January 22, 2018

Bradley J Lohrum
817 S Sappington Rd
Crestwood, MO 63126

RE: Missouri Asbestos Occupation Certification Card

Enclosed is your certification card for Asbestos Inspector, as issued by the Asbestos Unit of the Missouri Department of Natural Resources’ Air Pollution Control Program.

Missouri Certification Number: 7118010518MOIR15873
Course Training Date: January 05, 2018
Missouri Certification Approval Date: January 22, 2018
Missouri Certification Expiration Date: January 22, 2019

Note:
- All Missouri-certified asbestos personnel must comply with the following statutes and regulations:
  - Sections 643.225 to 643.225, RSMo;
  - 10 CSR 10-6.241 Asbestos Projects-Registration, Abatement, Notification, Inspection, Demolition, and Performance Requirements; and
  - 10 CSR 10-6.250 Asbestos Projects-Certification, Accreditation and Business Exemption Requirements.
- To keep your occupation certification up-to-date, you must complete an annual refresher course and submit a renewal application each year.
- In order to be eligible to renew your certification, you must successfully complete a refresher course with a Missouri-accredited training provider within 12 months of the expiration date of your current training certificate. If you exceed this grace period, you will be required to retake a Missouri-accredited initial course in order to be eligible for Missouri certification.

To obtain a copy of the certification renewal application, or review regulations and requirements, please visit our website at http://dnr.mo.gov/env/apcp/asbestos/index.htm.

If you have any questions please call the Air Pollution Control Program at 573-751-4817.

AIR POLLUTION CONTROL PROGRAM

Kyla L Moore
Director of Air Pollution Control Program
Certification:

Bradley Lohrum has attended 8 contact hours of training and successfully passed an examination titled "Lead Risk Assessor Refresher".

Certificate # CEET 325 - 9/19/2016 - 116967
Examination Date: 9/19/2016
CEUs: 0.8

Certificate expiration is 3 years from examination date for Illinois Dept. of Public Health.

Center for Environmental Education and Training, 3545 Lafayette, St. Louis, MO 63104
(314) 977-8256
slu.edu/39753.xml
This training course has been accredited by the Illinois Department of Public Health, and by the Missouri Department of Health & Senior Services.
STATE OF MISSOURI
DEPARTMENT OF HEALTH AND SENIOR SERVICES

LEAD OCCUPATION LICENSE REGISTRATION

Issued to:

Bradley J. Lohrum

The person, firm or corporation whose name appears on this certificate has fulfilled the requirements for licensure as set forth in the Missouri Revised Statutes 701.300-701.338, as long as not suspended or revoked, and is hereby authorized to engage in the activity listed below.

Lead Risk Assessor
Category of License

Issuance Date: 11/19/2016
Expiration Date: 11/19/2018
License Number: 121119-300004110

Peter Lyskowski
Director
Department of Health and Senior Services

Lead Licensing Program, PO Box 570, Jefferson City, MO 65102
<table>
<thead>
<tr>
<th>Homogeneous Area Number/Location</th>
<th>Type of Material</th>
<th>Quantity</th>
<th>Sample I.D.</th>
<th>Location of Sampled Material/Substrate</th>
<th>Friability Category</th>
<th>Asbestos</th>
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<tbody>
<tr>
<td>#1 / Garage Office</td>
<td>Drywall / Joint Compound</td>
<td>NQ</td>
<td>1A</td>
<td>Garage Office / Concrete</td>
<td>F</td>
<td>ND</td>
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<td></td>
<td></td>
<td>1B</td>
<td>Garage Office / Concrete</td>
<td>F</td>
<td>ND</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>1C</td>
<td>Garage Office / Concrete</td>
<td>F</td>
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<td>#2 / Throughout</td>
<td>Interior Door Caulk</td>
<td>NQ</td>
<td>2A</td>
<td>Garage / Metal</td>
<td>NF II</td>
<td>ND</td>
</tr>
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<td>2B</td>
<td>Motor Control Center / Metal</td>
<td>NF II</td>
<td>ND</td>
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<td></td>
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<td>2C</td>
<td>Storage Room / Metal</td>
<td>NF II</td>
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<td>#3 / Second Floor</td>
<td>Ceiling Tile - 2' x 4' Pin and Worm</td>
<td>NQ</td>
<td>3A</td>
<td>Storage Room / Suspended</td>
<td>F</td>
<td>ND</td>
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<td></td>
<td></td>
<td></td>
<td>3B</td>
<td>Hallway / Suspended</td>
<td>F</td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3C</td>
<td>Shower Room / Suspended</td>
<td>F</td>
<td>ND</td>
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<td>#4 / Second Floor</td>
<td>Floor Tile / Mastic - 12&quot; x 12&quot; Tan Mottled</td>
<td>425 SF</td>
<td>4A</td>
<td>Hallway / Concrete</td>
<td>NF I</td>
<td>CH (Mastic Only) 4</td>
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<td>4B</td>
<td>Shower Room / Concrete</td>
<td>NF I</td>
<td>NA</td>
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<td></td>
<td></td>
<td></td>
<td>4C</td>
<td>Restroom / Concrete</td>
<td>NF I</td>
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<tr>
<td>#5 / Second Floor Hallway</td>
<td>Floor Tile / Mastic - 12&quot; x 12&quot; Cream Mottled</td>
<td>12 SF</td>
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<td>CH (Mastic Only) 3</td>
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<td>5B</td>
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<td>5C</td>
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<td>NF I</td>
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<td>Covebase Mastic - 4&quot; Brown</td>
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<td>6A</td>
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<td>NF II</td>
<td>ND</td>
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<td></td>
<td>6B</td>
<td>Shower Room / Concrete</td>
<td>NF II</td>
<td>ND</td>
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<td></td>
<td></td>
<td>6C</td>
<td>Restroom / Concrete</td>
<td>NF II</td>
<td>ND</td>
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<td>#7 / Lunchroom</td>
<td>Ceiling Tile - 2' x 4' Pin and Peck</td>
<td>NQ</td>
<td>7A</td>
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<td>F</td>
<td>ND</td>
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<td>7B</td>
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<td>ND</td>
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<td></td>
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<td>7C</td>
<td>Lunchroom / Suspended</td>
<td>F</td>
<td>ND</td>
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<tr>
<td>#8 / Lunchroom</td>
<td>Covebase Mastic - 4&quot; Black</td>
<td>NQ</td>
<td>8A</td>
<td>Lunchroom / Concrete</td>
<td>NF II</td>
<td>ND</td>
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<td></td>
<td>8B</td>
<td>Lunchroom / Concrete</td>
<td>NF II</td>
<td>ND</td>
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<td></td>
<td></td>
<td></td>
<td>8C</td>
<td>Lunchroom / Concrete</td>
<td>NF II</td>
<td>ND</td>
</tr>
</tbody>
</table>

Highlighted items were found to contain asbestos.

