Delaware County Regional Sewer District

Sanitary Sewer Master Plan

Technical Memorandum #3 – Existing Service Area, Infrastructure Condition/Capacity, Rehabilitation Alternatives, and Operations Summary

January 25, 2017

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1.0 Executive Summary

HDR was tasked with developing a Sanitary Sewer Master Plan for the Delaware County Regional Sewer District (DCRSD). This Master Plan was to collect and analyze available data, perform a condition and capacity assessment of existing infrastructure, develop recommendations for future growth, and assess rate structure. As a part of the Master Plan, five Technical Memoranda were to be completed focusing on individual elements of the final plan. Technical Memorandum #3 is the conclusion of extensive discussions with District staff, investigations and analysis of assets, data collection, and data review. The goal of this analysis was to determine the condition of existing assets and their ability to properly convey and treat the existing sewage load to the level of service that DCRSD expects. This includes meeting code and permit requirements, proper system redundancy, safety, and security. The problems identified as part of this investigation can be classified as either condition or capacity related, with both categories having long term areas of concern and acute problems which will require immediate solutions. This memorandum focuses on three critical parts of the system: the collection system, pumping stations, and the treatment facilities. A complete collection of the major conclusions of this memorandum can be found in Findings – Section 6.0.

Both the Alum Creek Water Reclamation Facility (ACWRF) and the Olentangy Environmental Control Center (OECC) were evaluated to consider their condition and capacity. There are a number of maintenance, electrical, instrumentation and control, and preliminary treatment processes that could be optimized to better treat the wastewater flow. These areas are further discussed in Section 4 of the Technical Memorandum. Major findings with regard to the treatment plants are as follows:

1.1 Olentangy Environmental Control Center (OECC)

This plant has two distinct treatment trains; OECC South and OECC North. They share the influent pumping, tertiary treatment, UV disinfection, post-aeration, and solids handling processes. Currently, OECC South and the processes shared with OECC North treat all of the flow to OECC. Key findings from this technical memorandum include:

- OECC does not utilize the screening and grit removal processes for preliminary treatment. Instead of screening, OECC uses raw sewage grinding to shred debris so that it can pass through downstream equipment and processes. OECC also does not have a grit removal process to capture grit particles such as sand and gravel. By not removing debris and grit, it accumulates in downstream process tanks and equipment, decreasing performance and reliability. During regularly scheduled maintenance of the dewatering centrifuge, the technician noted significant debris buildup in the equipment. Centrifuges are sensitive to the intrusion of foreign debris and its accumulation may result in damaging vibration and even failure.

- The grinder room in the Control Building, which is located directly above the raw sewage wet well, is prone to flooding during wet weather flows. This is likely the result of capacity limitations in the raw sewage pumping process. This flooding allows material that would otherwise be shredded by the grinders to exit the channels and circumvent the grinders. Material that is not shredded by the grinders can enter the raw sewage pumps and may result in accelerated wear and premature failure.

- The tertiary filters operate with high headloss during high flow events. This causes the filters to backwash continuously until the high flows subside. This sustained backwashing results in excessive media loss, higher energy consumption, and recycle flows that consume available hydraulic and treatment capacity. This high headloss results in a portion of filter influent being bypassed around the tertiary filtration process before being recombined with filter effluent. The OEPA recently granted the District approval to use this bypass provided that effluent limits are met, sampling is done during the bypass to demonstrate this, and the bypass is to ensure efficient operation.

- The collection system model predicts peak plant inflows resulting from 5-year, 10-year, and 25-year design storms would exceed OECC's maximum hydraulic capacity.

- District staff has stated that sidestream flow management from the solids handling and disposal processes has been problematic. These flows contribute high levels of nutrients (ammonia and phosphorus) to the head of OECC. These nutrients can affect aeration demands and effluent quality depending upon when they are returned. They also contribute to increased ferric chloride consumption which in turn produces more chemical sludge that increases solids loading rates on clarifiers and biosolids processing units. Future regulations targeting reduced effluent nutrient concentrations are anticipated and management of these flows is important.

- During a desktop evaluation of unit process treatment capacities, it was found that OECC has insufficient treatment capacity to treat inflows resulting from the 25-year design storm under current observed peak pollutant loading. A dynamic process model is recommended for further evaluation.

- RAS VFDs have reached the end of their useful service life along with numerous digester, sludge blower, and aeration blower soft starters.

- The District has initiated facility planning activities to restore OECC North to service. Equipment unique to OECC North has reached the end of their useful lives and requires replacement. This includes the following large equipment: aeration blowers and diffusers, final clarifier collection mechanisms, waste activated sludge (WAS) and return activated sludge (RAS) pumps.

1.2 Alum Creek Water Reclamation Facility (ACWRF)

While ACWRF does not suffer from condition problems to the extent OECC does, it does have a number of maintenance issues which deserve continued monitoring. These issues include:

- Grit accumulates in the aeration basins. According to District staff, grit accumulation is caused by recycle flows from the tertiary filtration process and not from the collection system. It is believed that when the tertiary filters backwash, some filter media is lost and recycled to the head of the plant.

- The tertiary filters are known to suffer from operational problems resulting from continuous backwashing. The filters start their backwash cycle due to the high headlosses created during high flows. This continues for the duration of the high flow event. Sustained backwashing results in increased energy consumption, accelerated media loss, and generation of recycle flows that use available hydraulic and treatment capacity. High flows also result in bypasses around the tertiary filters. The OEPA recently granted the District approval to use this bypass provided that the District monitors the bypass and effluent limits are met during bypassing.

- ACWRF removed the anoxic zone mixers from their aeration tanks amid reliability troubles and the lack of manufacturer support due to equipment obsolescence. The District is currently investigating replacement mixer technologies. Valves installed on the air diffuser drop legs have failed in some locations, limiting the District's ability to control airflow throughout the aeration tank. The District plans to replace the valves and diffusers as part of a near-term CIP.

- Tertiary filter 1 is out of service and is used as a source of spare parts. This results in reduced treatment capacity.

- ACWRF does not aerobically digest sludge due to odor complaints. By not digesting sludge, the District does not benefit from a reduction in sludge volumes. This results in increased hauling and disposal fees.

- It is also recommended that ACWRF review and replace a large number of the VFDs and soft starters on the pumps and blowers as well as conduct an arc flash analysis on the distribution equipment.

- ACWRF has remaining hydraulic capacity to receive flows predicted during a 25-year design storm. However, the plant may become biologically limited due to the pollutant strength of the wastewater entering the facility being greater than what was originally anticipated. This trend will need to be monitored going forward as additional flow is added in the future.

- Treatment capacities extracted from a desktop evaluation show that ACWRF is not capable of treating flows corresponding to a 25-year design storm under peak pollutant loading. Treatment capacity is limited by the aeration process. It should be noted that observed peak influent $CBOD_5$ concentrations were used in this evaluation and are approximately 25% higher than the design assumptions. District staff does not monitor influent Total Kjeldahl Nitrogen (TKN) concentrations and a representative value was assumed to complete the analysis. A dynamic process model is recommended for further evaluation.

- Duct heater DH1-PR, located in the odor control room in the Pre-Treatment Building, is installed within a classified buffer zone surrounding the odor control scrubber. This will require replacing DH1-PR with an explosion proof unit or reconfiguring the duct work in the room to move it outside of this buffer zone.

1.3 Pump Stations

In addition to the treatment facilities, DCRSD owns and maintains a number of sewage pumping stations and force mains which represent an integral part of the collection system. These pump stations are necessary to keep the gravity sewer system operating without backups and moving the sewage towards its eventual treatment at the water reclamation facilities. The nine pump stations evaluated as part of this project were all in fairly good condition with only minor electrical, safety, or code based upgrades recommended at this time, with the exception of three pump stations. These three pump stations – Leatherlips, Cheshire, and Peachblow – are all identified as having flow restrictions under existing conditions. In addition to minor maintenance improvements recommended at all 9 pump stations, these locations are recommended for upsizing or a reduction in influent flow. Pump station improvements will be further discussed in Technical Memorandum #4. The evaluation of the pump stations is further discussed in Section 4 of this memorandum. Primary findings related to the condition or existing capacity of the pump stations includes:

- National Electrical Code (NEC) requirements – Alum Creek, Leatherlips, Maxtown. This is related to the National Fire Protection Association (NFPA) requirements stating that a minimum of 6 air changes per hour is necessary to mitigate hazardous location.
- Corroded discharge and valve piping – Cheshire and East Alum Creek.
- Wet well lacks fall protection – Cheshire, Scioto Reserve, Peachblow.
- Vandalism or animal infestations – Scioto Reserve and Golf Village.
- Significant oil and grease buildup – East Alum Creek.
- No gutters on station exterior – Cheshire, Golf Village, Vinmar, East Alum Creek.

1.4 Collection System

The sanitary sewer collection system was the final element evaluated. The collection system was modeled utilizing County provided GIS and flow data collected specifically for this project with monitoring device locations selected in part to maximize their value to the modeling effort. This data allowed for the sewer system hydraulic model already being developed, to be calibrated to match the conditions and configuration appearing in the existing sewers. Once calibrated, this model allows for various condition scenarios to be run reflecting system deterioration, growth, and capacity to handle a range of rainfall events. The details of this evaluation are discussed in Section 5 of this memorandum. The outcome of this effort was to identify sections that are either under capacity, in disrepair, or both.

In the case of both the OECC and ACWRF collection systems, there are multiple segments where the hydraulic model indicated inadequate sewer capacity in storms larger than a 5 Year Design Storm under current conditions. Although this does not signify that the sewers cannot handle existing dry weather flow or some quantity of wet weather flow, it does identify which areas will become more problematic as additional dry weather flow is added to the system and the system deteriorates as it ages. It also identifies the areas which would be anticipated to show significant surcharge during high peak flows. The following are areas which already show some capacity constraints under various wet weather scenarios run on the calibrated hydraulic model:

- Along portions of the 8” sewer which is part of the Indian Run Interceptor East on Old 3C Highway.
- Along the 30” Alum Creek Interceptor upstream of the influent pump station to the northwest.
- Along portions of the 18” Villages of Oak Creek Trunk sewer north of Orange Road upstream of the Alum Creek Interceptor.
- The 10” Huffman Sanitary Trunk line downstream of the Quail Meadows Pump Station Forcemain.
- The 24” Wedgewood Section 2 Offsite Sewer line upstream of the Leather Lips Pump Station.
- The 18” Leatherlips Development Sanitary Sewer line at the Leather Lips Forcemain outlet to the downstream end of Jewett Road.
- The 15” Cardinal Hill and Retreat Sanitary Sewers downstream of the Sherborne Mews Pump Station Forcemain.
- Upstream of the Perry Taggart Part 2 and Wingate Farms Sewers on S.R. 315 where a 15-inch line downsizes to 8-inch line all the way upstream to Liberty Road.
- The 10” Woodland Hall Sewer that runs along Woodland Hall Drive.

2.0 Introduction and Overview

Delaware County Regional Sewer District (DCRSD) commissioned a Sanitary Sewer Master Plan to characterize and evaluate the existing sanitary sewer system and future requirements to fit their growing community. Previous Technical Memoranda as part of this project have focused on collecting and summarizing available data (Technical Memorandum #1) and developing the criteria upon which future decisions for the system could be based (Technical Memorandum #2). This document intends to identify and evaluate the condition and capacity of the existing sanitary sewer collection system, major wastewater pumping stations, and two major wastewater treatment facilities. The focus of this memorandum will be on the system as it exists at the time of publication, although projects currently under design or construction will also be considered. The impact of future growth on all aspects of the system and the implications upon the sewer system and treatment works will be further discussed in Technical Memorandum #4.

3.0 Service Areas

3.1 Land Use

The analysis of existing service areas across the system included an initial evaluation of the types of land use present. To analyze the existing system, parcel data from Delaware County was utilized to characterize the type of land use.

A summary of the parcels was developed for each of the water reclamation facility service areas. The total number of residential, commercial, and industrial parcels (as well as the overall %) are shown in Table 1 for each of the water reclamation basins. Remaining parcels (all others besides residential, industrial, and commercial) are shown as "other".

Table 1 – Parcel Land Use Breakdown by Service Area

Treatment Plant	Residential		Commercial		Industrial		Other	
	Number of Parcels	%	Number of Parcels	%	Number of Parcels	%	Number of Parcels	%
ACWRF	16590	98.10%	182	1.08%	16	0.09%	123	0.73%
Bent Tree	11	84.62%	1	7.69%	0	0.00%	1	7.69%
Hoover Woods	77	98.72%	0	0.00%	0	0.00%	1	1.28%
Northstar	67	97.10%	1	1.45%	0	0.00%	1	1.45%
OECC	10938	91.17%	822	6.85%	102	0.85%	136	1.13%
Scioto Hills	118	99.16%	0	0.00%	0	0.00%	1	0.84%
Scioto Reserve	1735	99.37%	10	0.57%	0	0.00%	1	0.06%
Tartan Fields	582	98.15%	8	1.35%	0	0.00%	3	0.51%

3.2 Population

The population served by Delaware County has steadily increased since the 2010 Census. Approximately 85% of residents are in townships, and approximately 60% of the total County population is served by DCRSD. Over the last 20 years commercial development occurred along major transportation routes (US 23, SR 315, I-71, and Sawmill Parkway) and recreational facilities (Alum Creek, Hoover Reservoir, and Olentangy River) within the county and new suburban residential developments drove the population growth. The suburban growth has developed along major thoroughfares or has widened existing roads and has been moving north into agricultural land. Between the 2010 Census and July 2015, the total Delaware County population has increased from approximately 174,000 to 193,000 which represents an 11% increase. Approximately half of Delaware County's population is located within areas currently served by DCRSD. See Table 2 for a breakdown of Delaware County population by township and incorporated area as estimated by the Delaware County Regional Planning Commission (DCRPC).

Table 2 - Delaware County Population - Delaware County Population (based on DCRPC Estimates)		
Area	**Census 2010**	**July 2015**
Berkshire Township	2,428	2,853
Berlin Township	6,496	7,175
Concord Township	9,294	10,604
Genoa Township	23,090	25,242
Kingston Township	2,156	2,255
Liberty Township	14,581	16,308
Orange Township	23,762	27,104
Columbus (in Delaware County)	7,245	9,667
Delaware	34,753	37,800
Galena	653	768
Sunbury	4,389	5,057
Powell	11,500	12,975
Westerville (in Delaware County)	7,792	8,444
Total Incorporated Areas:	**73,004**	**81,690**
Total County:	**174,214**	**193,421**

To determine projected population growth, the quantity and location of planned residential and commercial developments, and the total number of occupants need to be taken into account. This is determined by considering past development and planning documents from sanitary sewer stakeholders. Each township and city within the county has a unique growth rate and varying amounts of remaining space for development. This growth rate is determined by consideration of four factors: existing development, outstanding building permits, availability of developable land, and proximity of existing and planned thoroughfare corridors. Table 3 provides ultimate build out population projections for townships and incorporated areas currently served by DCRSD, as provided by the Delaware County Regional Planning Commission. These projections are based on combining two different estimating techniques; the “Step-Down Method” and “Housing Unit Method”. The “Step-Down Method” uses known population numbers and growth rates at a local and regional level while the “Housing Unit Method” incorporates data from building permits. The combination of applying these two techniques has yielded accuracy within 3% of Census determined counts since the previous iteration of the Sanitary Sewer Master Plan.

Table 3 - Projected Delaware County Populations - Selected Delaware County Populations and Projected Build Out (as of 2015)*			
Area	**2010**	**2015**	**Ultimate**
Berkshire Township	2,428	2,853	17,113
Berlin Township	6,496	7,175	23,537
Concord Township	9,294	10,301	31,298
Genoa Township	23,090	25,242	28,454
Liberty Township	14,581	16,308	29,900
Orange Township	23,762	27,104	37,038
Columbus**	7,245	9,667	12,974
Powell**	11,500	12,975	13,500
Westerville**	7,792	8,444	9,633
Estimated Total	**105,188**	**120,069**	**203,447**

*Per "Demographic Information – Delaware County, Ohio. October, 2013" Prepared by DCRPC and based on current Comprehensive Plans.

**Population of areas of municipality within Delaware County only; does not account for potential future annexation.

3.3 Wastewater Flows

Utilizing the available land use and parcel data, estimates of Average Dry Weather Flow (ADF) were developed for each of the facilities, as shown in Table 4. Note that these flows were based on the estimated land use and population; updated flows based on the results of flow monitoring and modeling are included in Section 5.

Table 4 - Average Dry Weather Flow and Capacity – (Land Use Estimates)			
Facility	**ADF Design (MGD)**	**ADF Actual (MGD)**	**% Remaining of ADF**
ACWRF	10	5.3	47%
OECC (north and south)	6.0	3.4	43%
Bent Tree	0.01	0.005	50%
Hoover Woods	0.025	0.011	56%
Northstar	0.4	0.057	86%
Scioto Hills	0.084	0.08	5%
Scioto Reserve	0.4233	0.286	32%
Tartan Fields	0.25	0.134	46%
Total	**18.7**	**9.9**	**47%**

Wet weather flows will be examined as part of the Section 5 analysis in evaluating flows across the service area.

4.0 Condition and Capacity Assessment of Existing Infrastructure

For this evaluation, two District owned treatment plants were reviewed: the Olentangy Environmental Control Center (OECC) and the Alum Creek Water Reclamation Facility (ACWRF). OECC was further broken down for this review into OECC North (original plant) and OECC South which was brought online in 1994. Nine pumping stations and the sewer collection system upstream of the two wastewater facilities being evaluated have also been assessed.

The condition assessment was performed through visual observation of District owned assets to identify needs for replacement or rehabilitation based on their estimated remaining useful life. This effort was supported through maintenance records and interviews with District staff. Treatment capacity determination was performed through a desktop evaluation of available data. A more detailed process evaluation utilizing dynamic computer modeling was beyond the scope of this assessment. It is recommended that this type of analysis be performed during more detailed facility planning efforts.

Discussions regarding unit process treatment capacity will reference Ten States Standards (10SS) where applicable. It should be noted that 10SS is intended to be used as design criteria for the preparation of plans and specifications of new wastewater facilities and that the strict adherence to those standards by operating facilities is not required. For the purposes of this document, 10SS will be used as a treatment capacity baseline for which to make comparisons against.

4.1 Olentangy Environmental Control Center

OECC consists of a north plant and a south plant. OECC North was commissioned in 1979 and was designed for an average flow of 1.5 MGD and a peak flow of 4.5 MGD. OECC South was commissioned in 1994 and was designed for an average flow of 4.5 MGD and a peak flow of 13.5 MGD. OECC North was taken offline with the completion of OECC South in 1994.

Treatment processes employed by OECC include raw sewage grinding and pumping, activated sludge aeration, final clarification, tertiary filtration, UV disinfection, post-aeration, aerobic digestion, and sludge thickening and dewatering. The tertiary filtration, UV disinfection, post-aeration, aerobic digestion, sludge thickening and dewatering processes are shared between OECC North and South.

4.1.1 Wastewater Characteristics, Flows, and Pollutant Loads

This characterization is based on the review of historical information listed below. Table 5 summarizes pertinent data obtained during this review.

- OECC North Operation and Maintenance Manual (1979)
- OECC South Preliminary Design Report (1994)
- OEPA reporting forms for OECC South from April 1, 2013 through March 31, 2015.
- OECC South operating data from September 15, 2006 through December 28, 2014.
- USEPA Enforcement and Compliance History Online (ECHO) facility report.

Table 5 - OECC Operating Data Summary

Parameter	Influent		Effluent		Units
	Design Criteria	**Current Conditions**	**NPDES Limit (Monthly)**	**Current Conditions**	
Average Flow	1.5 (NP)	-	-	-	MGD
	4.5 (SP)	3.4	-	-	
Peak Flow	4.5 (NP)	-	-	-	MGD
	13.5 (SP)	14.4[1]	-	-	
Dissolved Oxygen	-	-	(winter) (summer)	7.38 avg 4.2 min	mg/L
Total Suspended Solids	200 (NP)	140.4 avg 760.0 peak	12	1.46 avg 76.0 peak	mg/L
Ammonia-Nitrogen	15 (NP)	-	1.28 (winter) 0.78 (summer)	0.28 avg 4.08 peak	mg/L
Nitrite + Nitrate	-	-	4.58	4.09 avg 15.2 peak	mg/L
Phosphorus	20 (NP)	-	1.0	0.76 avg 3.32 peak	mg/L
E. Coli	-	-	126	23.9 avg 510 peak	#/100 mL
5-day Carbonaceous Biochemical Oxygen Demand	200 (NP)	-	-	-	mg/L
	167(SP)	84.3 avg 267.0 peak	8.5	1.81 avg 6.56 peak	

[1]June 23, 2016 wet weather event
SP = South Plant
NP = North Plant (not in service)
"-" =Not monitored/available

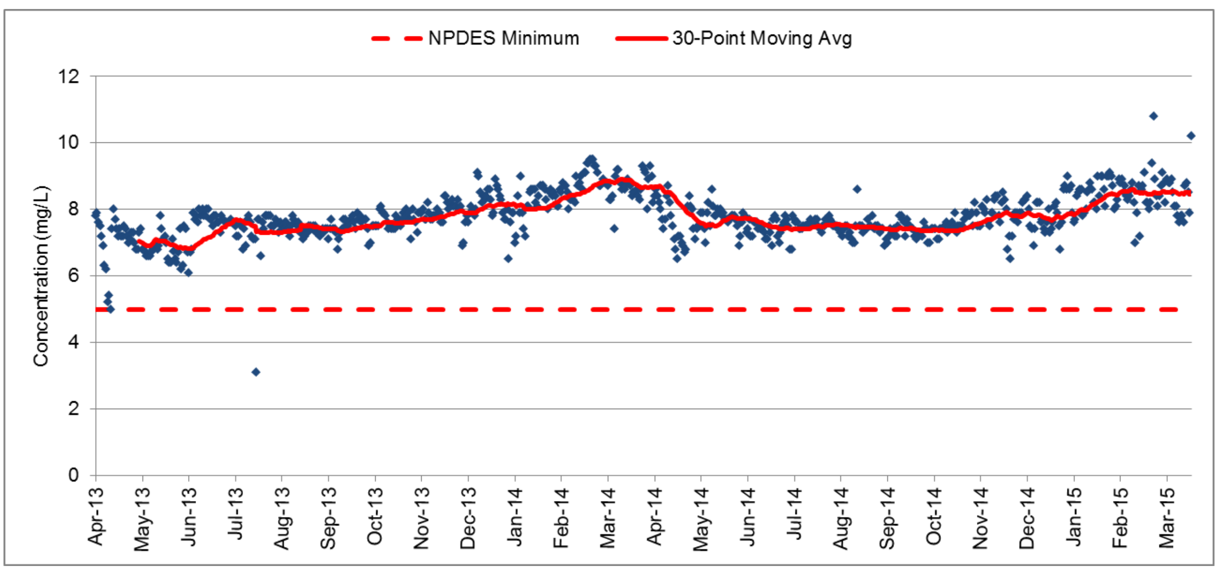
Key findings from are summarized as follows:

- As of March 31, 2016, OECC is not in significant non-compliance (SNC) or reportable non-compliance (RNC) with NDPES permit limits according to EPAs ECHO. However, 5 of the past 12 quarters were considered non-compliant based on single-event or permit schedule violations and were not considered to be in SNC or RNC. The last quarter of pollutant-related non-compliance was quarter 2 of 2014 for phosphorus. No formal enforcement actions (i.e., administrative orders, civil/judicial litigation) in the past 5 years have occurred. The District has received 2 informal enforcement actions in the past 5 years which were letters of violation/warning. The last informal enforcement action occurred on June 30, 2015. It should be noted that the compliance status for quarter 2 of 2016 is still in progress.

- OECC South is currently operating at an average flow of 3.4 MGD and has experienced a peak flow of at least 14.4 MGD. Peak flows are likely larger than 14.4 MGD as evidenced by flooding in the Control Building grinder room. The grinder room is located directly above the raw sewage pumping wet well.

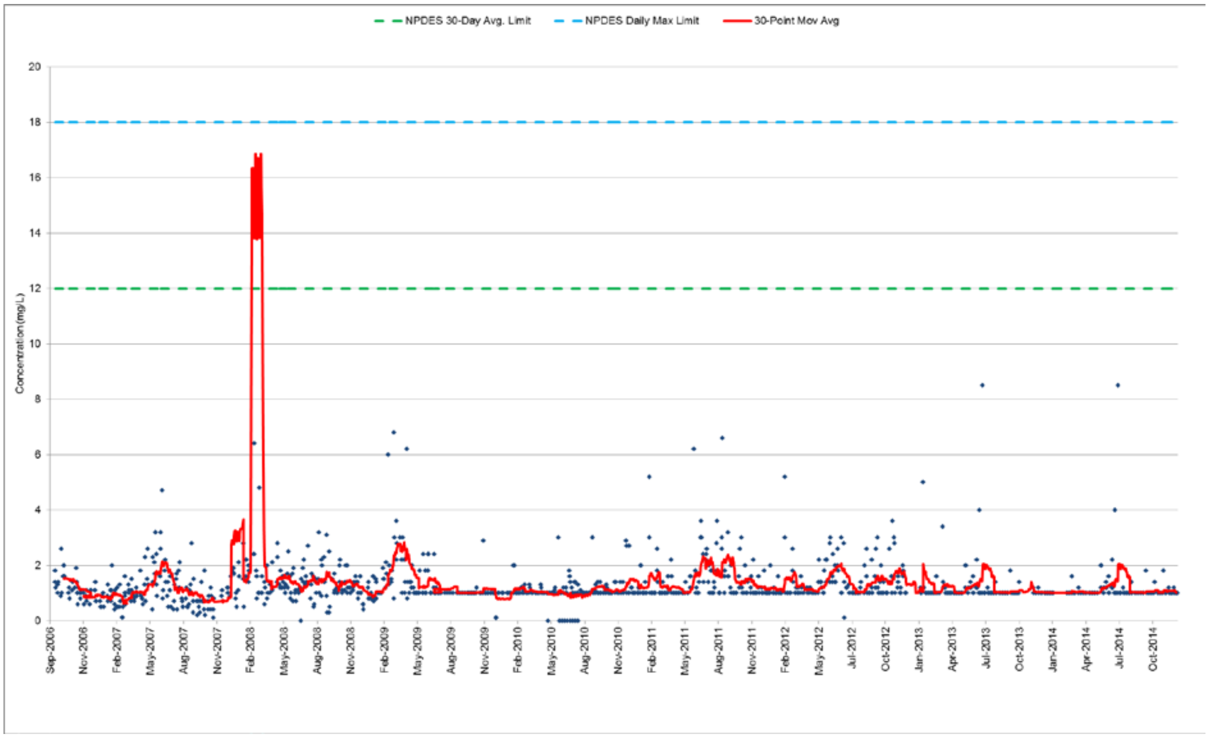
- Dissolved oxygen (DO) concentrations routinely exceed the minimum permit requirement. The average DO concentration over the review period was 7.38 mg/L. Refer to Figure 1 for effluent DO concentrations.

Figure 1- OECC Effluent DO Concentrations



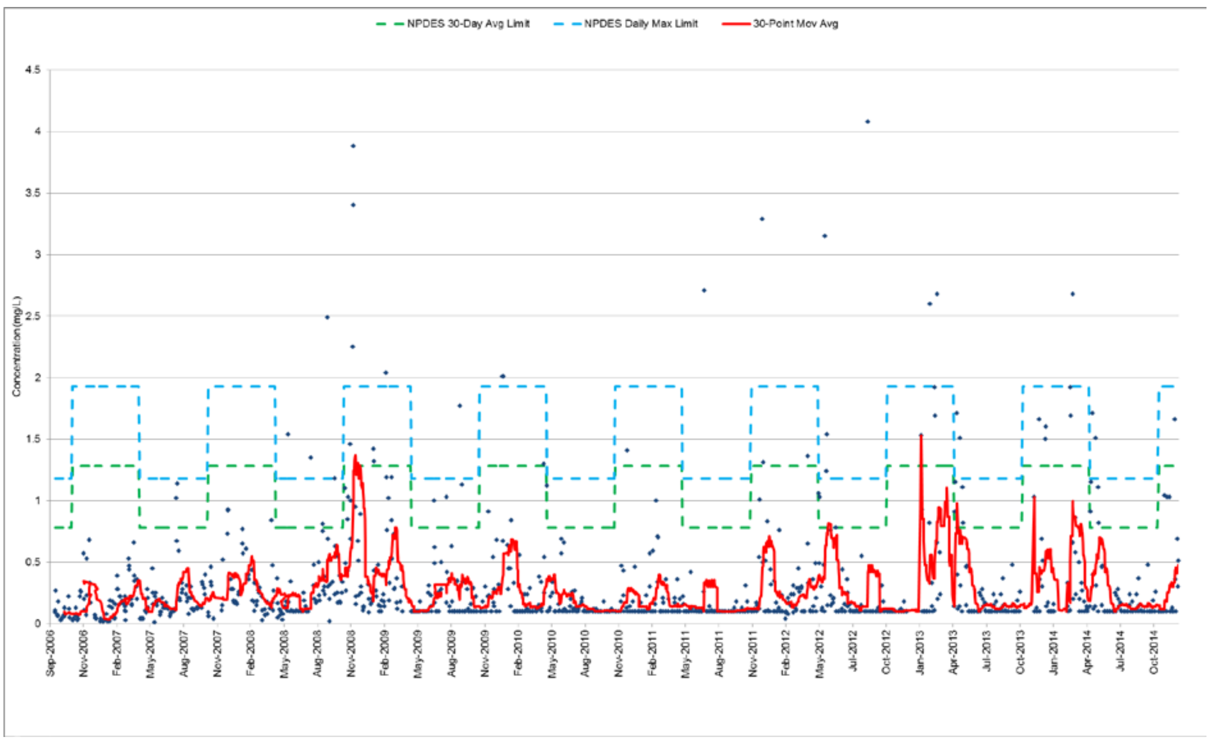
- Over the review period, average effluent TSS concentrations demonstrate consistent and sufficient removal with a 30-point moving average that routinely trends below NPDES permit limits. The average TSS concentration over the review period was 1.46 mg/L. Refer to Figure 2 for effluent TSS concentrations.

Figure 2 - OECC Effluent TSS Concentrations



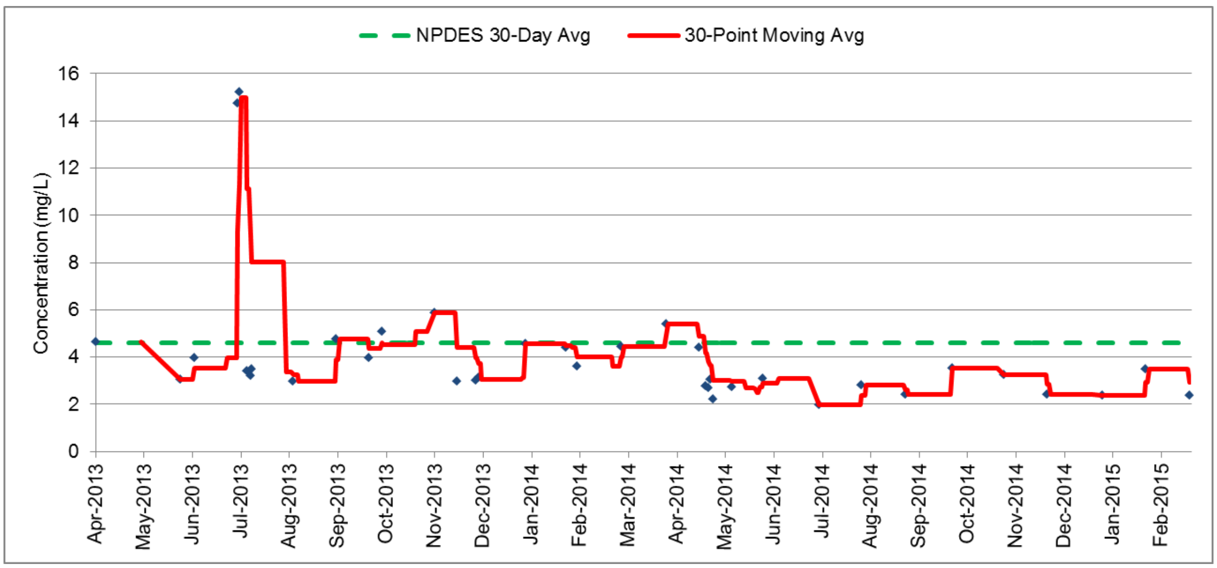
- Over the review period, the average effluent ammonia-nitrogen (NH_3-N) concentration was 0.28 mg/L, which indicates sufficient nitrification is occurring. Removal of NH_3-N is accomplished through the nitrification process occurring in the aeration tanks. While effluent NH_3-N concentrations generally trend below the NPDES 30-day average and daily maximum limits, these limits have been exceeded on occasion. Causes of incomplete nitrification include, but are not limited to: insufficient solids retention time (SRT), low dissolved oxygen, and insufficient alkalinity. Ammonia can also be re-released by the death of aerobic bacteria in the final clarifiers. Sidestream flows from solids handling and disposal processes containing high concentrations of ammonia affect aeration system design and chemistry which may negatively affect the removal of ammonia-nitrogen. Refer to Figure 3 for effluent NH_3-N concentrations.

Figure 3 - OECC Effluent NH_3-N Concentrations



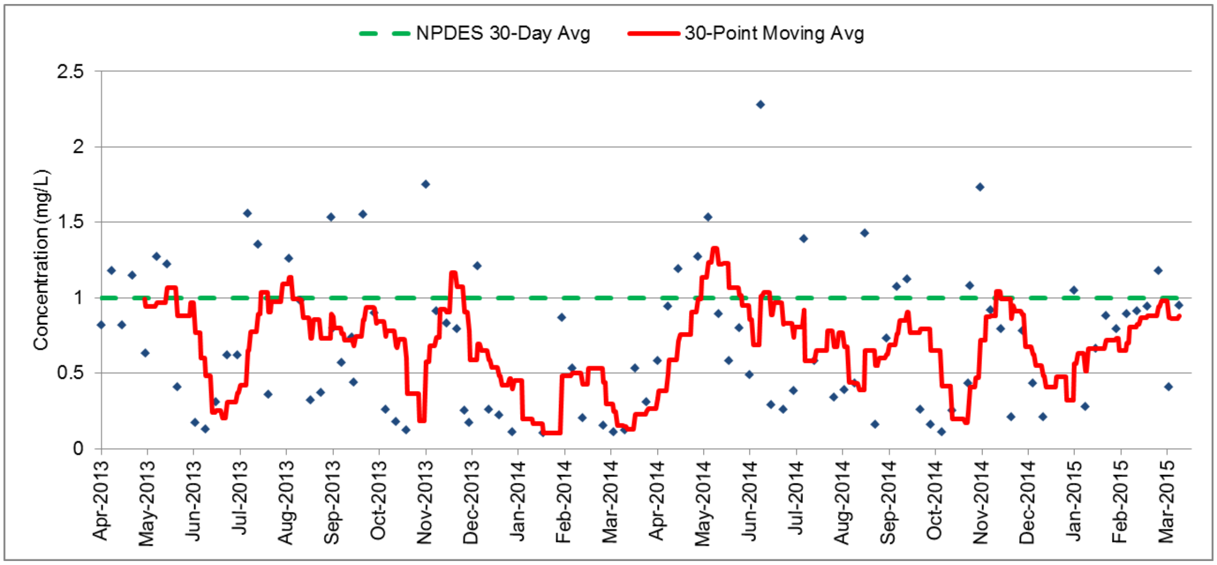
- Denitrification in the aeration tanks reduces nitrate + nitrite (NO_3 + NO_2) concentrations. Effluent NO_3 + NO_2 concentrations have routinely trended below the NPDES 30-day average limit since May 2014. Over the review period, the effluent NO_3 + NO_2 concentration was 4.09 mg/L. Between April 2013 and May 2014, effluent concentrations were trending near or above the NPDES 30-day average limit, potentially indicating problematic denitrification was occuring. Denitrification performance is most affected by the availability of organic compounds and DO concentrations in the aeration tanks. Denitrifying bacteria use organic compounds present in the wastewater as a source of carbon and energy. If DO concentrations are higher than optimum, denitrifying bacteria prefer the free molecular oxygen over nitrite and nitrate ions. Refer to Figure 4 for effluent NO_3 + NO_2 concentrations.

Figure 4 - OECC Effluent NO_3 + NO_2 Concentrations



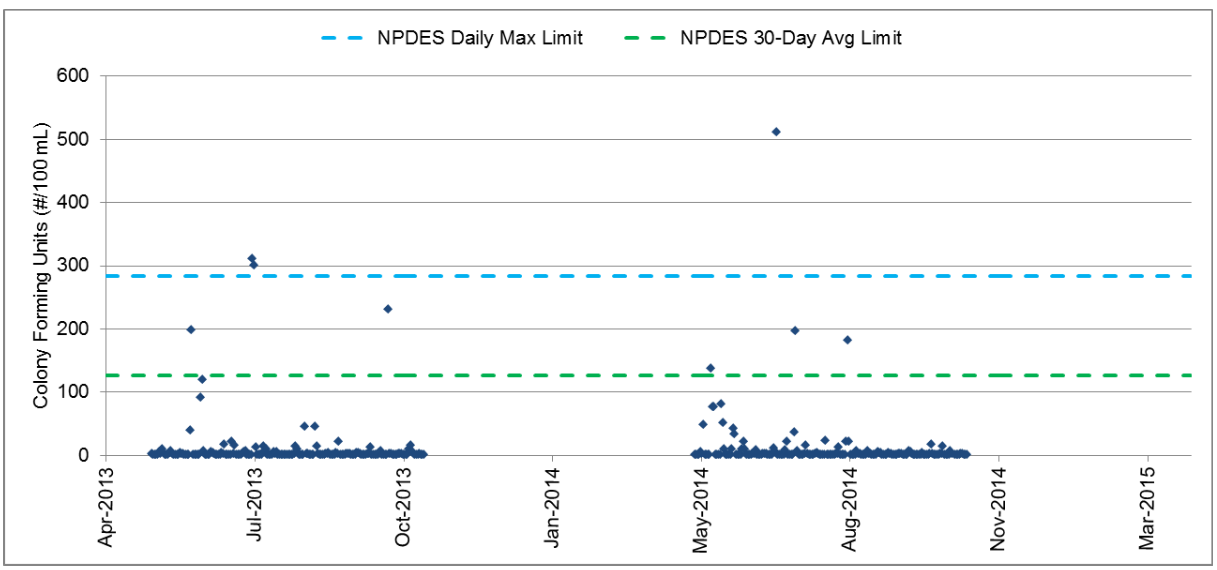
- Effluent phosphorus concentrations generally trend under the NPDES 30-day average limit. However, effluent concentrations exceed limits on occasion. This may be the result of insufficient ferric chloride dosing in response to elevated phosphorus concentrations in sidestream flows from the solids handling and disposal processes. Refer to Figure 5 for effluent phosphorus concentrations.

