DRAFT REPORT

Flow Projections and Liquids Processing Facilities Hydraulic Review

City Project No. 15073-121

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Prepared for

City of St. Petersburg

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CH2M HILL Engineers, Inc.
4350 West Cypress Street
Suite 600
Tampa, FL 33607

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List of Acronyms

AADF – Annual Average Daily Flow

ASR – Aquifer Storage Recovery

AWWRF – Albert Whitted Water Reclamation Facility

FDEP – Florida Department of Environmental Protection

gpd – gallons per day

HMI – Human-machine Interface

MAIC – Maximum Available Injection Capacity

MDF – Maximum Day Flow

MMADF – Maximum Month Average Day Flow

mg – million gallon

mgd – million gallons per day

NEWRF – Northeast Water Reclamation Facility

NWWRF – Northwest Water Reclamation Facility

PHF – Peak Hour Flow

ppd – pounds per day

RAS – Return Activated Sludge

SPMRS – St. Petersburg Master Reuse System

SWWRF – Southwest Water Reclamation Facility

TAZ - Transportation Analysis Zone

UIC – Underground Injection Control

WAS – Waste Activated Sludge

WRF – Water Reclamation Facility

1 Introduction

1.1 Background

CH2M has been tasked by the City of St. Petersburg to perform a peer review of the hydraulic capacity and the emergency operations plan for each of its three wastewater treatment facilities: Southwest Water Reclamation Facility (SWWRF), Northeast Water Reclamation Facility (NEWRF), and the Northwest Water Reclamation Facility (NWWRF). As part of this project CH2M will review historical flow, review peaking factors and flow projections, identify hydraulic restrictions and emergency operations plans for peak wet-weather flow events. At the completion of this project CH2M will provide recommendations to mitigate future issues due to peak flow events such as capacity upgrades or operational procedures

1.2 Objective

The objective of this report is to evaluate the hydraulic and process capacity of three of the City of St. Petersburg's WRF: Southwest, Northwest and Northeast. The report includes a review of existing WRF conditions, a summary of flow projections for three WRFs, an identification of any hydraulic limitations and recommendations for a solution.

1.3 Historical Document and Data Review

The following data and documents were reviewed as part of the evaluation:

- Florida Department of Environmental Protection (FDEP) Facility Operating Permits for NEWRF, NWWRF, and SWWRF
- FDEP Injection Well Operating Permits for NEWRF, NWWRF, and SWWRF
- WRF Daily Flow and Rainfall data 2000 to 2015 (Excel spreadsheets)
- Transportation Analysis Zone Data (GIS data and Excel spreadsheet)
- Pump Curves for SWWRF Collection System Pump Station 28 (Lake Maggoire), Pump Station 85 (Albert Whitted Collection Basin), SWWRF Influent Pump Stations, SWWRF In-plant Lift Stations, and SWWRF Distribution Pump Station
- Biosolids to Energy Project Preliminary Design Report Draft (Brown and Caldwell, September 2013)
- Biosolids to Energy Project Preliminary Design Report Final (Brown and Caldwell, June 2015)
- Albert Whitted Water Reclamation Facility Operation Alternatives Report (CDM, October 2010)
- Southwest Water Reclamation Facility Reclaimed Water Pump Station Modifications (CDM, January, 2014)
- Southwest Water Reclamation Facility Treatment Process and Hydraulic Evaluation (Brown and Caldwell, April 2013)
- Southwest Water Reclamation Facility Wet Weather and Liquid Process Capacity Assessment (Brown and Caldwell, July 2014)

2 Site Observations of Liquid Processing Facilities

Site visits and discussions with operations staff were conducted on August 18, 2015, September 29, 2015 and September 30, 2015, at the City of St. Petersburg's Northeast Water Reclamation Facility, Northwest Water Reclamation Facility, and Southwest Water Reclamation Facility with a focus on the liquid processing facilities and hydraulic capacity. Each visit began with a review of the current flows, observed hydraulic capacity and any known hydraulic restrictions or limitations with the respective chief operator as well as other operators as needed. The facilities were then observed and photographed.

A review of the liquid treatment facilities at the NEWRF, NWWRF, and SWWRF indicated that a majority of the equipment is well maintained, and sufficient redundancy is available. Some treatment assets were in moderate to poor condition, but plans are in the Capital Improvement Plan and in progress to address these in the next couple of years.

After discussions with operations at each WRF, it appears that the NEWRF and NWWRF had sufficient hydraulic capacity to effectively pass and treat all peak flows and loads received during the July/August wet weather event, although the City Operations has indicated that both of these facilities were reaching their treatment limits for short periods around August 3rd, 2015. The bottleneck at each of these facilities seemed to be the filters. The SWWRF however experienced sustained peak flows above the capacity of the treatment and disposal systems. Based on the City's Operations team, the high flows stressed the filters and increased head loss upstream of the filters causing water levels in the headworks and secondary treatment facilities to rise. The increased frequency of backwashing reduces hydraulic and process capacity (only three filters are available as one is backwashed; reducing capacity by 25%) and sends more flow back to the headworks of the plant. Operations have the ability to bypass the filters, but the City's Operating Protocol dictates that filtration must be used to produce reclaimed water which impacts the disposal of the treated wastewater.

3 Average Flow Projections

This section of the report presents the methodology that was used for calculating the updated flow projections for each facility. This section also includes the data inventory and subsequent methodology adopted for the analysis of each individual facility's flow projection in detail. The section concludes with draft projections for each facility. Based on reviewing previous reports (Brown and Caldwell, 2015) and using the engineering judgement, TAZ (transportation analysis zone) data was used for population projection and flow projection analysis for this study.

TAZ data is a commonly accepted for population projections and is based on Census data. TAZ data are well suited for determining population projections and calculating flow projections because each datum covers a generally small surface area, and the service area can be accurately represented. Places such as Pasco County, FL; Detroit, MI; King County, WA; and Raleigh-Durham, NC; among others, use TAZ as the basis for population projections in the prediction of future flows.

3.1 Methodology

3.1.1 Data Inventory

The following data sources were obtained and considered in developing the projection methodology:

- Pinellas County geographical information system (GIS) data were obtained from the Pinellas County GIS website (http://opendata.pinellas-egis.opendata.arcgis.com).
- Population projection data based on TAZ was obtained from the County Metropolitan Planning Organization.
- Population projection for single family and work population for the County based on TAZ distribution was available at five year increments from 2010 through 2040. School enrollment data and projections were only available for 2010, 2030 and 2040.
- Historical flow and rain data for all the treatment facilities from the City.

3.1.2 Proposed Flow Projection Techniques

Flows, loadings, and operational constraints must be forecasted at least ten years forward to determine the projected capacity exceedance date. Several potential scenarios were considered to project flow over the next twenty years:

- **Linear extrapolation of the historical growth rate.** In an area of stable, consistent change, and in the absence of global limiting factors (such as finite real estate, job market, etc.), the use of linear extrapolation is valid.
- **Use of power, exponential or logarithmic growth functions.** In an ordinary system, population growth follows a distinctive S-shaped curve described by a logistics function. In this function, the population increase is approximately exponential at first, followed by a declining rate of increase and ultimately a flattening of the population when growth ceases. This is a useful approach for a situation of rapid development, but requires a great deal of data that may not be available.
- **Use of TAZ population projections.** This method develops a flow projection model based on the planned growth within discrete analysis areas known as TAZ. The TAZ is a planning-level projection typically considered during the compilation of local and regional population projections, such as those used for state-required comprehensive planning. While this method achieves a conceptual level of agreement between planning populations and wastewater flow, such plans are typically somewhat aggressive in their growth rates. This could, in turn, lead to a higher projection than actually occurs. Therefore, it is appropriate to use scaling methods to choose an appropriate “time zero” value, and propagate the TAZ based projection through the analysis period to provide a more realistic population estimate.
- The TAZ population projection, corrected as described above, is used in this report as a basis for developing flow and load projections.

3.2 TAZ Population Projection

The step by step methodology used for flow projection analysis using the TAZ population projections is described below:

1. The GIS shape file delineating the County TAZs, obtained from the Metropolitan Planning Organization is intersected with existing service area boundaries for each of the WRFs. This provides the contributing TAZs for each service area. If a particular service area is composed of multiple TAZs, an area weighted coefficient is calculated to identify the contribution of each TAZ to the service area.
2. For this analysis, TAZ population is divided into three categories: Single Family, Work Population, and School Population. Since three TAZ projections are available, a quadratic interpolation technique is incorporated to obtain the growth rate slope.
3. Vander monde matrix (quadratic interpolation technique) and its inverse are calculated to determine the slope coefficients which are further used for population projection for each year.
4. Per Capita rates of 71, 9, and 18 gallons per day per person are assumed for single family, work population, and school population, respectively, and are used for converting the total population projection to total wastewater flow projection.
5. School enrollment data was interpolated for the years that were not available.
6. 2010 data was used as base year for TAZ projection.
7. Using the TAZ coefficients previously calculated, per capita flow is determined for the respective wastewater service area. Then WRF flow projections are determined by multiplying the population projection by the per capita flow rate. Since these projections are based on interpolation techniques, it is important to compare the flow projection with a base year for calibration. The calibration to actual flow is performed via a scaling factor based on historical

trends using five year average flows for each WRF. The scaling factor is calculated individually for each WRF, and then applied to the flow projection.

8. Flow projection analysis were done for average year, wet year and dry year conditions.
9. For an average year condition, historical flows from 2010 through 2014 date was used to estimate the average flow for each facility. The resulting average flow was used to calibrate the flow projections.
10. Rainfall data analysis was done to estimate wet and dry years. To do this, daily total rainfall data collected from the rain gauges at the NEWRF, NWWRF, and SWWRF from year 2000 through 2014 were averaged. Annual totals were calculated for each calendar year based on the average daily rainfall. Of these annual totals, the five wet years were 2004, 2009, 2011, 2013, and 2014, and the five dry years were 2005, 2006, 2007, 2008, and 2010. For each facility, the average flows during the five wet years and five dry years were computed for each facility to calibrate the flow projections for wet and dry year conditions.