LF=Linear Feet  
NF=Non-Friable  
CH=Chrysotile  
PACM=Presumed Asbestos Containing Material  
ND=Non-Detect  
SF=Square Feet  
F = Friable  
AM=Amosite  
PTC=Point Count  
NA=Not Analyzed per stop 1st positive  
NQ=Not Quantified  
CR=Crocidolite
<table>
<thead>
<tr>
<th>Homogeneous Area Number/Location</th>
<th>Type of Material</th>
<th>Quantity</th>
<th>Sample I.D.</th>
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<th>Friability Category</th>
<th>Asbestos Type</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>#9 / Lunchroom</td>
<td>Sink Insulation</td>
<td>1 Sink</td>
<td>9A</td>
<td>Lunchroom / Metal</td>
<td>F</td>
<td>ND</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>9B</td>
<td>Lunchroom / Metal</td>
<td>F</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9C</td>
<td>Lunchroom / Metal</td>
<td>F</td>
<td>ND</td>
<td></td>
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<tr>
<td>#10 / Exterior</td>
<td>Exterior Door Caulk</td>
<td>NQ</td>
<td>10A</td>
<td>Exterior / Metal</td>
<td>NF II</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10B</td>
<td>Exterior / Metal</td>
<td>NF II</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>10C</td>
<td>Exterior / Metal</td>
<td>NF II</td>
<td>ND</td>
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<tr>
<td>#11 / Exterior</td>
<td>Expansion Joint Caulk</td>
<td>NQ</td>
<td>11A</td>
<td>Exterior / Concrete</td>
<td>NF II</td>
<td>ND</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>11B</td>
<td>Exterior / Concrete</td>
<td>NF II</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11C</td>
<td>Exterior / Concrete</td>
<td>NF II</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>#12 / Exterior at Lunchroom</td>
<td>Window Caulk</td>
<td>8 LF</td>
<td>12A</td>
<td>Exterior / Metal</td>
<td>NF II</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12B</td>
<td>Exterior / Metal</td>
<td>NF II</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12C</td>
<td>Exterior / Metal</td>
<td>NF II</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td>#13 / Exterior</td>
<td>Foundation Caulk</td>
<td>NQ</td>
<td>13A</td>
<td>Exterior / Concrete</td>
<td>NF II</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13B</td>
<td>Exterior / Concrete</td>
<td>NF II</td>
<td>ND</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13C</td>
<td>Exterior / Concrete</td>
<td>NF II</td>
<td>ND</td>
<td></td>
</tr>
</tbody>
</table>

Highlighted items were found to contain asbestos, or were assumed to contain asbestos.

LF=Linear Feet                NF=Non-Friable    CH=Chrysotile   PACM=Presumed Asbestos Containing Material   ND=Non-Detect
SF=Square Feet                F = Friable       AM=Amosite      PTC=Point Count                NA=Not Analyzed per stop 1st positive
NQ=Not Quantified             CR=Crocidolite
Polarized Light Microscopy Asbestos Analysis Report

QuanTEM Lab No. 292707
Account Number: C039
Date Received: 04/04/2018
Received By: Jeff Mlekush
Date Analyzed: 04/11/2018
Analyzed By: Cristal Veech
Methodology: EPA/600/R-93/116

Client: Geotechnology, Inc.
11816 Lackland Rd., STE 150
St. Louis, MO 63146

Project: O'Fallon WWTP - Biofilter Bldg.
Project Location: O'Fallon Missouri
Project Number: J030160.01

<table>
<thead>
<tr>
<th>QuanTEM Sample ID</th>
<th>Client Sample ID</th>
<th>Composition</th>
<th>Color / Description</th>
<th>Asbestos (%)</th>
<th>Non-Asbestos Fiber (%)</th>
<th>Non Fibrous</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>1A</td>
<td>Layered</td>
<td>White Joint Compound</td>
<td>Asbestos Not Present 400 Point Count</td>
<td>NA</td>
<td>CaCO3 Paint</td>
</tr>
<tr>
<td>001a</td>
<td></td>
<td>Layered</td>
<td>White Sheetrock</td>
<td>Asbestos Not Present 400 Point Count</td>
<td>Cellulose 2</td>
<td>Gypsum</td>
</tr>
<tr>
<td>002</td>
<td>1B</td>
<td>Layered</td>
<td>White Joint Compound</td>
<td>Asbestos Not Present 400 Point Count</td>
<td>NA</td>
<td>CaCO3</td>
</tr>
<tr>
<td>002a</td>
<td></td>
<td>Layered</td>
<td>White Sheetrock</td>
<td>Asbestos Not Present 400 Point Count</td>
<td>NA</td>
<td>Gypsum</td>
</tr>
<tr>
<td>003</td>
<td>1C</td>
<td>Layered</td>
<td>White Joint Compound</td>
<td>Asbestos Not Present 400 Point Count</td>
<td>NA</td>
<td>CaCO3</td>
</tr>
<tr>
<td>003a</td>
<td></td>
<td>Layered</td>
<td>White Sheetrock</td>
<td>Asbestos Not Present 400 Point Count</td>
<td>Cellulose 2</td>
<td>Gypsum</td>
</tr>
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<td>004</td>
<td>2A</td>
<td>Homogeneous</td>
<td>White Caulk</td>
<td>Asbestos Not Present</td>
<td>NA</td>
<td>Silicone</td>
</tr>
</tbody>
</table>

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Polarized Light Microscopy Asbestos Analysis Report

QuanTEM Lab No. 292707
Account Number: C039
Date Received: 04/04/2018
Received By: Jeff Mlekush
Date Analyzed: 04/11/2018
Analyzed By: Cristal Veech
Methodology: EPA/600/R-93/116

Client: Geotechnology, Inc.
11816 Lackland Rd., STE 150
St. Louis, MO 63146
Project: O’Fallon WWTP - Biofilter Bldg.
Project Location: O’Fallon Missouri
Project Number: J030160.01

<table>
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<tr>
<th>QuanTEM Sample ID</th>
<th>Client Sample ID</th>
<th>Composition</th>
<th>Color / Description</th>
<th>Asbestos (%)</th>
<th>Non-Asbestos Fiber (%)</th>
<th>Non Fibrous</th>
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<td>White_Caulk</td>
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<td>White_Ceiling Tile</td>
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<td>010</td>
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<td>Tan_Floor Tile</td>
<td>Asbestos Not Present</td>
<td>NA</td>
<td>Vinyl CaCO3</td>
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</tbody>
</table>

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# Polarized Light Microscopy Asbestos Analysis Report

**QuanTEM Lab No.:** 292707  
**Client:** Geotechnology, Inc.  
**Account Number:** C039  
**Date Received:** 04/04/2018  
**Received By:** Jeff Mlekush  
**Date Analyzed:** 04/11/2018  
**Analyzed By:** Cristal Veech  
**Project:** O’Fallon WWTP - Biofilter Bldg.  
**Methodology:** EPA/600/R-93/116

## Project Location: O'Fallon Missouri  
## Project Number: J030160.01

<table>
<thead>
<tr>
<th>QuanTEM Sample ID</th>
<th>Client Sample ID</th>
<th>Composition</th>
<th>Color / Description</th>
<th>Asbestos (%)</th>
<th>Non-Asbestos Fiber (%)</th>
<th>Non Fibrous</th>
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<td>010a</td>
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<td>Layered</td>
<td>Tan Floor Tile</td>
<td>Asbestos Not Present</td>
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<td>011a</td>
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<td>Asbestos Not Present</td>
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<td>Asbestos Present Chrysotile 3</td>
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<td>Tar Glue</td>
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</table>