Figure 5 - OECC Effluent Phosphorus Concentrations



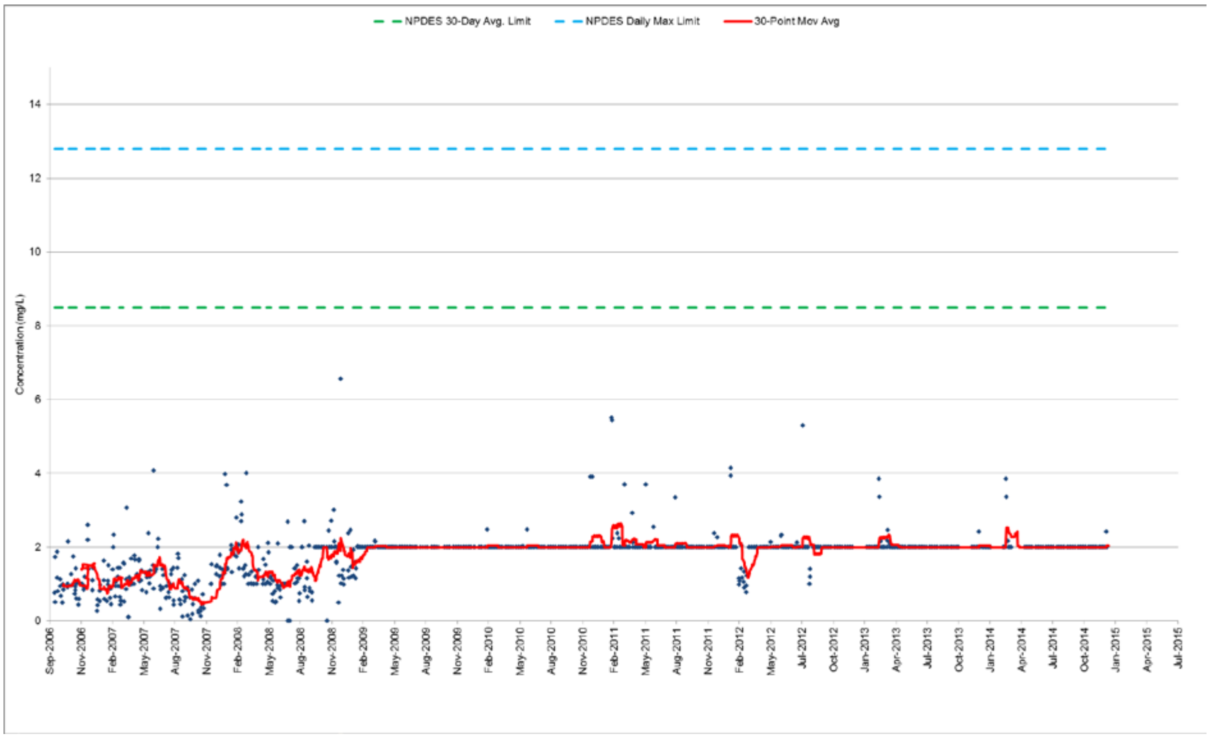
- Reported effluent E. Coli, measured in colony-forming units, demonstrates sufficient inactivation by the UV disinfection process. Refer to Figure 6 for effluent E. Coli colony-forming units.

Figure 6 - OECC Effluent E. Coli Colony-Forming Units



- The average influent 5-day carbonaceous biochemical oxygen demand ($CBOD_5$) concentration is lower than the design assumptions for OECC South. OECC South is receiving an average $CBOD_5$ concentration that is approximately 50% of what the plant was designed for. Effluent $CBOD_5$ concentrations demonstrate consistent and sufficient removal with a 30-point moving average that routinely trends below NPDES permit limits. The average effluent $CBOD_5$ concentration over the review period was 1.81 mg/L. Refer to Figure 7 for effluent $CBOD_5$ concentrations.

Figure 7 - OECC Effluent $CBOD_5$ Concentrations



4.1.2 Hydraulic Capacity

Plant hydraulic capacity was evaluated through a combination of visual inspection, staff interviews, and collection system and plant hydraulic profile modeling. The collection system model was used to estimate plant inflows and will be discussed in greater detail in Section 5 of this memorandum. The hydraulic profile model, which was created in the computer program Visual Hydraulics, produces a hydraulic profile by calculating headlosses through plant process structures, piping, and channels. The hydraulic profile was used to check separation distances between the water surface and the tops of structures and channels (freeboard) and for submerged weirs. Flows predicted by the collection system model were used to execute the hydraulic profile model.

OECC South is currently the only plant in service. As illustrated in Table 5, OECC South has a design average flow of 4.5 MGD and a peak flow of 13.5 MGD. OECC South is currently operating at an average flow of 3.4 MGD and has experienced a peak flow of at least 14.4 MGD. Typically, when observed average flows are within 75% of the average design flow, plant expansion should be considered to provide sufficient time for planning, design and construction activities. This need is further compounded by observed peak flows exceeding design conditions for OECC South. The District has already initiated facility planning activities to restore OECC North to service for additional capacity. Assuming that plant flow ratings are additive, restoring OECC North to service would provide OECC cumulative average and peak flow ratings of 6 MGD and 18 MGD, respectively. The additional peak flow capacity provided by OECC North would still put the observed peak flow within 80% of the cumulative peak flow rating OECC.

The Control Building's grinder room is known to flood during wet weather events. On June 23, 2016, OECC experienced a wet weather event that resulted in a plant inflow of at least 14.4 MGD as recorded by the flow meter on the raw sewage forcemain. With OECC North offline, hydraulic capacity is limited by OECC South's maximum raw sewage pumping capacity of 14.4 MGD. Grinder room flooding suggests plant inflows exceeded this pumping capacity and were greater than 14.4 MGD. According to District staff, the water surface in the grinder room reached approximately 13 feet above the operating floor. This capacity issue may be the result of a combination of items such as insufficient pumping capacity, high rainfall-dependent inflow and infiltration in the collection system, and/or channel grinder capacity.

Treatment plant hydraulics were further evaluated during a 25-year design storm. Plant inflows resulting from this design storm were estimated through a collection system model (see Section 5). Discharge conditions in the Olentangy River resulting from this design storm were interpolated from information contained in the Delaware County Flood Insurance Study (April 2009) prepared by the Federal Emergency Management Agency (FEMA). Discharge conditions resulting from a 25-year river elevation were estimated to be 766.5 ft. The collection system model estimated plant inflows to reach approximately 26 MGD which is over 44% greater than the combined design peak flow for OECC. OECC does not have sufficient hydraulic capacity to handle this flow. At this flow rate, the plant effluent weir, the effluent weirs in the North and South plant final clarifiers and the plant effluent parshall flume become submerged. Improvements to increase hydraulic capacity will be discussed in further detail in Technical Memorandum #4.

4.1.3 Existing Site

Characteristics of the existing site including the property and its location, access, security, and safety are discussed herein.

Property

- OECC (north and south plants) is situated on a 69 acre parcel of land bounded by SR-315 to the west and the Olentangy River to the east. A 44 acre parcel to the north is also owned by the County where a small drying bed for collected fats, oils, and grease is located and used by plant operations. The 44 acre parcel provides the District with additional land that may be used for future plant expansion if needed. If OECC were expanded, the drying bed may need to be relocated.

Access

- Two entrances to the WWTP are provided. The north entrance grants access to the north and south plants and the south entrance grants access to the Maintenance Building. This relieves traffic congestion within the north and south plants by separating traffic local to the Maintenance Building. Traffic can continue past the Maintenance Building and into the north and south plant process areas if needed.
- The two plant entrances allow larger wheelbase vehicles (i.e. semis, dump trucks) to travel in one overall direction through the site by driving from the north to south entrance and vice-versa. This aids in the delivery and/or pickup of large equipment and materials.
- Plant drives provide access to all process areas and are approximately 20 feet wide to allow for two-way traffic. As a result, District staff can easily use pickup trucks for moving equipment and material between process areas.
- Sufficient parking is provided near the Administration and Maintenance Buildings to keep plant drives free of parked vehicles.
- Design of the Centrifuge Dewatering Facility included a one-way traffic flow pattern on the north and south sides of the building. This may lead to traffic congestion in the vicinity of the building as vehicles travel to and around the facility.

Security and Safety

- Vehicular access to the site is controlled by a security gate at the north entrance and a cable locked between two posts at the south entrance. The north and south entrances are left open during normal business hours. The south entrance is locked during weekday evenings and over the weekend. Neither entrance is equipped with security cameras nor an intercom.
- A perimeter fence does not enclose OECC to keep non-site personnel and wildlife out of the site.
- Plant is staffed 24 hours a day.
- Site lighting is provided near the process areas but not around the eastern perimeter drive closest to the Olentangy River.
- Copies of chemical material safety data sheets (MSDS) were located near chemicals and stored in the Administration Building for convenient access by District staff.
- Ear protection is provided in areas with high noise levels.
- Guardrail surrounds all openings.

4.1.4 Raw Sewage Grinding and Pumping

OECC North and South share the raw sewage grinding and pumping processes located in the Control Building. The Control Building consists of two in-channel sewage grinders, one auxiliary manual bar rack that serves as a backup to the grinders, and seven raw sewage pumps. Raw sewage pumps 1, 2, and 3 are dedicated to OECC South and pumps 6 and 7 are dedicated to OECC North. Pumps 4 and 5 are capable of feeding both OECC North and South. With OECC North offline, pumps 6 and 7 have been removed from service by having their drives disconnected.

The pumps, piping/valves and electrical equipment are located on the south side of the building. The influent raw sewage channels and wet well are contained in the north side. Each side is served by separate exterior entrance with the electrical gear isolated from any gases generated by raw sewage. The raw sewage pumps are capable of feeding the North and South plants' aeration processes separately via individual discharge via 14 inch and 24 inch forcemains, respectively. Major process components of the raw sewage grinding and pumping processes are shown in Table 6.

Table 6 - Raw Sewage Grinding And Pumping Process Summary

Equipment	Quantity	Features
Channel Grinders	2	60" H screen & 8.5" W x 60" cutting chamber
Raw Sewage Pumps 1-3, 5	4	2,350 GPM, 75 HP
Raw Sewage Pump 4	1	2,300 GPM, 70 HP
Raw Sewage Pumps 6, 7	2	1,600 GPM, 50 HP

Condition Assessment

Raw Sewage Grinding

- District staff has indicated that channel grinder maintenance is becoming burdensome due to the manufacturer's refurbishment costs, long turn around time for service and parts, increased frequency of maintenance due to aging equipment and resulting capacity reduction during equipment outages.

- Interviews with District staff indicate that the grinder room floods during certain wet weather events. Sewage has reached as high as 13 feet above the grinder room operating floor, submerging lighting, instrumentation, and some ventilation ductwork. The unpredictable nature of flooding events and their severity poses a significant threat to the safety of staff which may be working in the grinder room.

- There is evidence of surface oxidation on electrical conduits. Raw sewage has the ability to produce hydrogen sulfide gas. This was observed in the side containing raw sewage as well as the side isolated from raw sewage. Copper wire and electrical gear is especially susceptible to corrosion by hydrogen sulfide.

- The sewage level in the grinder room routinely rises above the grinder channel walls during storm events due to raw sewage pumping capacity restrictions. When this happens, raw sewage is diverted around the grinders meaning that untreated sewage enters the plant, putting pumps and other downstream equipment at risk.

- The grinders shred incoming material in the sewage and the shredded particles remain suspended and conveyed into the plant. This approach is seldom practiced in contemporary treatment works because the shredded materials have a tendency to recombine and build up in pumps, tanks, and solids handling equipment causing problems. Often the long term maintenance of these systems is a much larger investment than removing material from the wastewater at the earliest opportunity.

Raw Sewage Pumping

- Pump bodies, motors, and piping have minor surface oxidation that is causing failure of protective coatings in some locations.

- Raw sewage pumps 6 and 7 were removed from service because their intended use was to supply north plant aeration with raw sewage. Each pump has had its drive belt removed.

- Visual observation of pumps and valves shows that they appear to be in good working order.

Capacity Assessment

OECC has a raw sewage grinding capacity of 18 MGD and a total raw sewage pumping capacity of 21.5 MGD. With raw sewage pumps 6 and 7 currently out of service (dedicated to OECC North), OECC currently has a total raw sewage pumping capacity of 16.8 MGD. According to District staff, the maximum pumping rate with raw sewage pumps 1 through 5 operating in parallel is 14.4 MGD as recorded by the magnetic flow meter installed on the forcemain to OECC South aeration. As evidenced by the continued occurrence of high water events, a capacity restriction exists within the raw sewage pumping process.

4.1.5 South Aeration

Sewage from the Control Building is pumped to OECC South aeration via a 24 inch forcemain. With OECC North currently offline, all influent raw sewage is treated by OECC South. Influent raw sewage is split into two pipes, each regulated by automatic pinch valves. Valves and piping are provided to allow for step feed operation (current practice). These valves are used to split the raw sewage into two streams. One stream is directed into an adjacent line that combines with the discharge from the return activated sludge (RAS) pumps to form mixed liquor before it is routed to the first pass of each aeration train. The second stream which consists of the remaining raw sewage that was not combined with RAS, continues and discharges to the second pass of each aeration train. OECC South aeration is operated as a single-stage nitrification process that denitrifies. Major process components of the south aeration process are shown in Table 7.

Table 7 - OECC South Aeration Process Summary		
Equipment	**Quantity**	**Features**
Aeration Basins	4	4 trains with 3 basins in each train. Each basin is 99' L x 22' W x 14.91 SWD
Centrifugal Blowers	5	5,300 SCFM, 300 HP

Condition Assessment

Aeration Tanks

- Because the raw sewage goes through grinders only, and no material is removed, stringy material accumulates and binds around the aeration mixers. This is a chronic maintenance problem. Additionally, the floatable debris is passed through aeration and end up in the final clarifiers. Final clarifier scum removal systems are not intended to remove the large amount of floatables in absence of up front removal.

- Similarly, because OECC has no grit removal, grit and heavy material builds up in the aeration tanks and must be cleaned regularly. This is a maintenance intensive process and requires the basins to be removed from service more frequently than necessary. Additionally, the grit and other debris may result in fouling and performance degradation of the diffusers, reducing treatment effectiveness.

- PVC diffusers and piping may be degraded due to long term exposure to UV radiation.

- Fine bubble diffusers typically require cleaning every 2 to 5 years and replacement every 8 to 12 years.

Blowers

- Based on age alone, the blowers are nearing the point at which rehabilitation is typically performed. According to the blower manufacturer, rehabilitation is performed every 25 to 30 years on average for blowers moving air only. Unique operating conditions may shorten this time frame. A detailed mechanical inspection of the blowers' internals to determine their need for rehabilitation was beyond the scope of this memorandum and therefore not performed.

Capacity Assessment

This capacity assessment will be based on the aeration system's ability to deliver the required air to meet the oxygen demand exerted by the oxidation of both $CBOD_5$, ammonia nitrogen (NH_3-N) and organic nitrogen while maintaining a dissolved oxygen (DO) concentration of 2.0 mg/L in the aeration tanks. The sum of the ammonia nitrogen and organic-nitrogen constituents is known as Total Kjeldahl Nitrogen (TKN). Plant staff do not measure influent TKN concentrations but do measure NH_3-N. To estimate influent TKN concentrations, the organic nitrogen component was assumed equal to 60% of the influent NH_3-N concentration. Table 8 illustrates the parameters used in this capacity assessment.

Table 8 - OECC South Aeration Process Data		
Parameter	**Units**	**Value**
Peak $CBOD_5$	mg/L	267
Peak TKN	mg/L	48.56
Alpha[1]	Unit less	0.5
Beta[1]	Unit less	0.95
Temperature[1]	deg-C	21
SOTE[1]	%	20

[1] April 1994 Design Report

The amount of oxygen required to oxidize $CBOD_5$ and TKN is considered the actual oxygen requirement (AOR). To calculate AOR, 1.1 pounds of oxygen per pound $CBOD_5$ oxidized and 4.6 pounds of oxygen per pound of TKN oxidized was used. Each wastewater treatment plant has unique field conditions that are affected by the following variables: site barometric pressure, process temperature, diffuser submergence, and alpha and beta factors. These variables are used to convert AOR to standard oxygen requirements (SOR) to properly determine the amount of process air required to satisfy the oxygen requirements of biological treatment. Alpha is a coefficient that accounts for the reduction in oxygen transfer caused by impurities in the wastewater. Beta is used to account for a reduction in oxygen transfer caused by dissolved solids in wastewater. Once SOR is determined, the air delivery in standard cubic feet per minute (SCFM) is calculated using the standard oxygen transfer efficiency (SOTE) of the diffusers; SOTE is the ratio between the amount of oxygen transferred to the process and the amount of air delivered.

Based on these process parameters listed in Table 8, OECC South aeration has sufficient blower capacity to treat approximately 11.8 MGD when using all available blowers under current conditions. With one blower out of service, the available air supply limits the maximum flow to 8.8 MGD. These values are lower than the peak design capacity of 13.5 MGD for OECC South. It should be noted that recorded peak $CBOD_5$ during the review period was found to be over 15% greater than the design assumption listed in the 1994 Design Report.

4.1.6 North Aeration

The OECC North aeration process is currently offline. Since OECC North aeration was altered then placed offline after OECC South was commissioned, a typical operating mode was never established. Inspection of the piping arrangement indicates that the process can be operated in a plug flow mode or a step feed mode.

If operational, raw sewage would be pumped to the process via a 14 inch force main. Raw sewage would be metered and split between the two trains via pinch valves located in the aeration tank influent meter chamber to the northeast of the tanks. RAS would be pumped to the head of the first pass of each aeration train where to mix with influent raw sewage. Ferric chloride storage and feed equipment located in the basement of the North Blower Building would add chemical to the effluent mixed liquor for phosphorus removal. Ferric chloride is fed to the OECC South aeration effluent from this location as well. Major process components of the north aeration process are shown in Table 9.

Table 9 - North Aeration Process Equipment		
Equipment	**Quantity**	**Features**
Aeration Basins	2	2 trains, each with 3 tanks @ 60.167’ L x 23’ W x 15.167’ SWD
Centrifugal Blowers	3	2,900 SCFM, 300 HP

Condition Assessment

Aeration Tanks

- Diffuser equipment is broken or uneven in some places. Diffusers and plastic air piping that have not been used, cleaned and/or have been exposed to UV for extended periods of time require replacement. The plastics dry and degrade with time due to UV degradation and are susceptible to cracking and failure.

- Foam control spray distribution header used for as-needed control of foaming is broken in some places.

- Maintenance records for the north aeration process gates and valves were not provided for review. If the seals and gaskets for the gates and valves have not been maintained according the manufacturer recommendations, the seals and gaskets should be considered as expired and require full replacement.

- Guardrail installed along perimeter of each tank consists of a wooden banister supported by aluminum spindles. The wooden banister in numerous locations has degraded significantly and is cracked in some locations.

Blowers

- Blowers appear original to facility (1979) and should be replaced due to age. High speed rotating equipment that has sat for long periods of time is susceptible to flat spots on bearing and shafts and more likely to fail when placed back in service.

Chemical Handling

- Equipment is currently used to feed south plant aeration. Ferric chloride holding tanks, piping, and spill containment area is stained, suggesting chemical leaks have occurred.

- Plant staff indicated that the chemical transfer line between the two 5,000 gal storage tanks is plugged and needs cleaned or replaced.

- Physical integrity of overhead ferric chloride transfer and feed piping appears to be in good condition. Spill containment of the overhead chemical transfer and feed piping has been installed.

- Chemical feed pumps appear new and in good operating condition. Flexible discharge hose appears to be in good condition.

Capacity Assessment

The District intends to restore OECC North to service. Due to the age and condition of process equipment, replacement will be necessary. Because sizing of the replacement equipment has not yet been performed, this capacity assessment is based on the existing systems.

Similar to OECC South, the capacity assessment for OECC North aeration will be based on the air delivery capacity available to oxidize $CBOD_5$ and TKN while maintaining a process DO concentration of 2.0 mg/L. Because OECC North is offline, $CBOD_5$ and TKN concentrations were assumed to be equal to OECC South. Table 8 in Section 4.1.5 illustrates the process parameters used in this capacity assessment.

Based on these process parameters, OECC North aeration has sufficient air delivery capacity to treat approximately 3.6 MGD when using all available blowers under current conditions. With one blower out of service, the available air delivery capacity limits the maximum flow to 2.4 MGD. These values are lower than the design peak flow of 4.5 MGD for OECC North.

4.1.7 South Final Clarification

The final influent splitter receives flow from the south aeration process via two, 30 inch pipes. The splitter box distributes flow to four final clarifiers, each 90 feet in diameter, through manually actuated slide gates. The final clarifiers feature a flocculating influent well, rake arms for settled sludge collection, and scum collection. Scum is collected and deposited into a trough for transport to a scum well where two scum pumps pump to the aerobic digestion process. Major process equipment for the OECC South final clarification process is shown in Table 10.

Table 10 - OECC South Final Clarification Process Equipment

Equipment	Quantity	Features
Clarifiers	4	90’ dia x 14.1’ SWD
V-notch weirs, ea.	532	Crest el. 774.33
RAS Pumps	4	1,560 GPM, 20 HP
WAS Pump	1	250 GPM, 5 HP
Spare RAS/WAS Pump	1	1,560 GPM, 20 HP
Scum Pump 1	1	300 GPM, 5 HP
Scum Pump 2	1	600 GPM, 25 HP

Condition Assessment

Final Clarifiers

- Protective coating on final clarifier collection mechanisms is faded and peeling in some locations. This condition was observed on all final clarifiers.
- One of the scum collection paddles on final clarifier 6 was broken.

- Wear patterns were observed on the concrete floor of final clarifier 6.
- The Northeast clarifier had what appeared to be metal components resting on the floor.
- At 15 years of age, the clarifiers are approaching the time when rehabilitation and replacement of wear components typically occurs. This often includes main and secondary gear reduction rehabilitation, preparation and application of protective coatings, concrete inspection and/or repair, and replacement of other worn or fatigued components.

Capacity Assessment

The capacity of OECC South's final clarification process will be based on surface overflow rate (SOR), solids loading rate (SLR), and weir loading rate (WLR) for final clarifiers used in nitrifying treatment plants employing chemical addition for phosphorus removal. RAS flows were assumed to equal 75% of the OECC South's design average flow. Process parameters used in this analysis are summarized in Table 11.

Table 11 - OECC South Final Clarification Process Data		
Parameter	**Units**	**Value**
Average MLSS	mg/L	2,610.22
Maximum RAS Flow	MGD	3.375

Based on these process parameters, OECC South secondary clarification has sufficient capacity to treat approximately 22.9 MGD with all tanks in service under current conditions. Capacity is limited by SOR due to the lower loading rate (900 gpd/sf) for treatment plants using chemical addition for phosphorus removal listed in 10SS.

District staff periodically measure final clarifier effluent TSS concentrations. Collected data indicate that TSS removal in the final clarifiers is sufficient, with an average concentration of approximately 3 mg/L. This is lower than the NPDES 30 day average and daily maximum limits of 12 mg/L and 18 mg/L, respectively.

4.1.8 North Final Clarification

The existing OECC North final clarification process consists of four tanks, each 50 feet in diameter. If operational, mixed liquor from the two aeration tanks would flow to separate splitter boxes via 18 inch pipes. Each splitter box would distribute influent mixed liquor to two final clarifiers via weir plates. The final clarifiers feature an organ pipe draft tube sludge collection mechanism, scum collection arm, and weir brush assemblies. Collected scum is deposited into a trough where it then flows by gravity to the head of the plant. Major process equipment for the north final clarification process is shown in Table 12.

Table 12 - OECC North Final Clarification Process Equipment		
Equipment	**Quantity**	**Features**
Clarifier	4	50’ dia x 9.25’ SWD
V-notch weirs, ea.	314	Crest el. 774.01
RAS Pumps	6	525 GPM, 20 HP
WAS Pumps	4	525 GPM, 20 HP

Condition Assessment

Final Clarifiers

- Some concrete edges have spalled off around the bases of guardrail posts.
- Guardrail installed along perimeter of each tank consists of a wooden banister supported by aluminum spindles. The wooden banister in numerous locations has degraded significantly and should be replaced.
- Weir brush bristles are worn and warped and require rehabilitation.
- Clarifier bridge protective coating is degraded and allowing surface oxidation of the substrate in various locations.
- PVC organ draft tubes appear faded from long term exposure to UV radiation.
- Substantial vegetative growth noted in offline tanks, therefore visual inspection of concrete floor near base of collection mechanism could not be performed.
- One tank was full and covered in algae during the inspections. District staff has used these tanks for flow equalization during high influent flows.
- The north final clarifiers feature organ draft tube sludge collection mechanisms. The diameter of these pipes is unknown but these types of mechanisms typically clog from insufficient velocity. Operationally, insufficient velocity is caused by the fact that the top of the tubes tend to be difficult to observe and adjust. As the velocity slows, the pipes tend to clog even more, reducing the velocity further.
- The sludge collection mechanisms appear to have been replaced during the construction of OECC South in 1994. These mechanisms should be replaced due to age of the equipment.

RAS/WAS Pumping

- The RAS pump located on the far left of the northern side of the basement was suffering from significant corrosion on the flange of the increaser attached to the pump discharge. Severe degradation of the flange and bolts was noted.
- There was an accumulation of water observed along length of joint near the south basement wall in the floor slab.

Capacity Assessment

The District intends to restore OECC North to service. Due to the age and condition of process equipment, replacement will be necessary. Because sizing of the replacement equipment has not yet been performed, this capacity assessment is based on the existing systems.

Similar to OECC South, the capacity assessment for OECC North final clarification will be based on SOR, SLR, and WLR for final clarifiers used in nitrifying treatment plants employing chemical addition for phosphorus removal. For this analysis, it was assumed that OECC North would operate similar to OECC South's final clarification process in terms of chemical addition for phosphorus removal, MLSS concentration, and RAS flows equaling 75% of OECC North's design average flow. Process parameters used in this analysis is summarized in Table 13.

Table 13 - OECC North Final Clarification Process Data

Parameter	Units	Value
Average MLSS	mg/L	2610.22
Maximum RAS Flow	MGD	1.125

Based on these process parameters, OECC North final clarification has sufficient capacity to treat approximately 7.1 MGD with all tanks in service under these assumed conditions.

4.1.9 Tertiary Filtration

Clarified effluent from the OECC South final clarification process enters the Tertiary Treatment Complex where six automatic backwashing filters remove additional suspended solids. OECC North final clarification is capable of sending clarified effluent to the shared Tertiary Treatment Complex when placed in operation. The filters receive clarifier effluent on top of the media, solids are captured as water flows from top to bottom of the media and filtered water is collected in underdrain cells below the media. Filtered solids are removed via periodic backwashing. Backwashing is accomplished by pumping filter effluent back through the underdrain cells and through the media in a bottom to top direction. A hood captures washwater from each row where it eventually is recycled back to the head of the plant. Major process equipment for the tertiary filtration process is shown in Table 14.

Table 14 - Tertiary Filtration Process Equipment		
Equipment	**Quantity**	**Feature**
Filter	6	40’ L x 12.5’ W
Sand Media	-	16”
Wash water Pumps	6 (1 per filter)	25 GPM/sf @ 16’ TDH
Skimmer Pumps	6 (1 per filter)	50 GPM @ 15’ TDH

Condition Assessment

Filters

- A visual observation was performed during winter and summer months. During winter, the humidity in the filter room was high with condensation noted on various surfaces. During summer, the humidity was at tolerable levels and condensation was not observed. District staff should keep HVAC systems operational during all months to mitigate the deleterious effects of high humidity exposure to the equipment and architectural items contained within the facility.

- Guardrail was not installed along the edges of the walkways that allow foot travel between the influent and effluent ends of the filters. It was assumed that this was done due to access requirements of the filters. The District should review their access and safety plan for the filter building.

Capacity Assessment

The capacity of OECCs tertiary filtration process will be based on the filtration rate. OECC’s tertiary filtration has adequate capacity to treat approximately 21.6 MGD with all filters in service. With one filter out of service, the available capacity drops to 18.0 MGD.

According to District staff, high flows resulting from wet weather events result in excessive headlosses through the filter media. This causes the filters to enter the backwashing mode. Per District staff, backwashing is sustained for the duration of the wet weather event. To ensure that the headloss through the media is not caused by biological growth, plant staff hand-apply calcium hypochlorite. Excessive backwashing may adversely affect the plant in the following ways:

- Recycle flows sent to the head of the plant use available hydraulic and treatment capacity.

- High energy consumption.

- Loss of fines from the media may migrate to upstream process tanks.

During high flow events, filter headloss activates the filter bypass. This bypass channels a portion of the filter influent around the filters where it is subsequently recombined with filter effluent prior to UV disinfection. This is done on occasion while still meeting NPDES limits as the south final clarification process consistently provides sufficient TSS removal. The OEPA recently gave the District approval to use this bypass for efficient filter operation as long as permit limits are met and the District samples the water quality during these bypass events to demonstrate adherence to permit limits. This approach will need to be monitored closely as flows to the plant increase to ensure continued compliance.

4.1.10 UV Disinfection

UV disinfection is housed in the Tertiary Treatment Complex downstream of the tertiary filtration process. Filter effluent is routed to three UV disinfection channels via a 4.5 foot wide flume. UV disinfection is operational between May 1 and October 31 where human contact with the receiving water body is most likely. The District has started replacing the vertical lamp UV disinfection equipment with a new horizontal lamp system. The District is operating both systems until the new system is fully commissioned. Major process equipment for the new horizontal lamp UV disinfection process is listed in Table 15.

Table 15 - UV Disinfection Process Equipment	
Equipment	**Quantity**
Modules per Channel	1 per channel, 3 total
Lamps per Module	48 per module, 144 total
UV Transmittance at 253.7 nm	60%

Condition Assessment

UV Disinfection

- A visual observation was performed during winter and summer months. During winter, the humidity in the UV room was high with condensation noted on various surfaces. During summer, the humidity was at tolerable levels and condensation was not observed. District staff should keep HVAC systems operational during all months to mitigate the deleterious effects of high humidity exposure to the equipment and architectural items contained within the facility.

- The grating over the UV modules does not prevent District staff from being exposed to UV light. Typically, the UV modules are fully enclosed by shields. The District should consider having precautions in place to protect plant staff against UV exposure.

- Due to observed algal growth in the UV influent channels, the District will want to be diligent about monitoring the condition of the UV system. Wet weather flows can result in algae sloughing off the channel walls that may damage the UV system. Periodic cleaning of the channels can help reduce this risk.

Capacity Assessment

Design standards for UV disinfection require the systems to be based on similar systems that can be demonstrated by the manufacturer’s experience at similar full scale installations or prototype testing. To treat additional flows, the equipment manufacturer should be consulted to determine the ultimate capacity of the system. Refer to Section 4.1.1 of this memorandum for a discussion regarding OECC effluent E. Coli performance.

4.1.11 Post-Aeration

The Tertiary Building, located northeast of the Tertiary Treatment Complex, houses the post-aeration process. Post-aeration is operational whenever the plant's effluent DO concentration falls below NPDES requirements. Disinfected effluent flows to the Tertiary Building via a 54 inch conduit where it is distributed between two contact tanks to provide sufficient detention time for the process. Two positive displacement blowers supply the required air. Each blower is rated for 330 SCFM with a discharge pressure of 9 PSIG.

Condition Assessment

Building Exterior

- Loading dock on Northwest side of building is in poor condition. Steel reinforcing is exposed.

Building Interior

- Concrete floor in post-aeration blower room is badly cracked with exposed structural steel.
- Chemical storage tanks remain plumbed but are no longer in use.
- Sample pump body and skid is exhibiting signs of surface oxidation resulting in failure of protective coatings. Grease stains around skid suggest that pump lubricant is leaking on to floor.

Capacity Assessment

This capacity assessment will be based on the post-aeration blowers' ability to deliver the required air to increase the influent flow's DO concentration from 2.0 mg/L to 5 mg/L. Table 16 illustrates the parameters assumed in this evaluation.

Table 16 - Existing Post-Aeration Process Data

Parameter	Units	Value
Alpha	Unit less	0.98
Beta	Unit less	0.95
Summer Temperature[1]	deg-C	21
SOTE[1]	%	20

[1] April 1994 Design Report

OECC is required to maintain a minimum effluent DO concentration of 5.0 mg/L year-round. Generally, air requirements are greater when the wastewater temperature is the warmest and is therefore used as the basis of this capacity assessment. With summer temperatures, OECC has sufficient blower capacity to treat 50.5 MGD with two blowers in service. This flow drops to 25.3 MGD with one blower out of service.

4.1.12 Solids Handling and Disposal

OECC does not have fine screens or primary clarification. All sludge and grit is passed through the channel grinders at the headworks and flows into the aeration tanks. Activated sludge is periodically wasted from the final clarifiers to the six (6) aerobic digester tanks and/or eight (8) sludge storage tanks. Digested or thickened sludge is drawn from these tanks through dedicated drain piping, through grinders, and discharged to the dewatering centrifuge with a feed pump. The existing gravity belt thickener is currently bypassed.

Digestion was implemented and modified over three separate projects. Two aerobic digester tanks (connected to the concentrator building) each have approximately 179,000 gallons, three aerobic digester tanks have 206,000 gallons and the sixth digester has approximately 197,000 gallons. At an average WAS flow rate of 100,000 gpd, the digestion residence time is approximately 11.5 days. Oxygen transfer capacity with the existing blowers is approximately 30 CF/min/1000 CF. OECC has 8 sludge storage tanks each with a 197,000 gallon capacity all of which have the ability to be aerated for solids suspension.

The gravity belt thickener (GBT) feed pumps (Digester pumps) have a design capacity of 115 gpm at 46 feet TDH. The one meter wide Komline Sanderson gravity belt thickener has a 150 gpm hydraulic capacity. The centrifuge feed pump has a design capacity of 115 gpm at 46 feet TDH. The Andritz D4LL dewatering centrifuge has a hydraulic loading capacity of 100 gpm at 1.2% total solids (TS) and a solids loading of 1000 lbs DS/hr. Average centrifuge input operating parameters are 70-95 gpm at 1.1% TS for approximately 18-20 hours per day, three days a week resulting in 3.3-5.0 DTPD processed. Sludge cake is discharged from the Centrifuge into a 30 degree inclined shaftless screw conveyor with a design volumetric flow capacity of 89 CF/hr at a 31% fill rate. The sludge cake is conveyed to a 6 ton/hour serpentine belt conveyor at a speed of 22 feet per minute at a 30 degree incline and then discharged to an 11 ton/hour serpentine belt conveyor at a speed of 35 feet per minute at a 42 degree incline. The 6 ton/hour belt conveyor discharges some of the sludge cake onto the floor even though some modifications have been made to mitigate that issue. Cake conveyed on the 11 ton/hour belt conveyor is then discharged into a receiving truck located in the adjacent truck bay, which transports sludge cake to a landfill. OECC landfills over 680 DT of sludge cake per year.

Generally, the condition of the solids handling equipment reflects the number of years in service with continued maintenance. The polymer system requires additional clearing to maximize performance. The operating parameters summarized above indicate that the centrifuge is solids under-loaded. Typical dewatering centrifuge sludge feed percent TS is in a range of 3-5%, but can be modified to accommodate lower percent TS sludge feed if desired. It is recommended to increase the centrifuge sludge feed percent total solids to increase the solids loading and throughput. It is also recommended to engage Andritz so that the centrifuge can be optimized by them for various flows and solids loadings. To maximize the centrifuge operation and feed at optimum hydraulic and solids feed rates the least amount of operating time to process equivalent loadings would be approximately 12 hours. However, the County prefers to operate the centrifuge dewatering process during one shift. To achieve this, a second dewatering machine would be necessary. The existing facility was designed to accommodate a second centrifuge. If a second dewatering centrifuge is desired, it is recommended to increase the solids/hydraulic loading/throughput capacity so that additional operational redundancy would be available. As an alternative to the dewatering centrifuge, a sludge screw press could be considered for its operational savings due to low HP motors and slow rotation (typically less than 1 RPM).

The lack of grit removal and screening can cause operational and maintenance issues for the centrifuge and its feed pump. During a recent regularly scheduled maintenance visit, the technician noted significant debris accumulation in the centrifuge. This debris accumulation can result in accelerated wear and more frequent repairs. Excessive centrifuge repairs (beyond normal wear and tear) are costly in two ways: higher maintenance costs and higher sludge management costs with the machine out of service.

In absence of fine screens installed at the plant influent, it is recommended to install a sludge screen system to protect the pumps, centrifuge and any future dewatering equipment.