3.3 Findings

This section presents the draft projected plant flows for each facility. Population and flow projections for each facility was done from 2016 through 2035. Three scenarios were reviewed for flow projection analysis. The scenarios are:

1. Flow projections under average year conditions (Table 1),
2. Flow projections under dry year conditions (Table 2),
3. Flow projections under wet year conditions Table 3)

Table 1. Wastewater Flow Projections based on Average Year Conditions

NEWRF, NWWRF, and SWWRF

Year	NEWRF (mgd)	NWWRF (mgd)	SWWRF (mgd)	Total (mgd)
2016	8.15	9.86	16.52	34.53
2020	8.18	10.13	16.86	35.17
2025	8.24	10.65	17.47	36.37
2030	8.33	11.41	18.30	38.04
2035	8.43	12.39	19.35	40.16

Table 2. Wastewater Flow Projections based on Dry Year Conditions

NEWRF, NWWRF, and SWWRF

Year	NEWRF (mgd)	NWWRF (mgd)	SWWRF (mgd)	Total (mgd)
2016	8.06	9.87	15.33	33.26
2020	8.10	10.13	15.67	33.90
2025	8.16	10.66	16.29	35.11
2030	8.24	11.41	17.13	36.79
2035	8.34	12.39	18.19	38.92

Table 3. Wastewater Flow Projections based on Wet Year Conditions
NEWRF, NWWRF, and SWWRF

Year	NEWRF (mgd)	NWWRF (mgd)	SWWRF (mgd)	Total (mgd)
2016	9.12	10.10	16.77	35.99
2020	9.18	10.37	17.12	35.67
2025	9.23	10.91	17.75	37.89
2030	9.32	11.68	18.61	39.61
2035	9.44	12.68	19.69	41.80

Based on this analysis, it is recommended that design flows for hydraulic capacity of the three WRFs remain at the permitted Annual Average Daily Flow (AADF): NEWRF 16 mgd, NWWRF 20 mgd and SWWRF 20 mgd. By the year 2035, the total AADF to all WRFs is projected to be 42 mgd (total permitted AADF capacity 56 mgd).

B&C's projected 2035 flow rates for NEWRF, NWWRF, and SWWRF as indicated in their Biosolids to Energy Program Preliminary Design Report were 11.57 mgd, 10.11 mgd, and 17.91 mgd, respectively. B&C recommended that the design flow rates for their Biosolids to Energy program be designed around the higher value of either the permitted flow rate or the 2035 projected flow rate, which is also CH2M's recommendation.

In 2012, CDM's recommendation to divert flow from AWWRF to SWWRF in their Albert Whitted Water Reclamation Facility Operation Alternatives Report (October 2010) was in part due to flow projections performed to 2030, which predicted that NEWRF, NWWRF, and SWWRF would observe 8.65 mgd, 10.03 mgd, and 16.23 mgd, respectively. The methodology for performing these flow projections were not reviewed as they were located in a previous report titled 201 Facilities Plan, CDM (April 2010); however, the projections were reasonable for the time that they were generated.

4 Peak Flow Projections

A key component of this analysis is determining the peak flows experienced at the SWWRF and what the peak flows will be in the future. In order to determine the peak flows already experienced historical flow data along with operational observations were reviewed. Multiple methods were used to project future peak flows including referenced calculations, historical data including separating wet and dry periods and the installed capacity of the pump stations that convey flow to the SWWRF headworks.

4.1 Historical Flow Data

The combined flow data for the SWWRF and Albert Whitted Water Reclamation Facility (AWWRF) was provided from June 2000 to September 2015. The table below summarizes the AADF, Maximum Month Average Daily Flow (MMADF), and Maximum Day Flow (MDF) flows along with the MMADF and MDF peaking factors by year.

Table 4. Historical Flow Data

Combined SWWRF and AWWRF Flows from 2000 to 2015

Timeframe	AADF	MMADF	Peaking Factor	MDF	Peaking Factor
2000	20.10	26.82	1.33	36.71	1.83
2001	17.50	25.74	1.47	45.03	2.57
2002	17.83	27.25	1.53	42.65	2.39
2003	21.29	32.20	1.51	45.46	2.14
2004	18.14	29.16	1.61	48.93	2.70
2005	15.98	20.75	1.30	29.90	1.87
2006	14.82	20.29	1.37	24.65	1.66
2007	14.54	18.22	1.25	27.37	1.88
2008	15.22	18.63	1.22	22.42	1.47
2009	15.52	21.48	1.38	27.64	1.78
2010	16.10	21.35	1.33	30.98	1.92
2011	16.18	22.98	1.42	32.97	2.04
2012	16.32	24.03	1.47	48.59	2.98
2013	17.15	27.50	1.60	46.12	2.69
2014	16.85	27.43	1.63	42.37	2.51
2015	18.65	33.49	1.80	46.96	2.52
15-year Average	16.91	24.83	1.45	37.42	2.18
5-year Average	17.03	27.08	1.58	43.40	2.55

Table Notes:

Peak hour data into the SWWRF and AWWRF from 2012 and 2015 was also provided and analyzed for this review. Some key points from this data set included:

- There were 181 instances where the peak hour flow was greater than 40 mgd—the current maximum hydraulic design for the SWWRF—out of more than 333,000 total values (< 0.1%)
- The 181 instances occurred over 6 periods
  - June 24th – 26th, 2012
  - August 21st – 22nd, 2012
  - July 2nd – 6th, 2013
  - September 24th – 27th, 2013
  - September 28th – 30th, 2014
  - July 27th – August 8th, 2015
- The single highest value recorded over this period was 60.72-mgd which occurred on September 25th, 2013.
- During the 2015 peak flow event, the headworks was bypassed during periods over four days. Operations estimated peak flow during this time at 65-mgd.

Prior to the 2015 instances where the peak hour flow at SWWRF was greater than 40 mgd, the City only recorded a sanitary sewer overflow in 2012 with the indication that Tropical Storm Debby may have been the cause.

4.2 Analysis

The historical flow data was analyzed to determine peaking factors for each of the key hydraulic and process flow conditions. The Southwest Water Reclamation Facility Wet Weather and Liquid Process Capacity Assessment (B&C, 2014) analyzed data from 2007 through 2013. The analysis lead to a recommendation of using the following peaking factors:

- MMADF/AADF = 1.57
- MDF/AADF = 2.63
- PHF/AADF = 3.41

4.2.1 Maximum Month Average Day

The MMADF is not critical in the hydraulic analysis but is important in evaluating the capacity of some treatment processes. The peaking factor for the MMADF was calculated using the following means:

- Average of peaking factor from 2000 – 2015: 1.45
- Average of peaking factors from 2011 – 2015: 1.58
- Peaking factor based on percentile (0.917 or 92nd percentile of the rolling 30-day average which is equivalent to the maximum 30 consecutive days) of the data from 2000 – 2015: 1.33
- Peaking factor based on the 92nd percentile of the data from 2011-2015: 1.35

The average of these methods was 1.43; however the recent data has trended higher. Based on this trend it is recommended to use a MMADF/AADF peaking factor of 1.50 for this analysis.

4.2.2 Maximum Day

The MDF is an important flow condition both for treatment and hydraulic capacity. The peaking factor for the MDF was calculated using the following means:

- Average of peaking factor from 2000 – 2015: 2.18
- Average of peaking factors from 2011 – 2015: 2.55
- Peaking factor based on the percentile (0.997 or 99.7th percentile of the daily data which is equivalent to the maximum days) of the data from 2000 – 2015: 2.41
- Peaking factor based on the 99.7th percentile of the data from 2011-2015: 2.52

Similarly to the MMAD data the MD peaking factors have trended higher in recent years. In addition the recent average peaking factor and the peaking factor from the 99.7th percentile were very similar. Based on the values above it is recommended to use a MDF/AADF peaking factor of 2.55 for this analysis.

4.2.3 Peak Hour

The PHF is critical to evaluating the overall hydraulic capacity of the WRF. The peaking factor for the PHF was calculated using the following means:

- Calculation of peaking factor from 10 States Standards: 1.49
- Average peaking factor from peak hour data from 2012 and 2013: 3.50
- Instantaneous flow capacity to WRF headworks and the design AADF: The headworks at the SWWRF is fed raw wastewater from two offsite lift stations (LS28 and LS85) and an onsite Influent Pump

Station. A review of the design points for the pump stations indicate that there is 82.8-mgd of installed capacity and 64.5-mgd of firm capacity.
- Peaking factor calculated using observed peak flow at SWWRF during August event and 2015 AADF: 3.50

The calculation from 10 States Standards (1997) does not account for significant wet weather, so that value is not appropriate for SWWRF. The historical data indicates that the total installed pumping capacity has not been utilized thus far, but with this capacity in place should be considered in future evaluations. Based on the values above it is recommended to use a MDF/AADF peaking factor of 3.50 for this analysis.

4.2.4 Recommended Flow for Analysis

The peaking factors recommended by B&C were similar to the peaking factors determined above, and the process to determine those peaking factors was reasonable. Due to the availability of more recent data, it is recommended that the City uses the following peaking factors for SWWRF presented in Table 5 as determined above.

Table 5. Recommended Flows for SWWRF
AADF, MMADF, MDF and PHFs

Flow Condition	Value	Note
AADF	20	Projected AADF in 2035 below permitted AADF of 20-mgd
MMADF	30	Based on a peaking factor of 1.50
MDF	51	Based on a peaking factor of 2.55
PHF	70	Based on a peaking factor of 3.50

5 Process and Hydraulic Evaluations

The liquid treatment processes at SWWRF were evaluated for treatment and hydraulic capacity. A process flow diagram of the SWWRF developed by B&C as part of the Biosolids to Energy project is located in Appendix A.