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<th>Non Fibrous</th>
</tr>
</thead>
<tbody>
<tr>
<td>014</td>
<td>5B</td>
<td>Layered</td>
<td>Tan Floor Tile</td>
<td>Asbestos Not Present</td>
<td>NA</td>
<td>Vinyl CaCO3</td>
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<tr>
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<td>**</td>
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<tr>
<td><strong>Positive Stop</strong></td>
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<td>Vinyl CaCO3</td>
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<tr>
<td>017</td>
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<td>Tan Cove Base Mastic</td>
<td>Asbestos Not Present</td>
<td>NA</td>
<td>Glue Binder</td>
</tr>
</tbody>
</table>

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Polarized Light Microscopy Asbestos Analysis Report

QuanTEM Lab No. 292707  
Account Number: C039  
Date Received: 04/04/2018  
Received By: Jeff Mlekush  
Date Analyzed: 04/11/2018  
Analyzed By: Cristal Veech  
Methodology: EPA/600/R-93/116

Client: Geotechnology, Inc.  
11816 Lackland Rd., STE 150  
St. Louis, MO 63146

Project: O'Fallon WWTP - Biofilter Bldg.  
Project Location: O'Fallon Missouri  
Project Number: J030160.01

<table>
<thead>
<tr>
<th>QuanTEM Sample ID</th>
<th>Client Sample ID</th>
<th>Composition</th>
<th>Color / Description</th>
<th>Asbestos (%)</th>
<th>Non-Asbestos Fiber (%)</th>
<th>Non Fibrous</th>
</tr>
</thead>
<tbody>
<tr>
<td>018 6C</td>
<td>Non-Fibrous</td>
<td>Homogeneous</td>
<td>Tan</td>
<td>Asbestos Not Present</td>
<td>NA</td>
<td>Glue Binder</td>
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<td></td>
<td></td>
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<td>Perlite Paint</td>
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<td>Ceiling Tile</td>
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<td>Glass Fiber</td>
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<td>Cellulose</td>
<td>Perlite Paint</td>
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<td>Glass Fiber</td>
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<td>White</td>
<td>Cove Base Mastic</td>
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<td>Cove Base Mastic</td>
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<td>NA</td>
<td>Glue Binder</td>
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<td>Cove Base Mastic</td>
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</table>

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### Polarized Light Microscopy Asbestos Analysis Report

<table>
<thead>
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<th>QuanTEM Lab No.</th>
<th>Client: Geotechnology, Inc.</th>
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<tbody>
<tr>
<td>Account Number:</td>
<td>11816 Lackland Rd., STE 150</td>
</tr>
<tr>
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<td>St. Louis, MO 63146</td>
</tr>
<tr>
<td>Date Received:</td>
<td>04/04/2018</td>
</tr>
<tr>
<td>Received By:</td>
<td>Jeff Mlekush</td>
</tr>
<tr>
<td>Date Analyzed:</td>
<td>04/11/2018</td>
</tr>
<tr>
<td>Analyzed By:</td>
<td>Cristal Veech</td>
</tr>
<tr>
<td>Methodology:</td>
<td>EPA/600/R-93/116</td>
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**Project Location:** O'Fallon Missouri  
**Project Number:** J030160.01

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<th>QuanTEM Sample ID</th>
<th>Client Sample ID</th>
<th>Composition</th>
<th>Color / Description</th>
<th>Asbestos (%)</th>
<th>Non-Asbestos Fiber (%)</th>
<th>Non Fibrous</th>
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<tbody>
<tr>
<td>025 9A</td>
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<td>CaCO3 Gypsum</td>
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# Polarized Light Microscopy Asbestos Analysis Report

**QuanTEM Lab No.** 292707  
**Account Number:** C039  
**Date Received:** 04/04/2018  
**Received By:** Jeff Mlekush  
**Date Analyzed:** 04/11/2018  
**Analyzed By:** Cristal Veech  
**Methodology:** EPA/600/R-93/116  
**Project Location:** O'Fallon Missouri  
**Project Number:** J030160.01  

**Client:** Geotechnology, Inc.  
**Address:** 11816 Lackland Rd., STE 150  
**City/State/Zip:** St. Louis, MO 63146  

<table>
<thead>
<tr>
<th>QuanTEM Sample ID</th>
<th>Sample ID</th>
<th>Composition</th>
<th>Color / Description</th>
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<tbody>
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<td>Tan Caulk</td>
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<td>CaCO3 Binder</td>
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<td>11C</td>
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<td>Tan Caulk</td>
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<td>CaCO3 Binder</td>
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Date Analyzed: 04/11/2018
Analyzed By: Cristal Veech
Methodology: EPA/600/R-93/116

Client: Geotechnology, Inc.
11816 Lackland Rd., STE 150
St. Louis, MO 63146

Project: O'Fallon WWTP - Biofilter Bldg.
Project Location: O'Fallon, Missouri
Project Number: J030160.01

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<th>Non-Asbestos Fiber (%)</th>
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<td>Caulk</td>
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Cristal Veech, Analyst  4/11/2018

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# ASBESTOS CHAIN OF CUSTODY

2033 Heritage Park Drive, Oklahoma City, OK 73120-7502  
(800) 822-1650  •  (405) 755-7272  •  Fax: (405) 755-2058

**LEGAL DOCUMENT - PLEASE PRINT LEGIBLY**

<table>
<thead>
<tr>
<th>Company: Geotechnology, Inc.</th>
<th>Phone: (314) 997-7440</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact: Brad Lohrum</td>
<td>Cell Phone:</td>
</tr>
<tr>
<td>Account #: C039</td>
<td>E-mail: <a href="mailto:blohrum@geotechnology.com">blohrum@geotechnology.com</a></td>
</tr>
<tr>
<td>SAMPLED BY: Name: Brad Lohrum</td>
<td>Date: 4/3/18</td>
</tr>
</tbody>
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<th>Project Information</th>
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<tr>
<td>Project Name: O'Fallon WWTP - Biofilter Bldg.</td>
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<tr>
<td>Project Location: O'Fallon Missouri</td>
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<tr>
<td>Project ID: J030160.01</td>
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<th>DATE &amp; TIME</th>
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## REQUESTED SERVICES (Please ☑ the Appropriate Boxes)

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<th>PLM</th>
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<tbody>
<tr>
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<td>☑ Vermiculite Attic Insulation (EPA 600/R-04/004)</td>
<td>☑ Air- AHERA</td>
<td>☑ Rush</td>
</tr>
<tr>
<td>☑ 400 Point Count</td>
<td></td>
<td>☑ Air- NIOSH 7402</td>
<td>☑ Same Day</td>
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<tr>
<td>☑ 1000 Point Count</td>
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<td>☑ Air- ISO 10312</td>
<td>☑ 24 - Hour</td>
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<td>☑ Gravimetric Preparation</td>
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<td>☑ Drinking Water- EPA 100.2</td>
<td>☐ 3 - Day</td>
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<td>☑ PCM</td>
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<td>☑ Waste Water- EPA 600/4-83-043</td>
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<th>No.</th>
<th>Sample ID (10 Characters Max)</th>
<th>☑ To Be Analyzed</th>
<th>Color</th>
<th>Description</th>
<th>Volume / Area (as applicable)</th>
<th>Comments / Notes</th>
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<td>☑</td>
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<td>4</td>
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<tr>
<td>7</td>
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<td>8</td>
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<td>☑</td>
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<td>Tan/Black</td>
<td>Floor Tile / Mosaic - 12” Tan Mottled</td>
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**SATURDAY FED EX SAMPLE DELIVERY - CALL TO SCHEDULE**  •  Use this address for Saturday Delivery only: 4220 N. Santa Fe Ave., Oklahoma City, OK 73105-8517  •  Mark Package "Hold for Saturday Pickup"  