It is recommended that the polymer system be modified to incorporate a manual mineral oil feeder to clean the pipes, valves, pumps and blending unit equipment. It is also recommended to reduce the polymer dose to 20 lbs/DT and modify the flow and concentration to maximize capture/dewatering performance.

District staff has indicated that managing sidestream flows originating from the solids handling and disposal processes has been troublesome. These sidestreams contain high nutrient concentrations (ammonia-nitrogen and phosphorus) that can overwhelm the nitrification and denitrification processes in the aeration tanks. Elevated phosphorus concentrations also increase ferric chloride consumption and generate more chemical sludge which increases solids loading rates on clarifiers and biosolids processing units. Management of these flows is particularly difficult in the winter or when the digesters go septic. This may be indicative of insufficient solids handling capacity, and/or insufficient ferric chloride dosing.

The District has contracted with a consultant to perform a biosolids study. This study will evaluate current and future solids production needs and disposal methods in greater detail.

4.1.13 Electrical

Elements of the Electrical System for both OECC North and South are intertwined to the extent that they will be discussed together in this section.

Utility Service

The Olentangy Environmental Control Center is supplied by three AEP services. The three services arrive below grade and each is terminated at an AEP owned utility transformer. The electrical services are metered for revenue on the secondary side of the service transformers. The three electrical services arrive to OECC through a shared AEP distribution circuit. The AEP distribution circuit is fed from a single double-ended substation. The AEP substation is served by two independent transmission lines which provide redundancy at the transmission level. However, there is no redundancy at the distribution level which is transmitted to the Plant. An outage across the distribution circuit would leave the Plant without power until the distribution circuit failure is corrected.

Solids Handling

The service transformer is located adjacent to the Sludge Thickener building. This service provides normal power supply to the Solids Handling, Dewatering, and Tertiary Treatment facilities. The service transformer is rated for 1000KVA, 13,200V primary-480Y/277V secondary. The service transformer was manufactured in 1996. The transformer has the capacity to supply 1200A at 480V, 3 phase. The largest electrical demand measured by AEP in the past year is 462.80KW [556.66A] which was recorded in February of 2016. According to this peak demand recording, the service transformer has 54% spare capacity.

OECC North Service

The service transformer is located adjacent to the North Blower building. This service provides normal power supply to the North Blower, Concentrator, Effluent, and Influent facilities. The service transformer is rated for 1000KVA, 13,200V primary-480Y/277V secondary. The service transformer was manufactured in 1994. The transformer has the capacity to supply 1200A at 480V, 3 phase. The largest electrical demand measured by AEP in the past year is 267.00KW [321.15A] which was recorded in March of 2015. According to this peak demand recording, the service transformer has 74% spare capacity.

OECC South Service

The service transformer is located adjacent to the South Blower building. This service provides normal power supply to the South Blower facility and Administration building. The service transformer is rated for 750KVA, 13,200V primary-480Y/277V secondary. The service transformer was manufactured in 2011. The transformer has the capacity to supply 900A at 480V, 3 phase. The largest electrical demand measured by AEP in the past year is 331.92KW [399.24A] which was recorded in February of 2016. According to this peak demand recording, the service transformer has 56% spare capacity.

Standby Power

OECC is supplied by two standby diesel generators, one each for the north and south plants. The generators are sized to provide 100% standby power to the plant in the event of a normal power supply outage. The generators are serviced by a third party maintenance contract. Critical loads, such as the plant process control systems are supported by uninterruptible power supply units.

OECC South Generator

The generator is located in the South Blower building. This diesel generator was manufactured by Caterpillar in 1998 and has 55% of its remaining useful service life. The diesel generator is rated for 1500KW with a 480V, 3 phase system voltage output. The South Plant generator provides standby power to both the South Plant and Solids Handling facilities. The generator has the capacity to supply 1800A at 480V, 3 Phase. The largest combined peak demand in the past year for the two services is 794.72KW [956.34A], which was recorded in February of 2016. According to this peak demand recording, the South Plant diesel generator has 47% spare capacity. The generator is supplied by a 10,000 gallon fuel tank. If the fuel tank is full, the generator would be capable of supplying standby power to the South Plant at the measured peak demand for 172 hours.

OECC North Generator

The generator is located adjacent to the Influent building. This diesel generator was manufactured by Caterpillar in 2013 and has 100% of its remaining useful service life. The diesel generator is rated for 1000KW with a 480V, 3 phase system voltage output. The North generator provides standby power to the North Plant facilities. The generator has the capacity to supply 1000A at 480V, 3 Phase. The largest measured peak demand in the past year for the North Plant service is 462.80KW [556.66A] which was recorded in March of 2015. According to this peak demand recording, the North Plant diesel generator has 44% spare capacity. The generator is equipped with a 2,600 gallon fuel tank. If the fuel tank is full, the generator would be capable of supplying standby power to the North Plant at the measured peak demand for 66 hours.

Large Electrical Distribution Equipment

Maintenance and repair of the distribution equipment (switchgear, auto transfer switches, switchboards, and motor control centers) is performed on a “condition based” assessment by the District maintenance staff. Normal preventive maintenance and minor corrective maintenance is covered within the Operations and Maintenance budget. Majority of the distribution equipment is working well with minor defects or is in new to excellent condition. This type of equipment may be expected to remain in service for up to 40 years, not including soft starters (15yrs) and variable frequency drives (10yrs). The percent of remaining useful life for the Plant’s large distribution equipment ranges from 55-100%.

4.1.14 Controls

Elements of the Controls System for both OECC North and South are intertwined to the extent that they will be discussed together in this section.

Control System Architecture

The Olentangy Environmental Control Center (OECC) utilizes a distributed, PLC-based control system with a PC-based SCADA system for process control and monitoring at the facility. Control systems of this type are commonly applied to similar wastewater treatment facilities. At this plant, the majority of the system functionality is monitoring—a relatively small amount of control is available in comparison to the newer Alum Creek facility.

Allen Bradley PLC 5 Series Programmable Logic Controllers

The majority of the control system consists of several original (1993) Allen Bradley (AB) PLC 5 Series programmable logic controllers and remote I/O racks installed in control panels at various locations near process equipment around the plant. In some locations, the original PLC 5 systems have been updated to the ControlLogix family. The PLC 5 series, introduced in 1986, was installed when the product line was the current flagship technology available from Allen Bradley.

Over the past several years, it has become increasingly difficult to find replacement parts for the PLC 5 product line. Allen Bradley is formally discontinuing the product line in June 2017 meaning the components will no longer be supported and can no longer be ordered from Allen Bradley. The plant currently has a project in construction which is replacing one of the existing PLC 5 systems to ControlLogix. As a result of the upgrade, the plant keeps the retired PLC 5 components for spare parts for the remainder of the system.

Although each PLC 5 system at the plant has significant available capacity to accommodate additional I/O capacity, such as empty slots in the PLC racks and panel space for terminals, discontinuance of the product line leads to an obvious recommendation of upgrading to the current ControlLogix platform.

Allen Bradley SLC 500 Series Programmable Logic Controllers

In addition to the PLC 5 Series, the plant has some Allen Bradley SLC 500 Series modular programmable controllers which are primarily associated with packaged equipment.

Although many of the individual products within the family have been discontinued, many components are still available including the higher-level processors and most of the offering of I/O modules. All the components which are still available are considered "Active Mature" by AB which means they are currently fully supported but a newer product exists and the manufacturer will eventually discontinue the product line.

Control Panels

The physical condition of the PLC control panels at the facility is good and better than expected considering the equipment age. Most panels appear to have been selected with ratings that are compatible with the environment in which they are located—there does not appear to be damage due to corrosion, leaks, poor cabinet sealing, or animals.

Although the master planning focused primarily on the control system infrastructure (field-located instruments and panels were not generally assessed), the planning team received input from plant staff regarding poor condition of the aeration tank mixer control panels. Components within the panels frequently break down and the plant has maintained limited operation by salvaging parts from out-of-service mixer panels. It is possible that exposure to high outdoor temperatures and temperature cycling may be limiting the life span of the failing components.

Supervisory Control and Data Acquisition System (SCADA)

The plant SCADA system is based on the General Electric iFix human-machine interface software family running on workstation-class Dell personal computers.

Consistent with the relatively short lifecycle of software and PCs, the SCADA system has been upgraded, most recently in approximately 2010. The operating system is Microsoft Windows 7 with Service Pack 1, which is the latest version supported with the current version of iFix installed. The iFix software version is 5.0. As of June 2016, the current shipping 7version of the GE iFix product line is 5.8. Microsoft defines two levels of support for their operating system products: Mainstream Support and Extended Support. Microsoft Mainstream Support ended on January 13, 2015 for Microsoft Windows 7. Extended Support for Windows 7 ends January 14, 2020. It is not uncommon for process control system software to lag behind in terms of being compatible with the newest operating system available. As the PCs running the SCADA software age and fail, it will eventually become more difficult to find replacement computers compatible with Windows 7.

Interviews conducted with District staff indicate the custom-developed PLC programs and SCADA application generally meet the needs of the process and staff. Most critical equipment and process instrumentation status is displayed, stored historically, and available for trending. The SCADA alarm system is sufficient and generally free of nuisance alarms. The plant staff is distracted at times by nuisance alarms associated with equipment that is out of service. Although this is a typical complaint of plant staff most SCADA software provides features and tools that allow operators to suppress or shelve alarms for long periods of times when the alarms are not applicable. Since the plant is staffed 24/7 and diligently monitored, there is not paging, text message, or similar remote alarm delivery mechanism in place.

Plant staff did indicate one area of deficiency in terms of monitoring, where the status (running/stopped, alarms) of equipment is not available, specifically for filter wash water, non-potable, and post-aeration systems.

Control System Network

The plant-wide Ethernet network connects the PLCs to the SCADA network for monitoring. The existing network consists of fiberoptic and copper Ethernet cabling, media converters, and ethernet switches. The network topology represents a daisy-chained configuration. Nearly none of the permanent cabling is labeled, which can make network troubleshooting extremely difficult during a failure.

Although the Ethernet media converters and switches are of varying age and condition, replacement components are inexpensive and readily available from a variety of sources. At one point in time, the process control system and County business system networks were interconnected. Although this connectivity facilitated support in times of need, the unsecured and “always-on” nature of the connectivity substantially increased the security risk of the process control system in terms of both intentionally malicious outside attacks and inadvertent internal configuration mishaps. Following a significant process network outage a few years ago, the networks have since been separated.

In addition to the Ethernet network, the PLC 5 and SLC 500 systems utilize two proprietary networks for linking remote I/O racks (AB Remote I/O) and for PLC-to-PLC communications (Data Highway Plus). Although the technology is very mature, there are known issues associated with the cabling or connectivity. Once the plant upgrades SLC and PLC 5 systems the networks are no longer required.

Control System Power Reliability

All PLC control panels, network switches, and SCADA PCs appear to be powered by uninterruptible power supplies to provide backup power during short power outages. Providing backup power for PLC systems is a good practice to prevent PLCs from losing their program or data during a power outage.

PLC memory is backed up with a battery in the CPU module and the battery is regularly maintained by plant staff. The PLCs also have memory backup via EEPROM modules, but this has limited usefulness as the backup procedure is not automatic and is infrequently performed (it is necessary to place the processor in programming mode which shuts down the process).

It is not known whether the UPS also provides a degree of backup power for process instrumentation.

The ages of the UPS batteries are unknown. If the UPS batteries are original, they are very likely in need of replacement.

Control System Maintenance and Support Services

Currently, the District relies on control system support services from SCI located in Kensington, Ohio, to provide troubleshooting, upgrades, and other system modifications. Both plant control systems were originally programmed by SCI and thus the consultant is very familiar with the systems.

SCI is a small firm that is owned and operated by two control system engineers.

Minor issues and planned work and upgrades are performed when they can be conveniently scheduled for SCI and the District.

The District has a support contract in place to provide priority support and after-hours support in the event of an emergency. Depending on the nature of the emergency, SCI is typically on-site the day after being called for support but generally within 48 hours.

SCI has identified a timeline of approximately 10 years for closing their operations.

Due to the separation of the networking and lack of a separate VPN (virtual private network) setup for the process control network, much troubleshooting and all changes must be made on-site.

Neither the plant not the District has directly employed staff capable of troubleshooting and supporting the more sophisticated aspects of the system such as PLC and SCADA system software changes and troubleshooting.

Disaster Recovery Preparation

The District does not have a formal disaster-recovery plan in place that addresses the process control system. Such a plan would typically involves formally identifying disaster risks, assembling important system documentation and original program files (PLC, SCADA), and identifying key personnel, roles, and procedures that may be called upon to restore the process control system to operation in the event of a disaster.

SCI maintains backups of the automation program files on behalf of the District. The District does not currently maintain copies on-site or at an off-site County facility for the purposes of disaster recovery.

Not as significant as PLC and SCADA automation program files, the alarm history and process data is not backed up in any way (with the exception of certain information that is duplicated between the redundant SCADA servers). Although alarm history tends to be less valuable over time, the process data is extremely valuable when looking for flow and treatment patterns over time. This kind of data can be useful for troubleshooting the treatment system and planning/engineering type activities for the facility.

Documentation

The plant has access to automation system documentation but the documentation is original and thus likely very much out of date. The ControlLogix upgrades that have been performed were not provided with documentation. Typical documentation for the control system includes control panel shop drawings, wiring diagrams showing all I/O connecting to the PLCs, network diagrams, and PLC program printouts.

4.2 Alum Creek Water Reclamation Facility

The Alum Creek Water Reclamation Facility (ACWRF) was commissioned in 2002 and was designed for an average flow of 10 MGD and a peak flow of 30 MGD. Treatment processes employed by ACWRF include raw sewage pumping, mechanical bar screening, activated sludge aeration, final clarification, tertiary filtration, UV disinfection, post-aeration, aerobic digestion, and sludge thickening.

4.2.1 Wastewater Characteristics, Flows, and Pollutant Loads

This characterization is based on the review of historical information listed below. Table 17 summarizes pertinent data obtained during this review.

- ACWRF Operations and Maintenance Manual (June 2003)
- OEPA reporting forms for ACWRF from April 1, 2013 through December 31, 2014.
- ACWRF operating data from September 14, 2012 through May 29, 2015.
- USEPA Enforcement and Compliance History Online (ECHO) facility report.

Table 17 - Alum Creek WRF Operating Data Summary					
Description	**Influent**		**Effluent**		**Units**
	Design Criteria	**Current Conditions**	**NPDES Limit (Monthly)**	**Current Conditions**	
Average Flow	10	5.3[1]	10	4.8	MGD
Peak Flow	30	26[2]	-	10.8	MGD
Dissolved Oxygen	-	-	7.0 (summer) 6.0 (winter)	9.58 avg 7.6 min	mg/L
Total Suspended Solids	-	224 avg 552 peak	12	4.33 avg 209 peak	mg/L
Nitrogen-Ammonia	-	-	3.0 (winter) 1.0 (summer)	0.23 avg 1.67 peak	mg/L
Nitrate + Nitrite	-	-	-	14.3 avg 19.8 peak	mg/L
Phosphorus	-	-	-	3.2 avg 5.6 peak	mg/L
5-day Carbonaceous Biochemical Oxygen Demand	167 avg 232 peak	208 avg 368 peak	10	2.39 avg 69.8 peak	mg/L
E. Coli	-	-	126	18.9 avg 1,299 peak	#/100mL

[1]Assumes 10% recycle for non-potable uses
[2]June 23, 2016 wet weather event
"-" = not monitored/available

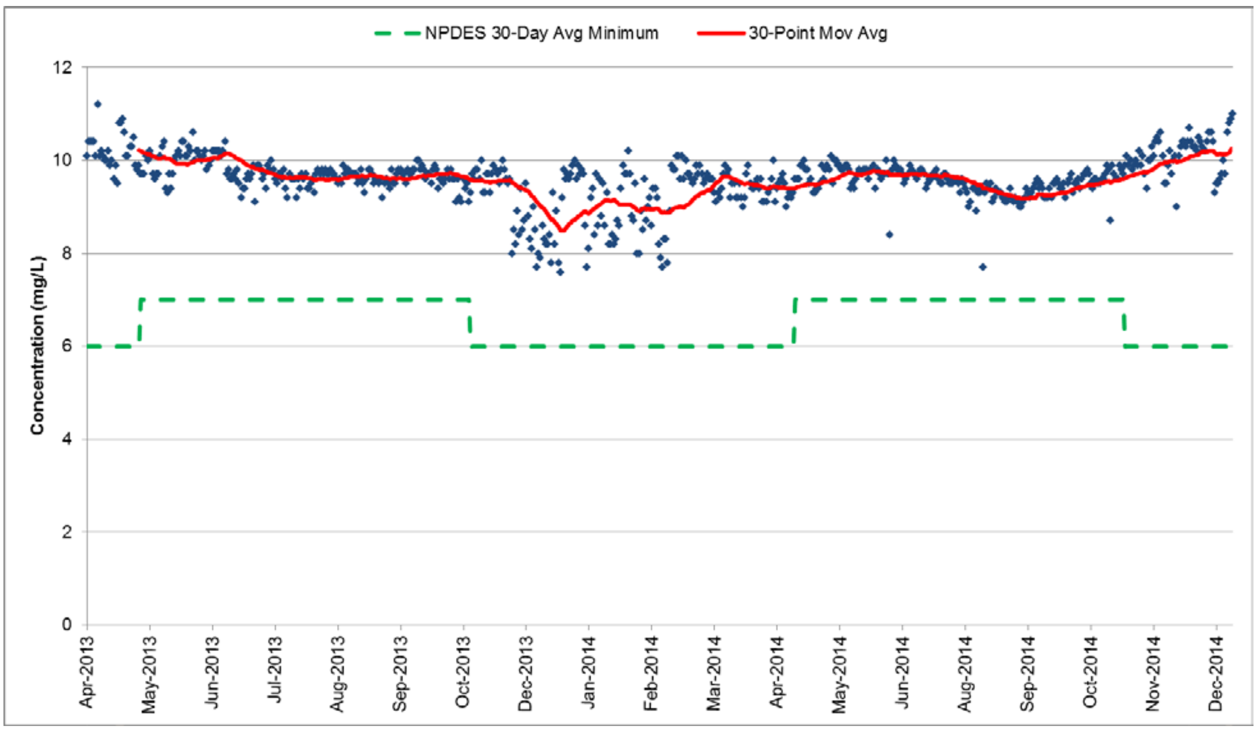
Key findings are summarized as follows:

- As of March 31, 2016, ACWRF is not in significant non-compliance (SNC) or reportable non-compliance (RNC) with NDPES permit limits according to EPAs ECHO. However, 1 of the past 12 quarters was considered non-compliant based on a single-event violation but was not considered to be in SNC or RNC. The quarter of non-compliance was quarter 4 of 2014 and was caused by effluent $CBOD_5$ and TSS concentrations exceeding permit limits. No formal enforcement actions (i.e., administrative orders, civil/judicial litigation) in the past 5 years have occurred. The District has received 3 informal enforcement actions in the past 5 years (2 letters of violation/warning, 1 notice of violation). The last informal enforcement action occurred on June 23, 2014. It should be noted that the compliance status for quarter 2 of 2016 is still in progress.

- ACWRF plant effluent flows were used as the basis for this analysis. Per District staff, the raw sewage influent flow meter is not accurate. To estimate influent flows, average and peak effluent flows were multiplied by a factor of 1.1 to estimate average and peak influent flows. This factor is a rule of thumb value that accounts for plant recycle streams. Therefore, current average flow is approximately 5.3 MGD and current peak flow is approximately 11.8 MGD which are lower than design values. Under average conditions, ACWRF is estimated to be operating within 47% of its rated average design flow and within 60% of its rated design peak flow. It should be noted that during a wet weather event that occurred on June 23, 2016, the raw sewage influent flow meter reading did reach approximately 26 MGD, or 87% of ACWRF's peak flow rating.

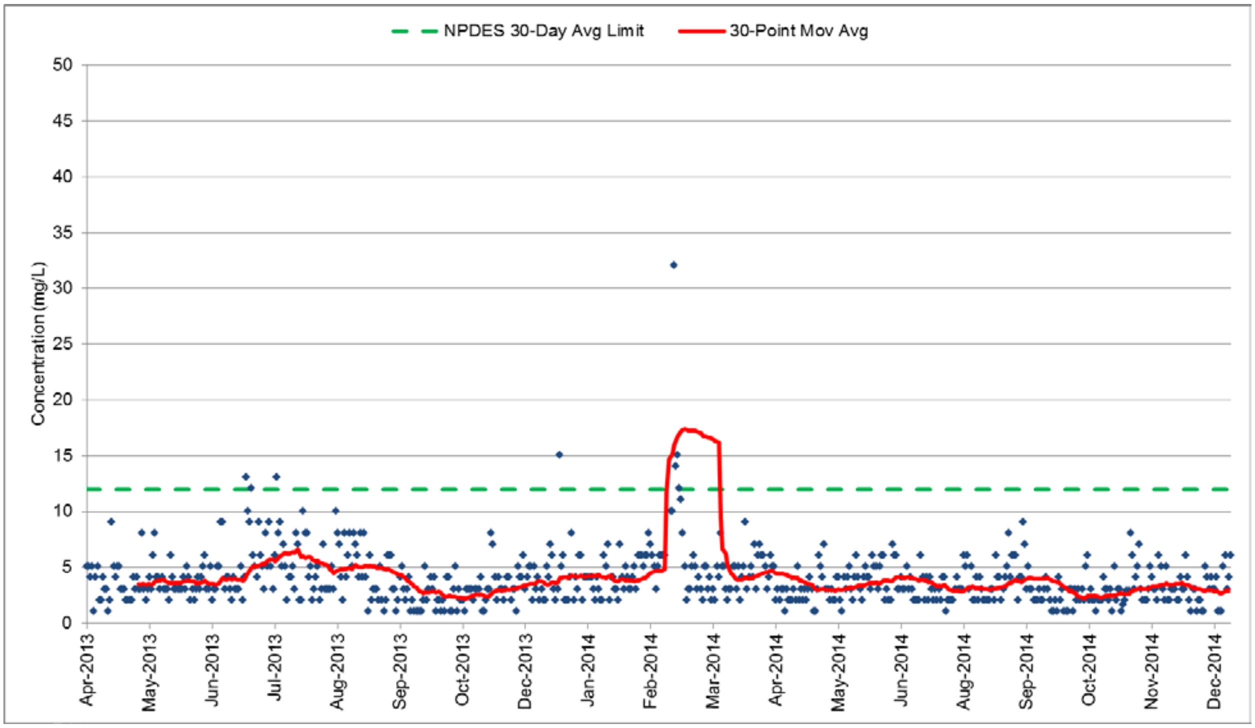
- Dissolved oxygen (DO) concentrations routinely exceed the minimum permit requirement. The average DO concentration over the review period was 7.38 mg/L. Refer to Figure 8 for effluent DO concentrations.

Figure 8 - ACWRF Effluent DO Concentrations



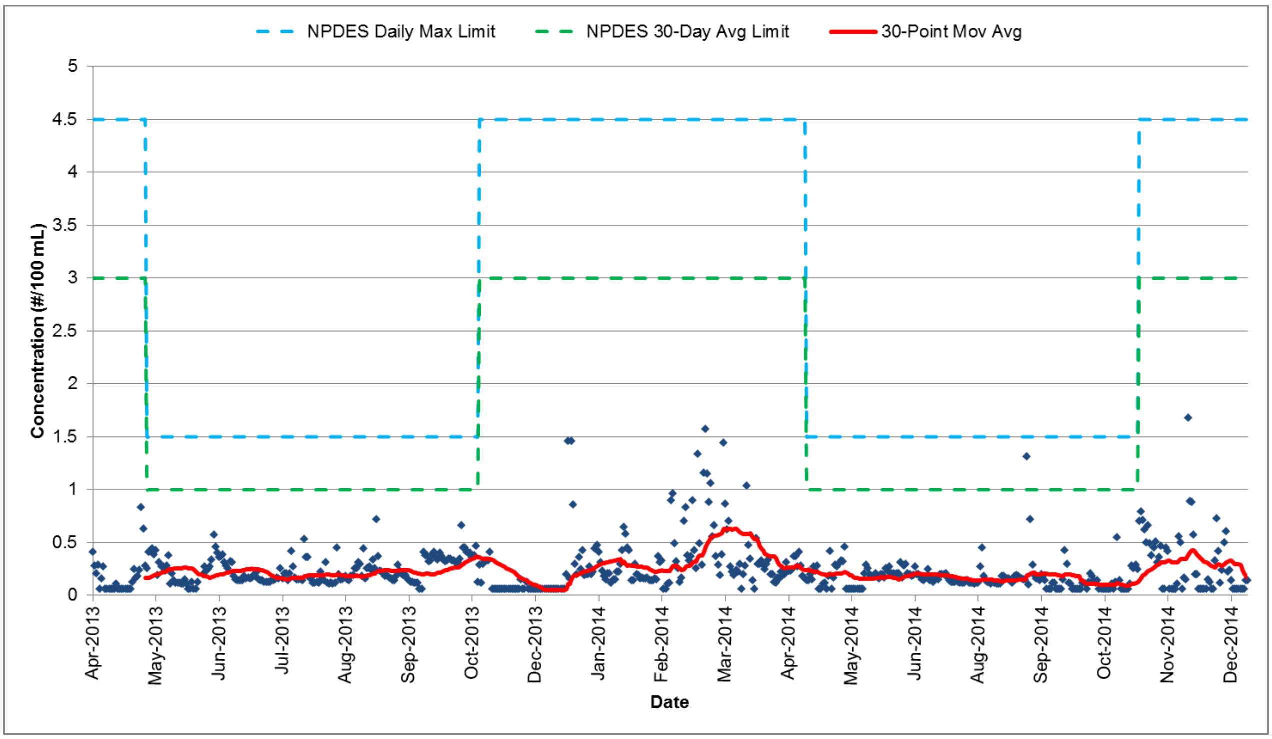
- The average influent TSS concentration is 224 mg/L. Design criteria for influent TSS is not known. Effluent TSS concentrations demonstrate consistent and sufficient removal with a 30-point moving average that routinely trends below NPDES permit limits. The average TSS concentration over the review period was 4.33 mg/L. Refer to Figure 9 for effluent TSS concentrations.

Figure 9 - ACWRF Effluent TSS Concentrations



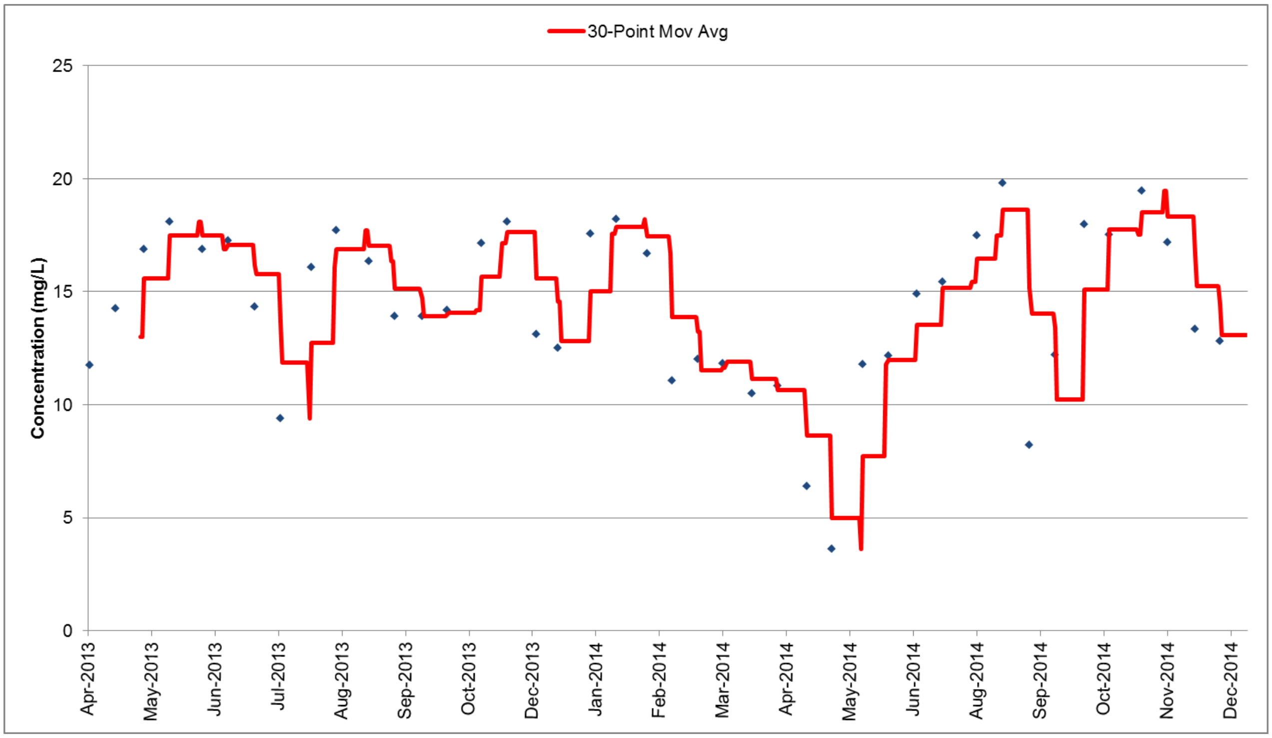
- Over the review period, the average effluent NH_3-N concentration was 0.23 mg/L, which indicates sufficient nitrification is occurring. Occasionally, the effluent NH_3-N concentrations exceeded 1 mg/L which suggests incomplete nitrification, however, they remained within permit limits. Incomplete nitrification can be the result of a process upset in the aeration tanks or final clarifiers. There are several potential causes of incomplete nitrification in the aeration tanks including insufficient SRT, low DO concentrations, and insufficient alkalinity. Ammonia can also be re-released by the death and breaking apart of aerobic bacteria when exposed to an environment lacking oxygen for a period of time in the final clarifiers. Refer to Figure 10 for effluent NH_3-N concentrations.

Figure 10 - ACWRF Effluent NH_3-N Concentrations



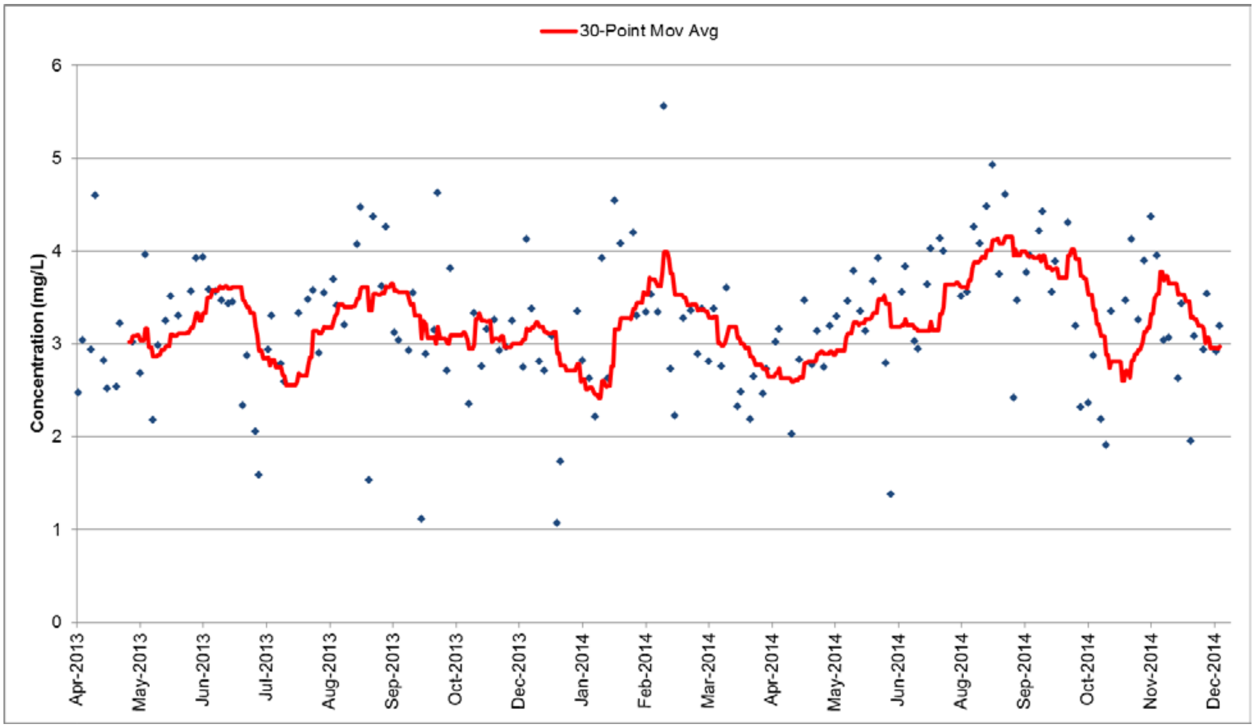
- ACWRF currently does not have a $NO_3 + NO_2$ limit. The average $NO_3 + NO_2$ concentration over the review period was 14.3 mg/L. In the event that $NO_3 + NO_2$ limits are enacted, ACWRF will need to denitrify in the aeration process. A project currently in progress will enhance ACWRF's ability to denitrify by providing new mixers and restoring the ability to control DO concentrations throughout the aeration basins with new valves. Refer to Figure 11 for effluent $NO_3 + NO_2$ concentrations.

Figure 11 - ACWRF Effluent $NO_3 + NO_2$ Concentrations



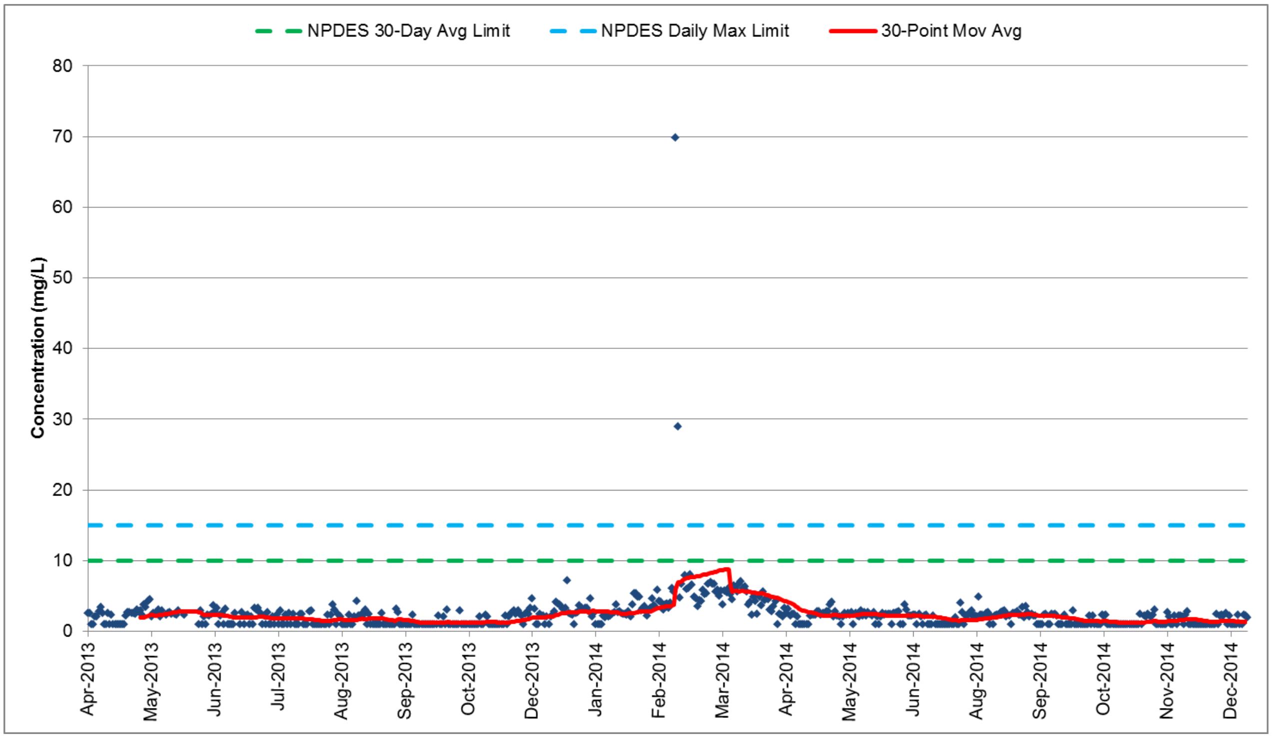
- ACWRF currently does not have a phosphorus limit. The average phosphorus concentration over the review period was 3.2 mg/L. ACWRF is equipped with a ferric chloride feed system that can be used for phosphorus removal if needed. This system is currently not in use. The feed system injects chemical to the effluent end of the aeration tanks to remove phosphorus. Refer to Figure 12 for effluent phosphorus concentrations.