5.1 Process Evaluation

A high level analysis of the key liquid treatment processes at SWWRF was performed in order to determine not just the ability to hydraulically pass peak flows, but also the quality of the treatment.

5.1.1 Headworks

The Headworks at the SWWRF consists of screening and grit removal, each with two units and a bypass channel. Previous design documents indicate that the maximum flow capacity for this process is 40 mgd. The process equipment (mechanical screens, grit chambers, etc.) are typically sized or selected for the hydraulic capacity with specific water surface elevations needed to achieve the desired performance. Therefore the hydraulic and process capacities are equivalent and equal to the design capacity.

5.1.2 Activated Sludge

The activated sludge process at SWWRF utilizes biological treatment by creating conditions (solids retention time, oxygen) for microorganisms to thrive and consume constituents found in municipal wastewater. The influent loading of these constituents in the raw wastewater is the key factor for this process which is determined by the population served. Peak hydraulic events influenced by wet weather and infiltration and inflow do not increase the overall loading and therefore do not directly impact this process. The equipment and aeration basins that comprise the activated sludge process at SWWRF is appropriately sized for the population served. However, the capacity of the activated sludge process is linked to and impacted by the performance of the downstream secondary clarifier. For example, if the secondary clarifier does not have the required capacity, solids washout may occur during peak flows. This can potentially lower the solids retention time (SRT) to less than the require SRT resulting in the failure of the upstream activated sludge process.

5.1.3 Secondary Clarification

The effluent from the aeration basins (called mixed liquor) proceeds to three secondary clarifiers at SWWRF. Secondary clarifiers are often the most important unit process that determine the peak capacity of the entire facility. Hence a good understanding of the operating conditions that impact their performance is crucial. Secondary clarifiers are required to perform two functions: separation of the mixed liquor solids from the liquid stream (clarification) and conveyance of the separated solids to the bottom of the clarifier to be compacted and removed as underflow (thickening). Consequently, the capacity of secondary clarifiers is impacted by both hydraulic and solids loading rates. During peak flows, the high overflow rate can interfere with solids separation (clarification failure) resulting in solids washout (high effluent solids). Likewise, if the mass of solids entering the clarifier exceeds the mass of solids exiting the clarifier as underflow, the excess solids will accumulate in the sludge blanket. If this condition persists, the rising sludge blanket will eventually reach the effluent weir (thickening failure) leading to solids washout, which will manifest as high effluent solids. Hence, both clarification and thickening failures can potentially cause permit excursions due to high effluent solids and failure of the upstream activated sludge system due to reduced SRT. Based on the high loading rates additional secondary clarification capacity is required in order to effectively treat the projected peak flows.

Table 6. Secondary Clarification Loading Criteria
Hydraulic and Solids Loading Rates

Operating Condition	AADF	MMADF	MDF	PHF
Hydraulic Loading Rates (gpd/ft^2)				
All Units in Service	466	699	1188	1631
One Unit Out of Service[1]	699	1048	1337	1835
Target Criteria[2]		< 500		< 1200
Solids Loading Rates (ppd/ft^2)[3]				
All Units in Service	19	24	32	38
One Unit Out of Service[1]	29	37	39	45
Target Criteria[2]		< 20	< 50	

Table Notes: gpd – gallons per day; ppd – pounds per day

1. MDF and PHF rates are for 75% of rated flow to match reliability and redundancy requirement
2. Per 10 States Standards
3. Solids loading rates assume a mixed liquor of 2,500-mg/L and a RAS rate of 20-mgd

5.1.4 Filtration

The liquid stream from the secondary clarifiers (secondary effluent) flows by gravity to one of four deep-bed filters. Filtration is another process that physical separates particles from the liquid stream. At SWWRF the filters utilize a bed of sand media to trap particles. Hydraulics impact this process. Peak flows higher than the designed capacity increase the velocity through the media and hinder the removal of particles. In addition, a sustained period of elevated flows (even if lower than the design hydraulic maximum capacity) can impact operations. The elevated flows increase solids loading on the filters which then increases the frequency of backwashing required (backwashing includes pumping clean water through the filter in the reverse direction to fluidize the media and remove larger particles). Increased backwashing impacts the filtration capacity since a filter is temporarily off-line and impacts the overall WRF hydraulics since the water used for backwashing must be returned to the Headworks.

The hydraulic loading to filtration at SWWRF at the projected flow conditions is included in the table below. Sufficient capacity exists for the AADF and MMADF conditions. However, the project MDF of 51-mgd and peak flow of 70-mgd is above the filter design capacity. At these flows filtration would be bypassed and no effluent from the SWWRF could be sent to the St. Petersburg Master Reuse System (SPMRS), so all effluent must be retreated or rejected. Based on this analysis additional filtration capacity is required to effectively treat the projected peak flows to SWWRF.

Table 7. Filtration Loading Criteria
Hydraulic Loading Rates

Operating Condition	AADF	MMADF	MDF	PHF
Hydraulic Loading Rates (gpd/ft^2)				
All Units in Service	2.5	3.7	6.3	8.6
One Unit Out of Service[1]	3.3	4.9	6.3	8.6
Target Criteria[2]	< 5	< 5	< 5	< 5

Table Notes: gpd – gallons per day

1. MDF and PHF rates are for 75% of rated flow to match reliability and redundancy requirement
2. Per 10 States Standards

5.1.5 Disinfection

At SWWRF all effluent must be treated to high level disinfection in order to be utilized in the SPMRS or sent to the injection wells. The existing two chlorine contact basins have sufficient volume to provide high level disinfection at all of the projected flow conditions as presented in the table below.

Table 8. Disinfection Criteria
Hydraulic Detention Times

Operating Condition	AADF	MMADF	MDF	PHF
Hydraulic Retention Time (min)				
All Units in Service	68	46	37	20
One Unit Out of Service[1]	34	23	27	20
Target Criteria[2]	> 15	> 15	> 15	> 15

Table Notes:

1. MDF and PHF rates are for 50% of rated flow to match reliability and redundancy requirement
2. 2. Minimum requirements per FAC 62-600

5.2 Hydraulic Evaluation

The hydraulic evaluation of the liquid processes at SWWRF included a review of the original design capacity of the processes, modeling the gravity flow through the plant and analyzing the effluent pumping storage and disposal capacities.

5.2.1 Design Capacity

The SWWRF has been operating for over five decades. Over that period the overall capacity has increased to a permitted flow of 20 mgd (AADF) through many design and construction projects. The SWWRF currently does not have primary clarification, but the addition of primary clarifiers to the treatment process is proposed as part of the Biosolids to Energy project to help treat the additional load from waste activated sludge that will be conveyed from the NEWRF and NWWRF. The listed design capacity and flow condition for key liquid processes as indicated in previous design project documents are included in the table below. These capacities consider all basins in service.

Table 9. Hydraulic Capacity Summary
Hydraulic and Solids Loading Rates

Process / Facility	Design Capacity	Notes
Preliminary Treatment		
Coarse Screening	AADF: 20-mgd PHF: 40-mgd	Used for screening of gravity influent flow only
Influent Pump Station	Installed Capacity: Firm Capacity:	Analysis ongoing; to be included in final report
Headworks	AADF: 20-mgd PHF: 40-mgd	Per SWWRF Headworks and Flow Splitter Box Expansion; CDM, 2001 As-Builts 48-in diameter bypass available for flows above design capacity
Primary Treatment (proposed)		
Primary Clarifiers	AADF: 20-mgd PHF: 40-mgd	Per GMP Biosolids Drawings Higher flows will proceed to secondary treatment from Step-Feed Splitter Box

Secondary Treatment		
Flow Splitter	AADF: 20-mgd PHF: 40-mgd	Per SWWRF Headworks and Flow Splitter Box Expansion; CDM, 2001 As-Builts
Aeration Basins	AADF: 20-mgd MDF: 40-mgd PHF: 70-mgd	Per GMP Biosolids Drawings
Secondary Clarifiers	AADF: 20-mgd PHF: 40-mgd	Per GMP Biosolids Drawings No hydraulic profile included in SWWRF Clarifier Improvements and Flow Splitter Box; CDM, 1998 Record Drawings
Tertiary Treatment		
Filtration	AADF: 20-mgd PHF: 40-mgd	Per GMP Biosolids Drawings 48-in bypass available for flows above design capacity[1]
Disinfection	AADF: 20-mgd PHF: 40-mgd	Per GMP Biosolids Drawings
Effluent Disposal		
Onsite Storage	Existing: 15-mg In Progress: 15-mg	One 5-mg and one 10-mg tanks One 15-mg under construction
Effluent Pumping	Existing Capacity: 39-mgd Future Capacity: 55-mgd	Five 250-hp pumps Two 450-hp pumps
Disposal Well Capacity	45-mgd at max wellhead pressure of 70 psi	Per FDEP Underground Injection Control Permit

Table Notes:

1. By-passing filtration impacts effluent disposal. Discussed further in following sections.

As indicated in the table a majority of the liquid processes at SWWRF were designed for a peak flow lower than those experienced. A review of the overall gravity flow through these facilities and available bypasses is included in the following section.

5.2.2 Hydraulic Modeling of Gravity Flow

The gravity flow through the SWWRF was modeled for this peer review using CH2M's proprietary WinHydro software. Information on the various facilities was gleaned from multiple design documents listed earlier in this report. The following assumptions and techniques were utilized in developing, running and analyzing the hydraulic model and the results:

- A Manning's n value of 0.013 was used for all channels and piping
- A Return Activated Sludge (RAS) rate of 20-mgd was included from the secondary clarifiers to Splitter Box No. 1
- An internal recycle rate of 5-mgd was included from the filters to the headworks.
- Available bypasses were used above the design flow for the Headworks and filtration.
- The PHF was assumed to pass through the existing secondary clarifiers despite the evaluation indicated this rate is higher than design. This was done because the out of service basins onsite--which can now accept overflows from the mixed liquor splitter box—will no longer be available after the Biosolids to Energy Project is complete.