Please Note - UPS and USPS are NOT available for Saturday Delivery
<table>
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<tr>
<th>No.</th>
<th>Sample ID (10 Characters Max)</th>
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<tr>
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<tr>
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<td>Covebase Mastic - 4&quot; Brown</td>
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<td>6B</td>
<td>✗</td>
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<td>6C</td>
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</tr>
<tr>
<td>19</td>
<td>7A</td>
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<td>White/Gray</td>
<td>Ceiling Tile - 2' x 4' Ply &amp; Rock</td>
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<td>7B</td>
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<td>Exterior Door Caulk</td>
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<td>Volume / Area (as applicable)</td>
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</table>

**ASBESTOS CHAIN OF CUSTODY**

2033 Heritage Park Drive, Oklahoma City, OK 73120-7502
(800) 822-1650  •  (405) 755-7272  •  Fax (405) 755-2058

LEGAL DOCUMENT - PLEASE PRINT LEGIBLY

**Project Information**

Company: Geotechnology, Inc.  Project Name: O'Fallon WWTP - Biofilter Bldg.  Project Location: O'Fallon Missouri

**SATURDAY FEDEX SAMPLE DELIVERY - CALL TO SCHEDULE**

- Use this address for Saturday Delivery only: 4220 N. Santa Fe Ave., Oklahoma City, OK 73105-8517
- Mark Package "Hold for Saturday Pickup"

Please Note - UPS and USPS are NOT available for Saturday Delivery
APPENDIX D

XRF LBP SURVEY LOGS
GEOTECHNOLOGY INC.
LEAD-BASED PAINT XRF CALIBRATION LOG

Project No.: J030160.01
Surveyed By: Brad Lohrum
Address: O’Fallon Wastewater Treatment Plant
Biofilter Building
150 Firma Road, O’Fallon, Missouri

Survey Date: April 3, 2018
XRF Serial No.: XLp 702A TR0944-24561

START OF SURVEY

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Standard mg/cm²</th>
<th>+ - mg/cm²</th>
<th>XRF mg/cm²</th>
<th>+ - mg/cm²</th>
<th>Other</th>
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<tbody>
<tr>
<td>751</td>
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<td>0.28</td>
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<td>752</td>
<td>1.040</td>
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<td>0.1</td>
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<td>3.1</td>
<td>0.7</td>
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END OF SURVEY

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<th>Sample No.</th>
<th>Standard mg/cm²</th>
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<th>XRF mg/cm²</th>
<th>+ - mg/cm²</th>
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<td>0.1</td>
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Comments/Note:
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

std par/lbp xrf surv calib log.doc
### GEOTECHNOLOGY INC.
### LEAD-BASED PAINT XRF SURVEY LOG

**Project No.:** J030160.01  
**Address:** O’Fallon Wastewater Treatment Plant  
**Biofilter Building**  
**150 Firma Road, O’Fallon, Missouri**

**Survey Date:** April 3, 2018  
**Surveyed By:** Brad Lohrum  
**XRF Serial No.:** XLp 702A TR0944-24561

<table>
<thead>
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<th>Sample No.</th>
<th>Color</th>
<th>Substrate</th>
<th>Specific Location</th>
<th>XRF mg/cm²</th>
<th>+ - mg/cm²</th>
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<tbody>
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<td>775</td>
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<td>East Exterior Wall</td>
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<tr>
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<td>Red</td>
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<td>778</td>
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<td>0.03</td>
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<td>Metal</td>
<td>Exterior Man Door Frame</td>
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<td>0.02</td>
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<tr>
<td>780</td>
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**Comments/Note:**

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

std par/lbp xrf surv calib log.doc
## GEOTECHNOLOGY INC.
LEAD-BASED PAINT XRF SURVEY LOG

Project No.: J030160.01  
Address: O’Fallon Wastewater Treatment Plant  
Biofilter Building  
150 Firma Road, O’Fallon, Missouri  
Survey Date: April 3, 2018  
Surveyed By: Brad Lohrm  
XRF Serial No.: XLp 702A TR0944-24561

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<th>Substrate</th>
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<td>0.02</td>
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Comments/Note:

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GEOTECHNOLOGY INC.
LEAD-BASED PAINT XRF SURVEY LOG

Project No.: J030160.01
Address: O'Fallon Wastewater Treatment Plant
Survey Date: April 3, 2018
Biofilter Building
Surveyed By: Brad Lohrum
150 Firma Road, O’Fallon, Missouri
XRF Serial No.: XLp 702A TR0944-24561

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<th>Sample No.</th>
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<th>+/- mg/cm²</th>
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Comments/Note:

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________________________________________________________________________________________
________________________________________________________________________________________
________________________________________________________________________________________

std par/lbp xrf surv calib log.doc
APPENDIX E

XRF SURVEY DATA SHEETS
NITON Corporation
900 Middlesex Turnpike
Billerica, MA 01821