Figure 12 - ACWRF Effluent Phosphorus Concentrations



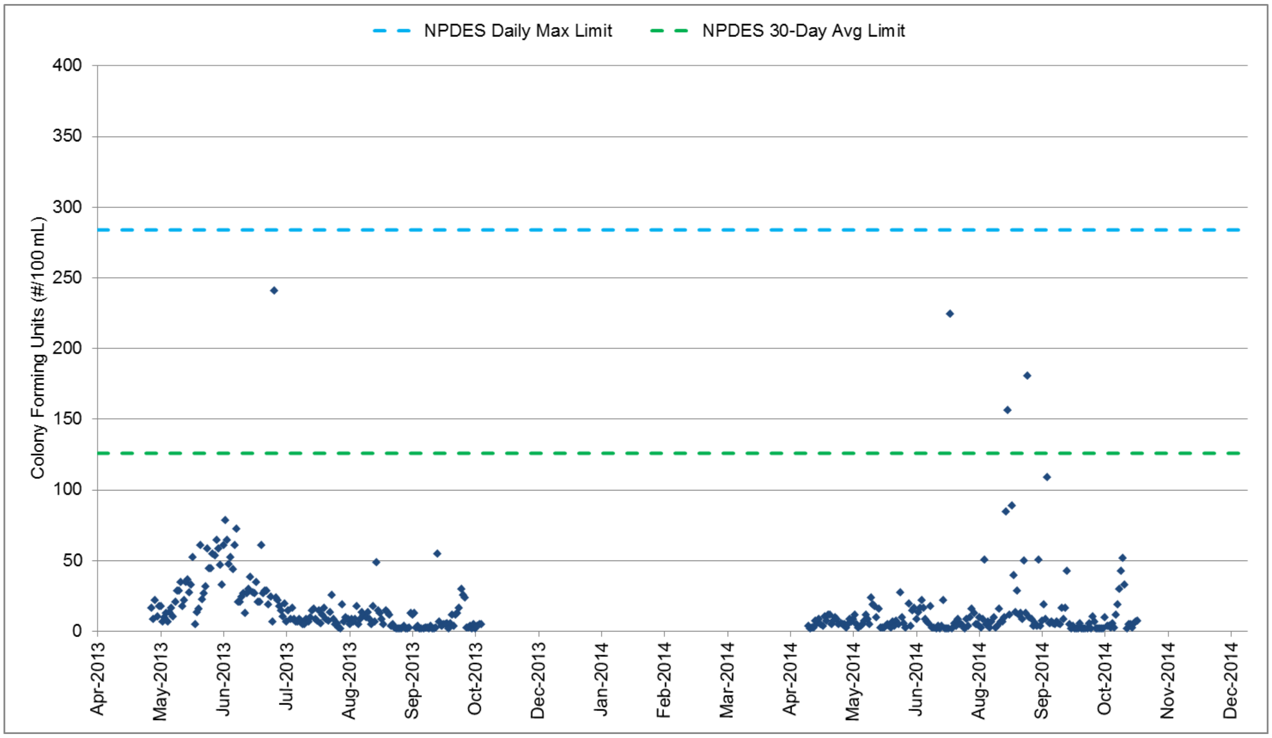
- The average influent $CBOD_5$ concentration is approximately 25% greater than the design assumptions. Effluent $CBOD_5$ concentrations demonstrate consistent and sufficient removal with a 30-point moving average that routinely trends below NPDES permit limits. The average effluent $CBOD_5$ concentration over the review period was 2.39 mg/L. Refer to Figure 13 for effluent $CBOD_5$ concentrations.

Figure 13 - ACWRF Effluent $CBOD_5$ Concentrations



- Reported effluent E. Coli, measured in colony-forming units, demonstrates sufficient inactivation by the UV disinfection process. The average E. Coli colony-forming units over the review period was 18.9. Refer to Figure 14 for effluent E. Coli colony-forming units.

Figure 14 - ACWRF Effluent E. Coli Colony-Forming Units



4.2.2 Hydraulic Capacity

Plant hydraulic capacity was evaluated through a combination of visual inspection, staff interviews, and collection system modeling. No hydraulic capacity concerns were noted during site inspections or during communications with District staff. The collection system model was used to estimate plant inflows and will be discussed in greater detail in Section 5 of this memorandum. The collection system model predicted that for a 25-year design storm, plant inflows would reach approximately 26 MGD. Because ACWRF is rated for a peak capacity of 30 MGD, further hydraulic analysis of the treatment was not investigated.

4.2.3 Existing Site

Characteristics of the existing site including the property and its location, access, security, and safety are discussed herein.

Site

- ACWRF is located on a 50 acre parcel of land due west of I-71. Available space for plant expansion is limited on the existing site.

- Hydrogen sulfide gas gives raw sewage its rotten egg smell. Residential development abuts the plant site to the north, west, and southwest with additional residential development located to the east past I-71. ACWRF's proximity to these developments makes the collection and treatment of this gas important in order to prevent odor complaints from nearby residents.

Access

- Two entrances to ACWRF from Walker Wood Boulevard are provided. The south entrance appears to serve vehicle traffic destined for the Administration Building. The north entrance appears to be dedicated to allowing vehicle access to the process areas. Separating traffic in this manner alleviates traffic congestion at the site entrance thereby improving plant logistics.

- Plant drives provide access to all process areas and are approximately 20 feet wide. This allows for two-way traffic, making the transportation of equipment and material between process areas easier.

- Ample parking is provided near the Administration Building and at the Maintenance Building. This helps keep the plant drives free of parked traffic thereby improving traffic flow.

- A traffic loop is provided at the Solids Handling Facilities to allow larger wheelbase vehicles (i.e. semis, dump trucks) to turn-around. This improves overall plant traffic flow by providing truck drivers sufficient space to turn with minimal negative impact to local traffic during sludge load out operations.

Security and Safety

- A security fence is installed and fully encloses the inner process area (aeration, final clarification, tertiary filtration, and aerobic digestion). The Pre-Treatment Building, Drain Pump Station, Solids Handling Facility, Maintenance Building, Tertiary Filter Building, and Post Treatment Building are outside this fence.

- A security gate is provided next to the Pre-Treatment Building which grants vehicular access to the Drain Pump Station, the Solids Handling Facility, the Maintenance Building, and the Post Treatment Building. A security gate next to the Tertiary Filter Building grants vehicular access to the inner process area.

- Sufficient site lighting illuminates the drives and process areas.

- Material safety data sheets (MSDS) are located near the chemical as well as stored in a centralized location in the Administration Building.

- Ear protection is provided in areas with high noise levels.

4.2.4 Pre-Treatment

The Pre-Treatment Building has two automatic screens and one manual bypass bar screen. The manual bypass bar screen provides redundancy should either of the automatic screens be out of service. Debris is removed from the automatic bar screen by a finger rake and deposited on a screw conveyor where they are transported to a washer/compactor. Washed and compacted screenings are then bagged by an automatic bagging system and deposited into a container prior to final disposal. An adjacent chemical handling and odor control area is attached to the Pre-Treatment Building to control foul air. Odor control for the Pre-Treatment Building is accomplished by sending the foul air to the aeration blowers as intake air. Major process equipment for the pre-treatment process is included in Table 18.

Table 18 - ACWRF Pre-Treatment Process Equipment

Equipment	Quantity	Features
Mechanical Bar Screens	2	15 MGD, ea., 0.25" clear spacing
Bypass Bar Rack	1	1" clear spacing
Odor Control Scrubber	1	7,100 CFM
Foul Air Fan	1	7,100 CFM @ 10" w.c.

Condition Assessment

Raw Sewage Screening

- An opening in the screen room operating floor was provided to install the screen influent slide gates upstream of the screens. A portion of this opening remains open without grating or safety guardrail to prevent falling through.
- Grit accumulation was noted in the influent channel of screen 2. The District should monitor this accumulation due to the operational and maintenance challenges grit imposes on treatment processes.
- Evidence of surface oxidation on piping. Raw sewage has the ability to produce hydrogen sulfide gas which is corrosive to numerous materials. The District should continue to monitor this oxidation and check for failure of the substrate.
- The raw influent sample pump is not installed in the sample room. A portion of the pump intake line remains in the floor and wobbles within the floor penetration. This wobbling is caused by the passing of raw sewage beneath. Foam insulation spray was applied around the floor opening but it does not appear to form a sufficient seal. Hydrogen sulfide gas from the raw sewage may enter this room and degrade equipment and electrical conduit.
- During visual observations of downstream treatment processes, debris accumulation on cables, pipes, and valve stems was observed. The extent of this accumulation is considered minor and not indicative of a large scale issue. The District is encouraged to monitor this accumulation.

Odor Control

- According to District staff, the odor control scrubber system, which is designed to treat foul air containing hydrogen sulfide through chemical application, has not been put in service since the completion of plant construction due to unidentified operational problems.

- The Odor Control Room contains equipment that handles odorous air containing hydrogen sulfide, a flammable gas in sufficient concentrations. This room has a National Electrical Classification (NEC) of 'declassified' except for within a 3 foot buffer area around possible leakage sources (i.e. dampers, flanges, fans, odor-control vessels, etc.). This buffer area carries a class 1, division 2 classification according to NEC. Duct heater DH1-PR, which is located within this buffer area, was observed to have an open flame which may ignite hydrogen sulfide in the event of a leak. Potential corrective actions include reconfiguring the duct work to move DH1-PR outside of this buffer zone or replacing DH1-PR with a unit suitable for use in class 1, division 2 spaces.

- The exterior chemical filling station was noted as having no spill prevention or control. An accidental release of chemical would overwhelm the fill station and spill out on to the nearby drive. According to District staff, this fill station is not used.

Capacity Assessment

ACWRF has two mechanical screens, each with a manufacturer rated capacity of 15 MGD. A redundant bar rack with a capacity of up to 30 MGD is provided should one of the mechanical screens be taken out of service. With two mechanical screens in service, the screening process has a capacity of 30 MGD. With one mechanical screen out of service, the screening process capacity remains at 30 MGD.

4.2.5 Aeration

Screened raw sewage enters the basement of the Blower Building via two 30 inch pipes where it is then split between the six aeration tanks. Six pinch valves regulate the flow of influent raw sewage to each aeration tank prior to introducing RAS. RAS is pumped directly in to each aeration tank's raw sewage influent pipe to form mixed liquor prior to discharge into an aeration tank.

The aeration tanks are typically operated in a conventional plug flow mode with all mixed liquor being discharged at the head of the aeration tank. Piping and valving for step feed and sludge re-aeration modes are also provided for but are not typically used. Foul air from the odor control process is also ducted into the intake line for the blowers. Major process equipment for the aeration process is included in Table 19.

Table 19 - ACWRF Aeration Process Equipment		
Equipment	**Quantity**	**Features**
Aeration Basins	6	6 trains with 3 basins in each train. Each basin is 119' L x 27' W x 15.17' SWD.
Centrifugal Blowers 1-4	4	7,850 SCFM @ 9 PSIG, 450 HP
Centrifugal Blowers 5-6	2	3,925 SCFM @ 9 PSIG, 250 HP

Condition Assessment

Aeration Tanks

- Surface oxidation was observed on globe valves and on the exposed raw sewage and mixed liquor distribution piping. This oxidation has led to protective coating failure in some locations. These observations apply to globe valves in all aeration tanks and for distribution piping installed in aeration tanks 1 through 3. During the time of inspection, aeration tanks 1 through 3 were offline and drained.

- Aeration basins 4B and 5B have a rolling water surface. This may be caused by air pockets trapped under the cantilevered walkway/pipe chase. These likely results in reduced tank freeboards and minor unevenness in air distribution.

- Exposed mixer power cables and guiderails show signs of debris accumulation.

- According to District staff, the existing tank mixers are suffering from reliability issues and replacement parts are not available from the manufacturer due to the limited production run of the mixer model used by the District.

- Grit accumulation noted in aeration tanks 1 through 3. The accumulation of grit in aeration tanks is not only a labor intensive and time consuming process; the accumulated grit may interfere with oxygen transfer of the diffusers, resulting in decreased treatment efficiency.

- The globe valves on the diffuser drop legs are unreliable, and have even failed in some locations. This inhibits the District's ability to control DO concentrations throughout the aeration tanks, decreasing treatment effectiveness.

Centrifugal Blowers

- The centrifugal blowers are known by District staff to have insufficient turndown capabilities. The District has entered into an agreement with a consultant to analyze the centrifugal blowers and identify replacement alternatives.

Capacity Assessment

This capacity assessment will be based on the aeration system's ability to deliver the required air to meet the oxygen demand exerted by the oxidation of both $CBOD_5$ and TKN while maintaining a DO concentration of 2.0 mg/L in the aeration tanks. District staff do not measure influent TKN concentrations, therefore, this analysis used the peak TKN concentration shown in the ACWRF's Operation and Maintenance Manual (June 2003). Parameters used in this evaluation are summarized in Table 20.

Table 20 - ACWRF Aeration Process Data		
Parameter	**Units**	**Value**
Peak $CBOD_5$	mg/L	345
Peak TKN[1]	mg/L	37
Alpha	Unit less	0.5
Beta	Unit less	0.95
Temperature	deg-C	21
SOTE	%	20

[1] June 2003 Operation and Maintenance Manual

A description of the derivation of air delivery requirements for the aeration process was provided in Section 4.1.5 and will not be reproduced here. Based on the process parameters listed in Table 20, ACWRF has sufficient blower capacity to treat approximately 15.1 MGD when using all available blowers under current conditions. With one blower out of service, the available air supply limits the maximum flow to 12.1 MGD. These values are lower than the peak design capacity of 30 MGD for ACWRF. It should be noted that recorded peak $CBOD_5$ during the review period was found to be nearly 50% greater than design criteria. Without measured TKN concentrations, a similar comparison could not be made.

A technical memorandum of findings from the ACWRF filter upgrade project study was completed in 2015. The memorandum proposed improvements to the aeration process to enhance the settling characteristics of the mixed liquor to reduce solids loading to the tertiary filtration process. These improvements included replacement globe valves and anoxic zone mixers. Globe valves on the diffuser drop legs will be replaced with new units to increase control of DO concentrations in different sections in the aeration tanks. New mixers will also be installed to enhance mixing in anoxic zones. In addition to increasing the settling properties of the mixed liquor, these improvements will increase treatment performance in the aeration process.

4.2.6 Final Clarification

The Clarifier Splitter Box receives mixed liquor from the upstream aeration process through two 48 inch diameter pipes. The splitter box is separated into two halves with each half supplying flow to two clarifiers. The splitter box may be operated as a single chamber although this not typically done. Manually controlled weir gates are provided to split flow to each clarifier. The final clarifiers are 135 feet in diameter and feature organ pipe draft tube sludge collection mechanisms, flocculating influent well, and scum collection. Scum is collected and deposited into a trough for transport to a scum well where two scum pumps pump to the aerobic digestion process. Major process equipment for the final clarification process is shown in Table 21.

Table 21 - ACWRF Final Clarification Process Equipment		
Equipment	**Quantity**	**Features**
Clarifiers	4	135’ dia x 15’ SWD
V-notch weirs, ea.	810	Crest el. 908.50
RAS Pumps	7	2,315 GPM @ 33’ TDH, 30 HP
WAS Pumps	4	500 GPM @ 40’ TDH, 15 HP
Scum Pumps	2	500 GPM @ 45’ TDH, 15 HP

Condition Assessment

Final Clarifiers

- Debris accumulation was observed within the influent flocculation wells.
- Lip of flocculating influent well was submerged which is not typical.

RAS/WAS/Scum Pumping

- Scum pumps 1 and 2, WAS pumps 1 and 2 were placed in extended storage. WAS pumping is handled by the RAS pumps by manipulating valves on the common discharge header.
- RAS pumps 2, 6, and 7 were noted as requiring repair by District staff.

Capacity Assessment

The capacity of ACWRF’s final clarification process will be based on surface overflow rate SOR, SLR, and WLR for a nitrifying plant using chemical addition for phosphorus removal. While ACWRF does not currently apply ferric chloride for phosphorus removal, this assessment will assume that this system is operational due to expected future phosphorus limits. RAS flows were assumed to equal 75% of ACWRF’s design average flow. Process parameters used in this analysis are summarized in Table 22.

Table 22 - OECC South Final Clarification Process Data		
Parameter	**Units**	**Value**
Average MLSS	mg/L	2,694.94
Maximum RAS Flow	MGD	7.5

Based on these process parameters, ACWRF final clarification has sufficient capacity to treat approximately 48.6 MGD with all tanks in service under current conditions. Process capacity is limited by WLR.

The 2015 filter upgrade technical memorandum also recommended that District staff operate a minimum of two final clarifiers and install TSS monitoring for the final clarifier effluent. Operating a minimum of two final clarifiers will increase the detention time and reduce solids loading to the tertiary filters during high flow events. Effluent TSS monitoring will allow the District to monitor final clarifier performance to optimize tertiary filter operation.

4.2.7 Tertiary Filtration

Clarified effluent travels to the Tertiary Filter Building where eight automatic backwashing filters remove additional suspended matter. The media filters are comprised of sand. Filtered solids are removed via backwashing by a filter carriage suspended from a traveling bridge that passes over the filter media. Major process equipment for the tertiary filtration process is shown in Table 23.

Table 23 - ACWRF Tertiary Filtration Process Equipment		
Equipment	**Quantity**	**Capacity**
Filter	8	48’ L x 12.5’ W
Sand Media	-	16”
Backwash Pumps	8 (1 per filter)	208 GPM @ 16’ TDH
Washwater Pumps	8 (1 per filter)	208 GPM @ 16’ TDH
Prewash Pumps	8 (1 per filter)	50 GPM @ 15’ TDH
Skimmer Pumps	8 (1 per filter)	50 GPM @ 10’ TDH

Condition Assessment

Filter Room

- An inspection was performed during winter and summer months. During winter, the humidity in the filter room was high with condensation noted on various surfaces. During summer, the humidity was at tolerable levels and condensation was not observed. Plant staff should keep HVAC systems operational during all months to mitigate the deleterious effects of high humidity exposure to the equipment and architectural items contained within the facility.
- Surface oxidation of ferrous materials was noted throughout the building.
- With prolonged exposure to the high humidity, the condition of exposed architectural wood laminate will begin to deteriorate.

Filters

- According to District staff, filter 1 is non-operational as parts have been used from this filter to maintain the remaining 7 filters.
- The baffling between the filter media cells is bent which may indicate excessive pressure buildup during backwash.
- Uneven filter media depths within individual cells witnessed in inactive filters suggest media washout.
- Floating material was noted in active filters.

Capacity Assessment

The capacity of ACWRF’s tertiary filtration process will be based on the filtration rate. According to 10SS, the filtration rate is not to exceed 5 gpm/sf under all conditions.

Because filter 1 is non-operational, this capacity assessment will consider 7 filters as opposed to 8. Based on the filter dimensions shown in Table 23, ACWRF's tertiary filtration has adequate capacity to treat approximately 30.2 MGD with 7 filters in service. With one filter out of service, the available capacity drops to 25.9 MGD. Restoring filter 1 to service would increase capacity to 30.2 MGD with one filter out of service (7 online).

The tertiary filters at ACWRF are known to have operational problems. During high flows, a portion of the filter influent is bypassed around the filters before recombining with filter effluent prior to flowing to the UV disinfection process. Bypassing is caused by excessive headloss through the filters resulting from these high flows. Excessive filter headloss also causes the filters to enter their backwash mode which is sustained until the high flow event ends. Excessive filter backwashing has the following negative impacts on ACWRF:

- Reduction in hydraulic and treatment capacity resulting from recycling filter washwater to the head of the plant.
- Increased energy consumption.
- Accelerated media loss that ends up in upstream process tanks.

The District initiated a filter upgrade study to evaluate replacement technologies to address these shortcomings. In 2015, a technical memorandum concluded that performance could be improved by reducing solids loading of the tertiary filters rather than installing new filters. To reduce solids loading, improvements to the aeration and final clarification processes were proposed. These improvements are targeted at producing mixed liquor with improved settling characteristics and providing sufficient detention time in the final clarifiers to mitigate TSS spikes during high flow events.

Following the implementation of the aeration improvements, the District will evaluate their performance to further determine the level of TSS polishing required to meet NPDES permit requirements. Once completed, the District will determine if rehabilitation of the tertiary filtration process is warranted or to place it in standby until required by future effluent criteria.

The OEPA recently gave the District approval to use the filter bypass for efficient filter operation as long as permit limits are met and the District samples the water quality during these bypass events to demonstrate adherence to permit limits. This approach will need to be monitored closely as flows to the plant increase to ensure continued compliance.

4.2.8 Post-Treatment

The Post-Treatment Building houses the ultraviolet (UV) disinfection and post-aeration processes. UV disinfection is operational between May 1 and October 31 whereas post-aeration is operational whenever the plant's effluent DO falls below seasonal thresholds. Filter effluent is channeled to the Post-Treatment Building via 48 inch pipe where it then discharges into a distribution channel for splitting among the UV channels. UV effluent flows into two post-aeration tanks which provide sufficient detention time to raise the DO concentration. Air for the post-aeration process is provided by four positive displacement blowers, each powered by a 50 HP motor and capable of delivering 755 SCFM at 7.8 PSIG. Aerated effluent flows through a Parshall flume for metering before exiting ACWRF. UV disinfection process equipment is summarized in Table 24.

Table 24 - UV Disinfection Process Equipment

Equipment	Quantity
Modules per Channel	5 per channel, 25 total
Lamps per Module	40 per module, 1000 total
Light Intensity	4,760 mW/sq cm

Condition Assessment

UV Disinfection

- The grating over the UV modules does not prevent from being exposed to UV light. Typically the UV modules are fully enclosed by shields.
- Level sensors and flow control equipment should be inspected for debris accumulation as improper control of lamp submergence may lead to potential exposure of workers to UV light, UV equipment damage, and over-heating of the UV equipment.
- UV influent channels showed signs of algae growth. These should be cleaned to prevent algae from sloughing off wall and damaging the modules.

Post-Aeration

- At the post-aeration tank effluent gates, no means of fall protection is provided.

Chemical Handling

- A spill at the exterior chemical loading area will flow through the grate and into the process stream below before it cannot be neutralized. However, the chemical handling area is no longer in use. Dormant equipment should be stored according to manufacturer recommendations. Overall condition of the area was acceptable.
- On one overhead sodium hypochlorite line, crystalized chemical from a previous leak was noted. This needs addressed if sodium hypochlorite feed is restored at ACWRF.

Capacity Assessment

Design standards for UV disinfection require the systems to be based on similar systems that can be demonstrated by the manufacturer's experience at similar full scale installations or prototype testing. To treat additional flows, the equipment manufacturer should be consulted to determine the ultimate capacity of the system. Refer to Section 4.2.1 of this memorandum for a discussion regarding ACWRF effluent E. Coli performance.

The capacity assessment for post-aeration will be based on the post-aeration blowers' ability to deliver the required air to increase the influent flow's DO concentration from 2.0 mg/L to a summer month minimum DO concentration of 7 mg/L. Summer temperatures were used in this assessment because air requirements increase with increasing wastewater temperatures.

Assumed process data used in this capacity analysis is provided in Table 25. The procedure for estimating air requirements for post-aeration is similar to the one used for activated sludge aeration. The alpha and beta factors are greater than those used previously for determining air requirements for activated sludge aeration due to the reduced concentrations of fouling contaminants. ACWRF has sufficient blower capacity to treat 58.7 MGD with all blowers in service. This flow drops to 44.0 MGD with one blower out of service.

Table 25 - ACWRF Post-Aeration Process Data

Parameter	Units	Value
Alpha	Unit less	0.98
Beta	Unit less	0.95
Temperature	deg-C	21
SOTE	%	20

4.2.9 Solids Handling and Disposal

The ACWRF has fine screens but does not have primary clarification. All sludge and grit smaller than the ¼-inch screen opening is passed through the headworks into the aeration tanks. Activated Sludge is periodically wasted from the final clarifiers to the nine (9) aerobic digester/storage tanks. Two (2) tanks can be dedicated to storing WAS prior to thickening. Three (3) tanks can be used to digest thickened WAS. Four (4) tanks can be dedicated to biosolids storage. If needed, any tank can be used for digestion or for storage. Currently, ACWRF does not digest; solids are removed from the site as soon as possible after wasting. All solids tanks are holding tanks under the current operation. The existing digesters will likely need retrofitted with updated airlines and diffusers due to deterioration of the existing air conveyance system with is through channels in the aluminum doors on the tank cover deck.

The digestion process is not utilized due to odor complaints and ACWRF uses 1-2 sludge storage tanks and 0-3 digesters for sludge storage, on average. Thickened sludge is drawn from these tanks through dedicated drain piping, grinders, and discharged to the Belt Filter Press (BFP) with a feed pump. The existing gravity belt thickener is currently bypassed.

Each of the nine digesters has approximately 370,000 gallons. At an average WAS flow rate of 110,000 gpd, the maximum storage tank residence time is approximately 30 days. Oxygen transfer capacity with the existing blowers is approximately 42 CF/min/1000 CF.

The gravity belt thickener (GBT) feed pump (Belt Thickener Pump 2 – WAS) has a design capacity of 500 gpm at 145 feet TDH. Currently, BFP#2 is not operational as parts have been removed to keep BFP#1 in operation; in order to use BFP#2, replacement parts would need to be installed with a start-up operation due to the length of time that it has been out of operation. The two meter wide Komline Sanderson GBT has a 500 gpm hydraulic capacity and 1,600-3,000 lb/hr solids capacity. Thickened sludge is discharged from the GBT into Thickened Sludge Pump 1 which has a design capacity of 400 gpm at 25 feet TDH.

The BFP feed pump (Belt Thickener Pump 2 – Biosolids) has a design capacity of 500 gpm at 145 feet TDH. The two meter wide Komline Sanderson BFP is a three-belt eight-pressure roll machine with an independent gravity drainage section and has a hydraulic loading capacity of 220 gpm and a solids loading of 1,100 lbs/hr. No BFP operating input parameters could be ascertained for this analysis. Some parameters can be assumed using process control data sheets and the OEPA sludge report data. BFP Feed sludge is between 0.7-0.8 %TS at an assumed feed rate of 400 gpm. The average dewatered sludge thickness discharged from the BFP is 12.2 %TS at an average rate of 6.5 WTPH. Cake discharged from the BFP onto a 5 ton/hour belt conveyor that discharges into a receiving truck located in the adjacent truck bay, which transports sludge cake to a landfill. ACWRF landfills over 1,000 DT of sludge cake per year.

The District does not operate the aerobic digesters because of odor complaints from nearby residents. By not operating the aerobic digestion process, the District does not significantly reduce the amount of volatile solids in the sludge. Without this reduction in volume, the District is forced to landfill greater volumes of sludge.

To further decrease operational costs, it is recommended to increase the BFP solids loading. The operating parameters summarized above indicate that the BFP is solids under-loaded. Typical BFP sludge feed %TS is in a range of 2-4%, but can be modified to accommodate lower %TS sludge feed if desired. Under current operations (low %TS feed sludge), the BFP will not consistently produce sludge cake higher than 14 %TS unless the polymer dose is higher. This results in a higher cost to landfill the sludge cake (85-90% of landfilled sludge cake is water). Previous testing completed by Komline Sanderson indicated that the BFP was unable to produce sludge cake greater than 12.8 %TS at a polymer dose of 10 lbs/DT with a feed sludge less than 1 %TS.

Testing completed by Komline Sanderson also indicated that feed sludge with a greater %TS processed by the BFP produced a thicker %TS sludge cake (14-17%). It is recommended to increase the BFP sludge feed percent total solids to increase the solids loading and throughput. To achieve this, it is recommended to utilize the existing GBT to thicken the influent feed sludge from 0.7 %TS to 3-4 %TS. It has been noted by DCRSD Operations Personnel that operating the GBT with polymer has caused the BFP's dewatering cake output to decrease. It is recommended to employ as little as polymer necessary to maintain a 90% capture with a wider dispersion of polymer by decreasing the polymer solution concentration and increasing the feed flow to achieve a target dosage of 6-10 lb active/DT or less.

The District has contracted with a consultant to perform a biosolids study. This study will evaluate current and future solids production needs and disposal methods in greater detail.

4.2.10 Electrical

This electrical evaluation is based upon the field observations, plan reviews, and interviews with maintenance staff.

Utility Service

The Alum Creek Water Reclamation Facility is supplied by a primary AEP service. The primary service arrives below grade and is terminated at an AEP owned Primary Loop Switch. The electrical service is metered for revenue across the primary feeders. The electrical service arrives to ACWRF through an AEP distribution circuit. The AEP distribution circuit is fed from a double-ended substation. The AEP substation is served by two independent transmission lines which provide redundancy at the transmission level. However, there is no redundancy at the distribution level which is transmitted to the Plant. An outage across the distribution circuit would leave the Plant without power until the distribution circuit failure is corrected.

Service Transformers

ACWRF has four County owned service transformers. Transformers T1 and T2 service the Administration building, Pre-treatment, and Aeration facilities. Transformers T3 and T4 service the Maintenance building, Drain Pump station, Tertiary Treatment, and Post Treatment facilities. Each service transformer is rated for 1500KVA, 13,200V primary-480Y/277V secondary. The service transformers were manufactured around 2000. Each of the four service transformers has the capacity to supply 1800A at 480V, 3 phase. The largest electrical demand documented by AEP in the past year is 1,072.75KW [1,291A@480V, 3 phase] which was recorded in December of 2015. All transformers are adequately sized for their connected loads. Percent of measured spare capacity for each service transformer can not be determined through the utility metering. The utility metering is located upstream of the service transformers and captures the four service transformers collectively. However, if the connected loads are spread equally among the four service transformers, then it could be assumed that measured peak demand is also divided equally. In this case, each service transformer would have an estimated 80% spare capacity.

Standby Power

ACWRF is supplied by two standby diesel generators. The generators are size to provide 100% standby power to the Plant in the event of a normal power supply outage. The generators share a common 10,000 gallon fuel tank. If the fuel tank is full, the generators would be capable of supplying standby power to the Plant at peak demand for 125 hours. If the connected loads are spread equally among the two generators, it could be assumed that measured peak demand is also divided equally. In this case, each generator would have an estimated 65% spare capacity. The generators are serviced by a third party maintenance contract. Critical loads, such as, The Plant Process Control Systems are supported by uninterruptible power supply units.

Generator 1

Generator 1 is located in the Maintenance building. This diesel generator was manufactured by Caterpillar around 1999 and has 60% of its remaining useful service life. The diesel generator is rated for 1750KW with a 480V, 3 phase system voltage output. The generator provides standby power to the Maintenance building, Drain Pump station, Solids Handling, Tertiary Treatment, and Post Treatment facilities. The generator has the capacity to supply 1900A at 480V, 3 Phase. The generator is adequately sized for its connected load.

Generator 2

The generator is located in the Maintenance building. This diesel generator was manufactured by Caterpillar around 1999 and has 60% of its remaining useful service life. The diesel generator is rated for 1750KW with a 480V, 3 phase system voltage output. The generator provides standby power to Administration building, Pre-Treatment, and Aeration facilities. The generator has the capacity to supply 1900A at 480V, 3 Phase. The generator is adequately sized for its connected load.

Large Electrical Distribution Equipment

Maintenance and repair of the distribution equipment (switchgear, auto transfer switches, switchboards, and motor control centers) is performed on a “condition based” assessment by the District staff. Normal preventive maintenance and minor corrective maintenance is covered within the Operations and Maintenance budget. A majority of the distribution equipment is working well with minor defects or is in new to excellent condition. This type of equipment may be expected to remain in service for up to 40 years, not including soft starters (15yrs) and variable frequency drives (10yrs). ACWRF’s large distribution equipment has about 60% of its remaining useful service life.

Areas of Concern

- All of the Plant’s Soft Starters and VFDs are reaching the end of their useful service life.

- Safety. The Plant's distribution equipment Arc Flash Analysis needs to be re-evaluated and updated every five years per NFPA 70E. Equipment PPE labels should be updated and re-applied accordingly.

4.2.11 Controls

Control System Architecture

The Alum Creek plant utilizes a distributed, PLC-based control system with a PC-based SCADA system for process control and monitoring at the facility. Control systems of this type are commonly applied to similar wastewater treatment facilities.

Allen Bradley PLC 5 Series Programmable Logic Controllers

The majority of the control system consists of several original Allen Bradley (AB) PLC 5 Series programmable logic controllers and remote I/O racks installed in control panels at various locations near process equipment around the plant. In some locations, the original PLC 5 systems have been updated to the ControlLogix family. At the time the facility was constructed (2001), the ControlLogix family was a relatively new product line (1997) while the PLC 5 line (1986) was reaching maturity.

Over the past several years, it has become increasingly difficult to find replacement parts for the PLC 5 product line. Allen Bradley is formally discontinuing the product line in June 2017 meaning the components will formally no longer be supported and can no longer be ordered from Allen Bradley. The plant has already completed the upgrade of two of the existing PLC 5 systems to ControlLogix under maintenance contracts with their preferred system integrator. As a result of the upgrades, the plant keeps the retired PLC 5 components for spare parts for the remainder of the system.

Although each PLC 5 system at the plant has significant available capacity to accommodate additional I/O capacity, such as empty slots in the PLC racks and panel space for terminals, discontinuance of the product line leads to an obvious recommendation of upgrading to the current ControlLogix platform.

Allen Bradley SLC 500 Series Programmable Logic Controllers

In addition to the PLC 5 Series, the plant has some Allen Bradley SLC 500 Series modular programmable controllers which are primarily associated with packaged equipment.

Although many of the individual products within the family have been discontinued, many components are still available including the higher-level processors and most the offering of I/O modules. All the components which are still available are considered "Active Mature" by AB which means they are currently fully supported but a newer product exists and the manufacturer will eventually discontinue the product line.

Control Panels

The physical condition of the PLC control panels at the facility is good and better than expected considering the equipment age. Most panels appear to have been selected with ratings that are compatible with the environment in which they are located—there does not appear to be damage due to corrosion, leaks, poor cabinet sealing, or animals.

The filter building comes closest to an exception as there is always a large amount of small flying insects within the process area. Plant staff has mitigated the infestation into the electrical room to a degree by permanently locking the door that separates the room from the process area. Further mitigation will occur with the project currently in design which plans to condition the control room separately from the rest of the Tertiary Filter Building.

Although the master planning focused primarily on the control system infrastructure (field-located instruments and panels were not generally assessed), the planning team received input from plant staff regarding poor condition of the aeration tank mixer control panels. Components within the panels frequently break down and the plant has maintained limited operation by salving parts from out-of-service mixer panels. It is possible that exposure to high outdoor temperatures and temperature cycling may be limiting the life span of the failing components.

Supervisory Control and Data Acquisition System (SCADA)

The plant SCADA system is based on the General Electric iFix human-machine interface software family running on workstation-class Dell personal computers.

Consistent with the relatively short lifecycle of software and PCs, the SCADA system has been upgraded, most recently in approximately 2012. The operating system is Microsoft Windows 7 with Service Pack 1, which is the latest version supported with the current version of iFix installed. The iFix software version is 5.5. As of June 2016, the current shipping version of the GE iFix product line is 5.8. Microsoft defines two levels of support for their operating system products: Mainstream Support and Extended Support. Microsoft Mainstream Support ended on January 13, 2015 for Microsoft Windows 7. Windows 8.1 Mainstream Support ends January 9, 2018, and Windows 10 Mainstream Support ends October 13, 2020. Extended Support for Windows 7 ends January 14, 2020. It is not uncommon for process control system software to lag behind in terms of being compatible with the newest operating system available. As the PCs running the SCADA software age and fail, it will eventually become more difficult to find replacement computers compatible with Windows 7.

Interviews conducted with District staff indicate the custom-developed PLC programs and SCADA application generally meet the needs of the process and staff. All critical equipment and process instrumentation status is displayed, stored historically, and available for trending. The SCADA alarm system is sufficient and generally free of nuisance alarms. The plant staff is distracted at times by nuisance alarms associated with equipment that is out of service. Although this is a typical complaint of plant staff most SCADA software provides features and tools that allow operators to suppress or shelve alarms for long periods of times when the alarms are not applicable. Since the plant is staffed 24/7 and diligently monitored, there is not paging, text message, or similar remote alarm delivery mechanism in place.

With the help of their system integrator, the plant implemented a web server solution to allow visualization of the process from other locations within the plant. Unfortunately, the solution did not address security appropriately and had to be abandoned—the system provided full access and did not apply role-based security to allow, for example "Read-Only" (no control) access. Ideally the staff would like to revisit the technology provided proper security can be an integral part of the solution.

The SCADA system architecture consists of four computers: two redundant SCADA servers, one historian server, and one operation workstation. In the event of a failure of one SCADA server (which provides the connectivity to the PLCs and the user interface to operate the plant), plant staff can control the process from the redundant system.

The plant has only one historian however, so failure of the historian would result in loss of certain data collection during the outage (no new data). Depending on the nature of the failure, there could also be a loss of the historic data (losing all previously logged data). Some key information is collected locally to each redundant SCADA server.

While the redundant SCADA servers provide history for the trending directly data accessible to operators via trends, the information collected by the historian is not readily accessible in the formats of "canned" reports. In other words, there is some useful data that is collected into the database but no mechanism exists for the operator to view the data. When it is necessary to examine this historical data (for troubleshooting or flow monitoring purposes) plant staff generally calls upon their system integrator to extract the data and present it in the required format.

Control System Network

The plant-wide Ethernet network connects the PLCs to the SCADA network for monitoring. The existing network consists of fiberoptic and copper Ethernet cabling, media converters, and Ethernet switches. The network topology represents a start configuration, with the majority of connections converging at the blower building network switch enclosure. Nearly none of the permanent cabling is labeled, which can make network troubleshooting extremely difficult during a failure.

Although the Ethernet media converters and switches are of varying age and condition, replacement components are inexpensive and readily available from a variety of sources. At one point in time, the process control system and County business system networks were interconnected. Although this connectivity facilitated support in times of need, the unsecured and "always-on" nature of the connectivity substantially increased the security risk of the process control system in terms of both intentionally malicious outside attacks and inadvertent internal configuration mishaps. Following a significant process network outage a few years ago, the networks have since been separated.

In addition to the Ethernet network, the PLC 5 and SLC 500 systems utilize two proprietary networks for linking remote I/O racks (AB Remote I/O) and for PLC-to-PLC communications (Data Highway Plus). Although the technology is very mature, there are known issues associated with the cabling or connectivity. Once the plant upgrades SLC and PLC 5 systems the networks are no longer required.

Control System Power Reliability

All PLC control panels, network switches, and SCADA PCs appear to be powered by uninterruptible power supplies to provide backup power during short power outages. Providing backup power for PLC systems is a good practice to prevent PLCs from losing their program or data during a power outage.