5.2.3 Effluent Pumping, Storage and Disposal

A critical component of keeping a water reclamation facility in operation is the storage and disposal of treated water. The effluent pumping, storage, and disposal for the SWWRF was investigated as it relates to peak flows recently observed.

5.2.3.1 Effluent Pumping

The SWWRF currently has two pump stations downstream of the chlorine contact chamber: the Filter Backwash Pump Station and the Distribution Pump Station. The Filter Backwash Station pumps water to back wash the filters and fill the ground storage tanks with either reclaimed water or reject water. A 54" gravity line hydraulically connects the wetwell of the Backwash Pump Station to the Distribution Pump Station. Reclaimed water stored in the ground storage tanks can be conveyed by gravity to the Distribution Pump Station by connection to the 54" line. The Distribution Pump Station is used to pump effluent that meets all permitted water quality criteria to the SPMRS, on-site Aquifer Storage and Recovery (ASR) well, and to the three on-site Deep Injection Wells. During the recent wet weather events in early August, the City disposed unfiltered effluent down the injection wells; however, the existing pumping capacity of five 250 horsepower pumps at the Distribution Pump Station would not allow for maximum disposal down the injection wells, which are rated for a combined capacity of 45 mgd provided that the wellhead pressures do not exceed 70 psi. The City is currently constructing an expansion to the Distribution Pump Station, which would add two 450 horsepower pumps.

On May 30, 2015, a Maximum Available Injection Capacity (MAIC) test was conducted on the SWWRF Injection Well System. During this test, the valves were configured so that only water could flow to the injection wells. The flow control valves to the injection wells were fully opened, and the five existing pumps were operated at full capacity for 15 minutes. The results from this test indicated that 39 mgd could be pumped to the injection wells, and the injection wells had an average wellhead pressure of 34 psi.

Using Applied Flow Technology's Fathom, a pressurized flow model, the pumping capacity to the injection wells including the two additional pumps were modelled. The model was developed using existing record drawings, the results of the last MAIC test, and the pump curves of the existing and new pumps. Based on this preliminary analysis, the model indicated that approximately 55 mgd could be pumped to the injection wells with all seven pumps in service, with an observed average pressure of approximately 66 psi. This flow rate and pressure was based on the above mentioned MAIC test that was performed after a recent well rehabilitation event that occurred from April 29, 2015, through May 14, 2015, which increased each of the injection wells' and the ASR well's ability to dispose of more water while keeping a reduced wellhead pressure. Over time, all of the wells begin to require higher wellhead pressures to discharge the same amount of water due to clogging of the porous disposal zones, so the actual maximum available injection capacity (MAIC) may be less than what was modelled.

Although this 55 mgd theoretical injection rate is greater than the injection well system's current permitted capacity, the injection wells have the potential to be re-rated up to a maximum injection rate of 19.05 mgd, if the wellhead pressure can remain below the maximum allowable of 70 psi.

A hydraulic limitation in the system is the 16" diameter branch pipes to each well, totaling approximately 1,200 linear feet. These pipes experience high velocities at these flowrates that increase the headloss and thus reduce the pumping capacity. The model was run again with these 16" diameter pipes increased to 24" diameter pipes. With 24" pipes in place of the existing 16" pipes, the model showed that the theoretical maximum injection rate would be approximately 59 mgd at an average wellhead pressure of 70 psi, which preliminarily indicates that the wells could be re-rated to the theoretical maximum capacity of 19.05 mgd per well provided that the 16” diameter pipes are upgraded to 24” diameter pipes. Further investigation into the feasibility of this piping modification and coordination with FDEP would be required to determine the actual maximum disposal capacity.

5.2.3.2 Effluent Storage

Along with the NEWRF and NWWRF, the SWWRF’s ground storage tanks are primarily used for Part III Public Access Reuse effluent; however, FDEP has approved the use of these ground storage tanks for storage of off-spec effluent as well. Per the City’s Operating Protocol, if the ground storage tanks are used in this manner, the off-spec water is routed to the head of the plant for retreatment once the SWWRF is producing Part III reuse quality effluent again. The tank is then flushed out twice with Part III quality effluent by the volume of off-spec water that was stored in the tank before the tank can be used again to store Part III reuse quality effluent.

During the July/August rain event, the SWWRF used the storage tanks for off-spec water, and therefore the existing 15 mg volume was not available for the additional effluent that could not be disposed of down the injection wells. For this analysis it is assumed that the existing wells were not operating at the performance observed during the May 30, 2015 MAIC, and the injection wells were accepting an approximate 37 mgd during July/August. The influent flows experienced at the SWWRF in early August were greater than the existing capacity of the injection well system. The table and figure below illustrate the deficiency and the impact of the current improvements:

Table 10. Effluent Pumping and Disposal Analysis
Flow Data at SWWRF for August 1st – 6th

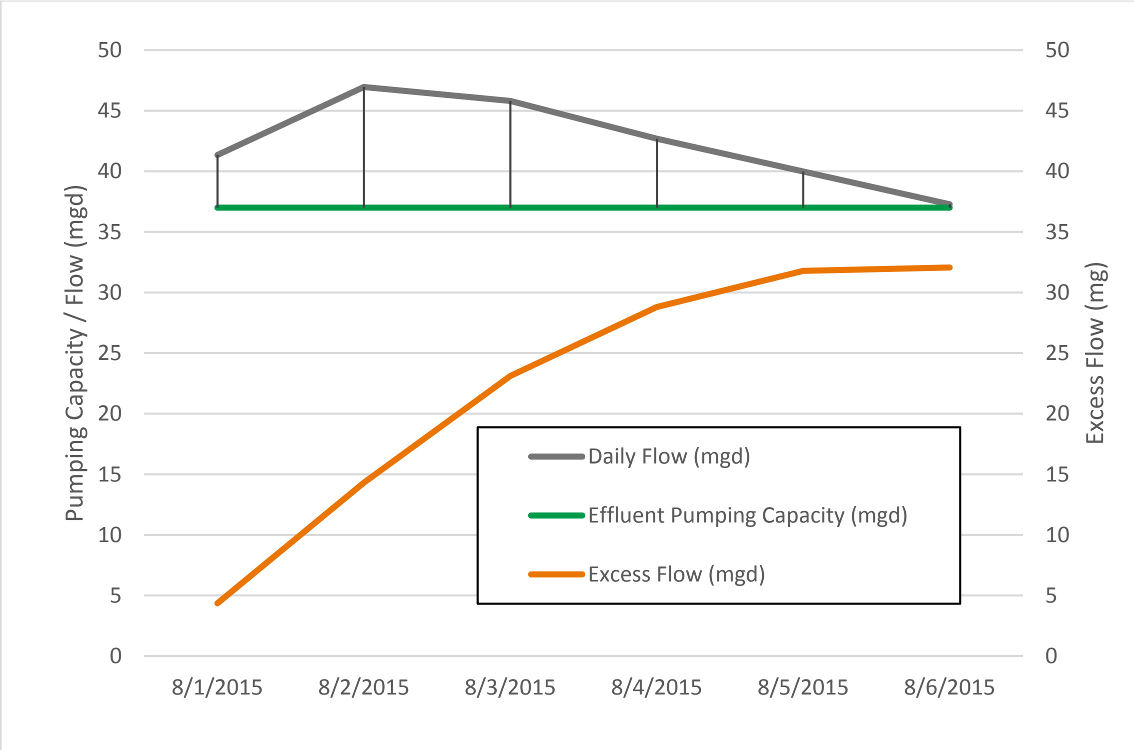
Date	Influent Flow (mgd)	Excess Effluent (mgd) – Existing Installed Capacity	Excess Effluent (mgd) – Future Installed Capacity[1]	Excess Effluent (mgd) – Future Firm Capacity[2]
8/1/2015	41.35	4.35	0	0
8/2/2015	46.96	9.96	0	0
8/3/2015	45.80	8.80	0	0
8/4/2015	42.69	5.69	0	0
8/5/2015	39.98	2.98	0	0
8/6/2015	37.28	0.28	0	0
		32.06 mg	0	0

Table Notes:

1. 55-mgd
2. 50-mgd

Figure 1. Effluent Pumping Analysis

Flow Data at SWWRF for August 1st – 6th

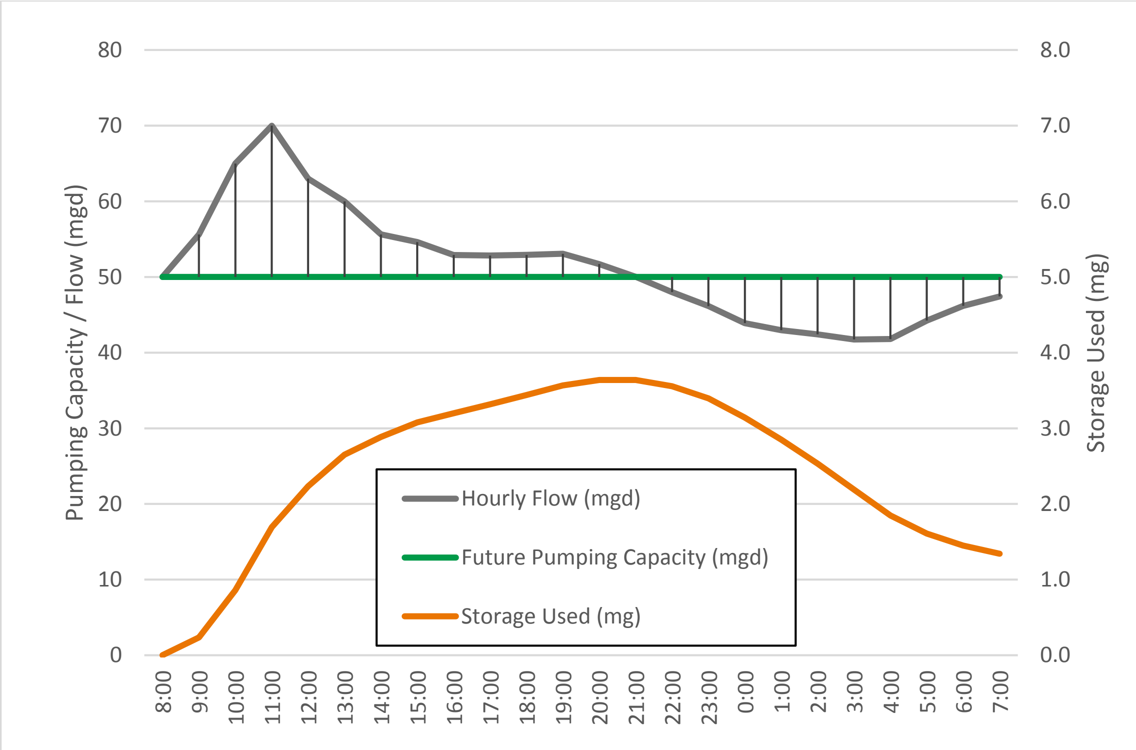


The data above shows that insufficient pumping capacity was available during the July/August peak flow event to meet the daily flows experienced at SWWRF. However, preliminary modeling of the injection well system with the additional pumps currently being added will increase the installed capacity to 55-mgd, and the firm capacity (capacity with the largest unit out of service) to 50-mgd. This level of service would have been sufficient to meet the daily flows experienced during the July/August peak flow event.