Index

Reading No

Time

Units

Sequence

Results

PbC

PbL

PbK

1

751

2018-04-03 11:01

mg / cm ^2

Final

Negative

0.28 ± 0.12

0.28 ± 0.12

< LOD : 2.28

2

752

2018-04-03 11:04

mg / cm ^2

Final

Positive

1.00 ± 0.10

1.00 ± 0.10

< LOD : 0.45

3

753

2018-04-03 11:04

mg / cm ^2

Final

Positive

3.10 ± 0.70

3.10 ± 0.70

< LOD : 4.20

25

775

2018-04-03 12:35

mg / cm ^2

Final

Null

< LOD : 0.03

< LOD : 0.03

< LOD : 1.80

26

776

2018-04-03 12:35

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.49

27

777

2018-04-03 12:36

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.14

28

778

2018-04-03 12:36

mg / cm ^2

Final

Negative

< LOD : 0.15

< LOD : 0.15

< LOD : 3.09

29

779

2018-04-03 12:37

mg / cm ^2

Final

Negative

< LOD : 0.06

< LOD : 0.06

< LOD : 1.05

30

780

2018-04-03 12:38

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 2.40

31

781

2018-04-03 12:38

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 3.45

32

782

2018-04-03 12:39

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 2.97

33

783

2018-04-03 12:40

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.52

34

784

2018-04-03 12:40

mg / cm ^2

Final

Null

< LOD : 0.03

< LOD : 0.03

< LOD : 3.45

35

785

2018-04-03 12:40

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.70

36

786

2018-04-03 12:41

mg / cm ^2

Final

Negative

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< LOD : 2.21

37

787

2018-04-03 12:42

mg / cm ^2

Final

Negative

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< LOD : 1.23

38

788

2018-04-03 12:43

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 0.93

39

789

2018-04-03 12:49

mg / cm ^2

Final

Negative

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< LOD : 0.03

< LOD : 3.94

40

790

2018-04-03 12:50

mg / cm ^2

Final

Negative

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< LOD : 0.03

< LOD : 3.15

41

791

2018-04-03 12:50

mg / cm ^2

Final

Negative

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< LOD : 0.03

< LOD : 3.45

42

792

2018-04-03 12:51

mg / cm ^2

Final

Negative

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< LOD : 0.03

< LOD : 2.20

43

793

2018-04-03 12:51

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.33

44

794

2018-04-03 12:56

mg / cm ^2

Final

Negative

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45

795

2018-04-03 12:57

mg / cm ^2

Final

Negative

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< LOD : 0.03

< LOD : 3.30

46

796

2018-04-03 12:58

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 2.70

47

797

2018-04-03 12:58

mg / cm ^2

Final

Positive

1.60 ± 0.40

1.60 ± 0.40

< LOD : 3.00

48

798

2018-04-03 12:59

mg / cm ^2

Final

Negative

< LOD : 0.17

< LOD : 0.17

< LOD : 2.50

49

799

2018-04-03 13:00

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 2.19

50

800

2018-04-03 13:01

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.80

51

801

2018-04-03 13:02

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.48

52

802

2018-04-03 13:03

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 3.26

53

803

2018-04-03 13:05

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 2.10

54

804

2018-04-03 13:05

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 0.96

55

805

2018-04-03 13:05

mg / cm ^2

Final

Null

< LOD : 0.03

< LOD : 0.03

< LOD : 3.21

56

806

2018-04-03 13:06

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.20

57

807

2018-04-03 13:10

mg / cm ^2

Final

Negative

< LOD : 0.05

< LOD : 0.05

< LOD : 2.78

58

808

2018-04-03 13:10

mg / cm ^2

Final

Negative

< LOD : 0.05

< LOD : 0.05

< LOD : 3.30

59

809

2018-04-03 13:11

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.33

60

810

2018-04-03 13:15

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.35

61

811

2018-04-03 13:16

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.55

62

812

2018-04-03 13:18

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.44

63

813

2018-04-03 13:19

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.50

64

814

2018-04-03 13:19

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.55

65

815

2018-04-03 13:20

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.20

66

816

2018-04-03 13:29

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.51

67

817

2018-04-03 13:36

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 2.55

68

818

2018-04-03 13:37

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.67

69

819

2018-04-03 13:38

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 1.05

70

820

2018-04-03 13:42

mg / cm ^2

Final

Negative

< LOD : 0.03

< LOD : 0.03

< LOD : 3.61

Page 1 of 2

04/12/18 14:42:17


<table>
<thead>
<tr>
<th>Index</th>
<th>Reading No</th>
<th>Time</th>
<th>Units</th>
<th>Sequence</th>
<th>Results</th>
<th>PbC ± Error</th>
<th>PbL ± Error</th>
<th>PbK ± Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>821</td>
<td>2018-04-03 14:05</td>
<td>mg/cm²</td>
<td>Final</td>
<td>Negative</td>
<td>0.27 ± 0.10</td>
<td>0.27 ± 0.10</td>
<td>&lt; LOD : 1.66</td>
</tr>
<tr>
<td>72</td>
<td>822</td>
<td>2018-04-03 14:06</td>
<td>mg/cm²</td>
<td>Final</td>
<td>Positive</td>
<td>1.00 ± 0.10</td>
<td>1.00 ± 0.10</td>
<td>0.60 ± 0.30</td>
</tr>
<tr>
<td>73</td>
<td>823</td>
<td>2018-04-03 14:06</td>
<td>mg/cm²</td>
<td>Final</td>
<td>Positive</td>
<td>3.80 ± 0.90</td>
<td>3.80 ± 0.90</td>
<td>&lt; LOD : 3.90</td>
</tr>
</tbody>
</table>
APPENDIX F

LIMITATIONS OF REPORT
ASBESTOS AND LEAD-BASED PAINT SURVEYS
LIMITATIONS OF REPORT

1. This report has been prepared on behalf of and for the exclusive use of the addressee, solely for use as an asbestos and lead-based paint survey of the site. If this report is provided to contractors, Client should make it clear that information is provided for data purposes only and not as a warranty of the asbestos conditions at the site. Unless other contractual agreements were made, the services described in this report were carried out in accordance with the Terms for Geotechnology’s Services that accompanied the proposal.

2. The surveys were performed in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area, and Geotechnology endeavored to conduct the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by other consultants under similar circumstances and conditions. The findings and conclusions stated herein must be considered not as scientific certainties, but rather as professional opinions concerning the significance of the limited data gathered during the course of the survey. Specifically, Geotechnology does not and cannot represent that the site contains no asbestos and lead-based paint beyond that observed by Geotechnology during its survey.

3. The observations described in this Report were made under the conditions stated therein. The conclusions presented in the Report were based solely upon the services described therein, and not on scientific tasks or procedure beyond the scope of described services or the time and budgetary constraints imposed by Client. Furthermore, such conclusions are based solely on site condition, and rules and regulations, which were in effect at the time of the study.

4. In the event that information is developed relative to asbestos or lead-based paint issues at the site and not contained in this report, such information shall be brought to Geotechnology’s attention. Geotechnology will evaluate such information and, on the basis of this evaluation, may modify the conclusions stated in this Report.

5. Observations were made of the site as indicated within the Report. Where access to portions of the site was unavailable or limited, Geotechnology renders no opinion as to the presence of potentially hidden asbestos and lead-based paint in that portion of the site. In addition, Geotechnology renders no opinion as to the presence of potentially hidden asbestos and lead-based paint where direct observation of the interior walls, floor, roof, or ceiling of a site was obstructed by objects or coverings on or over these surfaces. These inaccessible and unobserved areas should be further investigated prior to any renovation/demolition activity that may disturb them.

6. Since it is not always possible to acquire a large enough sample of adhesively applied suspect asbestos-containing material to adequately analyze the underlying mastic without seriously defacing the surface, prior to renovation/demolition in those indeterminate areas additional sampling should be accomplished.
7. Except as noted within the text of the Report, no quantitative laboratory testing was performed as part of the survey. Where such analyses have been conducted by an outside laboratory, Geotechnology has relied upon the data provided, and has not conducted an independent evaluation of the reliability of these data.

8. The purpose of the asbestos survey portion of this Report was to assess the physical characteristics of the subject site with respect to the presence on the building surfaces of asbestos as defined in 40 CFR Parts 761 and 763, and 29 CFR Part 1926. No specific attempt was made to check on the compliance of present or past owners or operators of the site with federal, state, or local laws and regulations, environmental or otherwise.

9. It is recommended that Geotechnology be retained to provide further asbestos consulting services during construction and/or implementation of any remedial measures recommended in this report. This is to allow Geotechnology to observe compliance with the concepts and recommendations contained herein, and to allow the development of design changes in the event that conditions differ from those anticipated.

10. This survey may address the identification requirements of the Communication of Hazards Duties of Building and Facility Owners – as described in OSHA 29 CFR 1296.1101(k) Asbestos (in construction) Standard, Practices and Procedures for removal, prior to demolition and disposal, should be in accordance with referenced regulations, the OSHA Asbestos in Construction Standard, and the EPA Interpretive Rule Governing Roof Removal (40 CFR Part 61, Appendix A to Subpart M).
LIMITED ASBESTOS AND LEAD-BASED PAINT SURVEYS
BLOWER BUILDING
O’FALLON WASTE WATER TREATMENT PLANT
O’FALLON, MISSOURI

Prepared for:
WOODARD & CURRAN
ST. CHARLES, MISSOURI

Prepared by:
GEOTECHNOLOGY, INC.
ST. LOUIS, MISSOURI

Date:
APRIL 16, 2018

Geotechnology Project No.:
J030160.01
April 16, 2018

Mr. Kevin White
Woodard & Curran
1520 South Fifth Street, Suite 306
St. Charles, Missouri 63303

Re: Limited Asbestos and Lead-Based Paint Surveys
Blower Building
O'Fallon Waste Water Treatment Plant
150 Firma Road
O'Fallon, Missouri
Geotechnology Project No. J030160.01

Dear Mr. White:

In accordance with our proposal P030160.01, dated March 6, 2018, Geotechnology, Inc. (Geotechnology) is pleased to provide this limited asbestos and lead-based paint (LBP) surveys report for the referenced project. Our scope of services included limited asbestos and LBP surveys, sampling of suspect asbestos-containing material (ACM), X-ray fluorescence (XRF) LBP screening, laboratory analysis of samples, and a letter report.