PLC memory is backed up with a battery in the CPU module and the battery is regularly maintained by plant staff. The PLCs also have memory backup via EEPROM modules, but this has limited usefulness as the backup procedure is not automatic and is infrequently performed (it is necessary to place the processor in programming mode which shuts down the process).

It is not known whether the UPS also provides a degree of backup power for process instrumentation.

The majority of the UPSs have stickers indicating they were installed in June 2010. If the UPS batteries are original, they are very likely in need of replacement.

Control System Maintenance and Support Services

Currently, the District relies on control system support services from SCI located in Kensington, Ohio, to provide troubleshooting, upgrades, and other system modifications. Both plant control systems were originally programmed by SCI and thus the consultant is very familiar with the systems.

SCI is a small firm that is owned and operated by two control system engineers.

Minor issues and planned work and upgrades are performed when they can be conveniently scheduled for SCI and the District.

The District has a support contract in place to provide priority support and after-hours support in the event of an emergency. Depending on the nature of the emergency, SCI is typically on-site the day after being called for support but generally within 48 hours.

Due to the separation of the networking and lack of a separate VPN (virtual private network) setup for the process control network, much troubleshooting and all changes must be made on-site.

Neither the plant nor the District has directly employed staff capable of troubleshooting and supporting the more sophisticated aspects of the system such as PLC and SCADA system software changes and troubleshooting.

Disaster Recovery Preparation

The District does not have a formal disaster-recovery plan in place that addresses the process control system. Such a plan would typically involves formally identifying disaster risks, assembling important system documentation and original program files (PLC, SCADA), and identifying key personnel, roles, and procedures that may be called upon to restore the process control system to operation in the event of a disaster.

SCI maintains backups of the automation program files on behalf of the District. The District does not currently maintain copies on-site or at an off-site County facility for the purposes of disaster recovery.

Not as significant as PLC and SCADA automation program files, the alarm history and process data is not backed up in any way (with the exception of certain information that is duplicated between the redundant SCADA servers). Although alarm history tends to be less valuable over time, the process data is extremely valuable when looking for flow and treatment patterns over time. This kind of data can be useful for troubleshooting the treatment system and planning/engineering type activities for the facility.

Documentation

The plant has access to automation system documentation but the documentation is original and thus likely very much out of date. The ControlLogix upgrades that have been performed were not provided with documentation. Typical documentation for the control system includes control panel shop drawings, wiring diagrams showing all I/O connecting to the PLCs, network diagrams, and PLC program printouts.

4.3 Additional County Treatment Facilities

The following information is being provided by the DCRSD staff as evaluation of these facilities was not part of the condition assessment scope. It is however important to consider needs that exist at these facilities as a capital improvement plan and financing strategy are prepared as part of this master plan effort.

4.3.1 Lower Scioto Water Reclamation Facility

Lower Scioto Water Reclamation Facility was installed and accepted by the county in 2007. To date no sewage flow has been directed to this facility but flow is anticipated to occur in early 2018 with initial flows in the range of 40,000 to 60,000 gpd and annual increases estimated to be 20,000 gpd. As a result, the breadth of capital expenditures related to starting up this plant is unknown. During startup of the facility all equipment will be assessed, maintained, replaced, or exercised. Cost associated with this are related to equipment, labor, and consultative support from engineering services firms and product suppliers. Because of the age of the facility, most of the initial manufacturer's warranties have expired. An additional vehicle/equipment storage facility and upgrades to the administration building to include locker rooms when the plant is staffed full time is planned once the facility is in service. It is anticipated that a consultant will be hired to evaluate the process design and assist in start-up and troubleshooting. The operation and maintenance budget for 2017 and 2018 will reflect some anticipated replacement of equipment. A capital improvements plan will be determined during the initial start-up.

4.3.2 Northstar Water Reclamation Facility

Northstar Water Reclamation Facility was installed in 2006. The facility is currently undergoing repairs for structural issues associated with the aeration and sludge holding tanks. As a result, the breadth of capital expenditures related to starting up this plant is unknown. During startup of this facility all equipment will be assessed, maintained, replaced, or exercised. Cost associated with this are related to equipment, labor, and consultative support from engineering services firms and product suppliers. Because of the age of the facility, most of the initial manufacturer's warranties have expired. A consultant has already been hired to assist in the structural evaluation and assist with start-up. The operation and maintenance budget for 2016 and 2017 will reflect these additional anticipated costs

4.3.3 Scioto Hills WWTP

Scioto Hills WWTP was installed and accepted by the county in 1989. This facility has recently gone through upgrades of the electrical components, including upgrades to the motor control center (MCC), a new generator, and new blower to help primarily with return activated sludge. Currently the treatment plant is not anticipated to have significant upgrades pending safety and/or compliance reviews, updates, issuances. The Scioto Hills collection system was installed in the 1970's and is suspected to have significant sources of I/I present.

4.3.4 Scioto Reserve Water Reclamation Facility

Scioto Reserve was installed and accepted by the county in 1999. Concurrent to the master plan, a review and recommendations analysis was performed on the facility. Updates and replacement of equipment associated with the influent and effluent pump stations, existing screens and headworks, aeration basins and piping, secondary clarifiers, blower appurtenances, and electrical upgrades are anticipated. In order to account for additional sludge disposal needs, the existing drive will need to be redone to allow for tanker truck access to the facility or purchase of a new 4,200 gallon hauling truck. The effluent filters are currently offline as they are not required to meet effluent criteria. In the event that compliance requirements would become more stringent, the filters may need to be retrofitted or overhauled. Design and Construction of the anticipated improvements should be included in the master plan capital improvements plan.

4.3.5 Tartan Fields

Tartan Fields was installed and accepted by the county in 1997. Tartan Fields recently received new filters to correct some hydraulic issues and a new backup generator. Lack of Equalization of the influent waste stream is an issue at the facility. It is noted that hydraulic problems occur throughout the entire process train from beginning to end and the facility cannot treat the current average design flow of 250,000 gpd. While not a significant performance limiting factor at the present time, the aeration system is undersized to provide sufficient air delivery necessary to meet process requirements under design conditions. Sludge storage and management capability is also restricting the treatment capacity at the plant. These limitations and concerns were expressed during an evaluation performed by a consultant in 2014 and preliminary costs were identified. Additional study is currently being performed at this facility.

4.3.6 Bent Tree

Bent Tree was installed and accepted by the county in 1988. Currently this treatment facility has no more allotted users. A determination of the long term service life of this facility will be needed to evaluate the potential for taking it offline. If the plant will continue to stay in service, upgrades would include update to the electrical components, including upgrades to the motor control center (MCC) and generator evaluation/replacement. Elimination of this plant should be considered as part of the planning, design, and construction of the Berkshire Pump Station and Forcemain project.

4.3.7 Hoover Woods

Hoover was installed and accepted by the county in 1988. A determination of the long term service life of this facility will be needed to evaluate the potential for taking it offline. Upgrades would include updates to the electrical components, including upgrades to the motor control center (MCC) if the plant is to remain in service long term.

4.4 Pump Stations

Nine of the most critical pump stations in the district were identified for evaluation, examining both the physical condition of the pump station and the operation of the station. Site visits were conducted to examine the pump station site for any access or safety issues as well as any issues associated with operations and maintenance or structural issues. In addition, data was provided on the historic run times as well as available draw down test information. This information was used to evaluate the overall condition of the station and indicate any operational issues as well as potential capacity limitations. Additional evaluation on the capacity of each pump station relative to flows under both dry and wet weather will be discussed in Section 5.

This section provides details on the specific pump stations and includes a summary of observations and analysis. Specific recommendations for improvement are included in Section 6.

4.4.1 Alum Creek

Features of the Alum Creek Pump Station are summarized in Table 26.

Table 26 - Alum Creek Pump Station Features	
Location of pump station	7850 Worthington Rd., Westerville, OH
Number of pumps	4
Size of pumps (horsepower per pump)	470
Manufacturer of pumps	Flygt
Type of station	Dry Pit Submersible
Type of pump	Submersible
Capacity of pump station	20,833 gpm (with 4 pumps in operation)
Capacity of forcemain (at 8 fps)	20” – 7,834 gpm 36” – 25,381 gpm
Forcemain size	20” & 36”
Forcemain material	DIP
Forcemain location	20” & 36” run SW of pump station
Forcemain age	1999
Forcemain outlet	20” FM to manhole ID: 11MH000001000020 or Alum Creek Water Reclamation Facility (dependent on valving) 36” FM to Alum Creek Water Reclamation Facility
General pump station condition	Performing well based on wet weather flows and observations. No recommendations for improvements.
Wet well size	54’ x 13’ overall footprint
Wet well depth	21.91’
Grinders, screens, grit or rock protection on site?	Grinders, screen (backup)

Pump Station Operation

a) Pump Run Time Review

Pump run time data was reviewed for 2010-2014 and a summary of the data is included in Table 27.

Table 27 – Alum Creek Run Time Data	
Year	**Average Run Time Per Day (Hours)**
2010	23.3
2011	23.9
2012	22.6
2013	22.7
2014	n/a

b) Drawdown Test Results and Rated Capacity

Drawdown test data was not available for analysis. Based on the data provided, the rated capacity of the pump station with all four pumps in operation is 20,833 gpm.

c) Forcemain Size and Capacity

Given the existing forcemains, an appropriate range of flows was developed using a minimum velocity of 2 feet per second (fps) and a maximum velocity of 8 feet per second (fps). Table 28 shows the range of flows using those velocities as a lower and upper bound.

Table 28 - Alum Creek Force Main Velocity Range		
Forcemain Size	**Flow at Minimum Velocity of 2 fps (gpm)**	**Flow at Velocity of 8 fps (gpm)**
20”	1,958.4	7,833.6
36”	6,345.2	25,380.9

d) Summary

For Alum Creek, the station appears in good operating condition based on discussions with operational staff and the available data. Given the number of pumps in operation, the pump run times are not excessive. However, there is no draw down test data to compare with the rated capacity of each pump. As for the forcemain, the rated capacity of the pump is within the flow calculated from the minimum velocity of 2 fps and maximum velocity of 8 fps for each pump for the 36” forcemain. Therefore, settling out of solids at low velocities and scouring of the pipe at high velocities is not occurring. For the 20” forcemain, given that it is not continually in use, it is recommended that it be inspected if it is required to be utilized full-time in the future. In addition, any air release valves or flow directional valves should continue to be exercised routinely as part of general operations and maintenance.

Site Evaluation and Access

The following observations were made during the site visit regarding the condition of the pump station, site access, security, and safety issues:

- A large HVAC duct was run in front of the cover plate of all the check valves, so in order to remove the plate, the duct has to be removed.
- Slight amount of rust / chipped paint throughout the discharge piping.
- The use of the exterior air handlers has been discontinued for a long time (by choice) and they have since sat idle and appear to be in poor condition.
- An evaluation of the vented nail base roof system is recommended to determine if the roof system has suffered any damage and would require any replacement. This building was contructed at the same time and using a similar design to the facilities at the Alum Creek Wastewater Reclamation Facility, which have required some material replacement.

Electrical Evaluation

- Utility Service: Underground service drop from Power Co. pad mounted Transformer. CONDITION: Good.
- Backup Power: Onsite indoor diesel generator. Generator appears well maintained. CONDITION: Good.
- Power Equipment and Motor Controllers: Drawout switchgear, Motor Control Center, stand alone VFD for large pumps. CONDITION: Good.
- Site Lighting: Building mounted security lights and pole lights. Building mounted security lights appear in good condition. Poles for pole mounted lights showing rust on several poles. CONDITION: Fair.
- Interior Lighting: Interior lights are fluorescent industrial fixtures. Lighting level is adequate. CONDITION: Good.
- SCADA: Remote monitoring via SCADA radio and High Tides Technologies. Local displays and controls appear functioning. CONDITION: Good.
- Code: No NEC code issues, with exception to hazardous area ventilation requirements per NFPA 820. The current NFPA, 2016, requires the station to have a minimum of 6 air changes per hour continuously to mitigate any hazardous location NEC requirements (explosion proof equipment). The HVAC equipment is required to have air flow monitored. The HVAC equipment is to be monitored for operation and have local and remote alarms if the equipment fails or is turned off. Refer to NFPA 820, Table 4.2.2, Row 17 for "Below Grade or Partially Below Grade Waste Water Pump Station Dry Well". HVAC equipment was not turned on and no alarms were

activated to indicate the HVAC equipment was not running as required per code. To comply, this may require installation or upgrade of HVAC equipment.

4.4.2 Leatherlips

Features of the Leatherlips Pump Station are summarized in Table 29.

Table 29 - Leather Lips Pump Station Summary	
Location of pump station	10975 Riverside Dr., Powell, OH
Number of pumps	3
Size of pumps (horsepower per pump)	88
Manufacturer of pumps	Flygt
Type of station	Dry Pit Submersible
Type of pump	Submersible
Capacity of pump station	1200 gpm
Capacity of forcemain (at 8 fps)	5,014 gpm
Forcemain size	16”
Forcemain material	DIP
Forcemain location	Exits SE of pump station
Forcemain age	Approx. 27 years
Forcemain outlet	To manhole ID: 09MH00134900070A
General pump station condition	The station is receiving flows greater than existing capacity. Station should be evaluated for an upgrade.
Wet well size	8’ by 22’
Wet well depth	23.5’
Grinders, screens, grit or rock protection on site?	Bar screen, grinder

Pump Station Operation

a) Pump Run Time Review

Pump run time data was reviewed for 2010-2014 and a summary of the data is included in Table 30.

Table 30 - Leatherlips Pump Run Time Summary		
Year	**Average Run Time Per Day (Hours)**	**Number of Days Above Design Run Time (8 Hours Per Day)**
2010	9.54	119
2011	10.83	210
2012	9.14	81
2013	10.02	173
2014	9.64	192

b) Drawdown Test Results and Rated Capacity

A drawdown test was performed at the Pump Station on December 8th, 2013. The resulting test showed the following:

- Pump 1: 1027 GPM
- Pump 2: 1007 GPM
- Pump 3: 1054 GPM

Based on the data provided, using calculations for the estimated head loss as well as the manufacturer's pump curve, the rated capacity of the pump station with a single pump running is 1200 gpm.

c) Forcemain Size and Capacity

Given the existing forcemains, an appropriate range of flows was developed using a minimum velocity of 2 feet per second (fps) and a maximum velocity of 8 feet per second (fps). Table 31 shows the range of flows using those velocities as a lower and upper bound.

Table 31 - Leatherlips Force Main Velocity Range		
Forcemain Size	**Flow at Minimum Velocity of 2 fps (gpm)**	**Flow at Velocity of 8 fps (gpm)**
16”	1253.4	5013.5

d) Summary

The number of days above the design time (8 hours) for each year that data was provided shows that receiving flows to the pump station are greater than the intended design flows of the pump station. Model data supports that this station is receiving flow beyond its original intended capacity. Based on the draw tests and the rated capacity for one pump, the pump station performs close to the intended design but may be performing slightly lower than the rated capacity depending on the accuracy of the draw down test. With one pump in operation, the flows calculated from the draw down tests are less than the flow calculated from the minimum velocity of 2 fps. Therefore, settling out of solids at low velocities could be occurring in the forcemain, although with two pumps in operation, the flows and velocities should be high enough to resuspend any settled solids.

Site Evaluation and Access

The following observations were made during the site visit regarding the condition of the pump station, site access, security, and safety issues:

- The overhead rail and crane system through the door is a poor installation. The upper panels and door frame need to be removed in order for the crane to travel out the door. This configuration could be improved by having tall doors notched out at the crane penetration.

- The wetwell and grinder access stairway is heavily corroded.
- Pumps can be hard to re-prime after maintenance, but flush water is available, so this is not a significant issue.

Electrical Evaluation

- Utility Service: Overhead service drop from Pole mounted Power Co. Transformers. CONDITION: Good.
- Backup Power: Onsite indoor diesel generator. Generator appears well maintained. CONDITION: Good.
- Power Equipment and Motor Controllers: Motor Control Center distribution equipment. Power distribution equipment and Motor Control Center appear well maintained. CONDITION: Good.
- Site Lighting: Building mounted security lights. Building mounted security lights appear to have yellowed lens, showing signs of age. CONDITION: Fair.
- Interior Lighting: Interior lights are fluorescent industrial fixtures. Lighting level is adequate. CONDITION: Good with a single exception. There is a non-functioning light fixture in the generator room that appears damaged, recommend replacing light fixture.
- SCADA: Remote monitoring via SCADA radio. Local displays and controls appear functioning. CONDITION: Good.
- Code: No NEC code issues, with exception to hazardous area ventilation requirements per NFPA 820. The current NFPA, 2016, requires the station to have a minimum of 6 air changes per hour continuously to mitigate any hazardous location NEC requirements (explosion proof equipment). The HVAC equipment is required to have air flow monitored. The HVAC equipment is to be monitored for operation and have local and remote alarms if the equipment fails or is turned off. Refer to NFPA 820, Table 4.2.2, Row 17 for “Below Grade or Partially Below Grade Waste Water Pump Station Dry Well”. HVAC equipment was not turned on and no alarms were activated to indicate the HVAC equipment was not running as required per code. To comply, this may require installation or upgrade of HVAC equipment.

4.4.3 Maxtown

Features of the Maxtown Pump Station are summarized in Table 32.

Table 32 - Maxtown Pump Station	
Location of pump station	7819 Maxtown Rd., Westerville, OH
Number of pumps	3
Size of pumps (horsepower per pump)	20
Manufacturer of pumps	Flygt
Type of station	Dry Pit Submersible
Type of pump	Submersible
Capacity of pump station	1200 gpm (with 2 pumps in operation); planned upgrade anticipated to increase capacity to 1880 gpm
Capacity of forcemain (at 8 fps)	5,014 gpm
Forcemain size	16”
Forcemain material	DIP
Forcemain location	Exits east of pump station then travels west.
Forcemain age	Approx. 24 years
Forcemain outlet	To manhole ID: 06MH001390000021
General pump station condition	The station is receiving flows greater than the existing capacity. County is planning an upgrade that should address some of the higher flows the station is receiving.
Wet well size	8’ by 24’
Wet well depth	34’
Grinders, screens, grit or rock protection on site?	Bar screen

Pump Station Operation

a) Pump Run Time Review

Pump run time data was reviewed for 2010-2014 and a summary of the data is included in the Table 33.

Table 33 - Maxtown Pump Run Time Data		
Year	**Average Run Time Per Day (Hours)**	**Number of Days Above Design Run Time (8 Hours Per Day)**
2010	10.49	18
2011	12.77	135
2012	11.97	66
2013	n/a	n/a
2014	12.32	101

b) Drawdown Test Results and Rated Capacity

A drawdown test was performed at the Pump Station. The resulting test showed the following:

- Pump 1: 755 GPM
- Pump 2: 680 GPM
- Pump 3: 750 GPM

Based on the data provided on the pump station sheet, the rated capacity of the pump station with two pumps running is listed at 1200 gpm.

c) Forcemain Size and Capacity

Given the existing forcemain, an appropriate range of flows was developed using a minimum velocity of 2 feet per second (fps) and a maximum velocity of 8 feet per second (fps). Table 34 shows the range of flows using those velocities as a lower and upper bound.

Table 34 - Maxtown Forcemain Velocity Range

Forcemain Size	Flow at Minimum Velocity of 2 fps (gpm)	Flow at Velocity of 8 fps (gpm)
16”	1253.4	5013.5

d) Summary

The number of days above the design time (8 hours) for each year that data was provided shows that receiving flows to the pump station are greater than the intended design flows of the pump station. The flows calculated from the draw down tests are less than the flow calculated from the minimum velocity of 2 fps. Therefore, settling of solids could be occurring at low flows.

Site Evaluation and Access

The following observations were made during the site visit regarding the condition of the pump station, site access, security, and safety issues:

- There is some observed rust and chipped paint on the piping.
- The overhead rail and crane system through the door is a poor installation. The upper panels and door frame need to be removed in order for the crane to travel out the door. This configuration could be improved by having tall doors notched out at the crane penetration.

Electrical Evaluation

- Utility Service: Overhead service drop from Pole mounted Power Co. Transformers. CONDITION: Good

- Backup Power: Onsite indoor diesel generator. Generator appears well maintained. CONDITION: Good.

- Power Equipment and Motor Controllers: Motor Control Center distribution equipment. Power distribution equipment and Motor Control Center appear well maintained. CONDITION: Good.

- Site Lighting: Building mounted security lights. Building mounted security lights appear to have yellowed lens, showing signs of age. CONDITION: Fair.

- Interior Lighting: Fluorescent industrial lights. Interior lights are fluorescent industrial fixtures. Lighting level is adequate. CONDITION: Good.

- SCADA: Remote monitoring via SCADA radio and cell phone, High Tides Technologies.   Local displays and controls appear functioning. CONDITION: Good.

- Code: No NEC code issues, with exception to hazardous area ventilation requirements per NFPA 820. The current NFPA, 2016, requires the station to have a minimum of 6 air changes per continuously to mitigate any hazardous location NEC requirements (explosion proof equipment). The HVAC equipment is required to have air flow monitored. The HVAC equipment is to be monitored for operation and have local and remote alarms if the equipment fails or is turned off. Refer to NFPA 820, Table 4.2.2, Row 17 for "Below Grade or Partially Below Grade Waste Water Pump Station Dry Well". HVAC equipment was not turned on and no alarms were activated to indicate the HVAC equipment was not running as required per code. To comply, this may require installation or upgrade of HVAC equipment.

4.4.4 Cheshire

Features of the Cheshire Pump Station are summarized in Table 35.

Table 35 - Cheshire Pump Station	
Location of pump station	2350 Africa Rd., Galena, OH
Number of pumps	2
Size of pumps (horsepower per pump)	20
Manufacturer of pumps	Flygt
Type of station	Submersible
Type of pump	Submersible
Capacity of pump station	600 gpm
Capacity of forcemain (at 8 fps)	8" – 1,253 gpm 10" – 1,958 gpm
Forcemain size	8" & 10"
Forcemain material	DIP
Forcemain location	8" FM runs West of pump station. 10" FM runs South of pump station.
Forcemain age	Approx. 41 years for original 8" FM; 15 years for 10" forcemain
Forcemain outlet	8" to manhole ID: 02MH000004000095 (not currently in service) 10" to manhole ID: 02MH001688000147
General pump station condition	Flows to station are high compared to original design and the model shows backup in upstream sewer. Station should be evaluated for an upgrade.
Wet well size	10' Dia.
Wet well depth	22.5'
Grinders, screens, grit or rock protection on site?	Screens

Pump Station Operation

a) Pump Run Time Review

Pump run time data was reviewed for 2010-2014 and a summary of the data is included in the Table 36.

Table 36 - Cheshire Pump Run Time Data		
Year	**Average Run Time Per Day (Hours)**	**Number of Days Above Design Run Time (8 Hours Per Day)**
2010	6.97	77
2011	8.1	160
2012	7.25	83
2013	n/a	n/a
2014	8.51	203

b) Drawdown Test Results and Rated Capacity

A drawdown test was performed at the Pump Station on November 25th, 2013. The resulting test showed the following:

- Pump 1: 589.64 GPM
- Pump 2: 647.88 GPM

Based on the data provided, the rated capacity of the pump station with a single pump running is 600 gpm.

c) Forcemain Size and Capacity

Given the existing forcemain, an appropriate range of flows was developed using a minimum velocity of 2 feet per second (fps) and a maximum velocity of 8 feet per second (fps). Table 37 shows the range of flows using those velocities as a lower and upper bound.

Table 37 - Cheshire Forcemain Velocity Range		
Forcemain Size	**Flow at Minimum Velocity of 2 fps (gpm)**	**Flow at Velocity of 8 fps (gpm)**
10”	489.6	1,958.4

d) Summary

The number of days above the design time (8 hours) for each year that data was provided shows that receiving flows to the pump station are greater than the original design flows. It appears based on the run time data as well as discussions with staff that this station is receiving flows above the original intended design. Based on the draw tests and the rated capacity for one pump, the pump station performs close to the intended design. The flows calculated from the draw down tests are within the flow calculated from the minimum velocity of 2 fps and maximum velocity of 8 fps for each pump. Given the size of the 10” forcemain, the station capacity could be increased without requiring the construction of a new forcemain.

For the 8” forcemain, given that it is not continually in use, it is recommended that it be inspected if it is required to be utilized full-time in the future. In addition, any air release valves or flow directional valves should continue to be exercised routinely as part of general operations and maintenance.

Site Evaluation and Access

The following observations were made during the site visit regarding the condition of the pump station, site access, security, and safety issues:

- Discharge piping is heavily corroded, some corrosion on guide rails.
- There are no gutters on the roof.

- The wet well does not have fall protection.
- The 480V unit heater is broken and replaced with a 120V plug-in heater.
- It would be beneficial to add a hinge to the valve pit access hatch, as it is a rectangular FRP grate which can easily fall down the opening.
- The valve piping is corroded and there are no actuators, just a square nut for use with a portable lever.
- The interior of building is all exposed insulation and is home to mice and snakes; it would be better to have either plywood or drywall installed.

Electrical Evaluation

- Utility Service: Overhead service drop from Pole mounted Power Co. Transformers. CONDITION: Good.
- Backup Power: Plug for portable generator connection. CONDITION: Good.
- Power Equipment and Motor Controllers: Panelboard distribution equipment. Motor Controllers part of engineered control panel. Power distribution equipment and Motor Controllers appear well maintained. CONDITION: Good.
- Site Lighting: Building mounted security lights. Building mounted security light at generator only. CONDITION: Good.
- Interior Lighting: Incandescent work light. CONDITION: Good.
- SCADA: Remote monitoring via SCADA cell phone, High Tide Technologies. Local displays and controls appear functioning. CONDITION: Good.
- Code: No code issues.

4.4.5 Golf Village

Features of the Golf Village Pump Station are summarized in Table 38.

Table 38 - Golf Village Pump Station	
Location of pump station	3239 Seldom Seen Rd., Powell, OH
Number of pumps	3
Size of pumps (horsepower per pump)	30
Manufacturer of pumps	Flygt
Type of station	Submersible
Type of pump	Submersible
Capacity of pump station	1,084 gpm
Capacity of forcemain (at 8 fps)	3,839 gpm
Forcemain size	14”
Forcemain material	DIP
Forcemain location	Runs South of pump station
Forcemain age	Approx. 15 years
Forcemain outlet	To manhole ID: 09MH001353000004
General pump station condition	The station is performing well and no capacity improvements are recommended.
Wet well size	9’-6” by 10’-6”
Wet well depth	31.5’
Grinders, screens, grit or rock protection on site?	Grinder (muffin monster)

Pump Station Operation

a) Pump Run Time Review

Pump run time data was reviewed for 2010-2014 and a summary of the data is included in the Table 39.

Table 39 - Golf Village Pump Run Time Data		
Year	**Average Run Time Per Day (Hours)**	**Number of Days Above Design Run Time (8 Hours Per Day)**
2010	2.5	0
2011	3.45	5
2012	2.88	0
2013	3	0
2014	3.19	0

b) Drawdown Test Results and Rated Capacity

A drawdown test was performed at the Pump Station. The resulting test showed the following:

- Pump 1: 1423 GPM
- Pump 2: 1384 GPM
- Pump 3: 1384 GPM

Based on the data provided, the rated capacity of the pump station with a single pump running is 1084 gpm.

c) Forcemain Size and Capacity

Given the existing forcemain, an appropriate range of flows was developed using a minimum velocity of 2 feet per second (fps) and a maximum velocity of 8 feet per second (fps). Table 40 shows the range of flows using those velocities as a lower and upper bound.

Table 40 - Golf Village Forcemain Velocity Range

Forcemain Size	Flow at Minimum Velocity of 2 fps (gpm)	Flow at Velocity of 8 fps (gpm)
8”	959.6	3838.5

d) Summary

The number of days above the design time (8 hours) for each year that data was provided shows that receiving flows to the pump station are within the intended design flows of the pump station. Based on the draw tests and the rated capacity for one pump, the pump station performs above the intended design with one pump in operation; with multiple pumps in operation, it may be performing close to intended design. The flows calculated from the draw down tests are within the flow calculated from the minimum velocity of 2 fps and maximum velocity of 8 fps for each pump.

Site Evaluation and Access

The following observations were made during the site visit regarding the condition of the pump station, site access, security, and safety issues:

- The staff is unable to read gauge on discharge without entering a ‘confined’ space.
- There is a noticeable oil and grease problem due to all the neighboring restaurants.
- For safety purposes, an option may be to install bollards at the bypass connection, as it is right by the road across from the station.
- The wet well vent is corroded.
- Discharge piping is fairly rusted and could use re-painting.

- There is some damage to the bioxide fence.
- There is no gutter on the building.

Electrical Evaluation

- Utility Service: Underground service drop from Pad mounted Power Co. Transformer. CONDITION: Good
- Backup Power: Onsite outdoor diesel generator. Generator appears well maintained, recently installed. CONDITION: Excellent.
- Power Equipment and Motor Controllers: Panelboard distribution equipment. Motor Controllers part of engineered control panel. Power distribution equipment and Motor Controllers appear well maintained. CONDITION: Good.
- Site Lighting: Building mounted security lights. Building mounted security light at generator only. CONDITION: Good.
- Interior Lighting: Incandescent work light. CONDITION: Good.
- SCADA: Remote monitoring via SCADA cell phone, High Tide Technologies. Local displays and controls appear functioning. CONDITION: Good.
- Code: No code issues.

4.4.6 Scioto Reserve

Features of the Scioto Reserve Pump Station are summarized in Table 41.

Table 41 - Scioto Reserve Pump Station	
Location of pump station	4651 Home Rd., Powell, OH
Number of pumps	2
Size of pumps (horsepower per pump)	10
Manufacturer of pumps	Flygt
Type of station	Submersible
Type of pump	Submersible
Capacity of pump station	162.5 gpm
Capacity of forcemain (at 8 fps)	313 gpm
Forcemain size	4”
Forcemain material	DIP
Forcemain location	Runs West of pump station.
Forcemain age	Approx. 17 years
Forcemain outlet	To manhole ID: 04MH001510000037
General pump station condition	The station is performing well and no capacity improvements recommended for existing service area. Potential service area expansion would require a potential capacity increase based on future planning.
Wet well size	5’ Dia.
Wet well depth	18’
Grinders, screens, grit or rock protection on site?	N/A

Pump Station Operation

a) Pump Run Time Review

Pump run time data was reviewed for 2010-2014 and a summary of the data is included in the Table 42.

Table 42 - Scioto Reserve Run Time Data		
Year	**Average Run Time Per Day (Hours)**	**Number of Days Above Design Run Time (8 Hours Per Day)**
2010	3.08	0
2011	3.69	0
2012	3.38	0
2013	n/a	n/a
2014	3.25	0

b) Drawdown Test Results and Rated Capacity

A drawdown test was performed at the Pump Station on March 18th, 2015. The resulting test showed the following:

- Pump 1: 216 GPM
- Pump 2: 222 GPM

Based on the data provided, the rated capacity of the pump station with a single pump running is 162.5 gpm.

c) Forcemain Size and Capacity

Given the existing forcemain, an appropriate range of flows was developed using a minimum velocity of 2 feet per second (fps) and a maximum velocity of 8 feet per second (fps). Table 43 shows the range of flows using those velocities as a lower and upper bound.

Table 43 - Scioto Reserve Forcemain Velocity Range		
Forcemain Size	**Flow at Minimum Velocity of 2 fps (gpm)**	**Flow at Velocity of 8 fps (gpm)**
4”	78.3	313.3

d) Summary

The number of days above the design time (8 hours) for each year that data was provided shows that receiving flows to the pump station are within the intended design flows of the pump station. Based on the draw tests and the rated capacity for one pump, the pump station performs slightly above the intended design. The flows calculated from the draw down tests are within the flow calculated from the minimum velocity of 2 fps and maximum velocity of 8 fps for each pump.

Site Evaluation and Access

The following observations were made during the site visit regarding the condition of the pump station, site access, security, and safety issues:

- The access to reach the pump station is very tough (golf cart path with steep topography and narrow bridge), especially for something like a vactor truck. Widening the golf cart path would provide easier access for large vehicles.
- The FRP valve vault access hatch is hinged but does not stay open because it is too long. To address, consider cutting it in half and adding a second set of hinges, or add a hook to hold the hatch open on the wall.
- The wet well does not have any fall protection.
- There is some animal damage to the exterior wood (squirrels or groundhogs).

- Vandalism is a bit of an issue and door has been kicked down. The use of a steel door and frame should be considered.

- It should be noted that upgrades and improvements may be completed by Village Communities

Electrical Evaluation

- Utility Service: Overhead service drop from Pole mounted Power Co. Transformers. CONDITION: Good.

- Backup Power: Onsite outdoor diesel generator. Generator appears well maintained, recently installed. CONDITION: Good.

- Power Equipment and Motor Controllers: Panelboard distribution equipment. Motor Controllers part of engineered control panel. Power distribution equipment and Motor Controllers appear well maintained. CONDITION: Good.

- Site Lighting: Building mounted security lights. Building mounted security light at generator only. CONDITION: Good.

- Interior Lighting: Incandescent work light. CONDITION: Good.

- SCADA: Remote monitoring via SCADA cell phone, High Tide Technologies and data radio. Local displays and controls appear functioning. CONDITION: Good.

- Code: No code issues.

4.4.7 Vinmar

Features of the Vinmar Pump Station are summarized in Table 44.

Table 44 - Vinmar Pump Station	
Location of pump station	7869 Vinmar Way, Galena, OH
Number of pumps	2
Size of pumps (horsepower per pump)	23
Manufacturer of pumps	Flygt
Type of station	Submersible
Type of pump	Submerisble
Capacity of pump station	255 gpm
Capacity of forcemain (at 8 fps)	705 gpm
Forcemain size	6”
Forcemain material	DIP
Forcemain location	Runs West of pump station
Forcemain age	Approx. 13 years
Forcemain outlet	To manhole ID: 06MH001513000028
General pump station condition	The station is performing well and there are no capacity improvements recommended.
Wet well size	8’ by 8’
Wet well depth	30.37’
Grinders, screens, grit or rock protection on site?	Grinder (muffin monster)

Pump Station Operation

a) Pump Run Time Review

Pump run time data was reviewed for 2010-2014 and a summary of the data is included in the Table 45.

Table 45 - Vinmar Pump Station Run Time Data		
Year	**Average Run Time Per Day (Hours)**	**Number of Days Above Design Run Time (8 Hours Per Day)**
2010	1.58	0
2011	2.16	0
2012	n/a	n/a
2013	n/a	n/a
2014	2.14	0

b) Drawdown Test Results and Rated Capacity

A drawdown test was performed at the Pump Station on November 25th, 2013. The resulting test showed the following:

- Pump 1: 320 GPM
- Pump 2: 292 GPM

Based on the data provided, the rated capacity of the pump station with a single pump running is 255 gpm.

c) Forcemain Size and Capacity

Given the existing forcemain, an appropriate range of flows was developed using a minimum velocity of 2 feet per second (fps) and a maximum velocity of 8 feet per second (fps). Table 46 shows the range of flows using those velocities as a lower and upper bound.

Table 46 - Vinmar Forcemain Velocity Range		
Forcemain Size	**Flow at Minimum Velocity of 2 fps (gpm)**	**Flow at Velocity of 8 fps (gpm)**
6”	176.3	705.0

d) Summary

The number of days above the design time (8 hours) for each year that data was provided shows that receiving flows to the pump station are within the intended design flows of the pump station. The station itself has some additional capacity for future development in the tributary area based on the analysis of existing flows. Based on the draw tests and the rated capacity for one pump, the pump station performs slightly above the intended design. The flows calculated from the draw down tests are within the flow calculated from the minimum velocity of 2 fps and maximum velocity of 8 fps for each pump. Therefore, settling out of solids at low velocities and scouring of the pipe at high velocities is not occurring.

Site Evaluation and Access

The following observations were made during the site visit regarding the condition of the pump station, site access, security, and safety issues:

- There are no gutters on the roof
- The wet well safety cage should open the other way, because the position it is in now makes it difficult to pull the transducer up for cleaning, which is done regularly.
- Based on discussions with staff, the valve pit sometimes gets a few inches of water in the bottom because the drain pipe between the wet well and the pit gets clogged.

Electrical Evaluation

- Utility Service: Underground service drop from Power Co. pad mounted Transformer.   CONDITION: Good.
- Backup Power: Plug for portable generator connection. CONDITION: Good.
- Power Equipment and Motor Controllers: Panelboard distribution equipment. Motor Controllers part of engineered control panel. Power distribution equipment and Motor Controllers appear well maintained. CONDITION: Good.
- Site Lighting: Building mounted security lights. Building mounted security light at generator only. CONDITION: Good.
- Interior Lighting: Industrial fluorescent lights. CONDITION: Good.
- SCADA: Remote monitoring via SCADA cell phone, High Tide Technologies. Local displays and controls appear functioning. CONDITION: Good.
- Code: No code issues.

4.4.8 East Alum Creek

Features of the East Alum Creek Pump Station are summarized in Table 47.

Table 47 - East Alum Creek Pump Station	
Location of pump station	201 Africa Rd., Galena, OH
Number of pumps	2
Size of pumps (horsepower per pump)	7.5
Manufacturer of pumps	Flygt
Type of station	Submersible
Type of pump	Submersible
Capacity of pump station	260 gpm
Capacity of forcemain (at 8 fps)	2,820 gpm
Forcemain size	12”
Forcemain material	DIP
Forcemain location	Runs SW of pump station
Forcemain age	Approx. 25 years
Forcemain outlet	To manhole ID: 02MH001863000007
General pump station condition	The station is performing well and no capacity improvements recommended.
Wet well size	10’ Dia.
Wet well depth	30.83’
Grinders, screens, grit or rock protection on site?	-

Pump Station Operation

a) Pump Run Time Review

Pump run time data was reviewed for 2010-2014 and a summary of the data is included in the Table 48.