The analysis above only considers the daily flows and not the PHFs during this period. As indicated earlier in this report, PHFs greater than 65-mgd have been recorded at SWWRF and the projected PHF for the future was 70-mgd. When the influent flow peaks above the maximum effluent disposal pumping capacity, the onsite storage can be used for mitigation. The figure below shows an example diurnal flow curve for a MDF of 51-mgd with a PHF of 70-mgd for 24 hours starting at 8 am. The influent flows are greater than the effluent pumping capacity during the morning peak and the excess can be stored onsite. As the flows decrease overnight the pumping capacity is greater than the flow received and additional effluent from storage can be disposed. In this scenario less than 4 mg of storage was necessary. Following the completion of the 15 mg storage tank currently under construction at SWWRF, operations will have a total of 30 mg of storage

Figure 2. Example Diurnal Flow Curve

Hourly Influent Flow, Effluent Pumping and Storage Requirements



5.2.3.3 Effluent Disposal

The SWWRF Underground Injection Control (UIC) Permit (Permit No. 36855-013-UO/1M, 36855-014-UO/1M, 36855-015-UO/1M) states that only water in compliance with 40 CFR 146.15 and 146.16 may be routed directly to the injection wells.

40 CFR 146.15 states that the injectate shall be treated using high-level disinfection in a manner that is no less stringent than the requirements of the Florida Administrative Code (FAC) 62-600.440(5)(a)-(f) within five years after notification by the Director that the well has caused or may cause fluid movement into a Underground Source of Drinking Water USDW.

FAC 62-600.440(5)(a)-(f) states that high-level disinfection shall include additional TSS control beyond secondary treatment levels to maximize disinfection effectiveness and shall be designed to result in fecal coliform values below detectable limits except as provided on FAC 62-600.440(5)(g) or FAC 62-600.440(5)(h). These two rules state other criteria for meeting high-level disinfection, but they do not apply to these injection wells. 62-600-440(5) states that rapid and uniform mixing provisions shall be designed when chlorine is used for disinfection, and a total chlorine residual of at least 1.0 mg/L must be maintained at all times. The SWWRF uses chlorine disinfection, and has rapid mixers installed upstream of the chlorine contact chambers. This rule gives design criteria for minimum chlorine contact times based on fecal coliform counts prior to disinfection. The rule also states that the facilities shall be designed to reduce TSS to 5.0 mg/L or less before disinfection, which does not preclude an additional application of disinfectant prior to filtration for the purpose of improving filter performance. Lastly, FAC 62-600.400(5)(f) states operational criteria for determining high level disinfection compliance states that 75% of fecal coliform values over a 30 day period shall be below detection limits, one sample shall not exceed 25 fecal coliform values per 100 mL of sample, and any one sample of TSS shall not exceed 5.0 mg/L prior to disinfection.

The SWWRF UIC Permit confirms the high-level disinfection requirement by stating that "Injection will be into the Avon Park Formation for the domestic effluent receiving a minimum of secondary treatment with high-level disinfection.

The SWWRF Operation Permit (Permit No. FLA128848) identifies the SPMRS as the primary disposal method of reclaimed water, and disposal of reclaimed water can be disposed in the ASR well and injection well system if necessary. However, effluent limitations for disposing into the injection well system is defined only as secondary treatment standards. Per the effluent limitations requirement B.8, treatment facilities shall be operated in accordance with the approved operating protocols. Reclaimed water that fails to meet the approved operating protocol criteria shall be directed to the on-site ground storage tanks or to the injection well system. The operating protocol shall be reviewed by FDEP and updated periodically and with each permit application to ensure compliance with the minimum disinfection and treatment requirements.

FAC 62-610.460 for Part III Public Access Reuse states that the reclaimed water shall not contain more than 5.0 mg/L before disinfection and that filtration shall be provided for TSS control; however, the requirement that effluent sent to the injection wells must meet Part III Public Access Reuse requirements is not identified in neither the SWWRF Operation Permit nor the SWWRF UIC Permit.

6 Identification of Hydraulic Limitations

The hydraulic evaluation included an analysis of the pumping systems into and out of the SWWRF, the gravity flow through the treatment processes within the SWWRF, the available storage of effluent and off-spec water and the capacity of the injection well system. From this analysis the following hydraulic limitations were identified:

6.1 Influent Pumping

This analysis is ongoing and will be included in the final report

6.2 Treatment Process

The following limitations were identified for processes at SWWRF:

- Screening and grit removal sized for 40-mgd, below projected MDF and PHF
- Secondary clarification loading rates above recommended for MMADF, MDF and PHF
- Hydraulic loading rates to tertiary filtration above recommended for MDF and PHF

6.3 Gravity Flow

The following locations were identified as hydraulic limitations within the gravity flow at the SWWRF:

- The 8-ft long weir at the effluent of the Headworks
- The 48-in diameter Screened Raw Sewage pipe between the Headworks and Splitter Box No. 1
- The 48-in diameter Secondary Effluent pipe between Secondary Clarifier No. 2 and Secondary Clarifier No. 1
- The 48-in diameter Secondary Effluent pipe between Secondary Clarifier No. 1 and the Filters
- The 54-in diameter Filter Effluent pipe between the Filters and the Chlorine Contact Basins

6.4 Effluent Pumping, Storage and Disposal

The following limitations were identified as part of the effluent pumping storage and disposal system:

- The existing effluent pumping capacity is below the MDF experienced at SWWRF (Note: additional pumps are currently being added).
- The SWWRF currently has 15-mg of storage for reclaimed water or for off-spec water as needed. Due to the time frame of recent hydraulic peak events this storage was not sufficient to store flow in excess of the disposal capacity. (Note: an additional 15-mg of storage is currently being added).
- Injection well maximum permitted disposal capacity of 45 mgd is below the MDF experienced at SWWRF. These wells could be re-rated up to a maximum of 19.05 mgd per well (57.15 mgd total), but maximum wellhead pressure of 70 psi must be considered, which may result in a smaller maximum capacity with the current injection well system piping constraints.

7 Summary and Recommendations

This report contains a description of the peer review performed on the wastewater flow projections and liquid processing facilities for the City of St Petersburg. The peer review included:

- Flow projections for the service areas were developed using TAZ data. The projected 2035 AADFs for each WRF was below the current permitted AADF so the permitted value should be used for all hydraulic evaluations, which are:
  - NEWRF – 16-mgd
  - NWWRF – 20-mgd
  - SWWRF – 20-mgd
- The following peaking factors and resulting design flows were developed for the SWWRF in order to evaluate the process and hydraulic capacity:
  - MMADF – 1.5; 30-mgd
  - MDF – 2.55; 51-mgd
  - PHF – 3.5; 70-mgd
- The treatment capacity of key liquid processes were evaluated using the projected flow conditions determined in this peer review. The following treatment processes had loading rates above the design capacity or recommended criteria
  - Headworks
  - Secondary clarification
  - Filtration
- The gravity flow through the SWWRF was modeled and evaluated using the projected flow conditions determined in this peer review and hydraulic limitations were identified. Hydraulic limitations were found at the following locations:
  - Headworks effluent weir
  - Secondary effluent piping
  - Filter effluent piping
- The capacity and operation of the effluent pumping, storage and disposal were also evaluated based on the peak flow conditions determined above. The existing pumping and storage capacity was not sufficient to handle the peak flows experience during the July/August 2015 event. The City currently has two projects underway that will address this deficiency: an additional 15-mg storage and two additional 450-hp effluent pumps. Based on this preliminary analysis these additional storage and pumping capacity would have been sufficient to avoid the recent overflows during the July/August event.

The following recommendations are presented as part of this peer review:

- The current peak flows into the SWWRF are greater than the design capacity for multiple facilities. Currently, SWWRF operations utilizes by-pass piping, and out of services basins along with the existing effluent/off-spec storage to handle these events. Since these peak flow events are primarily caused by infiltration/inflow (I/I) due to wet weather there are two ways to solve this capacity issue: 1) reduce I/I with collection system improvement and 2) increase treatment and disposal capacity at the WRF
- The following process upgrades are recommended to increase treatment capacity at the SWWRF:
  - Upgrade/expand the Headworks to provide additional screening and grit removal capacity up to the design PHF
  - Add a fourth secondary clarifier
  - Add filtration capacity
  - Piping improvements would be required along with these new processes in order to increase the overall WRF capacity
- Collection system improvements to reduce the amplitude of flows coming into the SWWRF during wet-weather events could prove to have some cost-effective solutions which would require less significant improvements at the SWWRF to be made. Identifying specific improvements to the collection system is not included in this project but will be evaluated as part of a future project. This project will also provide additional detail for potential WRF upgrades including preliminary level costs estimates. These costs will be compared to estimates for potential collection system upgrades and the recommended approach will be developed which includes the optimum combination of collection system and WRF improvements.
- The following upgrades are recommended to increase disposal capacity at the SWWRF:
  - Consider modifying the City's Operating Protocol to allow disposal of effluent meeting secondary treatment and high-level disinfection standards without the requirement to go through the filters.
  - When the two new 450 horsepower pumps are online, consider rerating the injection wells up to 19.05 mgd each for a total of 57.15 mgd. With the new pump addition, the injection wells are anticipated to dispose of approximately 55 mgd. Replacing the existing 16" piping, valves, and meters in the injection well disposal system with 24" diameter piping would give the system less hydraulic restriction allowing the current pumps to provide the maximum allowable flowrate of 19.05 mgd to each injection well without exceeding the wellhead pressure limitation.