SITE AND PROJECT DESCRIPTION

The subject property consists of an approximately 19.8-acre waste water treatment plant located southeast of the intersection of Missouri Route 79 and Firma Road in O'Fallon Missouri. The extent of the asbestos and LBP surveys was limited to the Blower Building.

LIMITED ASBESTOS SURVEY

The objective of the limited asbestos survey was to identify potential ACM in suspect building materials located within the subject building. In general conformance with the National Emission Standards for Hazardous Air Pollutants (NESHAPs) and the Missouri Department of Natural Resources (MDNR) requirements, the survey was conducted on April 3, 2018, by Mr. Brad Lohrum, a Missouri-licensed asbestos inspector. Copies of Mr. Lohrum’s training certificate and asbestos inspector license are included in Appendix A.

Samples were collected in general conformance with the NESHAPs and MDNR requirements. The identified suspect ACMs were subdivided into homogeneous areas (an area of surfacing material, thermal system insulation material or miscellaneous material that is uniform in color
and texture). Samples were collected from each identified homogeneous area, consistent with industry practice.

Using standard chain-of-custody procedures, the suspect ACM samples were submitted to QuanTEM Laboratories of Oklahoma City, Oklahoma, a National Voluntary Laboratory Accreditation Program (NVLAP)-accredited laboratory, for identification by Polarized Light Microscopy (PLM) coupled with dispersion staining, according to the test method, “Method for Determination of Asbestos in Bulk Building Materials” (EPA/600/R-93/116). Separable layered samples were analyzed by layer. A copy of the asbestos survey summary is included in Appendix B and a floor plan sketch with room layout is included in Appendix F.

LIMITED ASBESTOS SURVEY RESULTS

Laboratory analyses of the submitted samples detected the presence of asbestos in the following materials in the building.

| TABLE 1  |
| ASBESTOS-CONTAINING MATERIALS SUMMARY |

<table>
<thead>
<tr>
<th>Blower Building</th>
<th>Estimated Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior Door / Window Caulk</td>
<td>50 LF</td>
</tr>
<tr>
<td>Exterior Window Glazing</td>
<td>10 LF</td>
</tr>
<tr>
<td>Exterior Seam Caulk</td>
<td>210 LF</td>
</tr>
</tbody>
</table>

LF = linear feet

Geotechnology will not be able to represent that the site contains no asbestos beyond that detected or observed by Geotechnology during the survey. Furthermore, the quantities listed in the asbestos survey summary sheets in Appendix B should be considered approximate only. For bidding purposes, we strongly recommend that contractors prepare abatement bids only after conducting a site reconnaissance. Copies of the asbestos laboratory analytical results are included in Appendix C.

LIMITED LEAD-BASED PAINT SURVEY

A limited LBP survey of painted surfaces was conducted at the subject building in general accordance with the HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing (HUD Guidelines) of June 1995 (updated July 2012). The limited LBP survey was performed by Mr. Brad Lohrum, a Missouri-licensed Lead Risk Assessor, on April 3, 2018. Copies of Mr. Lohrum’s training certificate and lead risk assessor license are included in Appendix A. The purpose of the limited LBP survey was to provide a professional opinion as to the potential extent of lead-based painted components, which may require future remedial action. A Niton XRF Spectrum Analyzer, Model XLp 702A, was used to identify the total lead
content of surface coatings (e.g., paints, varnishes, etc.) in units of milligrams of lead per square centimeter of surface area (mg/cm²).

Lead-based paint is generally defined as a surface coating containing greater than or equal to 1.0 mg/cm² lead. Total lead content should not be confused with Toxicity Characteristic Leaching Procedure (TCLP) lead content used to determine if lead is present at levels deemed as hazardous (5 ppm). Geotechnology is not aware of a definitive relationship between total lead content and TCLP lead content.

**LIMITED LEAD-BASED PAINT SURVEY RESULTS**

The survey included accessible areas of the subject building. A total of 20 XRF readings and six calibration readings were obtained during the survey. Of the 20 XRF readings, one was positive for lead-based paint and 19 were negative.

XRF results indicated the presence of LBP on the following surface and material:

- Green metal blower / piping.

The LBP XRF calibration and survey logs which contain the XRF screening locations and results collected during the survey are included in Appendix D. The XRF survey data sheets are included in Appendix E.

The Niton XRF Spectrum Analyzer 702 Series was calibrated against manufacturer-supplied standards at the beginning and end of the survey. Calibration data is also included in the attached field survey data sheets.

**ASBESTOS RECOMMENDATIONS**

Our recommendations are summarized below:

- The identified window glazing appears to be Friable ACM and should be removed by a licensed abatement contractor prior to demolition or renovation activities that may impact this material.

- The identified interior door / window caulk and exterior seam caulk appear to be Category II Non-Friable ACM and should be removed by a licensed abatement contractor prior to demolition or renovation activities that may impact these materials.

- For demolition and renovation projects which require the removal of friable and/or Category I Non-Friable and/or Category II Non-Friable ACM, NESHAPs and MDNR notifications are required.

- Third party clearance sampling and testing may be required.
• Geotechnology has performed third-party monitoring on similar projects and would be pleased to submit a proposal to conduct those services at your request.

LEAD-BASED PAINT RECOMMENDATIONS

The results of the XRF screening indicated the presence of LBP on one material and surface. The identified lead-based paint should be removed by a licensed abatement contractor prior to demolition or renovation activities that may impact this material. Geotechnology recommends that a licensed lead project designer specify removal requirements and that a licensed abatement contractor (using licensed abatement personnel) remove LBP or lead-based painted components as appropriate.

Lead removal regulations that are outlined in Missouri Revised Statutes, Chapter 701, Sections 701.300-701.338 and administered by the Missouri Department of Health and Senior Services (MDHSS), contain provisions for lead-abatement activities, including project notifications and clearance requirements.

* * * * *

The following attachments are included in and complete this report:

Appendix A       - Certificates and Licenses of Environmental Professional
Appendix B       - Asbestos Survey Summary
Appendix C       - Asbestos Laboratory Analytical Results
Appendix D       - XRF LBP Survey Logs
Appendix E       - XRF Survey Data Sheets
Appendix F       - Floor Plan Sketch
Appendix G       - Limitations of Report

* * * * *

We appreciate the opportunity to be of service to Woodard & Curran. If you have any questions or comments, please contact me at (314) 997-7440.

Very truly yours,

GEOTECHNOLOGY, INC.