Table 48 - East Alum Creek Pump Station Run Time Data		
Year	**Average Run Time Per Day (Hours)**	**Number of Days Above Design Run Time (8 Hours Per Day)**
2010	3.74	1
2011	4.11	2
2012	3.76	1
2013	n/a	n/a
2014	5.55	27

b) Drawdown Test Results and Rated Capacity

A drawdown test was performed at the Pump Station on March 11th, 2015. The resulting test showed the following:

- Pump 1: 457.78 GPM
- Pump 2: 323.79 GPM

It should be noted that, since this testing, a single pump has been put in place that is undersized and is only putting out 260 gpm. Based on the data provided, the rated capacity of the pump station with a single pump running is 350 gpm.

c) Forcemain Size and Capacity

Given the existing forcemain, an appropriate range of flows was developed using a minimum velocity of 2 feet per second (fps) and a maximum velocity of 8 feet per second (fps). Table 49 shows the range of flows using those velocities as a lower and upper bound.

Table 49 - East Alum Creek Forcemain Velocity Range		
Forcemain Size	**Flow at Minimum Velocity of 2 fps (gpm)**	**Flow at Velocity of 8 fps (gpm)**
8”	313.3	1253.4

d) Summary

The number of days above the design time (8 hours) for each year that data was provided shows that receiving flows to the pump station are within the intended design flows of the pump station. Based on the draw tests and the rated capacity for one pump, the pump station performs slightly above the intended design. The flows calculated from the draw down tests are within the flow calculated from the minimum velocity of 2 fps and maximum velocity of 8 fps for each pump.

Site Evaluation and Access

The following observations were made during the site visit regarding the condition of the pump station, site access, security, and safety issues:

- Oil and grease is a big problem here due to the 36 / 71 interchange development.
- The 480V unit heater is broken and replaced with a 120V plug-in heater.
- There are no gutters on the roof.
- The discharge piping is a little corroded.
- The bioxide fill pipe is placed is in an awkward position in the front of the station and is away from any access point.

Electrical Evaluation

- Utility Service: Overhead service drop from Pole mounted Power Co. Transformers. CONDITION: Good.
- Backup Power: Plug for portable generator connection. CONDITION: Good.
- Power Equipment and Motor Controllers: Panelboard distribution equipment. Motor Controllers part of engineered control panel. Power distribution equipment and Motor Controllers appear well maintained. CONDITION: Good.

- Site Lighting: Building mounted security lights. Building mounted security light at generator only. CONDITION: Good.

- Interior Lighting: Incandescent work light. CONDITION: Good.

- SCADA: Remote monitoring via SCADA cell phone, High Tide Technologies. Local displays and controls appear functioning. CONDITION: Good.

- Code: No code issues.

4.4.9 Peachblow

Features of the Peachblow Pump Station are summarized in Table 50.

Table 50 - Peachblow Pump Station	
Location of pump station	5001 S. Old Stat Rd., Lewis Center, OH
Number of pumps	2
Size of pumps (horsepower per pump)	35
Manufacturer of pumps	Flygt
Type of station	Submersible
Type of pump	Submersible
Capacity of pump station	500 gpm
Capacity of forcemain (at 8 fps)	1,253 gpm
Forcemain size	8”
Forcemain material	DIP
Forcemain location	East and South of pump station
Forcemain age	Approx. 41 years
Forcemain outlet	To manhole ID: 11MH000004000058
General pump station condition	Flows to station are high compared to original design and the model shows backup in upstream sewer. Station should be evaluated for an upgrade.
Wet well size	10’ Dia.
Wet well depth	30.3’
Grinders, screens, grit or rock protection on site?	Screen

Pump Station Operation

a) Pump Run Time Review

Pump run time data was reviewed for 2010-2014 and a summary of the data is included in the Table 51.

Table 51 - Peachblow Pump Station Run Time Data		
Year	**Average Run Time Per Day (Hours)**	**Number of Days Above Design Run Time (8 Hours Per Day)**
2010	5.34	12
2011	6.89	90
2012	6.22	11
2013	7.04	102
2014	6.69	55

b) Drawdown Test Results and Rated Capacity

A drawdown test was performed at the Pump Station on November 22nd, 2013. The resulting test showed the following:

- Pump 1: 497 GPM
- Pump 2: 500 GPM

Based on the data provided, the rated capacity of the pump station with a single pump running is 500 gpm.

c) Forcemain Size and Capacity

Given the existing forcemain, an appropriate range of flows was developed using a minimum velocity of 2 feet per second (fps) and a maximum velocity of 8 feet per second (fps). Table 52 shows the range of flows using those velocities as a lower and upper bound.

Table 52 - Peachblow Forcemain Velocity Range		
Forcemain Size	**Flow at Minimum Velocity of 2 fps (gpm)**	**Flow at Velocity of 8 fps (gpm)**
8”	313.3	1253.4

d) Summary

The number of days above the design time (8 hours) for each year that data was provided shows that receiving flows to the pump station are greater than the intended design flows of the pump station. Based on the draw tests and the rated capacity for one pump, the pump station performs close to the intended design. The flows calculated from the draw down tests are within the flow calculated from the minimum velocity of 2 fps and maximum velocity of 8 fps for each pump.

Site Evaluation and Access

The following observations were made during the site visit regarding the condition of the pump station, site access, security, and safety issues:

- It would be beneficial to add a hinge to the valve pit access hatch, as it is a rectangular FRP grate which can easily fall down the opening.

- The 480V unit heater is broken and replaced with a 120V plug-in heater.
- A vehicle appears to have hit the roof near the corner of the building and the roof panels are a little mangled.
- There are no gutters on the roof.
- The valves do not have actuators, just a square nut for use with a portable lever.
- The wet well vent is corroded.
- The wet well does not have fall protection.
- The trash rack in the wet well is not really ever lifted (but not causing a problem).

Electrical Evaluation

- Utility Service: Overhead service drop from Pole mounted Power Co. Transformers. CONDITION: Good.
- Backup Power: Plug for portable generator connection. CONDITION: Good.
- Power Equipment and Motor Controllers: Panelboard distribution equipment. Motor Controllers part of engineered control panel. Power distribution equipment and Motor Controllers appear well maintained. CONDITION: Good.
- Site Lighting: Building mounted security lights. Building mounted security light at generator only. CONDITION: Good.
- Interior Lighting: Incandescent work light. CONDITION: Good.
- SCADA: Remote monitoring via SCADA cell phone, High Tide Technologies. Local displays and controls appear functioning. CONDITION: Good.
- Code: No code issues.

4.5 Collection System

The County provided GIS shapefiles to AECOM with CCTV coded observations. The data includes 9,461 total observations, which corresponds to 1,198 inspected sewer lines. The majority of the observations are taps (3,356), manholes (2,358), starting points against flow (409), starting points with flow (786), stopped inspections (1,166), high water levels (1,201) and abandoned surveys (36). The remaining observations are classified as either operation and maintenance (O&M) issues (124), or structural defects (22). The total number of O&M issues and structural defects do not include multiple observations of the same code for the same sewer line. Table 53 summarizes the codes and their descriptions for both O&M issues and structural defects.

The DCRSD maintains an aggressive maintenance regime to ensure that the system is monitored and acute issues are fixed in a timely manner. This includes regular CCTV investigations of sewers on a rotating basis as well as routine sewer jetting and root cutting. The DCRSD owns and operates two vehicles to perform this work. The District also performs point repairs on 8” and 10” sewers in their system that are found to have defects. All necessary repairs on assets 12” and above are contracted out on an as needed basis.

Table 53 - Coded Observations Summary from CCTV		
Classification	**Code**	**Code Description**
Structural Defects	B	Broken
	BSV	Broken Soil Visible
	BVV	Broken Void Visible
	CC	Crack Circumferential
	CH2	Crack Longitudinal Hinge, 2
	CH4	Crack Longitudinal Hinge, 4
	CL	Crack Longitudinal
	CM	Crack Multiple
	D	Deformed
	FH2	Fracture Longitudinal Hinge, 2
	HVV	Hole Void Visible
	JOL	Joint Offset Large
	JOM	Joint Offset Medium
	JSM	Joint Separated Medium
	XP	Collapse Pipe Sewer
O&M Issues	DAE	Deposits Attached Encrustation
	DAGS	Deposits Attached Grease
	DAR	Deposits Attached Ragging
	DAZ	Deposits Attached Other
	DNGV	Deposits Ingressed Gravel
	DNZ	Deposits Ingressed Other
	DSC	Deposits Settled Compacted
	DSF	Deposits Settled Fine
	DSGV	Deposits Settled Gravel
	DSZ	Deposits Settled Other
	ID	Infiltration Dripper
	IG	Infiltration Gusher
	IR	Infiltration Runner
	IW	Infiltration Weeper
	OBM	Obstacle Pipe Material
	OBR	Obstacle Rocks
	OBZ	Obstacle Other
	RBB	Roots Ball Barrel
	RBC	Roots Ball Connection
	RBJ	Roots Ball Joint
	RBL	Roots Ball Lateral
	RMJ	Roots Medium Joint
	RML	Roots Medium Lateral

The sewer lines with structural defects and/or O&M issues were identified and are listed in Tables 54 and 55. Each sewer line is associated with a code determined from the CCTV data provided to AECOM. The conduit ID was provided in the shapefile from the County, and is used to identify the specific sewer line with the structural or O&M issue. Given the data provided to AECOM of inspected sewers, 0.02% are identified as having a structural defect and 1% are identified as having O&M issues.

Table 54 – Structural Defects Summary	
Conduit ID	**Code**
06LN000005092091	B
11LN001094026025	BSV
11LN001339092064	BSV
11LN001339085084	BVV
11LN001593002001	XP
11LN001338062061	CC
06LN000006035034	CC
06LN001120011010	CL
11LN0014790F20F1	CL
11LN001297005004	CL
11LN0014800G10A6	CL
06LN000005095092	CH2
06LN001708010009	CH4
06LN000005067066	CM
11LN000001050049	CM
06LN001654022005	D
11LN001608010009	FH2
11LN001609015014	HVV
11LN001396065064	JOL
06LN001086016015	JOM
06LN001086013012	JOM
06LN000005060006	JSM

Table 55 – O&M Issues Summary							
Conduit ID	**Code**	**Conduit ID**	**Code**	**Conduit ID**	**Code**	**Conduit ID**	**Code**
11LN001590002001	DSF	11LN001590002001	DSF	11LN001590005004	DSZ	11LN001339094095	IR
09LN001850001010	DSF	09LN001850001010	DSF	11LN001590004003	DSZ	11LN001339092064	IR
06LN00132801A001	DSF	06LN00132801A001	DSF	06LN001093003002	DSZ	11LN001339094093	IR
06LN001085005004	DSGV	06LN001085005004	DSGV	11LN001402011010	DSZ	06LN001330007006	IR
06LN001329001009	DSGV	06LN001329001009	DSGV	11LN001399006005	DSZ	06LN001565007006	IW
06LN00108700302A	DSGV	06LN00108700302A	DSGV	11LN001400004003	DSZ	06LN000005047046	OBZ
11LN001338051050	DSGV	11LN001338051050	DSGV	09LN001271026010	DSZ	06LN000006042041	OBZ
06LN001708028027	DSGV	06LN001708028027	DSGV	11LN001402002001	DSZ	11LN001452011010	OBZ
11LN001397038037	DSGV	11LN001397038037	DSGV	06LN001091004003	DSZ	06LN000005042041	OBM
11LN001402006005	DSGV	11LN001402006005	DSGV	04LN001679004003	DSZ	06LN001145001005	OBR
06LN000005068067	DSZ	06LN000005068067	DSZ	11LN001609014008	DSZ	06LN000006034033	RBB
06LN000005069068	DSZ	06LN000005069068	DSZ	06LN001091015014	DSZ	11LN001608003002	RBB
06LN001329003002	DSZ	06LN001329003002	DSZ	06LN001091005004	DSZ	11LN001339084083	RBB
06LN001329002001	DSZ	06LN001329002001	DSZ	06LN001091018017	DSZ	06LN001565008007	RBC
06LN001329015014	DSZ	06LN001329015014	DSZ	06LN001091017016	DSZ	06LN000006033032	RBJ
06LN001329014013	DSZ	06LN001329014013	DSZ	06LN001330002001	DSZ	11LN001094029028	RBJ
06LN001370004003	DSZ	06LN001370004003	DSZ	06LN000005086085	ID	11NL001608006001	RBJ
06LN001370003002	DSZ	06LN001370003002	DSZ	06LN000006031030	ID	11LN001608003002	RBJ
06LN001370002001	DSZ	06LN001370002001	DSZ	11LN001339092064	ID	11LN001608004001	RBJ
06LN001329013012	DSZ	06LN001329013012	DSZ	06LN000005044043	IG	11LN001094027025	RBJ
06LN001093009008	DSZ	06LN001093009008	DSZ	11LN001399012011	IG	11LN001339084083	RBJ
06LN000005042041	DSZ	06LN000005042041	DSZ	11LN001094028006	IG	11LN001339082081	RBJ
06LN001708010009	DSZ	06LN001708010009	DSZ	11LN001339001075	IG	11LN001339081080	RBJ
06LN001093004003	DSZ	06LN001093004003	DSZ	06LN000005067066	IR	11LN001339094093	RBJ
06LN001093006005	DSZ	06LN001093006005	DSZ	06LN000005080079	IR	11LN001397073072	RBL
11LN001716001066	DSZ	11LN001716001066	DSZ	06LN001083011007	IR	11LN001094029028	RBL
06LN000005066065	DSZ	06LN000005066065	DSZ	06LN000005035034	IR	11LN001608004001	RMJ
06LN000005063062	DSZ	06LN000005063062	DSZ	06LN000005050049	IR	11LN001609016015	RML
06LN000005062061	DSZ	06LN000005062061	DSZ	06LN000006031030	IR	11LN001339094095	IR
06LN000005061060	DSZ	06LN000005061060	DSZ	11LN001396069068	IR	11LN001339092064	IR
06LN000006034033	DSZ	06LN000006034033	DSZ	11LN0017170C40C3	IR	11LN001339094093	IR
11LN001402003002	DSZ	11LN001402003002	DSZ	11LN001339076001	IR	06LN001330007006	IR

Figures 15 and 16 are maps showing the locations of the sewer lines having structural defects or O&M issues.

Figure 15 – Locations of Structural Defects

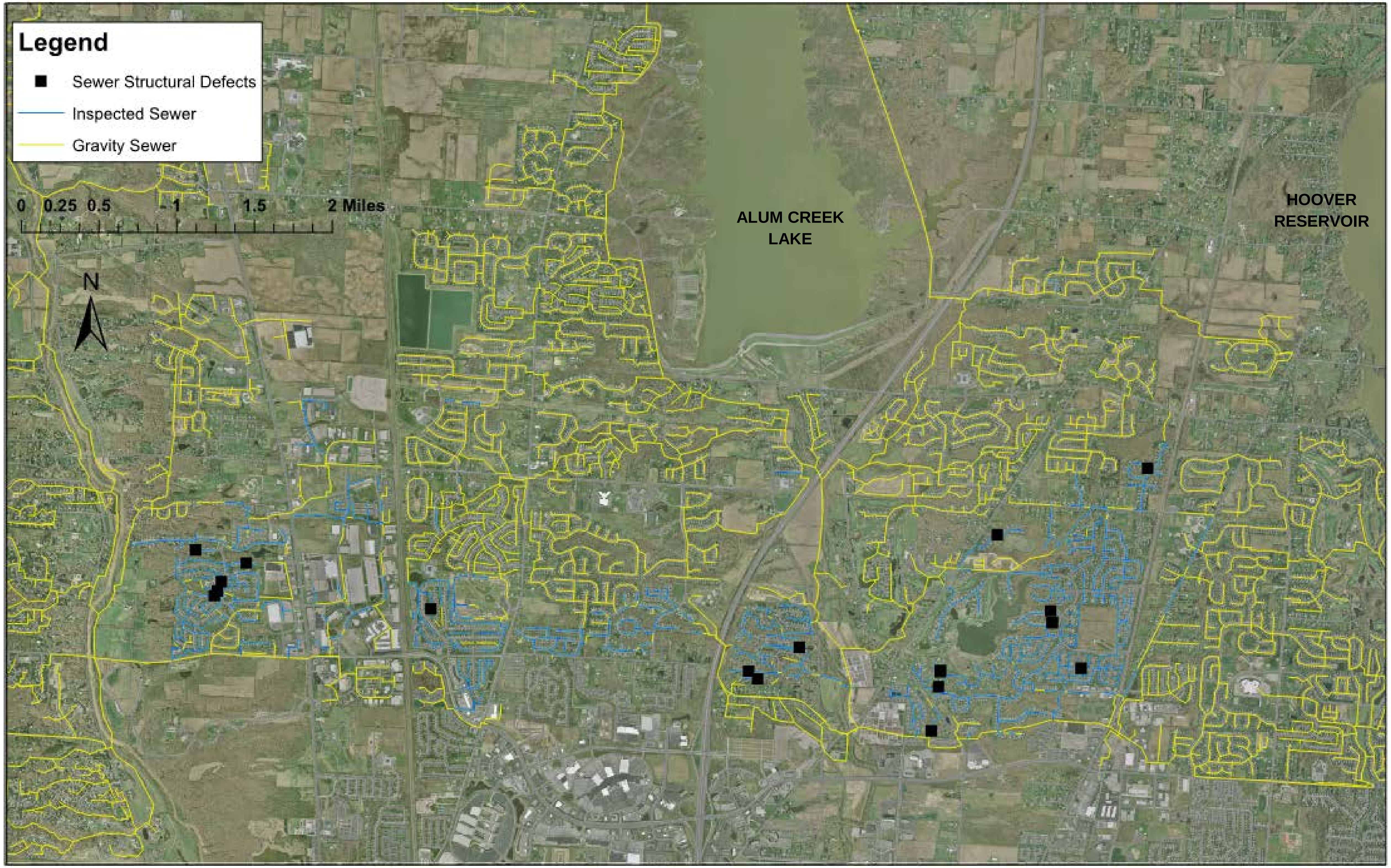
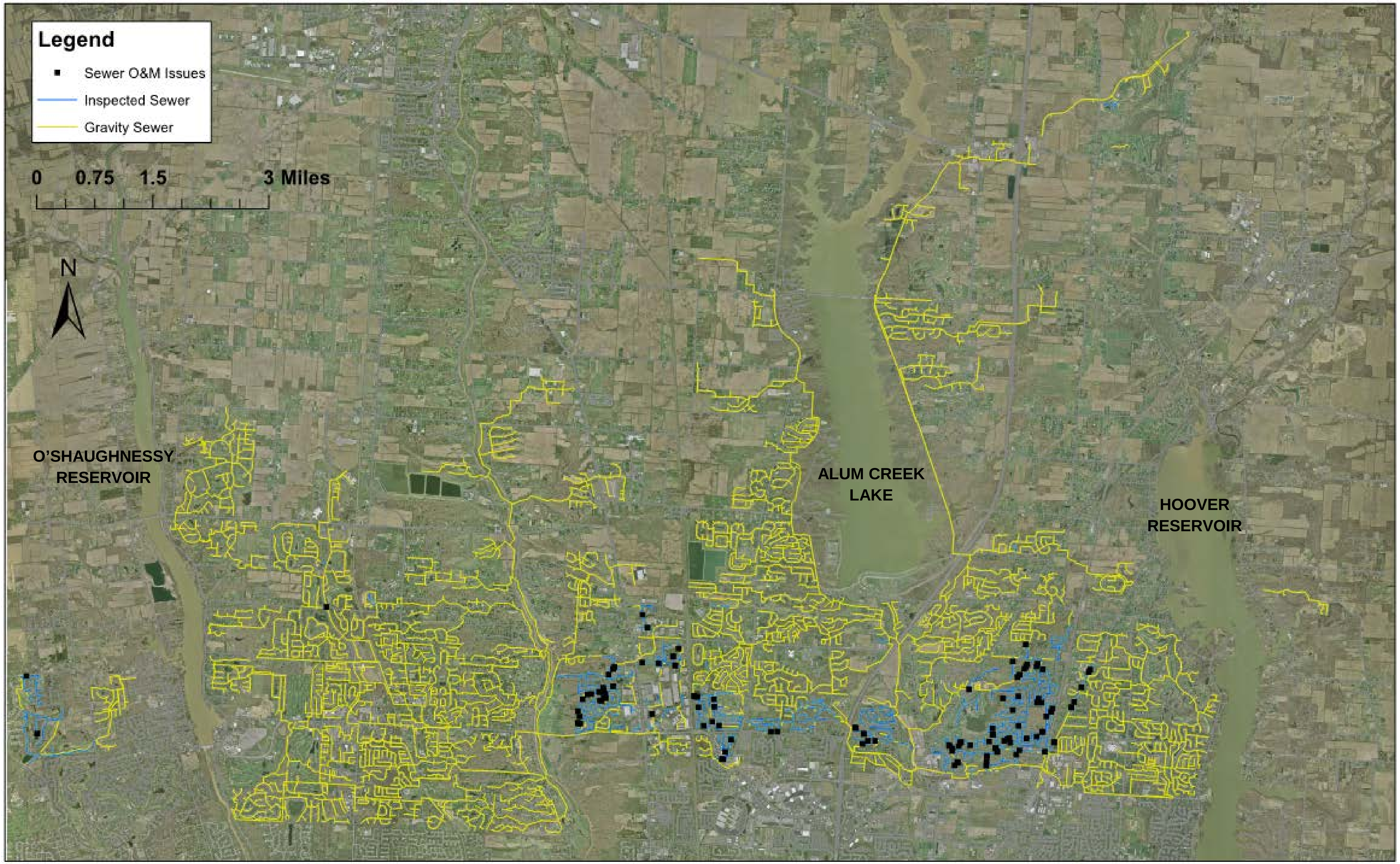


Figure 16 – Locations of Operation & Maintenance Issues



5.0 Hydraulic Model of Existing Collection System

To support the Master Plan, Delaware County's modeling strategy includes application of a Storm Water Management Model (SWMM) hydraulic model to the two largest treatment basins, OECC and ACWRF. The hydraulic model simulates a representation of all the County's sewers to determine the flow characteristics and system limitations based on event simulations. The hydraulic model for the sanitary sewer system was constructed using PCSWMM Version 6.0.2025, which incorporates GIS information and uses USEPA SWMM5 Version 5.1.009 as the hydrology and hydraulics calculation engine. The SWMM5 model engine simulates complex hydraulics that occurs in closed conduits, such as branched or looped networks, pressure flow, flow reversals, backwater, weirs, orifices, and storage. The SWMM5 model also allows for the dynamic representation of the hydraulic grade line and the viewing of hydraulic time series at any point within the modeled collection system for the duration of model simulation. GIS data and record drawings were used to create the hydraulic model. The constructed hydraulic model is a representation of the components of the sanitary sewers for the County. These components include but are not limited to interceptors, trunk sewers, interconnects, and pump stations.

The purpose of performing the hydraulic modeling was to develop an accurate model for use in evaluating system response to future growth for the Master Plan. The model has the ability to estimate any system limitations and identify future capacity issues. The ability to identify system limitations will assist the County in identifying improvement projects before capacity issues occur.

5.1 Model Components and Construction

5.1.1 Model Sanitary Flow Components

There are three major components of wet weather wastewater flow in a separate sanitary collection system: base sanitary flow (BSF), groundwater infiltration (GWI), and rainfall dependent inflow/infiltration (RDII). These flow components are shown on Figure 17.

BSF is the residential, commercial, institutional, and industrial flow discharged into a sanitary sewer system for collection and subsequent treatment. BSF normally varies with water use patterns within a service area throughout a 24-hour period. Higher flows occur during the day and lower flows occur at night. In most cases, the average daily BSF is more or less constant throughout the year but can vary slightly monthly or seasonally. BSF

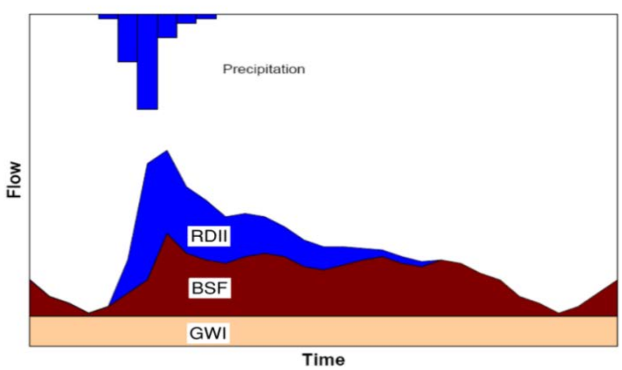


Figure 17 - Components of Wet-Weather Wastewater Flow for Separate System

often represents a significant portion of the flows treated at the wastewater treatment facility. If a collection system has minimal I/I, BSF would be the only flow treated at a wastewater treatment facility.

GWI is the infiltration of groundwater that enters the collection system through leaking pipes, pipe joints, and manhole walls. GWI varies throughout the year, often trending higher in late winter and spring as groundwater levels and soil moisture levels rise. GWI subsides in late summer or during an extended dry period. Although the amount of GWI is dependent on overall weather trends, GWI does not respond directly to rainfall events. GWI and BSF together comprise the dry weather flow (DWF) that occurs in a sanitary sewer collection system.

RDII is the rainfall-derived flow response in a sanitary sewer system. The RDII response is essential to understanding the sewer system hydraulic behavior and achieving accurate model calibration and analysis. In most sewer systems, RDII is the major component of peak wastewater flows and is typically responsible for capacity-related issues in sanitary sewers. Although rainfall is typically associated with RDII, snowmelt may also cause RDII flows. RDII flows are typically zero before the start of a rainfall event, increase during the rainfall event, and then decline to zero sometime after the rainfall event ends. For cases with less than saturated antecedent moisture conditions, surfaces and soils may take up some of the rainfall early in an event before a response is observed. If the rainfall event is small enough, there may not be a visible response. The maximum amount of rainfall that does not produce a flow response in a collection system is termed the "initial abstraction."

5.1.2 Dry Weather Flow Analysis

Due to site conditions, seasonal conditions, varying monitoring durations, and the accuracy of the flow monitoring during dry weather conditions, the calibration of DWF within the model used a multiple step approach. The first step of the DWF analysis involved creating a baseline for DWF to be distributed across the collection system. To accomplish this, zoning information and parcel proximity were used to assign default BSF and GWI values to nearby manholes. Default values were selected for each zoning classification to create baseline flows that can be distributed in a representative fashion across the collection system.

The second step of the DWF analysis involved looking at data from each individual flow monitor to evaluate periods where DWF was observed and monitoring data was of acceptable quality. From this step, two (2) sets of values were evaluated: the average DWF value and the normalized, diurnal pattern. The average DWF value is the mean value of a given day and the diurnal pattern

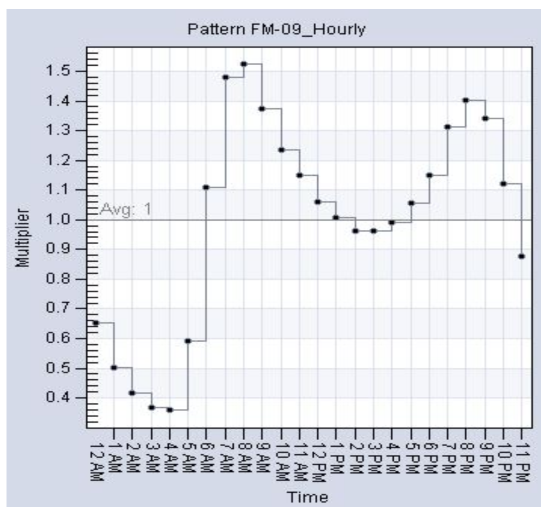


Figure 18 - Example DWF Pattern

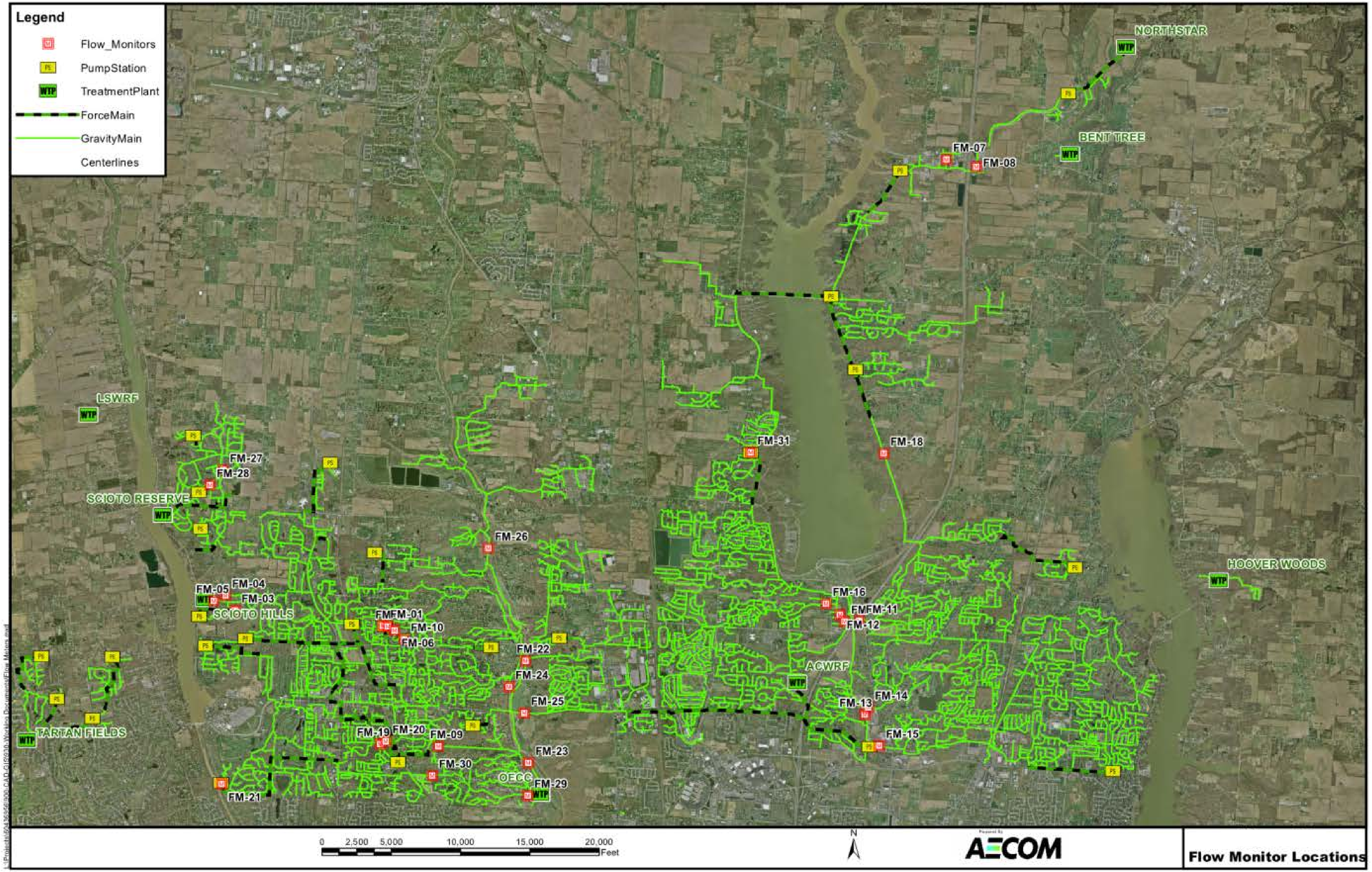
represents the fluctuations in flow based on water use patterns. Figure 18 is an example diurnal pattern generated by PCSWMM. A pattern was created using PCSWMM for each flow monitor used in the model construction. Certain flow monitors that are sited in areas of extremely low levels of DWF can have trouble measuring low flows. In these circumstances, DWF was estimated from a downstream flow monitor collecting flows from a larger area.

The next step in the DWF analysis was to compare the DWF average values with the upstream and downstream monitors. This is an additional check to confirm flow monitoring data is accurate. During this process average values are adjusted up and down in comparison to other monitors that are in series and that are captured by a downstream monitor. This process ensures that the average DWF for the entire system is equivalent to that which is experienced at the downstream treatment plants. Once the average values were selected for each flow monitor, the baseline values selected from the first step were adjusted by a factor to allow the flow monitor tributary to match the observed DWF at each flow monitor. Table 56 lists the DWF values assigned to the flow monitor and the sewershed area tributary to the flow monitor. Flow monitor locations are shown in Figure 19. For tributary basins in which a flow monitor was not available, downstream flow monitors and treatment plant flows were used to estimate remaining basins.

Table 56 - Model DWF Analysis

Tributary	Sewershed Area (ac)	Average DWF (MGD)	Tributary	Sewershed Area (ac)	Average DWF (MGD)
ACWRF Basin			**OECC Basin**		
FM-11	844	0.3447	**FM-09**	2007	0.4064
FM-12	1142	0.5544	**FM-19**	-	-
FM-13	200	0.0702	**FM-20**	233	0.2320
FM-14	845	0.2298	**FM-21**	1588	0.8751
FM-15	2836	0.6330	**FM-22**	1003	0.3799
FM-16	1082	0.5055	**FM-23**	433	0.0560
FM-17	262	0.1006	**FM-24**	1618	0.2963
FM-18	1026	0.6498	**FM-25**	581	1.2750
FM-31	494	0.1842	**FM-26**	597	0.2315
ACWRF	448	0.1558	**FM-29**	315	0.0696
Polaris	1389	1.3550	**FM-30**	285	0.1398
Total	10568	4.7830	**OECC**	179	0.0444
			Total	8840	4.0061

Figure 19 – Flow Monitor Locations



5.1.3 Wet Weather Flow Analysis

Wet weather flow analysis starts with the evaluation of the flow monitoring data. Flow monitoring data is compared with rainfall data and events are created for the duration in which the system takes to subside from the wet weather event. Wet weather events quantify the total number of events observed for each flow monitor and statistical data is collected for each event. Once the events are created, the flow data is checked for quality assurance and any data with false readings is either amended or removed from analysis. The remaining events are then used in flow monitoring analysis and subsequently in the model calibration. The flow monitoring analysis considers statistical data such as maximum flow and volume of flow.

Flow monitoring data was used to characterize the RDII within the Delaware County's sanitary sewer system. SWMM5 uses the RTK method to derive the sanitary sewer system RDII response using the associated rainfall and flow monitoring data. The RTK method is similar to unit hydrograph methods that are commonly used to simulate flows in storm water runoff analyses. The RTK method is based on fitting three triangular unit hydrographs to an actual RDII hydrograph derived from flow metering data. A unit hydrograph is defined as the flow response that results from one unit of rainfall during one unit of time. Figure 20 depicts the RTK method and how RDII hydrographs are generated. This unit hydrograph is described by the following parameters:

- R: The fraction of rainfall volume that enters the sewer system which equals the volume under the hydrograph
- T: The time from the onset of rainfall to the peak of the unit hydrograph in hours
- K: The ratio of time to recession of the unit hydrograph to the time to peak
- A: The sewershed area
- P: Rainfall depth over one unit time
- Volume: The volume of RDII in the unit hydrograph
- Qp: Peak flow of the unit hydrograph

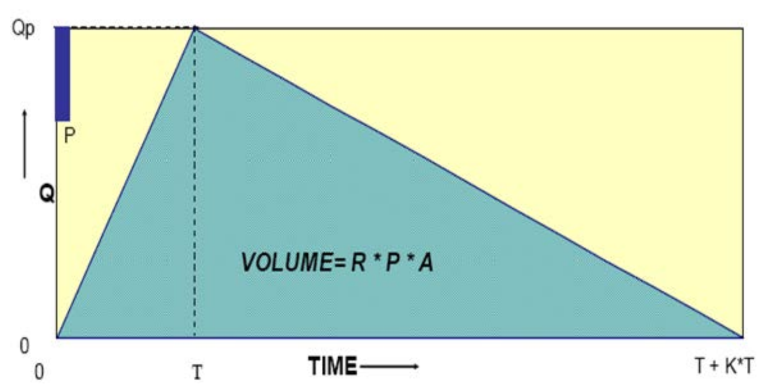


Figure 20 - RTK Unit Hydrograph

The unit hydrograph RTK method was utilized in the SWMM5 model to characterize the wastewater flow response to rain events throughout the sewer system. For each rainfall event, the amount of infiltration and inflow was calculated and the RTK parameters were established.

5.1.4 Model Construction

The objective of the model construction was to include all sanitary sewer components to make an accurate hydraulic representation of the County's collection system. Sewer attribute data from the system GIS and record plans were the primary sources of information for model development. Sanitary sewer attributes from the record plans were entered in the model database and include invert elevations, diameter, cross section type, offset above manhole invert, and sewer tributary service areas. Pump curve data was an additional source of information allocated to each pump station. When pump curve data was not available or representative of the station, draw down tests performed by the County were used to identify the pump station capacity.

Delineation of the sanitary sewer sheds increased the accuracy of the model and provided the appropriate allocation of land use across the model tributaries. The creation of these sewer sheds increased the model precision by isolating areas within the system where I/I is present. From using sanitary sewer sheds, the RTK methodology was utilized to represent wet weather contributions.

A sanitary sewer shed is an area of land or group of parcels that are serviced by a manhole or node within the hydraulic model. Sanitary sewer sheds define the boundaries of service area for sanitary sewer system. This allowed for accurate modeling results, by delineating the sanitary sewer sheds with the best available information. The delineation consisted of modifying the GIS information to include areas where sanitary service is provided and to exclude areas within basins that are uninhabited providing no service.