Redundancy in wet weather events is key. Consider adding a fourth deep injection well to use normally, reduce the current load on the three existing injection wells during normal operation scenarios, serve as a backup in case one injection well is offline, and bring the total permitted disposal capacity potentially up to 76.2 mgd

8 References

Policies for the Design, Review and Approval of Plans and Specifications for Wastewater Collection and Treatment Facilities (10 States Standards): A Report of the Wastewater Committee of the Great Lakes—Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers. Health Research Inc., Health Education Services Division. 2004 Edition.

CH2M and ASRus, 2015. 2014 Summary Report: City of St. Petersburg Deep Injection Well and ASR Systems – January 2014 through December 2014. August.

CH2M and ASRus, 2015. Southwest Water Reclamation Facility Deep Injection Wells and ASR Well Acidization Summary Report. October.

Appendix A
SWWRF Process Flow Diagram

GENERAL NOTES

1. ABBREVIATIONS FOR THE ENTIRE PROJECT EXCEPT ELECTRICAL ARE PROVIDED IN THESE GENERAL SHEETS.
2. ALL MECHANICAL SYMBOLS ARE IDENTIFIED IN THESE GENERAL SHEETS. GENERAL SHEETS DO NOT PROVIDE SYMBOLS NOR DETAILS FOR FOR ANY DISCIPLINE OTHER THAN MECHANICAL SYMBOLS. REFERENCE THE INDIVIDUAL DISCIPLINE SHEETS FOR ADDITIONAL DISCIPLINE-SPECIFIC SYMBOLS.

PIPING SYSTEM ABBREVIATIONS

FLOW STREAM ABBREVIATIONS

A	AERATION AIR
ABE	AERATION BASIN EFFLUENT
ABI	AERATION BASIN INFLUENT
BFPF	BELT FILTER PRESS FILTRATE
CD	CHEMICAL DRAIN
CHEM	CHEMICAL
CEN	CENTRATE
CGR	CHILLED GLYCOL RETURN
CGS	CHILLED GLYCOL SUPPLY
CS	CONTACT STABILIZATION
CULV	CULVERT
CW	COLD WATER
CWR	COLD WATER RETURN
CWS	COLD WATER SUPPLY
D	DRAIN
DG	DIGESTER GAS
DG/OF	DIGESTER GAS/ OVERFLOW
DS	DIGESTED SLUDGE
DSF	DIESEL FUEL
FA	FOUL AIR
FBW	FILTER BACKWASH
FECL	FERRIC CHLORIDE
FOG	FATS OIL GREASE
GBTF	GRAVITY BELT THICKENER FILTRATE
HDG	HIGH PRESSURE DIGESTER GAS
HPA	HIGH PRESSURE AIR
HW	HOT WATER
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
IA	INSTRUMENT AIR
ML	MIXED LIQUOR
NGA	NATURAL GAS
NIT	NITROGEN
OA	OUTSIDE AIR
ODO	ODORANT
OF	OVERFLOW
PD	GRAVITY PROCESS DRAIN
PE	PRIMARY EFFLUENT
PE-CS	PRIMARY EFFLUENT - CONTACT STABILIZATION
PE-SF	PRIMARY EFFLUENT - STEP FEED
PLW	CHLORINATED PLANT WATER
POL	POLYMER
PS	PRIMARY SLUDGE
PSC	PRIMARY SCUM
PPD	PUMPED PROCESS DRAINAGE
PW	POTABLE WATER
RAS	RETURN ACTIVATED SLUDGE
RD	ROOF DRAIN
RNG	RENEWABLE NATURAL GAS
RS	RAW SEWAGE
SD	SANITARY DRAIN OR STORM DRAIN
SE	SECONDARY EFFLUENT
SF	STEP FEED
SLW	SEAL WATER
SPW	SPRAY WATER
SRS	SCREENED RAW SEWAGE
SS	SANITARY SEWER
SSC	SECONDARY SCUM
STD	STORM DRAIN
STM	STEAM
THS	THICKENED SLUDGE
TD	TANK DRAIN (PROCESS UNIT TANK DRAIN)
UG	UNDERDRAIN
V	VENT
VC	CHEMICAL VENT
W	WATER
WAS	WASTE ACTIVATED SLUDGE
WGA	WASTE GAS

PIPING TYPE ABBREVIATIONS

304SS	304 STAINLESS STEEL
316SS	316 STAINLESS STEEL
CI	CAST IRON
CIS	CAST IRON SOIL PIPE
CMLS	CEMENT LINED STEEL
CMP	CORRUGATED METAL PIPE
CPVC	CHLORINATED POLYVINYL CHLORIDE
CU	COPPER PIPE
CUK	COPPER PIPE - TYPE K
CUL	COPPER PIPE - TYPE L
DI	DUCTILE IRON
DIGL	GLASS LINED DUCTILE IRON
ELS	EPOXY LINED STEEL
FRP	FIBER REINFORCED PLASTIC
HDPE	HIGH DENSITY POLYETHYLENE
PCCP	PRESTRESSED CONCRETE CYLINDER PIPE
PE	POLYETHYLENE
PP	POLYPROPYLENE
PVC	POLYVINYL CHLORIDE
RCP	REINFORCED CONCRETE PIPE
ST	STEEL
VCP	VITRIFIED CLAY PIPE

EQUIPMENT ABBREVIATIONS

A	AERATOR
AB	AERATION BASIN
ACC	AIR CONDITION COIL
ACU	AIR CONDITIONING UNIT
AD	AIR DRYER
AF	AIR FILTER
AHC W/COIL	AIR HANDLING UNIT
AHU	AIR HANDLING UNIT
APU	AIR PURIFICATION UNIT
ASC CONTROL	ADJUSTABLE SPEED
ASD	ADJUSTABLE SPEED DRIVE
ARV	AUTOMATIC AIR RELEASE VALVE
B	BLOWER
BFP	BELT FILTER PRESS
BLR	BOILER
BNR	BURNER
C	COIL
CCT	CHLORINE CONTACT TANK
CDR	CONDENSER
CFR	CHEMICAL FEEDER
CHR	CHILLER
COL	COLLECTOR
COM	COMMINUTOR
CON	CONVEYOR
CP	COMPRESSOR
CPUL	CARBON POLISHER
CRN	CRANE
CT	COOLING TOWER
CTF	CENTRIFUGE
CU	CONDENSING UNIT
CV	CONTROL VALVE
CVR	FLOATING COVER
CYL	CYLINDER
DIS	DISTRIBUTOR
DPR	DAMPER
DS	DISCONNECT SWITCH
DU	DRIVE UNIT
E	ENGINE
EB	ENGINE BLOWER MODULE
ED	EQUIPMENT DRAIN
EF	EXHAUST FAN
EPR	EVAPORATOR
F	FAN
FAR	FLAME ARRESTER
FCT	FERRIC CHLORIDE TANK
FLT	FILTER
FPU	FLUID POWER UNIT
FT	FOG TANK
FUR	FURNACE
GBT	GRAVITY BELT THICKENER
GDR	GRINDER
GEN	GENERATOR
GT	GATE
H	HOIST
HEX	HEAT EXCHANGER
HOP	HYDRAULIC OPERATOR
HP	HEAT PUMP
HPU	HYDRAULIC POWER UNIT
HTR	HEATER
HTT	HEAT TRACE TAPE
HV	HAND OPERATED VALVE
INJ	INJECTOR
IW	INJECTION WELL
LCP	LOCAL CONTROL PANEL
LVR	LOUVER
M	MOTOR
MME	MISC. MECHANICAL EQUIPMENT
MOP	MOTOR OPERATOR
MSP	MOTOR STARTER PANEL
MUX	MULTIPLEXER
MX	MIXER
MZ	MULTIZONE UNIT
ORT	ODOR REMOVAL TOWER
P	PUMP
PC PRIMARY	PROCESS OR PERSONAL COMPUTER OR CLARIFIER
PLC	PROGRAMMABLE LOGIC CONTROLLER
POP	PNEUMATIC OPERATOR
PRV	PRESSURE/VACUUM RELIEF VALVE OR PRESSURE REGULATING VALVE
PVL	PRESSURE VESSEL
RAD	RADIATOR
REC	RECEIVER
SC	SECONDARY CLARIFIER
SCR	SCRUBBER
SEP	SEPARATOR
SF	SUPPLY FAN
SFP	SLUDGE FEED PUMP
SLG	SLIDE GATE
SLR	SILENCER
SMP	SAMPLER
ST	STEAM TRAP
STDP	STANDPIPE
STN	STRAINER
STP	SEDIMENT TRAP
SUB	SUBSTATION
SWBD	SWITCHBOARD
T	TANK
TBN	TURBINE
TCV VALVE	TEMPERATURE CONTROL
TFR	TRANSFORMER
TM	TIMER
TRP	TRAP
TRS	TRANSFER SWITCH
TSP	THICKENED SLUDGE PUMP
UH	UNIT HEATER
VE	VESSEL
VEN	VENTILATOR
VP	VACUUM PUMP
WCC	WATER CONTROL CABINET
WGB	WASTE GAS BURNER
WH	WATER HEATER
WHR	WASHER
WSR	WATER SOFTENER UNIT