Bradley J. Lohrum
Senior Scientist

BJL/DTK:bjl
APPENDIX A

CERTIFICATES AND LICENSES OF ENVIRONMENTAL PROFESSIONAL
Does hereby certify

Bradley Lohrum
11816 Lackland Road, St. Louis, MO 63146

Has successfully completed and passed the course examination with at least 70% for re-accreditation under AHERA (Title II)

Asbestos Building Inspector Refresher

Class Date: January 05, 2018
Examination Date: 01/05/2018
STC Certificate Number: STC-01052018-002017ABIR
Certification Expiration: 01/05/2019

David M. Mendoza – President/Training Director
Certified Environmental Specialist
OSHA Authorized Instructor

This training course is accredited by the Illinois Department of Public Health and the Missouri Department of Natural Resources
January 22, 2018

Bradley J. Lohrum
817 S Sappington Rd
Crestwood, MO 63126

RE: Missouri Asbestos Occupation Certification Card

Enclosed is your certification card for Asbestos Inspector, as issued by the Asbestos Unit of the Missouri Department of Natural Resources’ Air Pollution Control Program.

Missouri Certification Number: 7118010518MOIR15873
Course Training Date: January 05, 2018
Missouri Certification Approval Date: January 22, 2018
Missouri Certification Expiration Date: January 22, 2019

Note:
- All Missouri-certified asbestos personnel must comply with the following statutes and regulations:
  - Sections 643.225 to 643.225, RSMo;
  - 10 CSR 10-6.241 Asbestos Projects-Registration, Abatement, Notification, Inspection, Demolition, and Performance Requirements; and
  - 10 CSR 10-6.250 Asbestos Projects-Certification, Accreditation and Business Exemption Requirements.
- To keep your occupation certification up-to-date, you must complete an annual refresher course and submit a renewal application each year.
- In order to be eligible to renew your certification, you must successfully complete a refresher course with a Missouri-accredited training provider within 12 months of the expiration date of your current training certificate. If you exceed this grace period, you will be required to retake a Missouri-accredited initial course in order to be eligible for Missouri certification.

To obtain a copy of the certification renewal application, or review regulations and requirements, please visit our website at http://dnr.mo.gov/env/apcp/asbestos/index.htm.

If you have any questions please call the Air Pollution Control Program at 573-751-4817.

AIR POLLUTION CONTROL PROGRAM

Kyre L. Moore
Director of Air Pollution Control Program
College for Public Health & Social Justice
Saint Louis University
Center for Environmental Education and Training

verifies that

Bradley Lohrum
817 S. Sappington Rd; St. Louis, MO 63126

has attended 8 contact hours of training and successfully passed an examination

Lead Risk Assessor Refresher
St. Louis, MO

Certificate # CEET 325 - 9/19/2016 - 116967
Examination Date: 9/19/2016
CEUs: 0.8

Certificate expiration is 3 years from examination date for Illinois Dept. of Public Health
Center for Environmental Education and Training, 3545 Lafayette, St. Louis, MO 63104
(314) 977-8256  slu.edu/x39753.xml
This training course has been accredited by the Illinois Department of Public Health, and by the Missouri Department of Health & Senior Services.
LEAD OCCUPATION LICENSE REGISTRATION

Issued to:

Bradley J. Lohrum

The person, firm or corporation whose name appears on this certificate has fulfilled the requirements for licensure as set forth in the Missouri Revised Statutes 701.300-701.338, as long as not suspended or revoked, and is hereby authorized to engage in the activity listed below.

Lead Risk Assessor
Category of License

Issuance Date: 11/19/2016
Expiration Date: 11/19/2018
License Number: 121119-300004110

Peter Lyskowski
Director
Department of Health and Senior Services

Lead Licensing Program, PO Box 570, Jefferson City, MO 65102
APPENDIX B

ASBESTOS SURVEY SUMMARY
**Geotechnology, Inc. Project No.: J030160.01**

**Project Name:** O'Fallon WWTP  
**Type of Structure:** Single-story Sheet Metal and Concrete Block Blower Building

---

### Homogeneous Area

<table>
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<tr>
<th>Number/Location</th>
<th>Type of Material</th>
<th>Quantity</th>
<th>Sample I.D.</th>
<th>Location of Sampled Material/Substrate</th>
<th>Friability</th>
<th>Asbestos</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 / Room 3</td>
<td>Cork Board Wall Adhesive</td>
<td>NQ</td>
<td>1A</td>
<td>Room 3 / Concrete Block</td>
<td>NF II</td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1B</td>
<td>Room 3 / Concrete Block</td>
<td>NF II</td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1C</td>
<td>Room 3 / Concrete Block</td>
<td>NF II</td>
<td>ND</td>
</tr>
<tr>
<td>#2 / Rooms 2 and 4</td>
<td>Interior Door / Window Caulk</td>
<td>50 LF</td>
<td>2A</td>
<td>Room 4 Window / Metal</td>
<td>NF II</td>
<td>CH 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2B</td>
<td>Room 4 Door / Metal</td>
<td>NF II</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2C</td>
<td>Room 2 Window / Metal</td>
<td>NF II</td>
<td>NA</td>
</tr>
<tr>
<td>#3 / Exterior at Room 4 Window</td>
<td>Window Glazing</td>
<td>10 LF</td>
<td>3A</td>
<td>Exterior / Metal</td>
<td>F</td>
<td>CH 6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3B</td>
<td>Exterior / Metal</td>
<td>F</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3C</td>
<td>Exterior / Metal</td>
<td>F</td>
<td>NA</td>
</tr>
<tr>
<td>#4 / Exterior at Wall Seams and Penetrations</td>
<td>Seam Caulk</td>
<td>210 LF</td>
<td>4A</td>
<td>Exterior / Metal</td>
<td>NF II</td>
<td>CH 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4B</td>
<td>Exterior / Metal</td>
<td>NF II</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4C</td>
<td>Exterior / Metal</td>
<td>NF II</td>
<td>NA</td>
</tr>
</tbody>
</table>

Highlighted items were found to contain asbestos.

- LF=Linear Feet
- NF=Non-Friable
- CH=Chrysotile
- PACM=Presumed Asbestos Containing Material
- ND=Non-Detect
- SF=Square Feet
- F=Friable
- AM=Amosite
- PTC=Point Count
- NA=Not Analyzed per stop 1st positive
- NQ=Not Quantified
- CR=Crocidolite
### Polarized Light Microscopy Asbestos Analysis Report

**QuanTEM Lab No.** 292702  
**Account Number:** C039  
**Date Received:** 04/04/2018  
**Received By:** Jeff Mlekush  
**Date Analyzed:** 04/11/2018  
**Analyzed By:** Cassie Sanborn  
**Methodology:** EPA/600/R-93/116

**Client:** Geotechnology, Inc.  
11816 Lackland Rd., STE 150  
St. Louis, MO 63146

**Project:** O'Fallon WWTP - Blower Bldg.  
**Project Location:** O'Fallon Missouri  
**Project Number:** J030160.01

<table>
<thead>
<tr>
<th>QuanTEM Sample ID</th>
<th>Client Sample ID</th>
<th>Composition</th>
<th>Color / Description</th>
<th>Asbestos (%)</th>
<th>Non-Asbestos Fiber (%)</th>
<th>Non Fibrous</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>1A</td>
<td>Homogeneous</td>
<td>Tan Adhesive</td>
<td>Asbestos Not Present</td>
<td>NA</td>
<td>Glue</td>
</tr>
<tr>
<td>002</td>
<td>1B</td>
<td>Homogeneous</td>
<td>Tan Adhesive</td>
<td>Asbestos Not Present</td>
<td>NA</td>
<td>Glue</td>
</tr>
<tr>
<td>003</td>
<td>1C</td>
<td>Homogeneous</td>
<td>Tan Adhesive</td>
<td>Asbestos Not Present</td>
<td>NA</td>
<td>Glue</td>
</tr>
<tr>
<td>004</td>
<td>2A</td>
<td>Homogeneous</td>
<td>White Caulk</td>
<td>Asbestos Present Chrysotile</td>
<td>3</td>
<td>CaCO3</td>
</tr>
<tr>
<td>005</td>
<td>2B</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>Not Analyzed</td>
<td></td>
</tr>
<tr>
<td>Positive Stop</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>006</td>
<td>2C</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>Not Analyzed</td>
<td></td>
</tr>
</tbody>
</table>

**Positive Stop**

| 007               | 3A               | Homogeneous | Gray Window Glazing | Asbestos Present Chrysotile | 6 | CaCO3 Binder |

Unless otherwise noted, upon receipt the condition of the sample was acceptable for analysis.