5.1.5 Model Quality Assurance/Quality Control (QA/QC)

After the data defining the model network and base flows were established, the data was subjected to a QA/QC procedure. This procedure included validating all model input data, verifying that all required manhole and sewer elevations and attributes were properly entered in the model from the record drawings, and ensuring consistency between upstream and downstream manholes and sewer attributes. Sewer model attributes included invert elevations, cross section type, diameter, offset above manhole invert and roughness.

In cases where the GIS and record drawings provide inconsistent data, due to inconsistent geographic projection or human error, best judgment was taken to adjust the model. When the model deviates from GIS and record drawings, individual components were identify and the adjustment was noted.

5.2 Model Calibration

The newly constructed model was calibrated by modifying information from the sanitary sewer sheds to match the flow monitoring data. To match the existing flow conditions from flow monitoring results, calibration required an iterative process of fine-tuning the

RDII within the model. The RTK method was used and values were assigned to each sanitary sewer shed to quantify the RDII for each sanitary sewer shed throughout the model. Total flow was obtained by combining the RDII and DWF values, which was then compared to the flow monitoring data and fine-tuned to produce a calibrated model.

The iterative process of fine-tuning the RDII values within the model consisted of breaking down the model into individual models for every flow monitor used in the calibration. These individual models encompass the entire tributary upstream of each flow monitor. By breaking down the model into individual flow monitoring components, the parameters that influence RDII can be adjusted to meet the defined criteria of calibration for both dry and wet weather. When a tributary of a flow monitor contains another flow monitor, the upper limit tributary is calibrated first and then introduced into the downstream tributary. Because flow monitors were installed and removed over a long period of time and entailed varying seasons and rainfall events, meeting the defined criteria during calibration between certain flow monitors can be unobtainable. In these circumstances, the calibration was adjusted to minimize the error between the two flow monitors and contribute the least amount of flow discrepancy downstream. The defined criterion for which the model was calibrated is listed below for both the DWF and WWF. When the criterion could not be met due to inherent errors, best engineering judgment was used to minimize inaccuracies to the rest of the system.

Certain restraints were present in the construction and calibration of the model. Due to the duration of a majority of the flow monitors, parameters such as GWI and DWF seasonal variation were not able to be estimated. Because some flow monitors were installed for periods of a few months, a full year’s worth of information was not able to be obtained. Therefore, the uncertainty of the GWI variation and seasonal DWF patterns makes estimating these values impossible during short flow monitoring periods. Due to this fact, GWI is included in the DWF and the DWF is a constant value with variations only in the pattern for 24-hour periods for weekdays and weekend, as well as daily multipliers for a week. Overall, the data shows that the average DWF can vary across seasons by 10-20% higher or lower depending on the specific conditions; this variability does not have a huge impact in the overall master planning process as we are mostly focused on average conditions and the use of design storms as opposed to long-term simulations across multiple seasons.

5.2.1 Dry Weather Flow Calibration

- The following criteria were used for the basis of model calibration for DWF:
- Predicted time of peaks and troughs are within one hour of observed flow;
- Predicted peak flow rates are within +/- 15 percent of observed flow;
- Predicted volumes of flow over a 24-hour event are within +/-10 percent of observed flow volume; and

- The above criteria are to be targeted for a minimum of two thirds of the events, however data resolution may not allow for this criteria to be met.

PCSWMM was used in the creation of a diurnal pattern for each of the flow monitors. This process matches the existing conditions and averages the daily values based off the events that were selected.

5.2.2 Wet Weather Flow Calibration

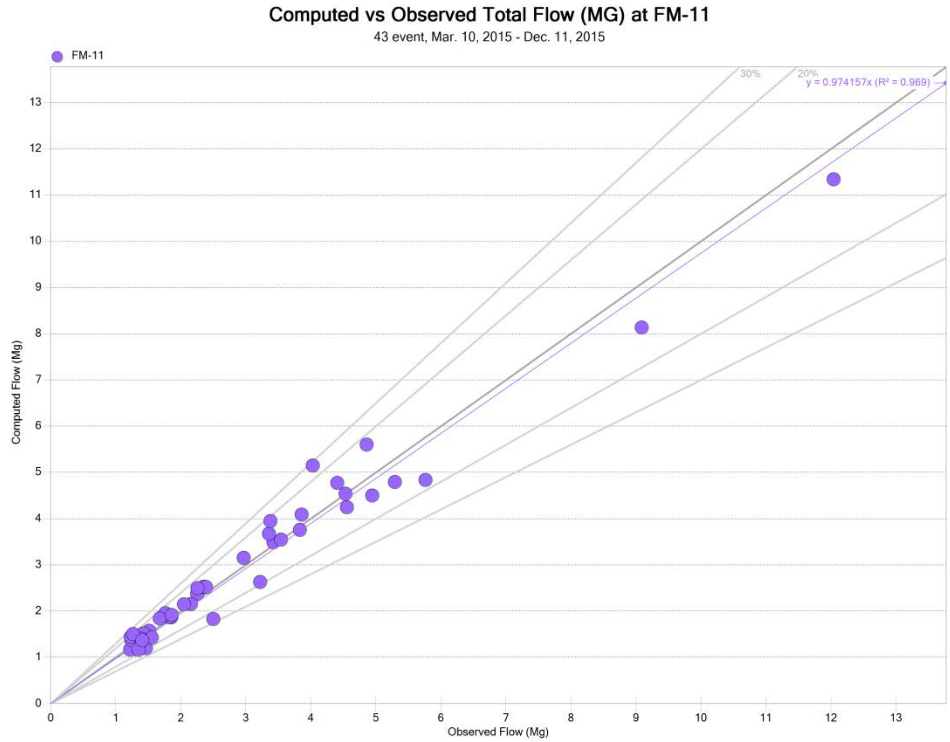
- The following model calibration criteria were established for WWF:
- Predicted time of peaks and troughs are within one hour of observed flow;
- Predicted peak flow rates are within +25 percent and -15 percent of observed flow;
- Predicted volumes of wet weather flow are within +20 percent and -10 percent of observed flow volume;
- Predicted surcharge depths in manholes or other structures are within +1.5 feet and -0.3 feet of observed flow depth;
- Predicted non-surcharge water surface elevations are within +/- 0.3 feet of observed flow depth; and
- The above criteria are to be targeted for a minimum of two thirds of the events, however data resolution may not allow for this criteria to be met.

5.2.3 Model Validation

Once all of the flow monitor models were calibrated, verification of proper model calibration was conducted by re-assembling the flow monitoring models into the originally constructed model, and then the entire flow monitoring duration was simulated again. For the calibrated model to be considered calibrated, each flow monitor site had to meet the defined calibration criteria, or meet or exceed the individual flow monitor model result. Flow monitoring sites within the calibrated model that did not meet these conditions were re-evaluated and adjusted until satisfactory results met the specified conditions.

In total, 20 flow monitors were used in the calibration of the hydraulic model. In the process of calibrating the model, scatter plots were used to minimize the error between observed and simulated results. Figure 21 shows examples of the scatter plots used to compare the flow monitoring data with the simulated data. The scatter plots were arranged to compare peak flow values or total volume for each identified wet weather event. The comparison of these charts to each flow monitor was done to minimize error and create the most calibrated model possible.

Figure 21 – Example Calibration Scatter Plot



Spatial and Temporal Data Resolution

The accuracy of the hydraulic model is dependent of the inputs that go into the calibration of the model. One of the factors that influence the precision of the model is the accuracy of the rainfall data. Rain gauges were not installed as part of the flow monitoring effort and supplemental data was used to calibrate the model. Active rain gauges within the study area were limited to four Ohio Emergency Management Agency sensor sites. The four sites are listed as Summitview, Highbanks Metro Park, Westerville Water, and Sunbury. All sites except for the Highbanks Metro Park gauge were located outside of the study area, not within any sewer tributary area. The gauges were still used due to their proximity to the area and were the best available data for the study. All four gauges record in 15-minute intervals, whereas a precision of 5-minute intervals is standard.

The spatial difference from the rain gauge sites with the flow monitor tributaries introduces a timing discrepancy for the storm travel time and an intensity discrepancy which occurs when the storm fluctuates in intensity. These spatial and temporal changes decrease the accuracy of the hydraulic model. Variables will change based off of the characteristics of the storm and increase the variability between the flow monitoring data and the hydraulic model.

The hydraulic model was calibrated using the flow monitors installed between 2014 and 2016. During that time, no rain gauge experienced a rainfall in excess of a 5-year frequency recurrence. Therefore, extrapolation will occur when the calibrated model simulated storms in excess of these storms. When simulating design storms larger than a 5-year storm, increased error is introduced into the equation due to the extrapolation of the calibrated data.

5.3 Model Results

5.3.1 Existing Conditions Summary

The two largest treatment basins, OECC and ACWRF, were modeled as part of this evaluation. Because the basins are independent of one another and considerably large, each basin was broken out into individual models for better functionality amongst the models.

Each model was evaluated for capacity limitations during dry weather and wet weather conditions. The design storms used to evaluate the wet weather conditions were 24-hour Soil Conservation Service (SCS) Type II for five, ten, and twenty-five year design storms. The total rainfalls represented in each design storm were 3.22in., 3.71in., and 4.41in., respectively.

5.3.2 Treatment Plant Summary

Each treatment plant hydraulic model was simulated using the specified design years. Table 57 shows the peak flow results for each design storm in comparison to the average dry weather flow and the treatment plants maximum capacity.

Table 57 - Modeled Peak Flows at Treatment Plants

Basin	Basin Acreage (ac)	Average DWF	Maximum Capacity	5 Year	10 Year	25 Year
ACWRF	10,568	4.783	30	20.3	23.31	25.81
OECC	8,840	4.008	18	21.03	23.12	25.97

The model results show that the peak flow experienced for storms larger than a 5 year design storm will result in peak flows exceeding OECC maximum capacity. The peak flows for a 25-year design storm are within the maximum capacity of the ACWRF.

5.3.3 Pump Station Summary

Pump stations are a key element to evaluating system limitations. Pump stations can become pinch points within a system and produce localized surcharging and flooding when they are under capacity. Table 58 shows a peak flow summary for each pump station with each respective design storm. The table also includes the average dry weather flows, modeled maximum capacity, upstream minimum freeboard and upstream surcharging for each pump station. The average dry weather flow accounts for all flows coming into the station and includes flows from other upstream pump stations. The modeled maximum capacity through the pump station forcemain is the maximum peak hourly flow observed within the hydraulic model an effort was made to ensure that these values correlated well with pump tests for single pumps in operation. In most cases, pump tests have not been conducted for multiple pumps in operation. This modeled maximum flow can be greater than the theoretical maximum capacity of the station due to surcharging within the station resulting in decreased head losses. The peak wet weather flows shown for each design storm are the peak flows observed from upstream tributary conduits coming into the station. Each one of these values is shown with a colored dot, which represents a comparison of the value to the station's modeled maximum capacity. Green represents that the flows coming into the station are less than 85% of the modeled maximum station flows. Yellow represents that the flows coming into the station are between 85% and 100% of the modeled maximum station flows. Red indicated that the tributary upstream of the pump station is delivering flows in excess of the station's modeled maximum capacity. To identify if excess flows into a pump station are causing upstream problems, two additional values were summarized for conditions found from the 25-year design storm. The first value looks at the minimum freeboard of the system directly upstream of the pump station. This was determined by examining all of the manholes that experienced backwater from the pump station and selecting the manhole that had the lowest available freeboard. Green dots are for freeboards in excess of 6 feet and red dots are for freeboards of less than 4 feet, with yellow in between. The second value looks at the surcharging of the system directly upstream of the pump station. Green dots are for surcharging less than 5 feet and red dots are for surcharging in excess of 10 feet, with yellow in between.

Table 58 – Modeled Pump Station Summary

Pump Station	Average DWF	Modeled Station Capacity (MGD)	Peak WWF (MGD) 5-Year	Peak WWF (MGD) 10-Year	Peak WWF (MGD) 25-Year	25-Year Conditions Upstream Minimum Freeboard (ft)	25-Year Conditions Surcharge (ft)
MAXTOWN	0.3045	2.380	2.623	2.812	2.779	8.3	14.1
EAST ALUM CREEK	0.05114	0.551	0.357	0.419	0.480	10.4	0.0
CHESHIRE	0.5377	1.116	0.975	1.195	1.187	0.0	9.3
SUMMERWOOD	0.1121	0.612	0.521	0.590	0.672	9.5	0.0
VINMAR FARMS	0.0342	0.428	0.153	0.166	0.193	19.2	0.0
PEACHBLOW	0.1842	0.864	0.989	0.925	1.041	2.6	15.1
TROTTERS GAIT	0.0616	0.423	0.462	0.512	0.577	3.9	13.2
SELDOM SEEN	0.0163	0.706	0.330	0.382	0.460	6.0	0.0
LEATHERLIPS	0.8751	2.993	4.404	4.762	5.185	0.0	11.7
GOLF VILLAGE NORTH	0.0104	0.474	0.235	0.300	0.350	16.2	0.0
WOODCUTTER	0.0074	0.186	0.102	0.122	0.145	22.5	0.0
GOLF VILLAGE	0.1698	1.795	2.156	1.888	2.199	5.1	12.1
LAKES OF POWELL	0.2649	0.860	0.603	0.732	0.913	13.9	0.0
DEERRUN	0.022	0.230	0.066	0.072	0.080	7.9	0.0
SHERBORNE MEWS	0.0088	0.154	0.165	0.234	0.177	7.5	6.4
QUAIL MEADOWS	0.0292	0.551	0.372	0.442	0.529	17.1	0.0

Peak WWF from Pump Station Tributary	Upstream Freeboard	Surcharge
80% Less than 85% of Station Capacity	6.0 Greater than 6 feet	4.0 Less than 5 feet
90% Between 85% & 100% of Station Capacity	4.0 Between 4 & 6 feet	5.0 Between 5 & 10 feet
100% Greater than 100% of Station Capacity	3.0 Less than 4 feet	10.0 Greater than 10 feet

While over half of the pump stations indicate that peak wet weather flows exceed the maximum capacity of the pump station, only four stations show adverse effects on the upstream systems during a 25-year design storm. These pump stations include Cheshire, Peachblow, Trotters Gait, and Leatherlips. Of these four, two of the stations indicate that flooding may occur with no available freeboard remaining. The Maxtown and Golf Village pump stations both show excessive surcharging upstream of each station. While minimum freeboard remains reasonable, surcharging of the upstream system can continue for up to two miles at each station.

Values found in Table 58 are for planning purposes only. Further evaluation of a pump station as well as potential future tributary flows should be conducted before designing any pump station improvements. This evaluation will be discussed in Technical Memorandum #4.

5.3.4 Collection System Summary

Dry Weather Evaluation

The collection system was evaluated in both wet weather and dry weather conditions.

System components were evaluated for flow capacity and surcharging issues. Table 59 shows the capacity variation of modeled conduits during dry weather conditions, as well as the base condition for conduits with velocities over 10 ft/s.

Table 59 - Dry Weather Flow Flow Capacity Summary - Number of Conduits

Basin	Model Simulation	Total Conduits	Velocity <1ft/s	<15%	16%-20%	21%-25%	26%-30%	>31%	Velocity >10 ft/s
ACWRF	DWF	5135	2712	4958	67	45	19	46	0
			52.8%	96.6%	1.3%	0.9%	0.4%	0.9%	0.00%
OECC	DWF	4146	2059	3844	117	54	33	98	1
			49.7%	92.7%	2.8%	1.3%	0.8%	2.4%	0.02%

Figures within Appendix A visually illustrate the conduit capacities shown within Table 59. Areas where conduits are over a quarter of the capacity within the ACWRF tributary during dry weather flow are listed below:

- Directly downstream of the Maxtown Pump Station Forcemain
- Along the majority of the Africa Road Interceptor
- Directly downstream of the Peachblow Pump Station Forcemain
- Along the Main Interceptor when the existing diameter is 24" or larger

Areas where conduits are over a quarter of the capacity within the OECC tributary during dry weather flow are listed below:

- Directly downstream of the Quail Meadows Pump Station Forcemain
- The trunk line directly upstream of the Leather Lips Pump Station
- From the Leather Lips Forcemain to the OECC Main Interceptor storage tank
- Portions of the trunk sewer that are on Presidential Parkway and Wallsend Court

Areas where flows exceed 10 feet per second can be harmful to the sewer and can make maintenance issues down the road for both conduits and forcemains. The one section of pipe that observes flow in excess of 10 feet per second is located on Powell Road coming down the hill near High Banks Park.

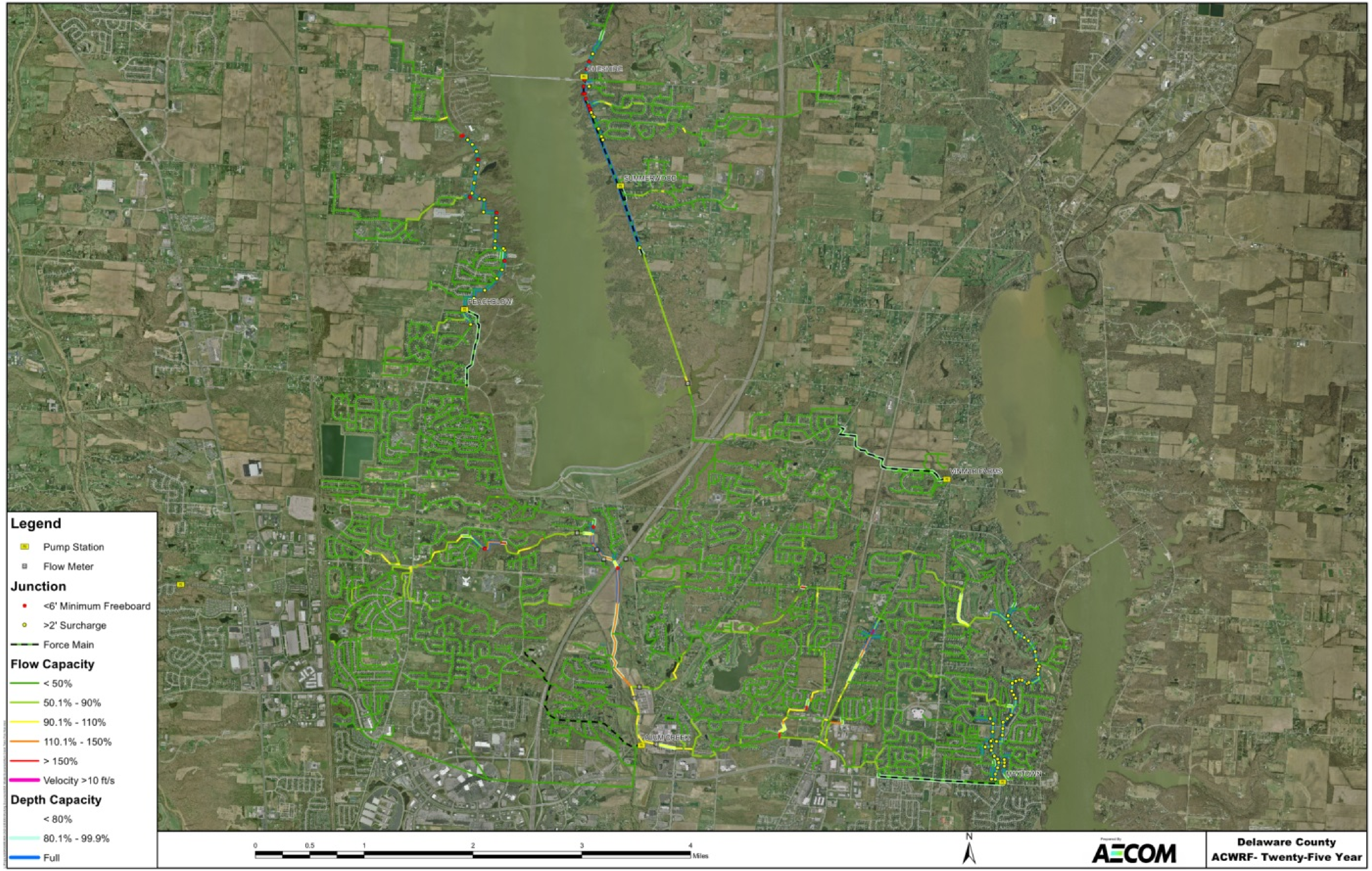
Wet Weather Evaluation

When evaluating wet weather flows, conduits can have peak flow capacities in excess of 100%. As long as excessive surcharging is not observed, the system can be considered to be operating as designed. Each basin model was simulated using the five, ten, and twenty-five year design storms. Figures within Appendix A visually illustrate system limitations for these design years. Such things that can be represented within the figures are the conduit capacities, conduits with velocity issues and nodes with surcharging and minimum freeboard limits.

Figure 22 is an example figure for all the model runs for each of the design years and model basins that are found in Appendix A. Within the figure surcharging was evaluated when surcharging was in excess of 2 feet above the crown of pipe. Minimum freeboard was evaluated when the surcharging rose within 6 feet of the top of the structure and the structure had a minimum depth of 7 feet. Flow capacities are represented for every conduit within the model. Conduit capacities in excess of 110% are important to note. These conduits are represented in orange and red, with red having a capacity of 150% or more. Additional conduit information for velocity and depth can also be found within the figure. When conduits reach above 10 feet per second the line will have a pink halo. When conduits reach a depth of over 80% full the conduit will have a light blue halo and a dark blue halo is used when the conduits are completely submerged. Areas where conduits show a blue halo and available capacity will represent backflow conditions. This will usually be present upstream of pump stations with limited capacity.

The results from these model simulations represent the level of service for the existing conditions. These results are to be used for planning purposes only. Technical Memorandum 4 will include improvements that will be in line with future growth.

Figure 22 – Example Wet Weather Model Result



The flow capacity results for wet weather conditions are summarized in Table 60 for each model. Conduits with flows in excess of 110% should be evaluated with future growth considerations to prevent a decrease in level of service.

Table 60 - Modeled Flow Capacities- Number of Conduits								
Basin	**Simulated Design Storm**	**Total Conduits**	**Velocity <2ft/s**	**<50%**	**51%-90%**	**91%-110%**	**111%-150%**	**>151%**
ACWRF	5-Year	5135	3920	4852	249	28	3	3
	10-year	5135	3838	4773	304	46	7	5
	25-Year	5135	3727	4682	349	64	33	7
OECC	5-Year	4146	2856	3702	297	62	69	16
	10-year	4146	2778	3647	306	85	81	27
	25-Year	4146	2682	3577	311	113	106	39
Flow Capacity- Percent of Total Conduits								
ACWRF	5-Year	5135	76.3%	94.5%	4.8%	0.5%	0.1%	0.1%
	10-year	5135	74.7%	93.0%	5.9%	0.9%	0.1%	0.1%
	25-Year	5135	72.6%	91.2%	6.8%	1.2%	0.6%	0.1%
OECC	5-Year	4146	68.9%	89.3%	7.2%	1.5%	1.7%	0.4%
	10-year	4146	67.0%	88.0%	7.4%	2.1%	2.0%	0.7%
	25-Year	4146	64.7%	86.3%	7.5%	2.7%	2.6%	0.9%

Figures within Appendix A visually illustrate the conduit capacity issues shown within Table 60. Conduits that experience capacities of over 100% will cause hydraulic conditions in the upstream system to rise. Surcharging and freeboard issues will develop as the flows continue to increase past the pipe design capacity. These issues are dependent on the duration of capacity exceedance and the magnitude by which the pipe exceeds capacity. Identification of capacity limitations and implementation of improvements can eliminate these issues in problem areas. Areas where conduits are over 110% of the capacity within the ACWRF tributary during wet weather flow are listed below:

- Along the portions of the trunk sewer on Old 3C Highway (plan set Indian Run Interceptor Sanitary Sewer – Contract S 74-2)
    - 8-inch sewer (between 06MH000005000042 and 06MH000005000046)
- Along the trunk sewer that runs along Pinewild Drive
- Along the Main Interceptor when sized 24” and larger (plan set Alum Creek Interceptor Sanitary Sewer Contract S 74-1)
    - 24-inch to 30-inch sewer (between 11MH000003000007 and 11MH000004000026)

- Along portions of the trunk sewer north of Orange Road, upstream of the Main Interceptor (plan set Villages of Oak Creek Sanitary Trunk Main)
  - 18-inch sewer (between 11MH001716000018 and 11MH001716000024)

The OECC Basin has a large number of capacity issues with over 3.5% of the pipes experiencing capacity limitations. Areas where multiple conduits are over 110% of the capacity within the OECC tributary during wet weather flow are listed below:

- The trunk line downstream of the Quail Meadows Pump Station Forcemain (plan sets Louis Huffman Sanitary Trunk Sewer and Bus Partnership – Huffman-Yoakam Sanitary Trunk Sewer)
  - 10-inch sewer (between 09MH001110000006 and 09MH001161000003)
- The trunk line upstream of the Leather Lips Pump Station (Plan set Offsite Sanitary Sewer for Wedgewood Section 2)
  - 18-inch to 24-inch sewer (between 09MH001431000001 and 09MH001431000024)
- The trunk line at the Leather Lips forcemain outlet to the downstream end of Jewett Road (plan sets Sanitary Sewer Improvement Leatherlips Development – From Sawmill Rd to State Route 315 and Bartholomew Lakes Estates)
  - 18-inch sewer (between 09MH00134900070A and 09MH00098900044A)
- Portions of the trunk sewer that are on Oakham Court and Wallsend Court
- The trunk line downstream of the Sherborne Mews Pump Station forcemain (plan sets Sherborne Mews Subdivision and The Retreat Sanitary Sewer Plan)
  - 8-inch to 15-inch sewer (between 09MH001514000002 and 09MH000977000001)
- Upstream of the trunk line on U.S. 315 where a 15-inch line downsizes to 8-inch line all the way upstream to Liberty Road (plan sets Sanitary Sewer Improvement Plan for The Woods of Powell South and Perry-Taggart Sanitary Sewer Improvements)
  - 10-inch to 15-inch then down to an 8-inch sewer (between 09MH001637000001 and 09MH001784000010)
- The local sewer that runs along Woodland Hall Drive (plan set Sanitary Sewer Improvements for Woodland Hall)
  - 10-inch sewer (between 09MH001560000018 and 09MH001560000003)

In addition to evaluating capacity limitations and minimum freeboard restraints, flooding is also identified for potential SSO sources. Within the model there are a few nodes that show flooding during the design storm simulations. While this may indicate potential locations for SSOs, further model refinement and field investigations should be conducted to confirm the claim that these sites can produce SSOs.

The following is a list of manholes that report flooding within the model and may be potential SSOs. Each manhole is listed under the design storm in which it is first observed to show flooding and whether the flooding is due to conveyance or pumping limitations.

ACWRF

5-Year Design Storm

- 02MH000004000185 (Cheshire PS Capacity)

OECC

5-Year Design Storm

- 09MH001429000001 (Leather Lips PS Capacity)
- 09MH001434000002 (Leather Lips PS Capacity)
- 09MH001434000004 (Leather Lips PS Capacity)
- 09MH001889000012 (Local Conveyance)

10-Year Design Storm

- 09MH001434000004 (Leather Lips PS Capacity)
- 09MH001514000010 (Sherborne Mews PS Capacity)

25-Year Design Storm

- 09MH001560000026 (Local Conveyance)
- 09MH001889000013 (Local Conveyance)
- 09MH000977000011 (Local Conveyance)
- 09MH001557000017 (Local Conveyance)
- 09MH001210000003 (Local Conveyance)
- 09MH001635000030 (Trotter Gait PS Capacity)

The ACWRF Basin only shows one (1) manhole as a potential SSO, while the OECC Basin has 11 different locations for potential SSOs. The flooding that occurs within the ACWRF Basin is due to the limitations at the Cheshire Pump Station, whereas the flooding within the OECC Basin is due to both local conveyance and pump station limitations. Leather Lips, Sherborne Mews and Trotters Gait are three pump stations that may lead to an SSO within this basin.

Table 61 shows the number of conduits with high velocities during specific design storm events. Of the 18 conduits with high velocities during a 25-year design storm in the OECC Model, two are forcemains. The two pump stations that can produce high velocities are Leather Lips and Seldom Seen. The conduits that experience high velocities are located on Jewett Road and Powell Road, directly upstream of the Main Interceptor.

Table 61 - Conduits with High Velocities

Basin	Simulated Design Storm	Total Conduits	Velocity >10 ft/s	Percent of Total
ACWRF	5-Year	5135	0	0.0%
	10-year	5135	0	0.0%
	25-Year	5135	0	0.0%
OECC	5-Year	4146	10	0.2%
	10-year	4146	12	0.3%
	25-Year	4146	17	0.4%

Table 62 shows the total number of nodes that surcharge during specific design events. Node surcharging can be due to capacity limitations for either conduits or pump stations. OECC shows the highest number of nodes to surcharge and reach a minimum freeboard limit. During a 25-year deign storm 1.8% of the nodes can be expected to reach a minimum freeboard of less than six feet for the OECC Model compared to 0.5% within the ACWRF Model.

Table 62 - Modeled Depth Results

Basin	Simulated Design Storm	Total Junctions	>2 ft. Surcharge	<6 ft. Freeboard	Percent Surcharged	Percent Minimum Freeboard
ACWRF	5-Year	5145	43	15	0.8%	0.3%
	10-year	5145	82	16	1.6%	0.3%
	25-Year	5145	95	27	1.8%	0.5%
OECC	5-Year	4153	50	26	1.2%	0.6%
	10-year	4153	88	40	2.1%	1.0%
	25-Year	4153	198	74	4.8%	1.8%

Areas that experience surcharging and freeboard issues due to capacity limitations will be evaluated for improvement during Technical Memorandum 4. During which, future development will also be incorporated into the recommended improvements.

6.0 Findings

After the review of DCRSD treatment plants, pump stations, and the sewer system, numerous deficiencies related to both condition and capacity have been identified and preliminary recommendations developed. The findings described in this section refer only to the system and assets at the time of the publication of Technical Memorandum #3 and will therefore relate only to the existing condition of the sewer system, pump stations, and treatment plants. Future growth, to be discussed in Technical Memorandum #4, has the potential to significantly impact the formal recommendations for many of the findings identified in this section. The potential impact of future growth on the issue will be discussed however, and areas which are minimally impacted by growth or are considered high risk will have more thorough recommendations below.

6.1 Olentangy Environmental Control Center

Key findings obtained from the review of the north and south treatment facilities at OECC are summarized as follows:

- OECC does not have sufficient hydraulic capacity to receive peak flows resulting from a 25-year design storm. Increasing raw sewage pumping capacity, restoring service to OECC North, and performing select hydraulic modifications are recommended .

- OECC South does not have sufficient treatment capacity to treat peak flows from a 25-year design storm and peak pollutant loadings as determined through a desktop evaluation. A more detailed evaluation using dynamic process modeling is recommended as part of a detailed facilities plan.

- OECC does not utilize a screening or grit removal process. These processes, which remove debris and grit particles from the raw sewage, are common in contemporary treatment works. Signs of debris and grit accumulation were noted during visual observation of OECC. This debris can foul downstream equipment such as pumps, aeration tank mixers, and the solids dewatering centrifuge. As evidenced by continued flooding of the grinder room in the Control Building, OECC has insufficient raw sewage pumping capacity to meet peak wet weather flows. Construction of a new headworks facility, containing screening, grit removal, and higher capacity raw sewage pumps is recommended.

- The protective coating on the final clarifier collection mechanisms appears faded and peeled in certain locations. Typically, protective coatings are removed and reapplied every 15 years.

- The tertiary filters are known to have high headloss during high flow events. This causes a portion of the filter influent to bypass the filters through a relief channel. Recently, the OEPA gave the District approval to use this bypass as long as permit limits are met as demonstrated through monitoring during this bypassing. Additionally, the high headloss causes the filters to enter their backwash mode which continues until the high flow event subsides. This results in excessive return flows being sent to the head of the plant, high energy consumption, and the loss of media fines from the filters.

- Restoring service to OECC North is recommended to increase OECC's overall capacity. OECC North has been out of service for over 20 years, and as such, most of the equipment will likely need replacement prior to restoring OECC North to service. The following components will require repair or replacement:
    - Aeration diffuser equipment is broken or uneven in a number of locations.
    - Seals and gaskets for gates and valves have likely not been maintained in out of services tanks and will need replaced.
    - Aeration blowers have not been operated in over 20 years and are nearing 40 years old.
    - RAS, WAS, and scum pumps require replacement.
    - Final clarifier sludge collection mechanisms have exceeded their useful lives and the protective coating has deteriorated. These should be replaced.
    - Concrete spalling on various aeration tanks and final clarifiers.
    - Guardrail installed on the aeration tanks and final clarifiers is damaged in multiple locations and should be replaced.
- The District has contracted with a consultant to perform a biosolids study. This study will evaluate current and future solids handling needs and investigate disposal alternatives.
- District staff has stated that sidestream flow management from the solids handling and disposal processes has been problematic. These flows contribute high levels of nutrients (ammonia and phosphorus) to the head of OECC. These nutrients can affect aeration demands and effluent quality depending upon when they are returned. They also contribute to increased ferric chloride consumption which in turn produces more chemical sludge that increases solids loading rates on clarifiers and biosolids processing units. Future regulations targeting reduced effluent nutrient concentrations are anticipated and management of these flows is important.

Key findings obtained from the review of electrical equipment at OECC North and South are summarized as follows:

- The electrical distribution equipment located in the Sludge Thickener building are exposed to high environmental temperatures which could and have lead to equipment shut down. Consider relocating the sludge thickener distribution equipment to a dedicated equipment area or provide HVAC to control the high environmental temperatures.

- Dry type transformers located in the lower level of the Control Building are showing signs of significant deterioration. These should be replaced and relocated.

- MCC-B, MCC-V1, and MCC-V2 located in the Control Building have reached their end of useful service life and have been abandoned in place. This equipment should be demolished.

- Digester and sludge blower soft starters are reaching the end of their useful service life and should be replaced.

- RAS pump VFDs have reached the end of their useful service life and should be replaced.

- South plant blower's soft starters have reached the end of their useful service life and should be replaced.

- 5,000 gallons of onsite fuel for the South generator would be sufficient to supply the South Plant with standby power for 86 hours.

- Perform Arc Flash Analysis for the North and South Plant distribution equipment. Apply equipment PPE labels.

Key findings obtained from the review of instrumentation and control systems at OECC North and South are summarized as follows:

- Control System Architecture

    - Due to the June 2017 discontinuance date of the Allen Bradley PLC 5 product line and partial discontinuance of the SLC 500 product line, we recommend that the District establishes a plan to replace the aging controllers as soon as possible.

    - It is recommended that the District continues the implementation of the ControlLogix platform for replacement of the PLC 5s. This is due to the wide acceptance and support of the product platform, the anticipated life cycle of the product line, and the fact that some PLCs have already been upgraded to this platform.

    - It is recommended that the upgrade design work includes an evaluation of the individual modules (PLCs, communication modules, I/O modules) to avoid selecting those that may be near the end of their life cycle.

    - It is recommended the District evaluates the various options available for SLC 500 replacement, which likely includes different models of the ControlLogix and CompactLogix programmable logic controller families.

- Control Panels

- While the plant maintenance staff tries to keep the existing aeration tank mixer control panels running by scavenging replacement parts, we recommend investigating the replacement of the panels.

- Supervisory Control and Data Acquisition System (SCADA)
  - Due to the relatively short life cycle of desktop PCs, operating system versions, SCADA software versions, and their inter-compatibility, we recommend the District consider planning the upgrade of the SCADA system within the next few years and implementing an upgrade within the next five years.

- Control System Network
  - It is recommended that the District plans for the execution of a network configuration and security audit within the next few years. Since there is no documentation available of the network configuration or topology, and individual connections are unlabeled, the District is at risk when it comes to making changes or troubleshooting the system. The audit should include the development of drawings representing the network architecture, network addressing details, and include the application of labeling for all network cabling and receptacles. The audit should also look for potential security risks (for example, unknown cross connections to business networks) and provide recommendations for minimizing risk from either intentional cyber attack or internal accidents.

- Control System Power Reliability
  - It is recommended the District implements a program for inspection, testing, and maintenance of the UPS systems in use at the plant. We recommend the regular replacement of batteries as indicated by the manufacturer.

- Control System Maintenance and Support Services
  - Due to the potential for long response times in the event of an emergency and risks associated with very small businesses, we recommend the District identify and build a relationship and possibly support agreement with an alternate control system support provider that may provide help if SCI is unavailable for any reason to support the plant in an emergency. In addition, since SCI has identified a timeline of approximately 10 years for closing their operations it is recommend to also identify a firm that can replace the support duties at that time.

- Documentation
  - It is recommended that the plant acquires and maintains updated control system documentation to aid in troubleshooting, maintenance, and future upgrades at

the facility. At a minimum, we recommend the creation of I/O wiring diagrams and network diagrams for all existing systems.

    - As noted in the Control System Network section, we recommend the creation of as-built documentation for the process control system networks.

- Disaster Recovery Preparation
    - We recommend that the district plans for the execution of a disaster recovery planning and implementation project for the plant SCADA and control systems.
    - The plant should include formally identifying disaster risks, assembling important system documentation and original program files (PLC, SCADA), and identifying key personnel, roles, and procedures that may be called upon to restore the process control system to operation in the event of a disaster.
    - Although SCI maintains backups of the automation program files on behalf of the District, we feel strongly that the same backup files also be stored at the plant site and at an off-site District or County facility for the purposes of disaster recovery.
    - The disaster recovery plan should examine the details of the SCADA system PCs and identify opportunities to mitigate risk such as installation of mirrored disk space, local tape or NAS (network attached storage) backup, and so on. A subsequent implementation phase would add the required hardware and provide training for plant staff.