GENERAL ABBREVIATIONS

A	AMPERE OR AERATOR
AB	AERATION BASIN
ABAND	ABANDONED
ACC	AIR CONDITION COIL
ACU	AIR CONDITIONING UNIT
AD	AIR DRYER
ADJ	ADJUSTABLE
AF	AIR FILTER
AFD	ADJUSTABLE FREQUENCY DRIVE
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AHC	AIR HANDLING UNIT W/COIL
AHU	AIR HANDLING UNIT
AL	ALUMINUM
APPROX	APPROXIMATE
ASC	ADJUSTABLE SPEED CONTROL
ASD	ADJUSTABLE SPEED DRIVE
ASPH	ASPHALT
ASR	AQUIFER SURFACE RECHARGE
ASSOC	ASSOCIATION
ASTM	AMERICAN SOCIETY OF TESTING MATERIALS
ATS	AUTOMATIC TRANSFER SWITCH
AUTO	AUTOMATIC
AUX	AUXILIARY
AVG	AVERAGE
AWG	AMERICAN WIRE GAGE
B	BLOWER
BC	BOTTOM OF CURB
BEL	BELOW
BF	BLIND FLANGE
BFPF	BELT FILTER PRESS FILTRATE
BFPV	BACKFLOW PREVENTER
BFV	BUTTERFLY VALVE
BHP	BRAKE HORSEPOWER
BK	BACK
BL	BASE LINE
BLDG	BUILDING
BLR	BOILER
BM	BENCH MARK
BNR	BURNER
BOT	BOTTOM
BRG	BEARING
BRK	BRICK
BT	BACKWASH TANK OR BATCH TANK
BTDPS	BATCH TANK DISCHARGE PUMP STATION
BUS	BIOGAS UPGRADE SYSTEM
BV	BALL VALVE
C	CELSIUS OR COIL
CAB	CABINET
CATV	CABLE TELEVISION
CB	CATCH BASIN
CC	CENTER TO CENTER
CCT	CHLORINE CONTACT TANK
CDR	CONDENSER
CE	CONSTRUCTION EASEMENT
CF	CUBIC FOOT
CFM	CUBIC FEET PER MINUTE
CFR	CHEMICAL FEEDER
C&G	CURB AND GUTTER
CHAN	CHANNEL
CHR	CHILLER
CI	CAST IRON
CIR	CIRCLE
CIRCUM	CIRCUMFERANCE
CJ	CONSTRUCTION JOINT
CL	CENTERLINE OR CLASS
CLG	CEILING
CLR	CLEAR
CMU	CONCRETE MASONRY UNITS
CO	CLEANOUT
COL	COLUMN OR COLLECTOR
COM	COMMINUTOR
COMB	COMBINED
CON	CONVEYOR
CONC	CONCRETE / CONCENTRIC
CP	COMPRESSOR OR COMPUTED POINT
CPLG	COUPLING
CR	CRANE
CS	COMBINED SEWER
CT	CURRENT TRANSFORMER
CTF	CENTRIFUGE
CTG	COATING
CULV	CULVERT
CYL	CYLINDER
D1	DIGESTER 1
D1PS	DIGESTER 1 DISCHARGE PUMP STATION
D1RPS	DIGESTER 1 RECYCLE PUMP STATION
D2	DIGESTER 2
D2PS	DIGESTER 2 DISCHARGE PUMP STATION
D3	DIGESTER 3
D3PS	DIGESTER 3 DISCHARGE PUMP STATION
DB	DUCT BANK
DC	DIRECT CURRENT
DEMO	DEMOLITION / DEMOLISH
DEPT	DEPARTMENT
DI	DROP INLET
DIA	DIAMETER
DIAG	DIAGONAL
DIM	DIMENSION
DIS	DISTRIBUTOR
DPR	DAMPER
DS	DISCONNECT SWITCH
DU	DRIVE UNIT
DWG	DRAWING
DWL	DOWEL
DWY	DRIVEWAY
E	EAST OR ENGINE
EA	EACH
EB	ENGINE BLOWER MODULE
ECC	ECCENTRIC
ECF	EQUIPMENT CONNECTION FITTING
ED	EQUIPMENT DRAIN
EF	EACH FACE
EL	ELEVATION
ELEC	ELECTRICAL / ELECTRIC
ELEV	ELEVATION
EMH	ELECTRICAL MANHOLE
ENGR	ENGINEER
EOP	EDGE OF PAVEMENT
EPR	EVAPORATOR
EPS	EFFLUENT PUMP STATION
EQ	EQUAL
EQUIP	EQUIPMENT
ES	ELECT3RICAL SERVICE
ESMT	EASEMENT
EW	EACH WAY
EST	ESTIMATE / ESTIMATED
EXIST	EXISTING
EXP	EXPANSION
EXT	EXTERIOR
EXIST	EXISTING
F	FAHRENHEIT OR FAN
FBW	FILTER BACKWASH
FC	FAIL CLOSED
FCO	FLOOR CLEANOUT
FCPS	FERRIC CHLORIDE PUMP STATION
FCT	FERRIC CHLORIDE TANK
FD	FLOOR DRAIN
F-F	FACE TO FACE
FFE	FINISH FLOOR ELEVATION
FG	FINISHED GRADE
FH	FIRE HYDRANT
FL	FLOW LINE
FLEX	FLEXIBLE
FLR	FLOOR
FLT	FILTER
FM	FORCEMAIN
FO	FAIL OPEN
FP&L	FLORIDA POWER & LIGHT
FPM	FEET PER MINUTE
FPS	FOG DISCHARGE PUMP STATION
FPU	FLUID POWER UNIT
FR/FPS	FOG RECYCLE FEED PUMP STATION
FSPS	FOAM SUPPRESSION PUMP STATION
FT	FEET / FOOT OR FOG TANK
FTP	FLAME TRAP
FUR	FURNACE
FURN	FURNISHED
G	GAS
GC	GRANITE CURB
GBFT	GRAVITY BELT THICKENER FILTRATE
GBV	GLOBE VALVE
GDR	GRINDER
GEN	GENERATOR
GFI	GROUND FAULT INTERRUPTER
GM	GAS METER
GPD	GALLONS PER DAY
GPM	GALLONS PER MINUTE
GR	GRADE
GRT	GROUT OR GRATE
GSKT	GASKET
GT	GATE
GV	GATE VALVE OR GAS VALVE
H	HIGH OR HOIST
HC	HEADER CURB
HGL	HYDRAULIC GRADE LINE
HGR	HANGER
HOA	HAND-OFF-AUTO
HOP	HYDRAULIC OPERATOR
HOR	HORIZONTAL
HP	HEAT PUMP OR HIGH POINT
HPU	HYDRAULIC POWER UNIT
HTR	HEATER
HTT	HEAT TRACE TAPE
HV	HAND OPERATED VALVE
HZ	HERTZ
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IN	INCH
INSUL	INSULATION
INV	INVERT
IPS	INFLUENT PUMP STATION
IW	INJECTION WELL
JB	JUNCTION BOX
JT	JOINT
JT FLR	JOINT FILLER
KW	KILOWATT
L	LENGTH
LB	POUND
LCP	LOCAL CONTROL PANEL
LF	LINEAR FEET
LOC	LOCATION
LP	LIGHT POLE / LIGHTING PANEL
LPNG	OPENING
LS	LIMIT SWITCH OR LIFT STATION
L/S	LANDSCAPE STRIP
LT	LEFT
M	MOTOR
MAS	MASONRY
MATL	MATERIAL
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTER
MECH	MECHANICAL
MFR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MH	MANHOLE
MIN	MINIMUM / MINUTE
MISC	MISCELLANEOUS
MON	MONUMENT
MOP	MOTOR OPERATOR
MPH	MILES PER HOUR
MSL	MEAN SEA LEVEL
MSP	MOTOR STARTER PANEL
MUX	MULTIPLEXER
MZ	MULTIZONE UNIT
N	NORTH
N/A	NOT APPLICABLE
NAVD	NATIONAL AMERICAN VERTICAL DATUM
N.C.	NORMALLY CLOSED
NE	NORTHEAST
NEC	NATIONAL ELECTRICAL CODE
NEG	NEGATIVE
NEUT	NEUTRAL
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NO	NUMBER
N.O.	NORMALLY OPEN
NOM	NOMINAL
NTS	NOT TO SCALE
NW	NORTHWEST
OA	OUTSIDE AIR
OD	OUTSIDE DIAMETER
OH	OVERHEAD
OHP	OVERHEAD POWER
OPER	OPERATOR
OPNG	OPENING
P	POWER
PAR	PARALLEL
PC	PROCESS OR PERSONAL COMPUTER OR PRIMARY CLARIFIER
PE-CS	PRIMARY EFFLUENT - CONTACT STABILIZATION
PE-SF	PRIMARY EFFLUENT - STEP FEED
PH	PHASE
PL	PROPERTY LINE
PLC	PROGRAMMABLE LOGIC CONTROLLER
PLT	PLANT
PLYWD	PLYWOOD
PNL	PANEL
POI	POINT OF INTERSECTION
POL	POLYMER
POP	PNEUMATIC OPERATOR
POT	POINT OF TANGENCY
PP	POWER POLE
PROP	PROPOSED
PRPS	PUBLIC REUSE PUMP STATION
PS	PUMP STATION
PSA	PRESSURE SWING ABSORPTION
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PT	POINT
PTS	PRELIMINARY TREATMENT STRUCTURE
PV	PLUG VALVE
PVL	PRESSURE VESSEL
PVMT	PAVEMENT
Q	FLOW
QTY	QUANTITY
R	RADIUS
R/W	RIGHT OF WAY
RA	RETURN AIR
RC	REINFORCED CONCRETE
RD	ROOF DRAIN
RE	RIM ELEVATION
REC	RECEIVER
REF	REFERENCE
REINF	REINFORCE / REINFORCED / REINFORCING
RP	REFERENCE POINT
REQD	REQUIRED
REV	REVISED OR REVISION
RPM	REVOLUTIONS PER MINUTE
RT	RIGHT
R/W	RIGHT OF WAY
S	SOUTH
SA	SUPPLY AIR
SAN	SANITARY
SB	SOIL BORING
SC	SECONDARY CLARIFIER
SCD	SCUPPER DRAIN
SCH	SCHEDULE
SCPS	SCUM PUMP STATION
SCR	SCREEN OR SCRUBBER
SD	STORM DRAIN OR SANITARY DRAIN
SE	SOUTHEAST OR SECONDARY EFFLUENT
SEC	SECTION
SEP	SEPARATOR
SHT	SHEET
SLR	SILENCER
SMP	SAMPLER
SPEC	SPECIFICATION
SSC	SECONDARY SCUM
SSK	SERVICE SINK
ST	STEAM TRAP OR STREET
STA	STATION
STD	STANDARD
STL	STEEL
STM	STEAM
STRUC	STRUCTURE / STRUCTURAL
STRW	STORAGE REJECT WATER
SUB	SUBSTATION
SV	SOLENOID VALVE
SW	SOUTHWEST OR SIDEWALK
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SWK	SIDEWALK
SYM	SYMMETRICAL
T	TELEPHONE
TBN	TURBINE
TC	TOP OF CURB
TCV	TEMPERATURE CONTROL VALVE
TEL	TELEPHONE
TEMP	TEMPORARY / TEMPERATURE
TFR	TRANSFORMER
TM	TIMER
T.O.	TOP OF
TP	TRAP PRIMER
TPS	TRANSFER PUMP STATION
TRS	TRANSFER SWITCH
TS	TEMPERATURE SWITCH
TYP	TYPICAL
TW	TOP OF WALL
UG	UNDERGROUND
UH	UNIT HEATER
US	UTILITY STATION
V	VOLTS OR VENT
VAC	VACUUM OR VOLT ALTERNATING CURRENT
VAR	VARIABLE / VARIES
VCP	VENDOR CONTROL PANEL
VE	VESSEL
VEL	VELOCITY
VEN	VENTILATOR
VERT	VERTICAL
VOL	VOLUME
VP	VACUUM PUMP
VTR	VENT THROUGH ROOF
W	WEST OR WIDTH
w.c.	WATER COLUMN
WCO	WALL CLEANOUT
W/	WITH
WM	WATER METER
W/O	WITHOUT
WB	WET BULB
WH	WATER HEATER
WHR	WASHER
WL	WATER LEVEL
WSR	WATER SOFTENER UNIT
WT	WATER TABLE
WV	WATER VALVE
XFMR	TRANSFORMER
XP	EXPLOSION PROOF
YCO	YARD CLEANOUT
YR	YEAR
ZS	POSITION SWITCH