QuanTEM is a NVLAP accredited PLM laboratory (Lab Code: 101959-0). This report relates only to the specific items tested. NVLAP accreditation applies only to analysis performed utilizing EPA/600/M4-82-020 and EPA/600/R-93/116 methods. This report may not be used to claim product endorsement by NVLAP or any agency of the US Government. This report may not be reproduced except in full, without the written approval of the laboratory.

Page 1 of 2
Polarized Light Microscopy Asbestos Analysis Report

QuanTEM Lab No. 292702
Account Number: C039
Date Received: 04/04/2018
Received By: Jeff Mlekush
Date Analyzed: 04/11/2018
Analyzed By: Cassie Sanborn
Methodology: EPA/600/R-93/116

Client: Geotechnology, Inc.
11816 Lackland Rd., STE 150
St. Louis, MO 63146

Project: O'Fallon WWTP - Blower Bldg.
Project Location: O'Fallon Missouri
Project Number: J030160.01

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Date of Report 4/11/2018
Cassie Sanborn, Analyst

Unless otherwise noted, upon receipt the condition of the sample was acceptable for analysis.

QuanTEM is a NVLAP accredited PLM laboratory (Lab Code: 101959-0). This report relates only to the specific items tested. NVLAP accreditation applies only to analysis performed utilizing EPA/600/M4-82-020 and EPA/600/R-93/116 methods. This report may not be used to claim product endorsement by NVLAP or any agency of the US Government. This report may not be reproduced except in full, without the written approval of the laboratory.
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## ASBESTOS CHAIN OF CUSTODY

2033 Heritage Park Drive, Oklahoma City, OK 73120-7502  
(800) 822-1650 • (405) 755-7272 • Fax: (405) 755-2058

**LEGAL DOCUMENT - PLEASE PRINT LEGIBLY**

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**SATURDAY FEDEX SAMPLE DELIVERY - CALL TO SCHEDULE**  •  Use this address for Saturday Delivery only: 4220 N. Santa Fe Ave., Oklahoma City, OK 73105-8517  •  Mark Package "Hold for Saturday Pickup"  
Please Note - UPS and USPS are **NOT** available for Saturday Delivery
APPENDIX D

XRF LBP SURVEY LOGS
# GEOTECHNOLOGY INC.
## LEAD-BASED PAINT XRF CALIBRATION LOG

Project No.: J030160.01  
Surveyed By: Brad Lohrum  
Address: O’Fallon Wastewater Treatment Plant  
Blower Building  
150 Firma Road, O’Fallon, Missouri  
Survey Date: April 3, 2018  
XRF Serial No.: XLp 702A TR0944-24561

### START OF SURVEY

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Comments/Note:

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GEOTECHNOLOGY INC.
LEAD-BASED PAINT XRF SURVEY LOG

Project No.: J030160.01
Address: O’Fallon Wastewater Treatment Plant
        Blower Building
        150 Firma Road, O’Fallon, Missouri
Survey Date: April 3, 2018
Surveyed By: Brad Lohrum
XRF Serial No.: XLP 702A TR0944-24561

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APPENDIX E

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APPENDIX G

LIMITATIONS OF REPORT
1. This report has been prepared on behalf of and for the exclusive use of the addressee, solely for use as an asbestos and lead-based paint survey of the site. If this report is provided to contractors, Client should make it clear that information is provided for data purposes only and not as a warranty of the asbestos conditions at the site. Unless other contractual agreements were made, the services described in this report were carried out in accordance with the Terms for Geotechnology's Services that accompanied the proposal.

2. The surveys were performed in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area, and Geotechnology endeavored to conduct the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by other consultants under similar circumstances and conditions. The findings and conclusions stated herein must be considered not as scientific certainties, but rather as professional opinions concerning the significance of the limited data gathered during the course of the survey. Specifically, Geotechnology does not and cannot represent that the site contains no asbestos and lead-based paint beyond that observed by Geotechnology during its survey.

3. The observations described in this Report were made under the conditions stated therein. The conclusions presented in the Report were based solely upon the services described therein, and not on scientific tasks or procedure beyond the scope of described services or the time and budgetary constraints imposed by Client. Furthermore, such conclusions are based solely on site condition, and rules and regulations, which were in effect at the time of the study.

4. In the event that information is developed relative to asbestos or lead-based paint issues at the site and not contained in this report, such information shall be brought to Geotechnology's attention. Geotechnology will evaluate such information and, on the basis of this evaluation, may modify the conclusions stated in this Report.

5. Observations were made of the site as indicated within the Report. Where access to portions of the site was unavailable or limited, Geotechnology renders no opinion as to the presence of potentially hidden asbestos and lead-based paint in that portion of the site. In addition, Geotechnology renders no opinion as to the presence of potentially hidden asbestos and lead-based paint where direct observation of the interior walls, floor, roof, or ceiling of a site was obstructed by objects or coverings on or over these surfaces. These inaccessible and unobserved areas should be further investigated prior to any renovation/demolition activity that may disturb them.

6. Since it is not always possible to acquire a large enough sample of adhesively applied suspect asbestos-containing material to adequately analyze the underlying mastic without seriously defacing the surface, prior to renovation/demolition in those indeterminate areas additional sampling should be accomplished.
7. Except as noted within the text of the Report, no quantitative laboratory testing was performed as part of the survey. Where such analyses have been conducted by an outside laboratory, Geotechnology has relied upon the data provided, and has not conducted an independent evaluation of the reliability of these data.

8. The purpose of the asbestos survey portion of this Report was to assess the physical characteristics of the subject site with respect to the presence on the building surfaces of asbestos as defined in 40 CFR Parts 761 and 763, and 29 CFR Part 1926. No specific attempt was made to check on the compliance of present or past owners or operators of the site with federal, state, or local laws and regulations, environmental or otherwise.

9. It is recommended that Geotechnology be retained to provide further asbestos consulting services during construction and/or implementation of any remedial measures recommended in this report. This is to allow Geotechnology to observe compliance with the concepts and recommendations contained herein, and to allow the development of design changes in the event that conditions differ from those anticipated.

10. This survey may address the identification requirements of the Communication of Hazards Duties of Building and Facility Owners – as described in OSHA 29 CFR 1296.1101(k) Asbestos (in construction) Standard, Practices and Procedures for removal, prior to demolition and disposal, should be in accordance with referenced regulations, the OSHA Asbestos in Construction Standard, and the EPA Interpretive Rule Governing Roof Removal (40 CFR Part 61, Appendix A to Subpart M).