6.2 Alum Creek Water Reclamation Facility

Key findings obtained from the review of the treatment facilities at ACWRF are summarized as follows:

- ACWRF has remaining hydraulic capacity to receive peak flows resulting from a 25-year design storm.
- According to a desktop evaluation of the treatment processes, ACWRF has insufficient capacity to treat wastewater at peak flows (25-year design storm) and peak pollutant loadings. Wastewater sampling indicates that influent wastewater strength is greater than the design assumptions. It is recommended to create a more detailed and dynamic process model as part of a facilities plan.
- An open flame was observed in duct heater DH1-PR in the odor control equipment room in the Pre-treatment Building. DH1-PR was located within a 3 foot buffer area surrounding the odor control scrubber, a possible leakage source for flammable gasses such as hydrogen sulfide. DH1-PR should be moved or replaced with a unit suitable for use in a classified space immediately.

- Grit accumulation in the aeration tanks has been problematic. According to District staff, the source of the grit is from filter media washing out from the tertiary filters during backwashing and being recycled to the head of the plant. A grit characterization study could be performed to compare the characteristics of the settled grit to the filter media. If the grit is found to be from the tertiary filters, improvements to the process is recommended. If the collected grit is found not to be from the tertiary filters, a grit removal facility is recommended to capture grit originating from the collection system.

- The tertiary filters are known to have high headloss during high flow events. This causes a portion of the filter influent to bypass the filters through a relief channel. Recently, the OEPA gave the District approval to use this bypass as long as permit limits are met as demonstrated through monitoring during this bypassing. Additionally, the high headloss causes the filters to enter their backwash mode which continues until the high flow event subsides. This results in excessive return flows being sent to the head of the plant, high energy consumption, and the loss of media fines from the filters.

- The District contracted with a consultant to perform a study on the tertiary filters and to evaluate replacement technologies. This report concluded that the District focus on reducing the solids loading on the filters through optimization of the aeration and final clarification processes. The optimizations target at producing mixed liquor with improved settling characteristics and providing sufficient detention time in the final clarifiers to mitigate TSS spikes during high flow events.

- ACWRF removed the anoxic zone mixers from their aeration tanks amid reliability troubles and the lack of manufacturer support due to equipment obsolescence. The District is currently investigating replacement mixer technologies. Valves installed on the air diffuser drop legs have failed in some locations, limiting the District's ability to control airflow throughout the aeration tank. The District plans to replace the valves and diffusers as part of a near-term CIP.

- The District does not operate the aerobic digesters because of odor complaints from nearby residents. By not operating the aerobic digestion process, the District does not significantly reduce the volume of volatile solids in the sludge and therefore must landfill greater volumes of sludge. ACWRF uses 1 to 2 sludge storage tanks and up to three digester for sludge storage, on average. Thickened sludge is withdrawn from these tanks through dedicated drain piping and grinders before being discharged to the belt filter press with a feed pump. The existing gravity belt thickener is bypassed.

- The Tertiary Filter Building had high humidity levels during the winter months. Surface oxidation of metal surfaces was observed throughout the building. Long term exposure to high humidity conditions will have deleterious effects on the structure and various components housed within.

- Solids Handling procedures and equipment at both OECC and ACWRF can be updated to allow for more efficient dewatering and disposal. This includes additional dewatering centrifuges at both facilities as well as various sludge screening improvements at OECC to ensure that the centrifuges are adequately protected. Additional sludge storage improvements at the ACWRF will provide additional flexibility in solids disposal and allow for reduced traffic by consolidating loads.

Key findings obtained from the review of electrical equipment at ACWRF are summarized as follows:

- It is recommended that all soft starters and VFDs throughout the plant be considered for replacement. These components have generally reached the end of their useful service life.

- It is also recommended to conduct an Arc Flash Analysis of the plants distribution equipment per NFPA 70E. Apply equipment PPE labels.

Key findings obtained from the review of instrumentation and control systems at ACWRF are summarized as follows:

- Control System Architecture
    - Due to the June 1027 discontinuance date of the Allen Bradley PLC 5 product line and partial discontinuance of the SLC 500 product line, we recommend that the District establishes a plan to replace the aging controllers as soon as possible.
    - We recommend the District continues the implementation of the ControlLogix platform for replacement of the PLC 5s. This is due to the wide acceptance and support of the product platform, the anticipated life cycle of the product line, and the fact that some PLCs have already been upgraded to this platform.
    - We recommend that the upgrade design work includes an evaluation of the individual modules (PLCs, communication modules, I/O modules) to avoid selecting those that may be near the end of their life cycle.
    - We recommend the District evaluates the various options available for SLC 500 replacement, which likely includes different models of the ControlLogix and CompactLogix programmable logic controller families.
- Control Panels
    - It is understood that replacement of the existing aeration tank mixer control panels is already underway under another project. Therefore, there are no additional recommendations for this topic.
- Supervisory Control and Data Acquisition System (SCADA)
    - Due to the relatively short life cycle of desktop PCs, operating system versions, SCADA software versions, and their inter-compatibility, we recommend the District

consider planning the upgrade of the SCADA system within the next few years and implementing an upgrade within the next five years.

- Control System Network
    - It is recommended that the District plans for the execution of a network configuration and security audit within the next few years. Since there is no documentation available of the network configuration or topology, and individual connections are unlabeled, the District is at risk when it comes to making changes or troubleshooting the system. The audit should include the development of drawings representing the network architecture, network addressing details, and include the application of labeling for all network cabling and receptacles. The audit should also look for potential security risks (for example, unknown cross connections to business networks) and provide recommendations for minimizing risk from either intentional cyber attack or internal accidents.
- Control System Power Reliability
    - It is recommended the District implements a program for inspection, testing, and maintenance of the UPS systems in use at the plant. It is recommended the regular replacement of batteries as indicated by the manufacturer.
- Control System Maintenance and Support Services
    - Due to the potential for long response times in the event of an emergency and risks associated with very small businesses, we recommend the District identify and build a relationship and possibly support agreement with an alternate control system support provider that may provide help if SCI is unavailable for any reason to support the plant in an emergency. In addition, since SCI has identified a timeline of approximately 10 years for closing their operations it is recommend to also identify a firm that can replace the support duties at that time.
    - As an alternative to having two support consultants available for support issues, the District may want to evaluate whether hiring an automation control system expert provides a better overall solution.
- Disaster Recovery Preparation
    - It is recommended that the district plans for the execution of a disaster recovery planning and implementation project for the plant SCADA and control systems.
    - The plant should include formally identifying disaster risks, assembling important system documentation and original program files (PLC, SCADA), and identifying key personnel, roles, and procedures that may be called upon to restore the process control system to operation in the event of a disaster.

- Although SCI maintains backups of the automation program files on behalf of the District, we feel strongly that the same backup files also be stored at the plant site and at an off-site District or County facility for the purposes of disaster recovery.
- The disaster recovery plan should examine the details of the SCADA system PCs and identify opportunities to mitigate risk such as installation of mirrored disk space, local tape or NAS (network attached storage) backup, and so on. A subsequent implementation phase would add the required hardware and provide training for plant staff.

- Documentation
  - It is recommended that the plant acquires and maintains updated control system documentation to aid in troubleshooting, maintenance, and future upgrades at the facility. At a minimum, we recommend the creation of I/O wiring diagrams and network diagrams for all existing systems.
  - As noted in the Control System Network section, we recommend the creation of as-built documentation for the process control system networks.
  - As an alternative to having two support consultants available for support issues, the District may want to evaluate whether hiring an automation control system expert provides a better overall solution.

6.3 Pump Station Recommendations

6.3.1 Alum Creek

At Alum Creek pump station, the only issue noted during the site visit was based on NFPA to comply with hazardous ventilation requirements. Based on wet weather flows and observation, the existing pump station is performing well and no recommendations for any improvements are necessary based on existing flows.

6.3.2 Leatherlips

At Leatherlips Pump Station, rehabilitation was identified based on the site visit for the following areas:

- Replace damaged light fixture in the generator room.
- Comply with hazardous area ventilation requirements per NFPA 820.

The station itself is receiving flows greater than the existing capacity. The station should be evaluated for an upgrade when examining existing flows as well as future development.

6.3.3 Maxtown

At Maxtown Pump Station, rehabilitation was identified based on the site visit for the following areas:

- Comply with hazardous area ventilation requirements per NFPA 820.

The station itself is receiving flows greater than the existing capacity. The County is already planning an upgrade to the station, which should address some of the higher flows that the station is receiving.

6.3.4 Cheshire

At Cheshire Pump Station, rehabilitation was identified based on the site visit for the following areas:

- Install fall protection for the wet well
- Replace the 480V unit heater
- Provide a hinge to the valve pit access hatch, as it is a rectangular FRP grate which can easily fall down the opening.
- Replace corroded valve piping and add actuators
- Install plywood or drywall on the interior to prevent presence of rodents and building damage

The flows to the pump station are found to be high relative to the design and the model shows backup in the upstream sewer; this station should be evaluated for an upgrade, considering both existing flows as well as future flows.

6.3.5 Golf Village

At Golf Village Pump Station, rehabilitation needs were identified based on the site visit for the following areas:

- Address discharge gauge issue to eliminate confined space entry
- Install bollards at the bypass connection, as it is directly adjacent to the roadway.
- Pump discharge piping should be recoated.
- Privacy fence surrounding bioxide storage should be repaired.
- Wet well vent should be replaced.

Based on wet weather flows and observation, the existing pump station is performing well and no recommendations for any capacity improvements are necessary based on existing flows. The station capacity will be examined considering future flows to ensure it has capacity for potential growth.

6.3.6 Scioto Reserve

At Scioto Reserve Pump Station, rehabilitation was identified based on the site visit for the following areas:

- Widening the golf cart path would provide easier access for large vehicles.
- Add a hook to the wall to keep the FRP valve vault access hatch open
- Provide fall protection for the wet well.
- Install a steel door and frame to limit potential for vandalism

Based on wet weather flows and observation, the existing pump station is performing well and no recommendations for any capacity improvements are necessary based on existing flows. The station capacity will be examined considering future flows to ensure it has capacity for potential growth. The station is currently being updated by a developer, which will address some of these concerns.

6.3.7 Vinmar

Operational data collected during the evaluation process illustrated that the pump station capacity is sufficient to manage flows under existing conditions. Additional information provided by DCRSD suggests that the station is frequently only operating at 162 gpm. The District is investigating the cause of the decreased capacity. Future growth upstream of the pump station will be examined to determine if any upgrades need to be considered for the pump station. Rehabilitation needs were identified based on the site visit and initially collected flow data for the following areas:

- Reorient the wet well safety cage to allow for easier transducer removal and cleaning.
- Inspect and clean the valve vault drain pipe.

6.3.8 East Alum Creek

At East Alum Creek Pump Station, rehabilitation was identified based on the site visit for the following areas:

- Replace the 480V unit heater.
- Provide fall protection for the wet well.

Based on wet weather flows and observation, the existing pump station is performing well and no recommendations for any capacity improvements are necessary based on existing flows. The station capacity will be examined considering future flows to ensure it has capacity for potential growth.

6.3.9 Peachblow

At Peachblow Pump Station, rehabilitation was identified based on the site visit for the following areas:

- Addition of a hinge to the valve pit access hatch would be beneficial to prevent the hatch from falling down the opening.

- The 480V unit heater is broken and should be replaced
- Include fall protection on the wet well.
- Replace the wet well vent.

The flows to the pump station are found to be high relative to the design and the model shows a backup in the upstream sewer; this station should be evaluated for an upgrade, considering both existing flows as well as future flows.

6.3.10 Pump Station Summary

Regarding pump station operation and maintenance, there are minor improvements that have been identified at each of the pump stations. With regards to existing capacity, Leatherlips, Cheshire, and Peachblow have been identified as having capacity issues and should continue to be examined along with the future flows to determine potential upgrades at each of the stations. Complete recommendations for these pump stations need to take into account future development and will be addressed considering the potential future growth as part of the overall master plan.

6.4 Collection System Recommendations

When evaluating the hydraulic model simulations, certain system limitations are present. The identification of these limitations is an important part in selecting capital improvement projects that will continue to have the system operate as expected. Capacity limitations or excessive I/I can lead to unwanted surcharging within a collection system. Areas identified as having excessive surcharging and minimum freeboard issues should be evaluated for future improvements to reduce the strain on the system. These areas should also be evaluated when upstream pump station improvements to be considered. Sections of sewer that are already stressed from high flows can become exacerbated when upstream pump stations send higher flow rates down stream.

In addition, the potential for future flows must be considered when considering the need for upsizing. This section is documenting the problem areas that have been identified by the modeling of the existing system, but it does not consider future flows. For most of the larger sewers, the service area has the potential to have upstream development or some infill development. As such, this section does not include specific recommendations on the magnitude of required capacity improvements based on existing flows; when the future flows are considered, the proposed sewers can be evaluated considering both the existing and future conditions to provide a complete picture of the required work.

6.4.1 Alum Creek Water Reclamation Facility Basin

The following is a list of areas identified within the ACWRF Basin that are capacity limited. These areas are identified as problem areas (less than 6' of freeboard) during a 25-year design storm but can be problematic during less intense storms.

- Along the portions of the trunk sewer on Old 3C Highway (plan set Indian Run Interceptor Sanitary Sewer – Contract S 74-2)
    - 8-inch sewer (between 06MH000005000042 and 06MH000005000046)
- Along the trunk sewer that runs along Pinewild Drive
- Along the Main Interceptor when sized 24” and larger (plan set Alum Creek Interceptor Sanitary Sewer Contract S 74-1)
    - 24-inch to 30-inch sewer (between 11MH000003000007 and 11MH000004000026)
- Along portions of the trunk sewer north of Orange Road, upstream of the Main Interceptor (plan set Villages of Oak Creek Sanitary Trunk Main)
    - 18-inch sewer (between 11MH001716000018 and 11MH001716000024)

These three areas show capacity limitations, with some surcharging. Any development upstream of these areas should include an evaluation to the impact to these sewers.

6.4.2 Olentangy Environmental Control Center Basin

The following is a list of areas identifies within the OECC Basin that are capacity limited. These areas are identified as problem areas (with less than 6’ of freeboard) during a 25-year design storm but can be problematic during less intense storms.

- The trunk line downstream of the Quail Meadows Pump Station Forcemain (plan sets Louis Huffman Sanitary Trunk Sewer and Bus Partnership – Huffman-Yoakam Sanitary Trunk Sewer)
    - 10-inch sewer (between 09MH001110000006 and 09MH001161000003)
- The trunk line upstream of the Leather Lips Pump Station (Plan set Offsite Sanitary Sewer for Wedgewood Section 2)
    - 18-inch to 24-inch sewer (between 09MH001431000001 and 09MH001431000024)
- The trunk line at the Leather Lips forcemain outlet to the downstream end of Jewett Road (plan sets Sanitary Sewer Improvement Leatherlips Development – From Sawmill Rd to State Route 315 and Bartholomew Lakes Estates)
    - 18-inch sewer (between 09MH00134900070A and 09MH00098900044A)
- Portions of the trunk sewer that are on Oakham Court and Wallsend Court
- The trunk line downstream of the Sherborne Mews Pump Station forcemain (plan sets Sherborne Mews Subdivision and The Retreat Sanitary Sewer Plan)

- 8-inch to 15-inch sewer (between 09MH001514000002 and 09MH000977000001)

- Upstream of the trunk line on U.S. 315 where a 15-inch line downsizes to 8-inch line all the way upstream to Liberty Road (plan sets Sanitary Sewer Improvement Plan for The Woods of Powell South and Perry-Taggart Sanitary Sewer Improvements)
  - 10-inch to 15-inch then down to an 8-inch sewer (between 09MH001637000001 and 09MH001784000010)

- The local sewer that runs along Woodland Hall Drive (plan set Sanitary Sewer Improvements for Woodland Hall)
  - 10-inch sewer (between 09MH001560000018 and 09MH001560000003)

All of the areas identified above show capacity limitations; they show varying degrees of surcharging. Any development upstream of these areas should include an evaluation to the impact to these downstream sewers. Capacity upgrades to the Leather Lips Pump Station will have beneficial impacts on upstream sewers, but will inevitably have negative impacts to the downstream sewers. Improvements to the downstream sewer will be necessary if Leather Lips Pump Station is to be upgraded. The 15-inch on S.R.315 that reduces down to an 8-inch line shows extensive levels of surcharging. Additional flow monitoring may be recommended in this area due to the identification of potential problems upstream of this area. Improvements may be necessary beyond the up sizing of the 8-inch section.

6.4.3 Collection System Summary

The overall condition of the DCRSD collection system is good. The Maintenance staff appear to currently have a reliable method for detecting condition issues as well as a means for addressing them. Capacity limitations for existing sewers and pump stations were also identified and are the larger source of issues in the capacity and condition assessment that was performed, but are also relatively manageable when compared to other similarly sized systems. The impact of rapid growth over the last 20 years combined with a relatively high Level of Service has lead to a number of capacity deficiencies being identified. Many of these issues will be worsened by additional growth and that impact will therefore need to be considered prior to recommendations. Each of these areas will be further discussed in Technical Memorandum #4 and in some cases, additional flow monitoring may be necessary. Complete recommendations for the collection system will take into account future development and will address the potential future growth as part of the overall master plan.

Appendix A

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER/ MODEL	COMPONENT SIZE/ RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
SOUTH BLOWER BLDG 'I'	MS-3	METAL ENCLOSED SWITCHGEAR	CUTLER-HAMMER / DSII	480/277V, 3200A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SOUTH BLOWER BLDG 'I'	SOUTH GEN SET	DIESEL GENERATOR	CATERPILLAR	480V, 1500KW	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	MAINTAINED WITH THIRD PARTY MAINTENANCE CONTRACT	NOT ENVISIONED IN NEXT 20YRS
SOUTH BLOWER BLDG 'I'	ATS-B2	AUTO TRANSFER SWITCH	RUSSELECTRIC	480V, 1600A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SOUTH BLOWER BLDG 'I'	MCC-B1	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 1600A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SOUTH BLOWER BLDG 'I'	MCC-B2	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 1600A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SOUTH BLOWER BLDG 'I'	MCC-B3	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 600A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SOUTH BLOWER BLDG 'I'	TB1	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 75KVA	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER/ MODEL	COMPONENT SIZE/ RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
SOUTH BLOWER BLDG 'I'	TB2	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 15KVA	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SOUTH BLOWER BLDG 'I'	B1	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER, POW-R-LINE C	208Y/120V, 150A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SOUTH BLOWER BLDG 'I'	B2	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER, POW-R-LINE C	208Y/120V, 60A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SOUTH BLOWER BLDG 'I'	B3	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER, POW-R-LINE C	208Y/120V, 150A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SOUTH BLOWER BLDG 'I'	RAS PUMP 1 VFD	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS	480V, 20HP	1998	10YRS	5%	WORKING, MODERATE DETERIORATION	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	CAPITALIZE REPLACEMENT IN NEXT CIP
SOUTH BLOWER BLDG 'I'	RAS PUMP 2 VFD	VARIABLE FREQUENCY DRIVE	ABB / ACX550	480V, 20HP	2015	10YRS	90%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SOUTH BLOWER BLDG 'I'	RAS PUMP 3 VFD	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS	480V, 20HP	1998	10YRS	5%	WORKING, MODERATE DETERIORATION	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	CAPITALIZE REPLACEMENT IN NEXT CIP

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER/ MODEL	COMPONENT SIZE/ RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
SOUTH BLOWER BLDG 'I'	RAS PUMP 4 VFD	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS	480V, 20HP	1998	10YRS	5%	WORKING, MODERATE DETERIORATION	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	CAPITALIZE REPLACEMENT IN NEXT CIP
SOUTH BLOWER BLDG 'I'	RAS PUMP 5 VFD	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS	480V, 20HP	1998	10YRS	5%	WORKING, MODERATE DETERIORATION	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	CAPITALIZE REPLACEMENT IN NEXT CIP
ADMINISTRATION BLDG	MCC-AD	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 600A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
ADMINISTRATION BLDG	AD1	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 112.5KVA	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
ADMINISTRATION BLDG	AD1	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER, POW-R-LINE C	208Y/120V, 150A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
ADMINISTRATION BLDG	AD2	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER, POW-R-LINE C	208Y/120V, 150A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
ADMINISTRATION BLDG	AD3	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER, POW-R-LINE C	208Y/120V, 200A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
SLUDGE THICKENER BLDG 'D'	MS-2	METAL ENCLOSED SWITCHGEAR	CUTLER-HAMMER / DSII	480/277V, 3200A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SLUDGE THICKENER BLDG 'D'	ATS-S1	AUTO TRANSFER SWITCH	RUSSELECTRIC	480V, 1600A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SLUDGE THICKENER BLDG 'D'	MCC-ST1	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 1200A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE. ENVIROMENTAL CONDITIONS NOT WELL SUITED FOR MCC LOCATION.	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	(MCC) NOT ENVISIONED IN NEXT 20YRS. SOFT STARTS NEED REPLACEMENT IN NEXT CIP.
SLUDGE THICKENER BLDG 'D'	MCC-ST2	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 1600A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE. ENVIROMENTAL CONDITIONS NOT WELL SUITED FOR MCC LOCATION.	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	(MCC) NOT ENVISIONED IN NEXT 20YRS. SOFT STARTS NEED REPLACEMENT IN NEXT CIP.
SLUDGE THICKENER BLDG 'D'	TS1	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 30KVA	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SLUDGE THICKENER BLDG 'D'	TS2	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 15KVA	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
SLUDGE THICKENER BLDG 'D'	S1	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER / POW-R-LINE C	208Y/120V, 150A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
SLUDGE THICKENER BLDG 'D'	S2	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER / POW-R-LINE C	208Y/120V, 60A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
DEWATERING BLDG 'B'	MCC-DWB	MOTOR CONTROL CENTER	CUTLER-HAMMER / FREEDOM SERIES 2100	480V, 600A	2008	40YRS	80%	EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
DEWATERING BLDG 'B'	T1	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 45KVA	2008	40YRS	80%	EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
DEWATERING BLDG 'B'	LP-1	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER / POW-R-LINE C	208Y/120V, 400A	2008	40YRS	80%	EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
TERTIARY TREATMENT BLDG 'E'	MCC-TFB	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 600A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
TERTIARY TREATMENT BLDG 'E'	DPT	DISTRIBUTION PANELBOARD	WESTINGHOUSE	480V, 100A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
TERTIARY TREATMENT BLDG 'E'	T	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER / POW-R-LINE C	208Y/120V, 150A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
TERTIARY TREATMENT BLDG 'E'	TT1	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 30KVA	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
TERTIARY TREATMENT BLDG 'E'	TT2	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 75KVA	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
TERTIARY TREATMENT BLDG 'E'	PDC 1A	DRY TYPE TRANSFORMER	FEDERAL PACIFIC / 36B	480V PRI - 120/208V SEC, 15KVA	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
TERTIARY TREATMENT BLDG 'E'	PDC 2A	DRY TYPE TRANSFORMER	FEDERAL PACIFIC / 36B	480V PRI - 120/208V SEC, 15KVA	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
TERTIARY TREATMENT BLDG 'E'	PDC 3A	DRY TYPE TRANSFORMER	FEDERAL PACIFIC / 36B	480V PRI - 120/208V SEC, 15KVA	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
NORTH BLOWER / INFLUENT / EFFLUENT	NORTH GEN SET	DIESEL GENERATOR		480/277V, 1000KW	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	MAINTAINED WITH THIRD PARTY MAINTENANCE CONTRACT	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	MS-1	METAL ENCLOSED SWITCHGEAR	CUTLER-HAMMER / MAGNUM DS	480/277V, 2000A	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	DS-2	METAL ENCLOSED SWITCHGEAR	CUTLER-HAMMER / MAGNUM DS	480/277V, 2000A	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	ATS-1	AUTO TRANSFER SWITCH	RUSSELECTRIC	480V, 800A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	ATS-2	AUTO TRANSFER SWITCH	RUSSELECTRIC	480V, 800A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	ATS-3	AUTO TRANSFER SWITCH	RUSSELECTRIC	480V, 400A	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	MCC-NB-1	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE 2100	480V, 1200A	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
NORTH BLOWER BLDG	MCC-A3	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 600A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	T1	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 30KVA	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	T2	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 9KVA	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	T3	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 15KVA	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	T4	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 30KVA	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	LP-A1	LOW VOLTAGE PANELBOARD	EATON / POWER-R-LINE C	208Y/120V, 225A	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	LP-A2	LOW VOLTAGE PANELBOARD	EATON / POWER-R-LINE C	208Y/120V, 100A	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
NORTH BLOWER BLDG	A3	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER / POW-R-LINE C	208Y/120V, 60A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
NORTH BLOWER BLDG	A4	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER / POW-R-LINE C	208Y/120V, 100A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
CONCENTRATOR BLDG 'G'	MCC-CB	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE 2100	480V, 600A	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
CONCENTRATOR BLDG 'G'	T-LP-C	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 30KVA	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
CONCENTRATOR BLDG 'G'	LP-C	LOW VOLTAGE PANELBOARD	EATON / POWER-R-LINE C	208Y/120V, 100A	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
EFFLUENT BLDG 'E'	MCC-EF-1	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE 2100	480V, 600A	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
EFFLUENT BLDG 'E'	TD1	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 15KVA	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
EFFLUENT BLDG 'E'	TD2	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 15KVA	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
EFFLUENT BLDG 'E'	TD3	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 55KVA	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
EFFLUENT BLDG 'E'	D1	LOW VOLTAGE PANELBOARD	EATON / POWER-R-LINE C	208Y/120V, 100A	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
EFFLUENT BLDG 'E'	D2	LOW VOLTAGE PANELBOARD	EATON / POWER-R-LINE C	208Y/120V, 100A	2016	40YRS	100%	NEW / EXCELLENT	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
EFFLUENT BLDG 'E'	D3	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER / POW-R-LINE C	208Y/120V, 60A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
INFLUENT BLDG 'A'	DS-1	LOW VOLTAGE SWITCHBOARD	CUTLER-HAMMER / POW-R-LINE C	480V, 800A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
INFLUENT BLDG 'A'	MCC-B	MOTOR CONTROL CENTER	GOULD I-T-E	480V, 600A	1977	40YRS	0%	SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPITALIZE REPLACEMENT IN NEXT CIP
INFLUENT BLDG 'A'	MCC-V1	MOTOR CONTROL CENTER	GOULD I-T-E	480V, 600A	1977	40YRS	0%	SIGNIFICANT DETERIORATION	ABBANDONED	ABBANDONED	CAPITALIZE DEMOLITION IN NEXT CIP

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
INFLUENT BLDG 'A'	MCC-V2	MOTOR CONTROL CENTER	GOULD I-T-E	480V, 600A	1977	40YRS	0%	SIGNIFICANT DETERIORATION	ABBANDONED	ABBANDONED	CAPITALIZE DEMOLITION IN NEXT CIP
INFLUENT BLDG 'A'	T5	DRY TYPE TRANSFORMER	GOULD I-T-E	480V PRI - 120/208V SEC, 15KVA	1977	40YRS	0%	SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPITALIZE REPLACEMENT IN NEXT CIP
INFLUENT BLDG 'A'	T4	DRY TYPE TRANSFORMER	GOULD I-T-E	480V PRI - 120/208V SEC, 45KVA	1977	40YRS	0%	SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPITALIZE REPLACEMENT IN NEXT CIP
INFLUENT BLDG 'A'	T1	DRY TYPE TRANSFORMER	CUTLER-HAMMER	480V PRI - 120/208V SEC, 15KVA	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
INFLUENT BLDG 'A'	PNL-V	LOW VOLTAGE PANELBOARD	GE / INTEGRAL TO MCC-V2	120/208V	1977	40YRS	0%	SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPITALIZE REPLACEMENT IN NEXT CIP
INFLUENT BLDG 'A'	PNL-B	LOW VOLTAGE PANELBOARD	GE / INTEGRAL TO MCC-B	120/208V	1977	40YRS	0%	SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPITALIZE REPLACEMENT IN NEXT CIP
INFLUENT BLDG 'A'	IP	LOW VOLTAGE PANELBOARD	CUTLER-HAMMER / POW-R-LINE C	208Y/120V, 60A	1998	40YRS	55%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN NEXT 20YRS
INFLUENT BLDG 'A'	VFD-1	VARIABLE FREQUENCY DRIVE	ALLEN-BRADLEY / 1336 PLUS	480V, 75HP	1998	10YRS	0%	WORKING, MODERATE DETERIORATION	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	CAPITALIZE REPLACEMENT IN NEXT CIP
INFLUENT BLDG 'A'	VFD-2	VARIABLE FREQUENCY DRIVE	ALLEN-BRADLEY / 1336 PLUS	480V, 75HP	1998	10YRS	0%	WORKING, MODERATE DETERIORATION	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	CAPITALIZE REPLACEMENT IN NEXT CIP
INFLUENT BLDG 'A'	VFD-3	VARIABLE FREQUENCY DRIVE	ALLEN-BRADLEY / 1336 PLUS	480V, 75HP	1998	10YRS	0%	WORKING, MODERATE DETERIORATION	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	CAPITALIZE REPLACEMENT IN NEXT CIP

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
INFLUENT BLDG 'A'	VFD-4	VARIABLE FREQUENCY DRIVE	ALLEN-BRADLEY / 1336 PLUS	480V, 75HP	1998	10YRS	0%	WORKING, MODERATE DETERIORATION	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	CAPITALIZE REPLACEMENT IN NEXT CIP
INFLUENT BLDG 'A'	VFD-5	VARIABLE FREQUENCY DRIVE	ALLEN-BRADLEY / 1336 PLUS	480V, 75HP	1998	10YRS	0%	WORKING, MODERATE DETERIORATION	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	CAPITALIZE REPLACEMENT IN NEXT CIP
INFLUENT BLDG 'A'	VFD-6	VARIABLE FREQUENCY DRIVE	ALLEN-BRADLEY / 1336 PLUS	480V, 50HP	1998	10YRS	0%	WORKING, MODERATE DETERIORATION	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	CAPITALIZE REPLACEMENT IN NEXT CIP
INFLUENT BLDG 'A'	VFD-6	VARIABLE FREQUENCY DRIVE	ALLEN-BRADLEY / 1336 PLUS	480V, 50HP	1998	10YRS	0%	WORKING, MODERATE DETERIORATION	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	CAPITALIZE REPLACEMENT IN NEXT CIP

T3 AND T4 CIRCUITS											
PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
MAINTENANCE BLDG.	SWG1-MA	SWITCHGEAR	SQUARE D / POWER-ZONE III	480/277V, 3200A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
MAINTENANCE BLDG.	ATS#2	TRANSFER SWITCH	RUSSELECTRIC	480V, 4000A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
MAINTENANCE BLDG.	SWG2-MA	SWITCHGEAR	SQUARE D / POWER-ZONE III	480/277V, 3200A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
MAINTENANCE BLDG.	GEN #1	CATERPILLAR	3516	480V, 1750KW	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
MAINTENANCE BLDG.	GEN #2	CATERPILLAR	3516	480V, 1750KW	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
DRAIN PUMP STATION	MCC-DP	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 600A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
SOLIDS HANDLING	MCC1-SH	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 2000A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
SOLIDS HANDLING	MCC2-SH	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 2000A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
SOLIDS HANDLING	SSRVS1 BLOWER 1	SOFT STARTER	ALEEN BRADLEY	480V, 150HP	2002	15YRS	1%	WORKING WELL, MODERATE DETERIORATION	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENCE	CAPATALIZE REPLACEMENT IN NEXT CIP
SOLIDS HANDLING	SSRVS2 BLOWER 2	SOFT STARTER	ALEEN BRADLEY	480V, 300HP	2002	15YRS	1%	WORKING WELL, MODERATE DETERIORATION	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENCE	CAPATALIZE REPLACEMENT IN NEXT CIP
SOLIDS HANDLING	SSRVS3 BLOWER 3	SOFT STARTER	ALEEN BRADLEY	480V, 300HP	2002	15YRS	1%	WORKING WELL, MODERATE DETERIORATION	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENCE	CAPATALIZE REPLACEMENT IN NEXT CIP
SOLIDS HANDLING	SSRVS4 BLOWER 4	SOFT STARTER	ALEEN BRADLEY	480V, 300HP	2002	15YRS	1%	WORKING WELL, MODERATE DETERIORATION	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENCE	CAPATALIZE REPLACEMENT IN NEXT CIP
SOLIDS HANDLING	SSRVS5 BLOWER 5	SOFT STARTER	ALEEN BRADLEY	480V, 300HP	2002	15YRS	1%	WORKING WELL, MODERATE DETERIORATION	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENCE	CAPATALIZE REPLACEMENT IN NEXT CIP
SOLIDS HANDLING	AFD1 THICKENED SLUDGE PMP1	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY	480V, 20HP	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP
SOLIDS HANDLING	AFD2 THICKENED SLUDGE PMP2	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY	480V, 20HP	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP
SOLIDS HANDLING	AFD1 FEED PMP1	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY	480V, 50HP	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
SOLIDS HANDLING	AFD2 FEED PMP2	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY	480V, 50HP	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP
TERTIARY FILTER BLDG.	MCC-TF	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 600A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
POST TREATMENT BLDG.	MCC-PO	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 1200A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
POST TREATMENT BLDG.	AFDNP1 NONPOTABLE WATER PMP1	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS II	480V, 100HP	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP
POST TREATMENT BLDG.	AFDNP2 NONPOTABLE WATER PMP2	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS II	480V, 100HP	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP

T1 AND T2 CIRCUITS											
PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
BLOWER BLDG.	SWG1-BL	SWITCHGEAR	SQUARE D / POWER-ZONE III	480/277V, 3200A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
BLOWER BLDG.	SWG2-BL	SWITCHGEAR	SQUARE D / POWER-ZONE III	480/277V, 3200A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
BLOWER BLDG.	ATS#1	TRANSFER SWITCH	RUSSELECTRIC	480V, 4000A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
BLOWER BLDG.	SSRVS BLOWER 1	SOFT STARTER	ALLEN BRADLEY	480V, 600A	2002	15YRS	1%	WORKING WELL, MODERATE DETERIORATION	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENCE	CAPATALIZE REPLACEMENT IN NEXT CIP
BLOWER BLDG.	SSRVS BLOWER 2	SOFT STARTER	ALLEN BRADLEY	480V, 600A	2002	15YRS	1%	WORKING WELL, MODERATE DETERIORATION	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENCE	CAPATALIZE REPLACEMENT IN NEXT CIP
BLOWER BLDG.	SSRVS BLOWER 3	SOFT STARTER	ALLEN BRADLEY	480V, 600A	2002	15YRS	1%	WORKING WELL, MODERATE DETERIORATION	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENCE	CAPATALIZE REPLACEMENT IN NEXT CIP
BLOWER BLDG.	SSRVS BLOWER 4	SOFT STARTER	ALLEN BRADLEY	480V, 600A	2002	15YRS	1%	WORKING WELL, MODERATE DETERIORATION	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENCE	CAPATALIZE REPLACEMENT IN NEXT CIP
BLOWER BLDG.	SSRVS BLOWER 5	SOFT STARTER	ALLEN BRADLEY	480V, 400A	2002	15YRS	1%	WORKING WELL, MODERATE DETERIORATION	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENCE	CAPATALIZE REPLACEMENT IN NEXT CIP

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
BLOWER BLDG.	SSRVS BLOWER 6	SOFT STARTER	ALLEN BRADLEY	480V, 400A	2002	15YRS	1%	WORKING WELL, MODERATE DETERIORATION	REHABILITATION, IF POSSIBLE	NORMAL PREVENTIVE AND MAJOR CORRECTIVE MAINTENCE	CAPATALIZE REPLACEMENT IN NEXT CIP
BLOWER BLDG.	MCC1-BL	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 800A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
BLOWER BLDG.	MCC(2)-BL	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 800A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
BLOWER BLDG.	MCC3-BL	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 800A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
BLOWER BLDG.	VFD#1 RAS PUMP 1	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS II	480V, 40A	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP
BLOWER BLDG.	VFD#2 RAS PUMP 2	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS II	480V, 40A	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP
BLOWER BLDG.	VFD#3 RAS PUMP 3	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS II	480V, 40A	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP
BLOWER BLDG.	VFD#4 RAS PUMP 4	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS II	480V, 40A	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP
BLOWER BLDG.	VFD#5 RAS PUMP 5	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS II	480V, 40A	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP
BLOWER BLDG.	VFD#6 RAS PUMP 6	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS II	480V, 40A	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP
BLOWER BLDG.	VFD#7 RAS PUMP 7	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS II	480V, 40A	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP
BLOWER BLDG.	VFD#1 WAS PUMP 1	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS II	480V, 40A	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP

PROCESS AREA	COMPONENT ID	ASSET	MANUFACTURER / MODEL	COMPONENT SIZE / RATING (V/A/KW)	ESTIMATED INSTALLATION YEAR	EQUIPMENT USEFUL LIFE	% OF REMAINING USEFUL LIFE	CONDITION RATING	NEEDS	MAINTENANCE STRATEGY	REPLACEMENT STRATEGY
BLOWER BLDG.	VFD#2 WAS PUMP 2	VARIABLE FREQUENCY DRIVE	ALLEN BRADLEY / 1336 PLUS II	480V, 40A	2002	10YRS	0%	WORKING, SIGNIFICANT DETERIORATION	REPLACEMENT	REPLACE	CAPATALIZE REPLACEMENT IN NEXT CIP
PRETREATMENT BLDG.	MCC-PR	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 600A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS
ADMINISTRATION BLDG.	MCC-AD	MOTOR CONTROL CENTER	ALLEN BRADLEY / CENTERLINE	480V, 600A	2002	40YRS	65%	WORKING WELL, MINOR DEFECTS ONLY	CONDITION BASED MAINTENANCE	NORMAL PREVENTIVE AND MINOR CORRECTIVE MAINTENANCE WITHIN O&M BUDGET	NOT ENVISIONED IN THE NEXT 20YRS