Brown AND Caldwell
TAMPA, FLORIDA

SUBMITTED: ______ PROJECT MANAGER DATE
APPROVED: ______ BROWN AND CALDWELL DATE

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)

DESIGNED:	B ELEAZER
DRAWN:	T DIMICELI
CHECKED:	B ELEAZER
CHECKED:	G ANIPSITAKIS
APPROVED:	B ELEAZER

EXTERNAL REFERENCE FILES
144490-TBK-0000-01.dwg

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP.

CITY OF St. PETERSBURG
3800 54th AVE. S
St. PETERSBURG, FL. 33711

BIOSOLIDS IMPROVEMENTS
GUARANTEED MAXIMUM PRICE

GENERAL
ABBREVIATIONS

FILENAME	144490-G-00-04.dwg
BC PROJECT NUMBER	144490
CLIENT PROJECT NUMBER	13057-111
SHEET NUMBER	G-00-04
CITY DRAWING NUMBER	10938-4

SEPTEMBER 2015

Sep 18, 2015 - 3:04pm
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GENERAL NOTES:

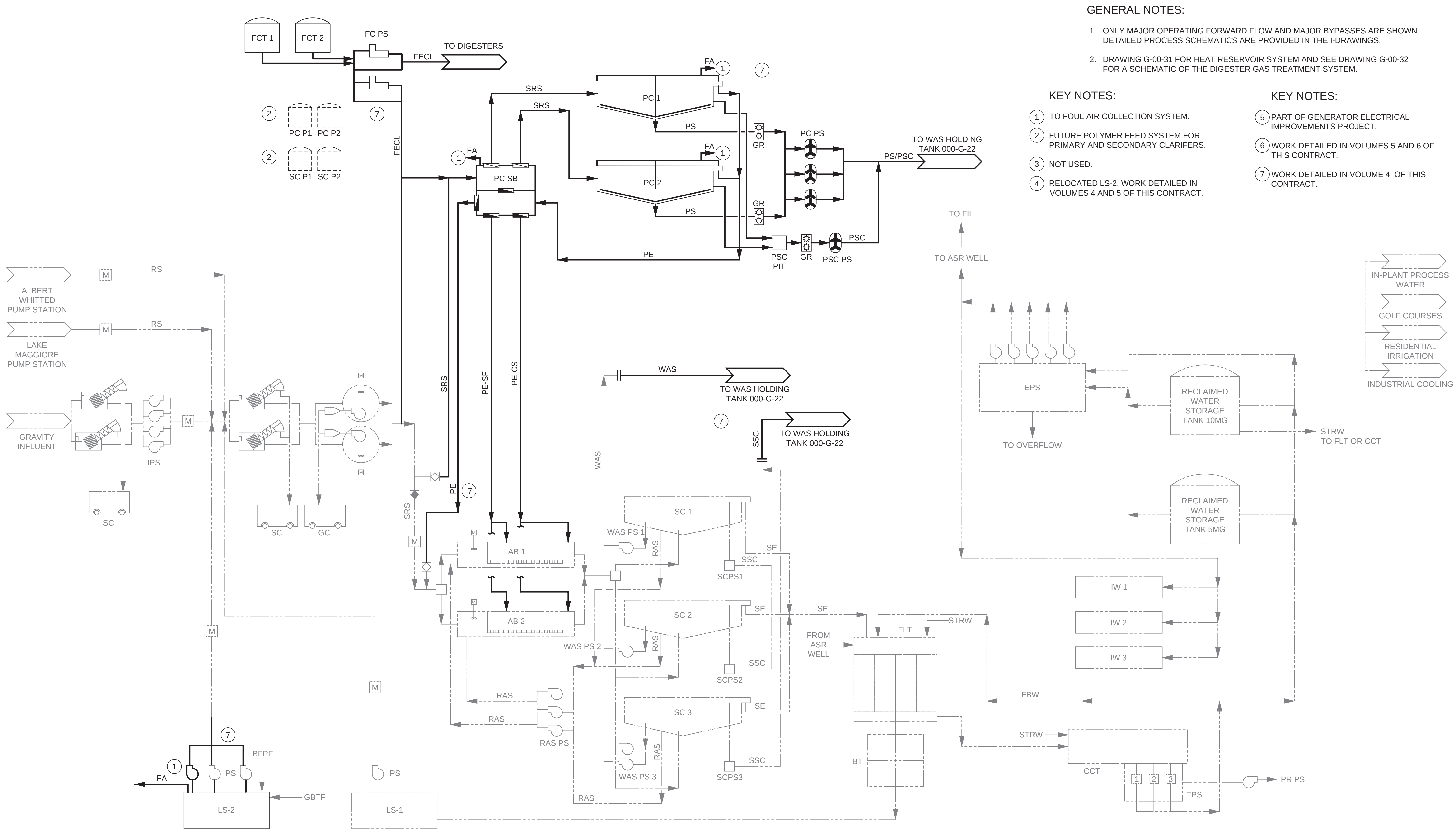
1. ONLY MAJOR OPERATING FORWARD FLOW AND MAJOR BYPASSES ARE SHOWN. DETAILED PROCESS SCHEMATICS ARE PROVIDED IN THE I-DRAWINGS.
2. DRAWING G-00-31 FOR HEAT RESERVOIR SYSTEM AND SEE DRAWING G-00-32 FOR A SCHEMATIC OF THE DIGESTER GAS TREATMENT SYSTEM.

KEY NOTES:

1. TO FOUL AIR COLLECTION SYSTEM.
2. FUTURE POLYMER FEED SYSTEM FOR PRIMARY AND SECONDARY CLARIFERS.
3. NOT USED.
4. RELOCATED LS-2. WORK DETAILED IN VOLUMES 4 AND 5 OF THIS CONTRACT.

KEY NOTES:

5. PART OF GENERATOR ELECTRICAL IMPROVEMENTS PROJECT.
6. WORK DETAILED IN VOLUMES 5 AND 6 OF THIS CONTRACT.
7. WORK DETAILED IN VOLUME 4 OF THIS CONTRACT.



Brown AND Caldwell TAMPA, FLORIDA	LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)	EXTERNAL REFERENCE FILES 144490-TBK-0000-01.dwg
SUBMITTED: ____ PROJECT MANAGER DATE	DESIGNED: B ELEAZER	
APPROVED: ____ BROWN AND CALDWELL DATE	DRAWN: T DIMICELI	
	CHECKED: B ELEAZER	
	CHECKED: G ANIPSITAKIS	
	APPROVED: B ELEAZER	

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP.

CITY OF St. PETERSBURG
3800 54th AVE. S
St. PETERSBURG, FL. 33711

BIOSOLIDS IMPROVEMENTS

GUARANTEED MAXIMUM PRICE

GENERAL

NEW PROCESS FLOW DIAGRAM 1

FILENAME 144490-G-00-21.dwg
BC PROJECT NUMBER 144490
CLIENT PROJECT NUMBER 13057-111
SHEET NUMBER G-00-21
CITY DRAWING NUMBER 10938-10

SEPTEMBER 2015

Sep 18, 2015 - 3:05pm
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